Conceptual Design Report

Proton - Proton Collider Upgrade (Main Injector, New Tevatron)

Project No. 90-CH-400

Technical Components and Civil Construction

May 1988

Fermi National Accelerator Laboratory

Batavia, Illinois

Operated By Universities Research Association Inc.

Under Contract with the United States Department of Energy

Fermilab

Fermi National Accelerator Laboratory
P.O. Box 500 • Batavia, Illinois • 60510

PROTON-PROTON COLLIDER UPGRADE
(NEW MAIN INJECTOR, NEW TEVATRON)

May 27, 1988

PROTON-PROTON COLLIDER UPGRADE
(New Main Injector, New Tevatron)

CONCEPTUAL DESIGN REPORT

MAY 27, 1988

CONTENTS **Page**

1. INTRODUCTION AND OVERVIEW

1.1 Scope of the Project

This project includes the removal of the old Fermilab Main Ring and reassembly of many of its components in a new enclosure to form a new Main Injector, and construction of a second superconducting synchrotron in the existing Tevatron enclosure.

The primary purpose of the project is to maintain the growth in physics output of the Fermilab collider program by converting to proton-proton collisions at higher luminosity than that realizable in the proton-antiproton mode.

The Fermilab site is shown in Figure 1-1. The large circle outlines the subsurface tunnel housing two proton synchrotrons, the original Main Ring that was commissioned in 1972 and the superconducting Tevatron that was brought into operation in 1983.

The smaller oval at the left side of the Figure represents the new Main Injector. Insofar as possible, the technical components of the Main Injector will be taken from the Main Ring. In particular, the magnets that fill most of the circumference of the accelerator will be entirely provided by dissassembly of the old synchrotron.

A plan view of the Main Injector Layout is shown in larger scale in Figure 1-2. The principal surface features are the earth berm covering the some 10,000 foot tunnel, circumferential roads and cooling ponds, and 10 service buildings situated along the berm. The service buildings house power supplies, controls and diagnostic equipment, and heat exchangers. One of the service buildings includes provision for major vehicle and equipment access to the subsurface enclosure.

The point of tangency between the two enclosures contains equipment necessary to transfer protons from the Main Injector to either the old or the new superconducting synchrotron, radiofrequency accelerating systems for all three rings, extraction from the Main Injector for antiproton production, the primary extraction septum in the Tevatron, and one of the injection lines to the Main Injector. While most of the technical components to carry out these functions are already in hand, expansion of the Radiofrequency Building is needed to provide space for this centralization of accelerator functions and is included in this project.

A cross section of the existing Tevatron enclosure is shown in Figure 1-3, with the Main Ring above the Tevatron. The Main Ring will be replaced by a second superconducting ring, as shown in Figure 1-4. The cross section of the Main Injector enclosure is illustrated in Figure 1-5.

In view of the existance of many of the technical components, the dominant costs in the Main Injector portion of the project are associated with conventional construction and installation. The reverse is the case in the new Tevatron portion of the project, where little conventional contruction is required and costs are dominated by the magnets of a new superconducting synchrotron.

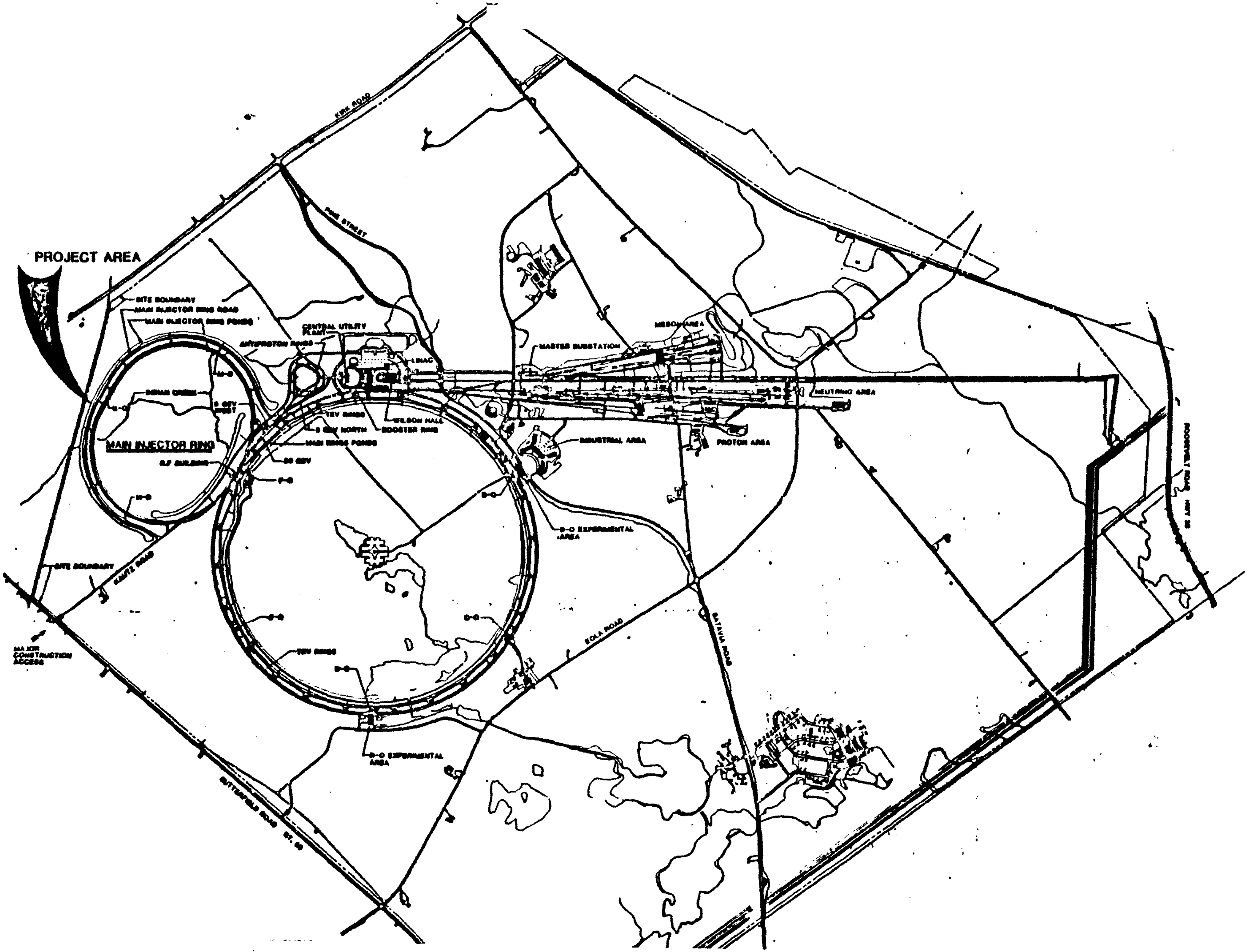


Figure 1-1. Fermilab site, including new Main Injector.

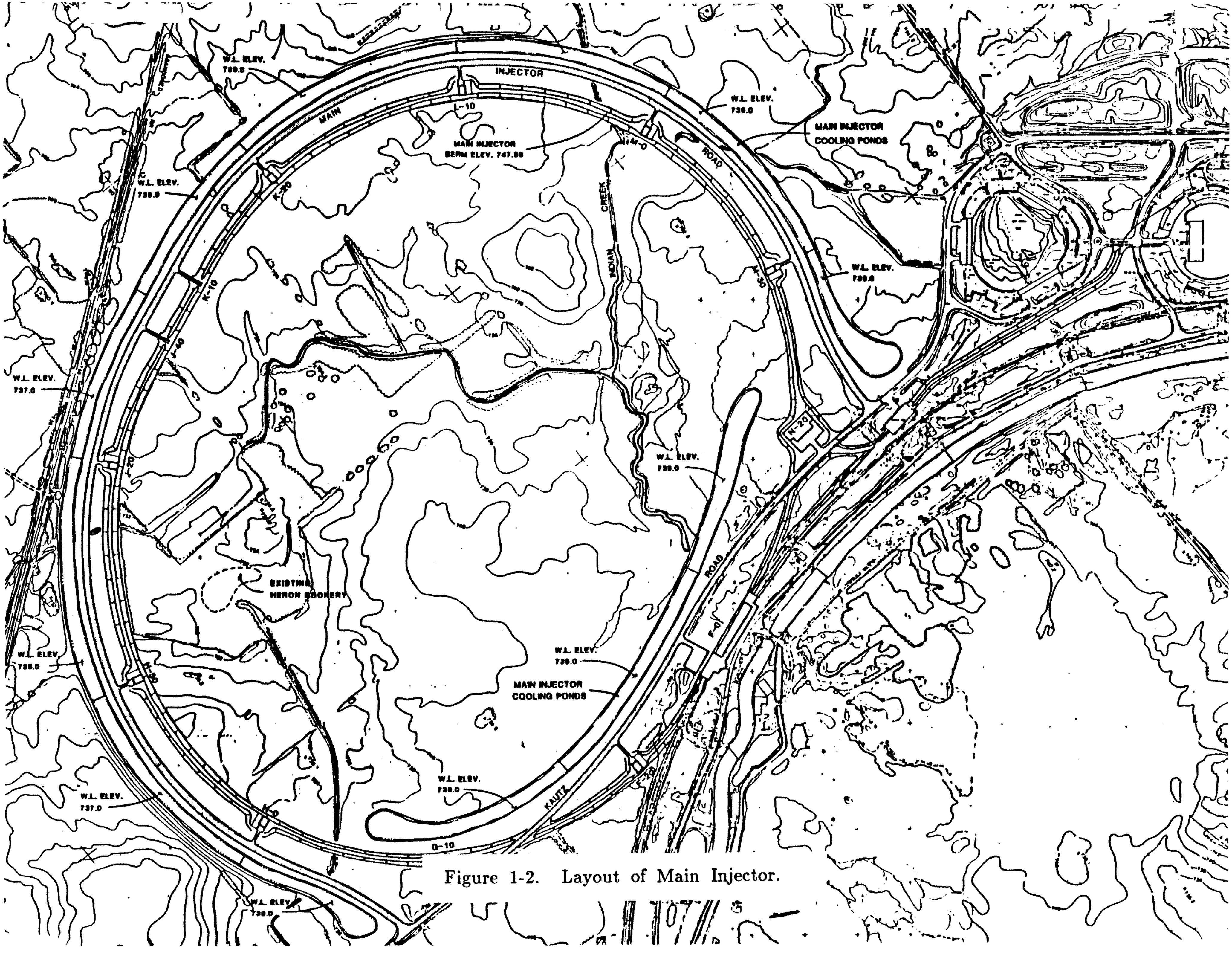


Figure 1-2. Layout of Main Injector.

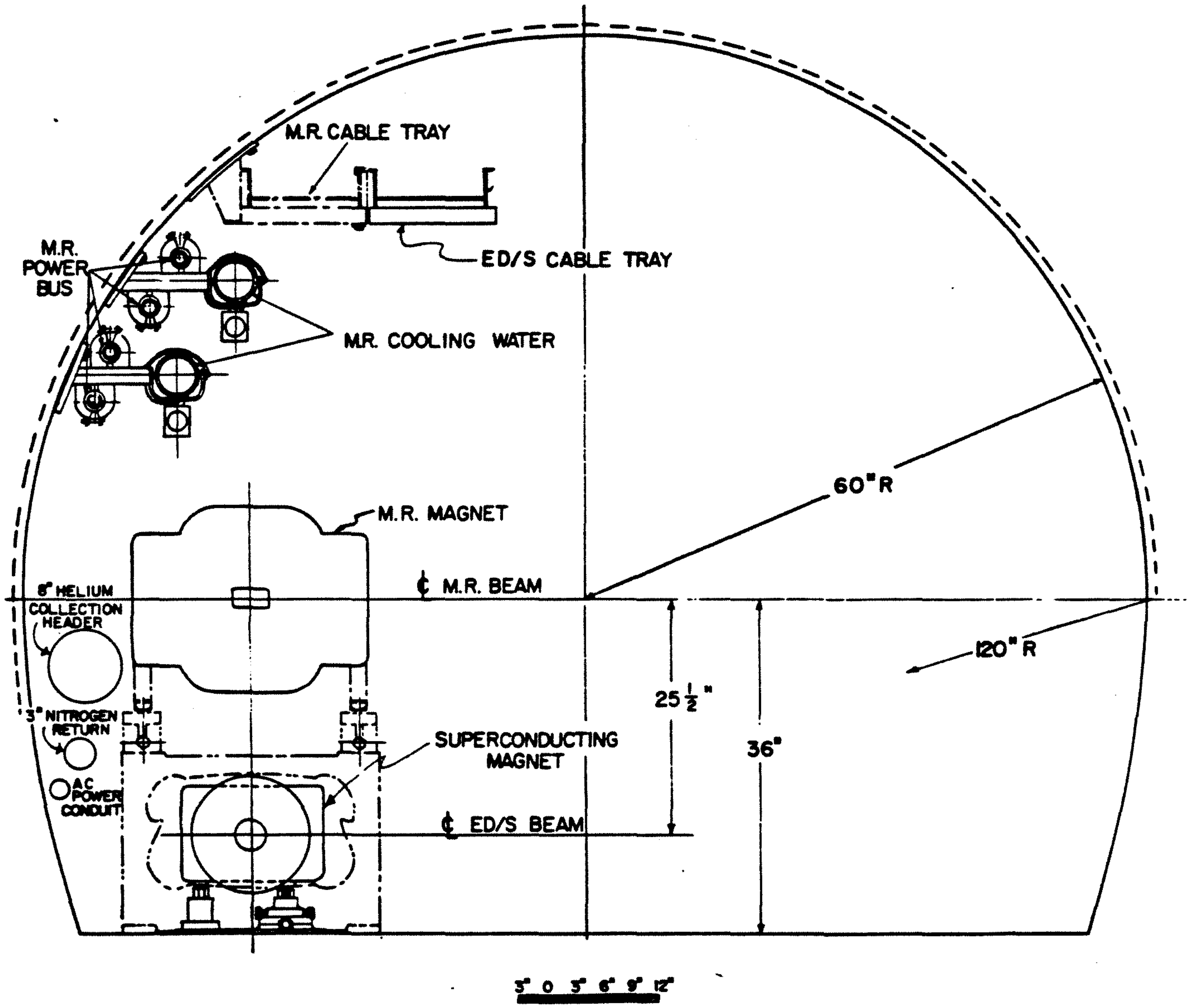


Figure 1-3. Cross section of present Tevatron enclosure.

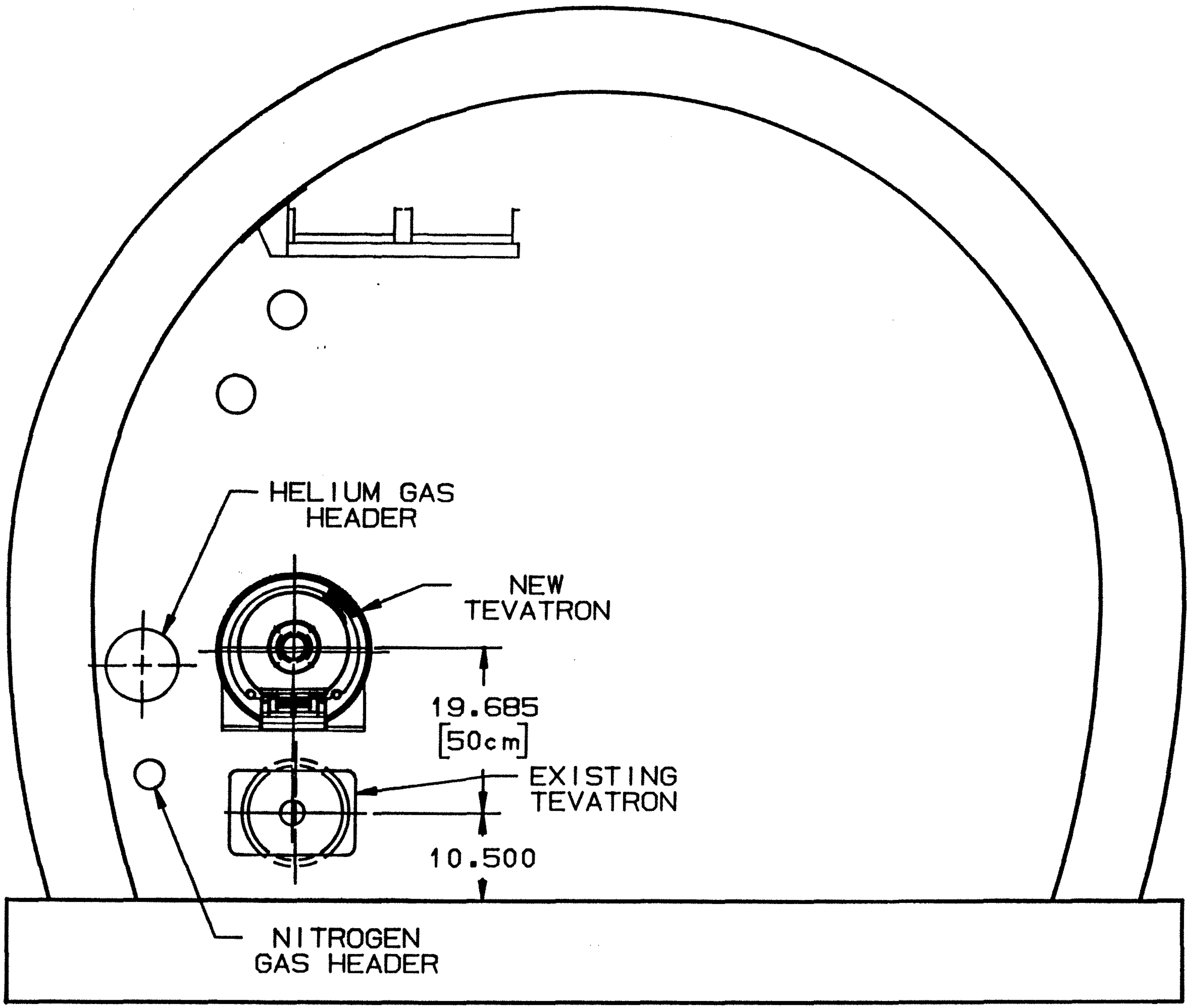


Figure 1-4. Cross section of Tevatron enclosure including Tevatron B.

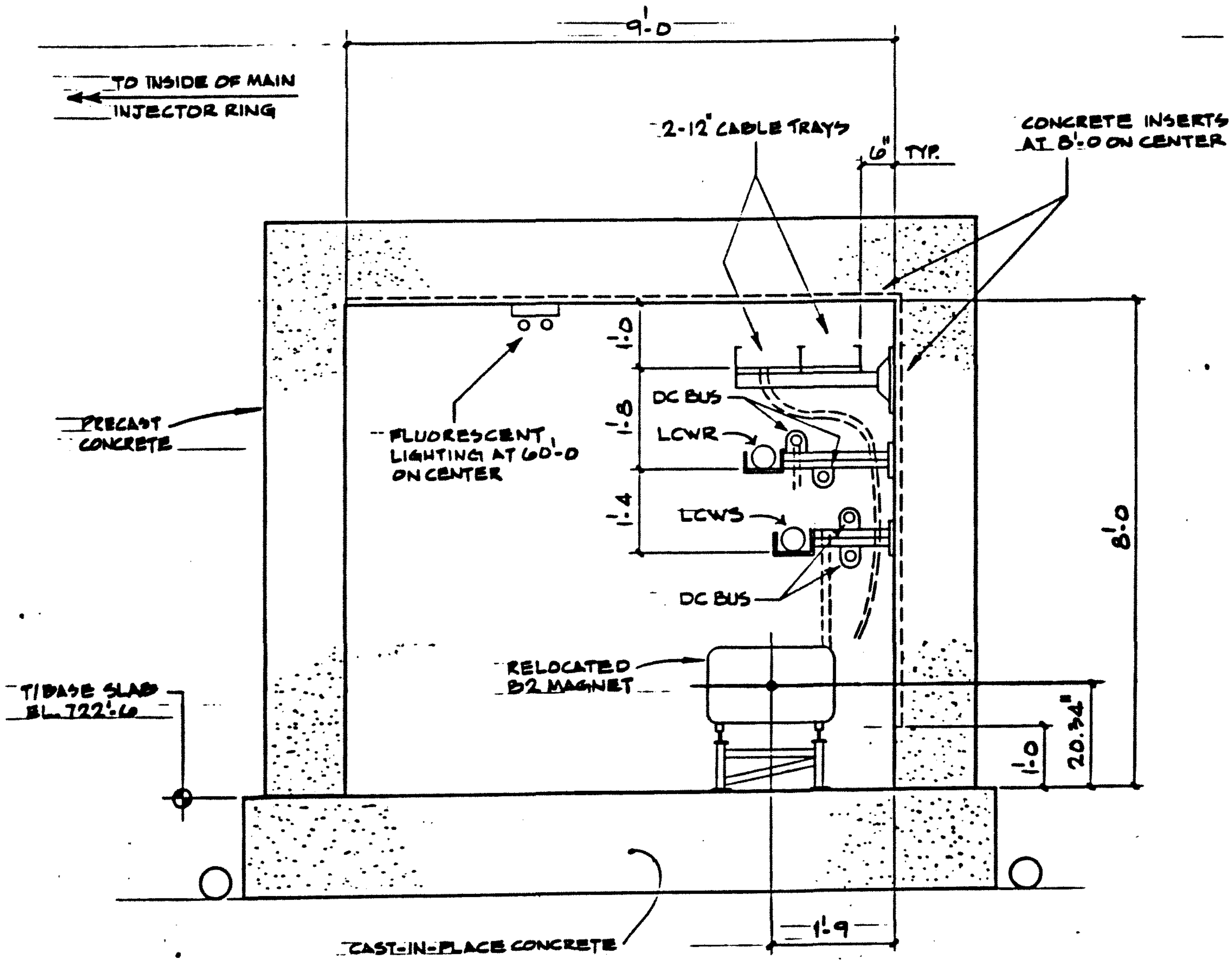


Figure 1-5. Typical cross section of new Main Injector Enclosure.

In addition to its complement of superconducting magnets, the second Tevatron will require non-magnetic cryogenic components associated with the liquid helium cooling system, quench protection system, a beam abort system, and duplication of the instrumentation of the present accelerator. The magnets for the new ring have been designed so that major additions to the refrigeration plant will not be required, nor are additional power supplies required for its excitation.

Beamlines are provided for injection into the Main Injector from the Booster synchrotron, and for targetting of protons from the Main Injector for antiproton production. To perform its role as injector into the two superconducting rings, the Main Injector must accelerate in both the clockwise and counterclockwise sense, and so two injection lines lead to it from the Booster. The layout of the beamlines is shown in Figure 1-6.

While some technical components are available for beamline construction from the present facility, significant numbers of new magnets and other components are required. Both conventional construction and technical components contribute in like measure to the cost of this phase of the project.

The resulting distribution of facility functions is summarized in Figure 1-7. It should be noted that one long straight section - that which is labeled E0 - is free of equipment and could be developed as a colliding beams interaction point at a later stage. No provision for producing collisions at E0 is included in the present project description. For comparison, the present distribution of accelerator functions is shown in Figure 1-8. Table 1-1 lists the enclosures and buildings in the project.

Table 1-1 Enclosures and Buildings

Item	Description
Main Injector Enclosure	9' wide 8' high 10010' long
8 GeV North Beam Enclosure	8' wide 8' high 1325' long
8 GeV West Beam Enclosure	9' wide 8' high 510' long
120 Gev Beam Enclosure	9' wide 8.5' high 680' long
Beam Transfer Area Enclosure	22.5' wide 8' high 690' long
Standard Service Building (9)	30'x50' 10' interior height
N-20 Hatch Building	50'x150' High Bay Area
	30'x100' Service Area
Radiofrequency Building Addition	10,400sf (irregular dimensions)
Main Injector Kicker Bldgs (2)	20'x20'
Tevatron B Abort Kicker Bldg	15'x20'

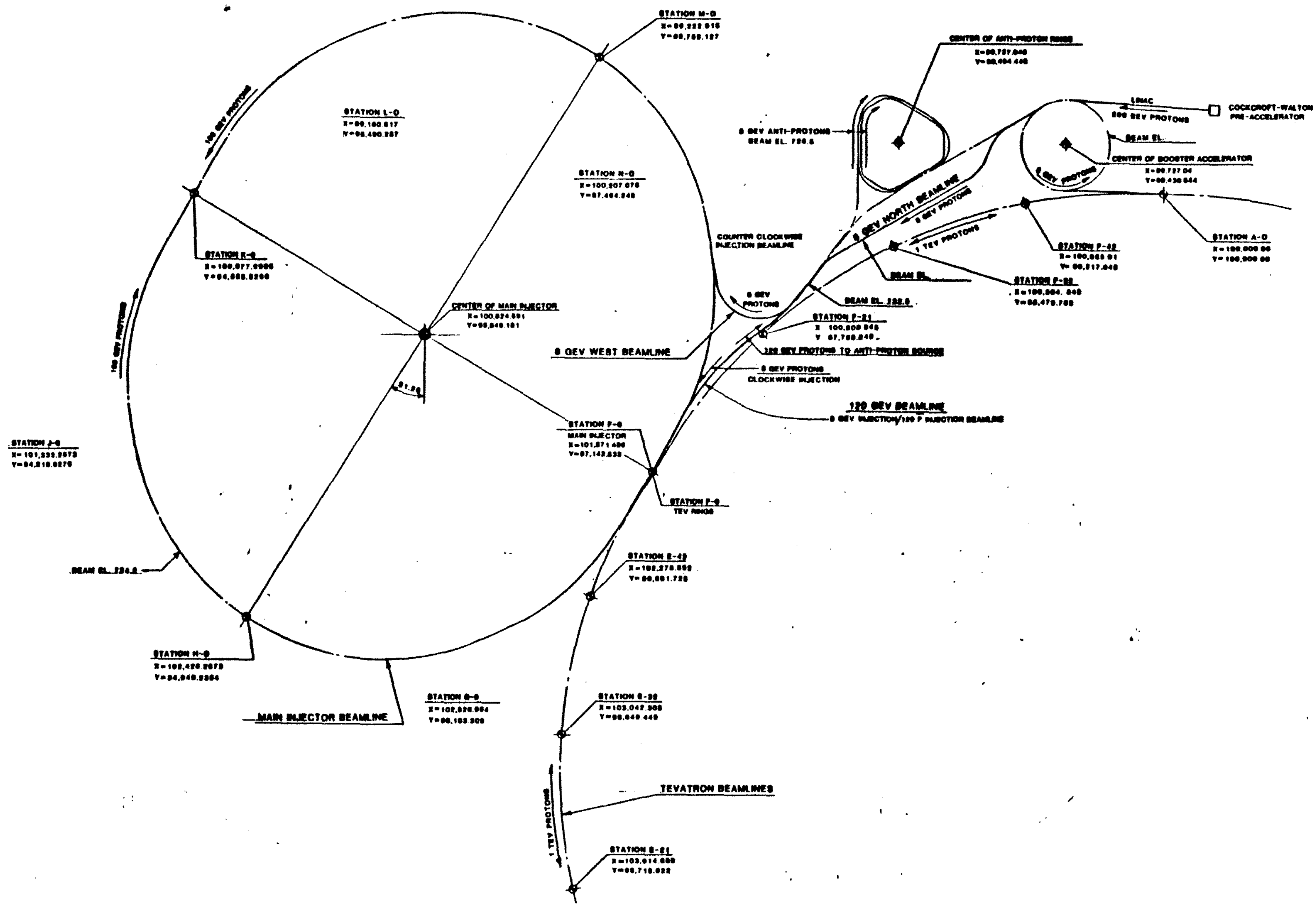


Figure 1-6. Layout of synchrotrons and interconnecting beamlines.

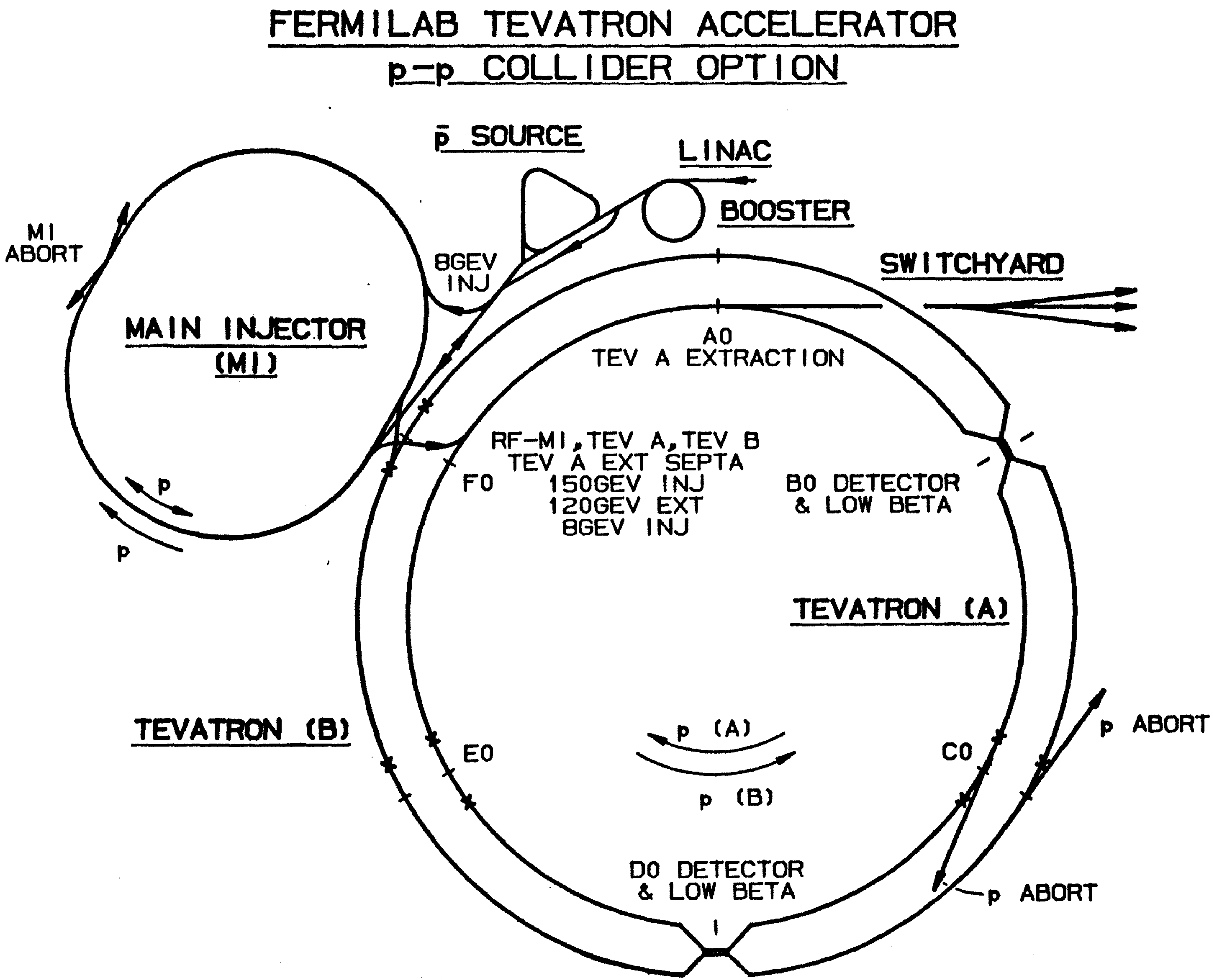


Figure 1-7. Accelerator facility functions upon project completion.

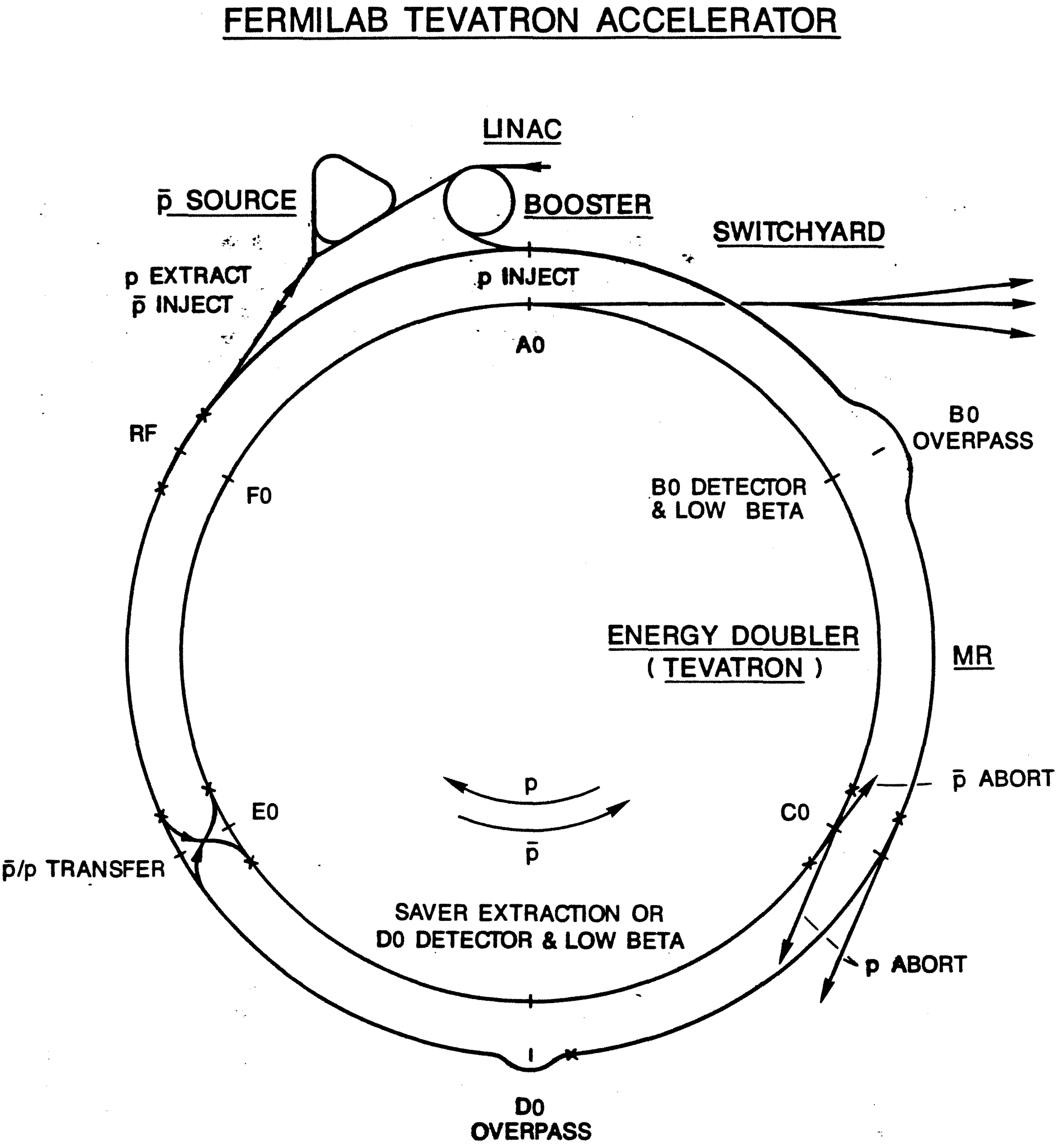


Figure 1-8. Present distribution of accelerator facility functions.

1.2 Role in the Upgrade Program

A luminosity upgrade of the Tevatron Collider is required in the pre-SSC era, if the measurement potential of the two major detector facilities is to be realized. At present, the proton-antiproton mode is used, in which the two particle species collide in a single superconducting synchrotron. The Upgrade Program calls for a luminosity e-folding time of 1-1/2 to 2 years.

The early stages of this program will be carried out within the proton-antiproton context. Implementation of a new interaction region optics design for both the B0 and D0 detectors is underway. Beam separators will be installed in the Tevatron to permit operation with more bunches. In the Antiproton Source, a number of improvements will be undertaken in order to increase the antiproton production rate by about a factor of 3 by ~FY91. In a separate proposal, plans have been put forward for an increase in the Linac energy from 200 MeV to 400 MeV, with an anticipated increase in antiproton production rate by a factor of 1.7, with attendant benefits for the fixed target program.

As a result of the steps sketched in the preceding paragraph, the luminosity will gradually increase through the next three collider runs, reaching the $5 \cdot 10^{30}$ $cm^{-2} sec^{-1}$ level by 1993. By that time, the first major physics run with the D0 detector will have been carried out.

Further luminosity increase via the antiproton route is possible, but requires further capital construction and is technologically exacting. The preferred route to higher luminosity is through conversion to proton-proton physics. Though more costly, in that a second superconducting synchrotron is needed, it offers the avenue for growth to the very high luminosity regime.

Thus, the proposal that is outlined in this report is the final phase of the Fermilab Collider Upgrade, offering the prospect of high luminosity hadron-hadron collisions in the mid-1990's as the pre-SSC era draws to a close.

1.3 Performance

In this section, we present the basic estimate for the luminosity in proton-proton collisions at Fermilab. The fashion in which the beams are brought together will be described in a later section.

In contrast to the situation with antiprotons, there is no shortage of protons, so in the proton-proton collider it is natural to design from the outset for the many-bunch case. In particular, with the present 53 MHz frequency of the acceleration system, we consider some 1000 bunches in each ring, spaced at 6 m intervals. The beams must then cross at an angle, in order to avoid additional collisions in the neighborhood of the interation point. The required crossing angle can be estimated as follows.

A beam separation at "near misses" of five times the standard deviation, σ, of the bunch transverse dimension has been found to be adequate in SPS operation with separated beams. In the proximity of the interaction point, between optical elements, then the beam centroid separation, d, is

$$d = 5\sigma = z\alpha .$$

Here, α is the crossing angle and z is the distance from the interaction point. For sufficiently small β^*, the value of the amplitude function at the interaction point, the approximation

$$\beta(z) = \beta^* + \frac{z^2}{\beta^*} \simeq \frac{z^2}{\beta^*}$$

can be used. With this approximation, the standard deviation, σ, as a function of distance from the crossing becomes

$$\sigma = \left(\frac{\beta\epsilon}{6\pi\gamma}\right)^{1/2} \simeq z\left(\frac{\epsilon}{6\pi\gamma\beta^*}\right)^{1/2} = z\,\sigma'^*$$

where ϵ is the normalized 95% emittance, γ is the Lorentz factor, and σ' is the standard deviation of the angular distribution. Combination of the expressions above leads to the conclusion that

$$\alpha = 5\sigma'^* ,$$

that is, the crossing angle is just five times the characteristic angle that beam particles make with repect to their centroid trajectory at the interaction point.

With the completion of the Linac Upgrade, a normalized emittance of 6π mm-mrad will be available at bunch intensities comparable to present operation. At $\beta^* = 1/4$ meter and $\gamma = 1000$,

$$\sigma^* = 16\ \mu\mathrm{m}$$
$$\sigma'^* = 63\ \mu\mathrm{rad}$$

and so

$$\alpha \simeq 1/3\ \mathrm{mrad}.$$

The finite crossing angle diminishes the luminosity from the value for head-on collisions by the factor

$$h(\alpha) = [\ 1 + (\alpha\sigma_z/2\sigma)^2\ ]^{1/2}$$

where σ_z is the rms bunch length. If the latter quantity is taken to be 0.1 m, then the two terms within the brackets of h(z) are equal, and the luminosity reduction is just $\sqrt{2}$ due to the crossing angle.

The expression for the luminosity is

$$L = f\frac{n^2}{4\pi\sigma^2}\frac{1}{h}$$

where f is the frequency of collisions and n is the number of particles per bunch. If there are 1000 bunches in each ring, each containing $1.4 \bullet 10^{10}$ protons, then

$$L = 2.0 \bullet 10^{32} \ /cm^2/sec$$

This figure sets the luminosity scale; it is not intended to be an estimate of the maximum possible luminosity achievable in time. The number of particles per bunch available at present is about 50% larger at injection into the Main Ring as it is today. While the new Main Injector is expected to have better performance than today's version, in arriving at the basic luminosity estimate we allow for substantial particle loss and emittance dilution.

1.4 Outline of This Report

The next three sections describe the design approach to the technical features of the project. In the case of the Main Injector, although the principal components are those of the Main Ring, it is possible to reassemble them so as to anticipate improved performance. Since the Main Injector will be just over half the circumference of the Tevatrons, two acceleration cycles of the former will be required to fill either superconducting ring. It is assumed that some antiproton production capability will be still be required when this project is completed, but not at the level of the requirements of the present program, so Main Injector power is limited accordingly.

The section on Beam Lines and Beam Transfers covers the lines themselves, the complex at the point of tangency of the Main Injector and the Tevatron enclosure, and magnet and power supply issues. The concentration of accelerator utilities in the F0 region requires more free space than that of either the original Main Ring or the Tevatron. In the Main Injector, the additional space can be produced rather easily, since the constraints of an existing enclosure are absent. In both the old and new superconducting rings, the space must be produced by introducing higher field bending magnets.

Higher field magnets are also required in the neighborhood of the collision points, as described in the section on the New Tevatron. The major technical components of this project - the new superconducting magnets - are also described here. That the new cryogenic load is compatible with the existing plant is the conclusion of an analysis presented in this section. The experience gained in the Tevatron design and construction regarding power supplies and quench protection, vacuum, and beam abort will be used in the corresponding systems of the new synchrotron.

Conventional construction is described in Section 5. As noted earlier, practically all of the conventional construction is associated with the Main Injector, its beam lines, and in the region where transfers are made between the Main Injector and the Tevatrons. The only conventional construction associated with the remainder of the Tevatron enclosure is a new beam abort line, beam dump, anda small building for the abort kicker magnet power supply.

The final two sections contain the cost estimate and discussion of its methodology, followed by a schedule and identification of major project milestones. The schedule is developed in the assumption that funding will be made with a profile consistent with a one-year shutdown starting at the beginning of calendar year 1993. In this picture, high energy physics would resume at Fermilab in early calendar 1994.

Appendices include the Schedule 44, the Validation Checklist, and a set of conventional construction drawings, some of which have been used to provide figures in earlier text

This introduction concludes with Tables 1-2 through 1-4 giving brief parameter lists for the collider program, the Main Injector, and the new Tevatron repectively.

Table 1-2 Collider Parameters

Number of Interaction Regions	2	
Free Space at IR	± 7.5	m
Transverse Emittance (Normalized)	6π	mm-mrad
β^*	0.25	m
Number of bunches	996	
Protons per bunch	$1.4\ 10^{10}$	
Crossing angle	1/3	mrad
Luminosity reduction due to above	$\sqrt{2}$	
Nominal Luminosity	$2.0\ 10^{32}$	$cm^{-2}sec^{-1}$
Interaction Rate at 100 mb	20	MHz
Interactions per bunch crossing	0.2	

Table 1-3 Main Injector Parameter List

Circumference	3263.311	meters
Injection Energy	8.9	GeV
Peak Energy	150.0	GeV
Harmonic Number (@53 MHz)	578	
Horizontal Tune	22.4-22.6	
Vertical Tune	22.4-22.6	
Transition Gamma	20.3	
Number of Bunches	498	
Protons/Bunch	2.0 e10	
Transverse Emittance (Normalized)	6π	mm-mr
Longitudinal Emittance/Bunch	.25	eV-sec
Transverse Acceptance (At 8 GeV)	40π	mm-mr
Momentum Acceptance	2.0	%
β max (Arcs)	57.0	meters
β max (Straights)	143.0	meters
Maximum Dispersion	2.2	meters
Number of Straight Sections	2	
Length of Standard Cell	34.0	meters
Phase advance of Cell	90	degrees
RF Frequency (Injection)	52.8	MHz
RF Frequency (Extraction)	53.0	MHz
RF Voltage	2	MV
Synchronous Phase (Max)	56	degrees
Number of dipoles in Standard Cell	2	
Number of Dipoles	320	
Dipole Length	6.0706	meters
Dipole Field (Max)	16.18	kGauss
Number of 7' Quadrupoles	184	
Number of 4' Quadrupoles	4	

Table 1-4 New Tevatron Parameter List

Circumference	6283	meters
Injection Energy	150	GeV
Peak Energy	1000.0	GeV
Harmonic Number (@53 MHz)	1113	
Horizontal Tune	20.6	
Vertical Tune	20.6	
Transition Gamma	18.4	
Number of Bunches	996	
Protons/Bunch	2.0 e10	
Transverse Emittance (Normalized)	6 π	mm-mr
Longitudinal Emittance/Bunch	.25	eV-sec
β^*	0.25	meters
β_{max}(Arcs)	100.0	meters
β_{max} (IR at Injection)	280.0	meters
β_{max} (IR at Low-β)	1650.0	meters
Maximum Dispersion	9	meters
Number of Straight Sections	6	
Number of Possible Interaction Regions	3	
Length of Standard Cell	59.4	meters
Phase advance of Cell	68	degrees
RF Frequency	53.0	MHz
RF Voltage	1	MV
Number of dipoles in Standard Cell	6	
Dipole Field (Max)	4.4/6.6	Tesla
Number of 4.4 Tesla Dipoles	507 + 37	
Number of 6.6 Tesla Dipoles	46	
Dipole Length	up to 8.5	meters
Number of Standard Quadrupoles	180	
Number of Quads in Non-crossing Straight	28	
Number of IR Quadrupoles	30	
Number of Special Length Quadrupoles	28	
Number of Vertical Crossing Magnets	12	

MAGNET MODIFICATIONS TO OLD TEVATRON:

Number of 6.6 Tesla Dipoles	44

2. THE MAIN INJECTOR

The design of the Main Injector (MI) is driven by two criteria. First, the circumference should be about half that of the superconducting machines so that each is filled, either for colliding operation or for fixed target operation, by two cycles from the MI. Secondly, the MI is to be built from existing Main Ring components. This includes not only the dipoles, but also explicitly means that the existing quadrupoles with the attached cradles will be used without modification. These two criteria, along with the additional criteria that a 90° cell has been chosen, fix both the approximate machine circumference, and the exact cell length.

The present Main Ring lattice is made of FODO cells with four dipoles between the quadrupoles. Two of these dipoles are constructed with a 1.5 inch vertical by 5.0 inch horizontal aperture. These are refered to as B1 dipoles and are placed nearest the horizontally focusing quadrupoles. The other two have a 2.0 inch vertical by 4.0 inch horizontal aperture, are referred to as B2 dipoles, and are placed near the vertically focusing quadrupoles. The MI will use only the B2 dipoles from the existing Main Ring. This choice is justified for several reasons. One is that recent magnet measurements have shown that the B1 magnet field quality is much worse when considering systematic higher order multipoles. At present, these high order systematics are believed to be a major contributor to the reduced dynamic aperture the Main Ring exhibits at 8 Gev. Thus although the B1 magnets have more physical aperture in the horizontal dimension than the B2 dipoles, the field in that region of B1 magnets is of poor enough quality to lead to eventual beam loss and therefore not be useful. Furthermore, since the injection field in the MI is more than twice what it is in the present Main Ring, even the multipole content of the B2 dipoles will be improved over what it is at present. As a result of this improved field quality and the restoration of the accelerator to a planar geometry significantly enhanced performance is expected from the Main Injector as compared to the existing Main Ring.

2.1 Lattice

The lattice of the MI is based on the 90° FODO cell shown in Figure 2-1. In contrast with the existing Main Ring only two dipoles (B2s) are interspersed between quadrupole pairs. The interelement spacing is the same as in the present Main Ring so that the length of the half cell is shorter by the length of two dipoles and the short drift spaces which follow them. Because of the shorter circumference, there are less than half as many dipoles as in the present Main Ring. This leads to higher fields in the dipoles, and also leads to a larger bending angle in each. The resulting sagitta (the amount of aperature in each magnet that will be used up by the bending of the beam) is .59 inch. For this reason the remainder of the design parameters have been chosen to minimize the beam size. The 90° phase advance per cell was chosen resulting in a maximum beta function in the cells of 58 meters and a maximum dispersion in cells of 2.0 meters. Thus the beam size due to transverse emittance will be only 70% of what it is presently, and the maximum beam size due to momentum spread will be down by a factor of three from what it is in the present Main Ring. There are locations in the present Main Ring where, to accomodate overpass magnets, two of the normal dipoles have been replaced by one running at double strength. The sagitta in this case is .48 inches, so the proposed sagitta for the MI is not unlike conditions which presently exist.

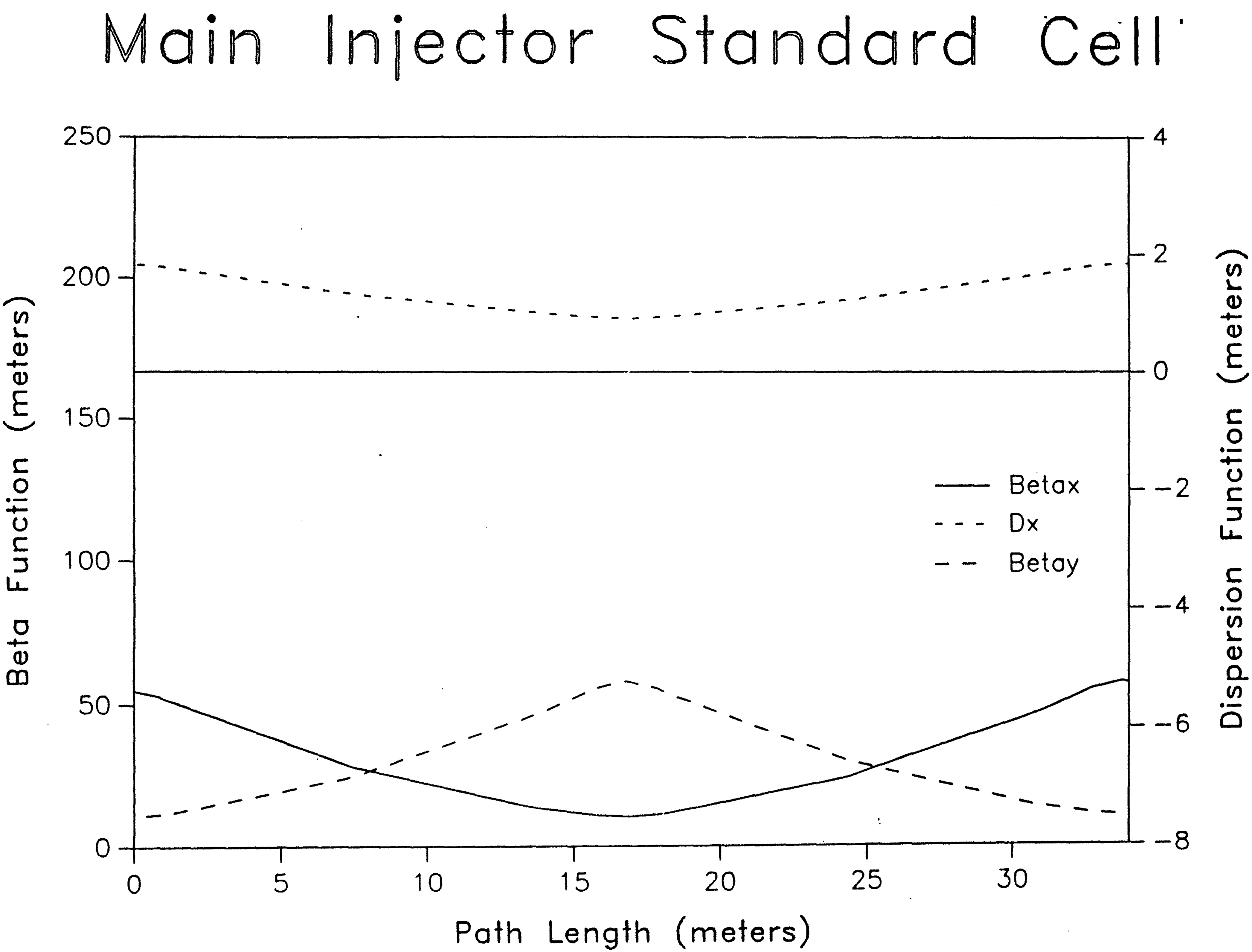


Figure 2-1: Main Injector standard FODO cell.

Two types of straight sections have been designed for the MI. The long straight, which is needed for 150 GeV extraction, was designed using matching quadrupoles. A solution was found that provides sufficient straight section length, and is made of existing quadrupoles. The main matching quadrupoles run at the same strength as the cell quadrupoles, and therefore can be on the same bus. Two of the Main Ring four foot quadrupoles are also needed at each long straight. These run at low current and will have to be powered separately. The long straight section insertion is dispersion matched to the cells by the removal of one dipole in each of the four cells nearest the insertion. In addition to providing the dispersion match this free space can be used for beam transfer kickers which in general will now be 90^{o} from the transfer points, a situation the present Main Ring lattice does not provide. The lattice functions for one half of the Main Injector are shown in Figure 2-2 and the entire "SYNCH" listing for the lattice can be found in Appendix C.

A second type of straight section is provided by omitting dipoles in the arcs of the ring. Pairs of dipoles separated by 180^{o} are omitted leaving the dispersion matched. This straight section is provided for the injection of counterclockwise rotating 8.9 GeV/c beam.

In order to provide beam for both of the counter rotating superconducting machines, the MI will have to accelerate protons in both directions. This means that the dipole field will be reversable. For purposes of injection matching into the superconducting machines the quadrupoles will not be reversed. This implies that the focusing nature of all quadrupoles in the MI will change roles. Since all dipoles will be of the B2 variety this has no impact on the lattice per se. The aperture everywhere is 2 inches by 4 inches and does not undulate in size as does the present Main Ring aperture. The primary impact of the lattice swapping rests on the beam position detection and correction schemes which are discussed in the next section.

2.2 Beam Position Detectors

New beam position detectors will be built for the MI. The present horizontal detectors in the Main Ring would not be acceptable because their aperture is the same as the B1 style dipole, 1.5 inches by 5 inches. Due to the lattice swapping the locations at which a horizontal position would normally be measured will move to the other set of quadrupoles. The same is of course true for the vertical detectors. The new detectors will have pickups for both horizontal and vertical positions so that either position is available at every quadrupole. Only one set of pickups will be available at any given time with a controllable switch in the tunnel selecting which pickup signal is sent upstairs.

2.3 Orbit Correction Schemes

The correction dipoles and correction schemes for the MI are complicated only by the problem of lattice swapping. In keeping with the goal of using existing Main Ring hardware as much as possible the assumption is made that no new correction elements will be built.

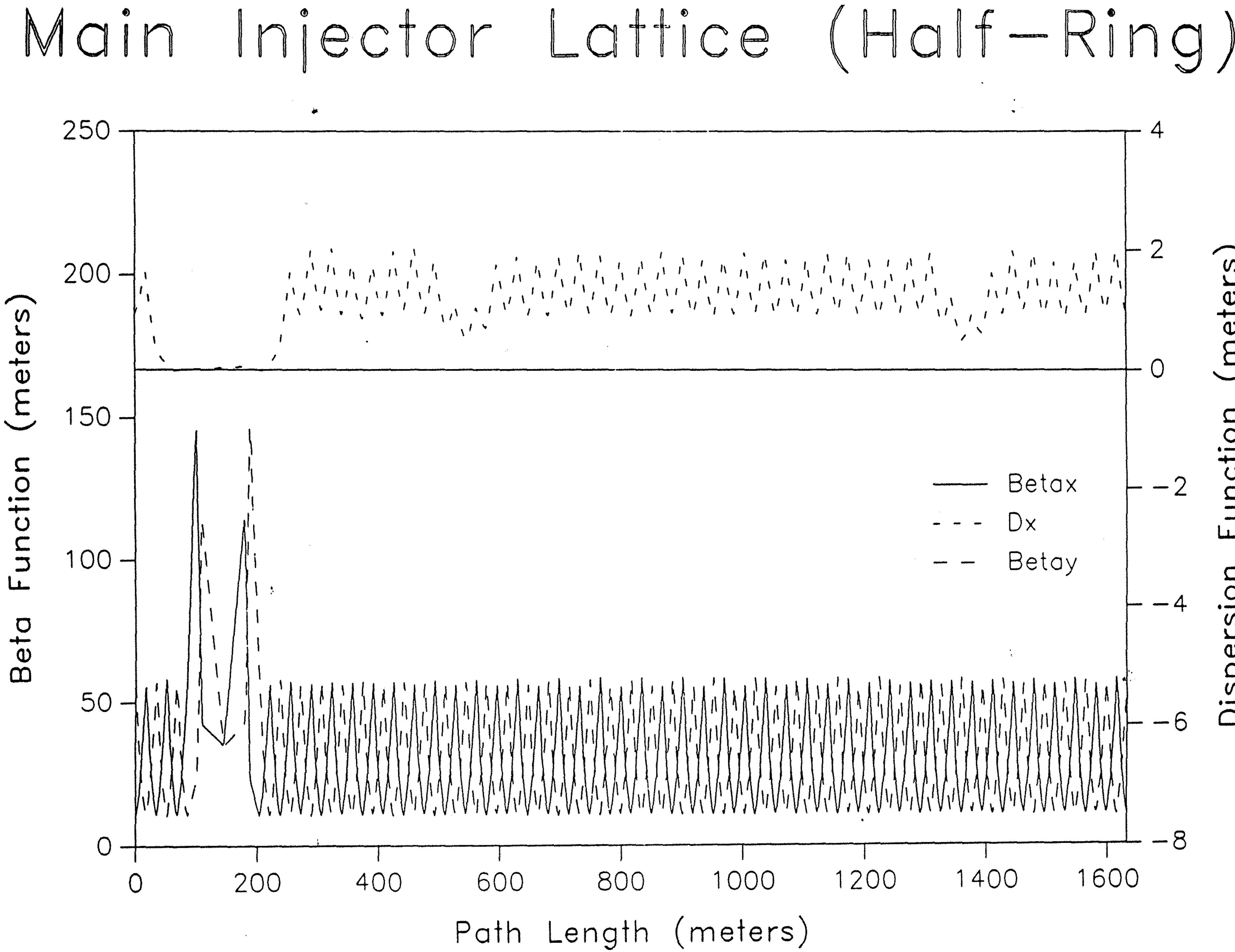


Figure 2-2: Main Injector lattice functions. One half of the total circumference of the ring is shown.

Therefore there are not enough correction elements to put both types of correctors at every quadrupole. For the remainder or this section we will assume that there is a natural lattice in the MI, that is one which has horizontal correctors at horizontally focusing quadrupoles and vertical correctors at vertically focusing quadrupoles. This will correspond to beam rotating counterclockwise. It is in this direction that the MI will operate to inject into the existing Tevatron for fixed target physics or collider physics, to provide 120 GeV for antiproton production, for machine commisioning, and for most machine studies. The only operation in the clockwise direction will be for loading the new superconducting ring or studies supporting that role. Thus the terminology is adopted refering to the natural lattice and the swapped lattice.

When operating with the natural lattice, beam position correction is straight forward. The only changes from the present Main Ring configuration is that the horizontal correction elements will have to have spacers inserted so that they can fit over the 2 inch beam pipe. This will reduce their strength to 75% of what it is at present. Analysis has shown that this amount of correction is sufficient to handle the anticipated orbit errors. All machine commissioning will be done with the machine in its natural lattice configuration. In particular, fine alignment of quadrupoles will be done with the objective of not only good high field orbits, but the additional objective of minimal corrector currents at low field. Thus when the lattice is swapped, the correction elements (which are now at a very low beta location, 12 meters) will have sufficient range available for correcting what is primarily the difference in the machine in the two configurations. For instance the remanent random dipole in the B2 magnets may be different with the current flowing in opposite directions. Analysis has shown that as long as the RMS of the distribution of differences is on the order of 1 or 2 gauss the present correction elements and power supplies are adaquate. Magnet measurements looking for this particular parameterization have not been made, but it is known that the remanent dipole in a B2 is on the order of 12 gauss.

2.4 RF System

The accelerating RF voltage for the MI will be provided by nine of the eighteen existing Main Ring cavities. Space is available near the long straight at F0 for these cavities. Due to the shorter circumference of the MI this number of cavities can provide the same rate of acceleration as in the present Main Ring.

2.5 Power Supply Systems

The Main Injector power supply system has been designed to ramp the magnet system from an injection level of 8 GEV to a 150 GEV excitation at a repetition rate adequate to meet beam injection requirements for the collider. The new power system uses major components from the present Main Ring system. These include 30 rectifier power supplies, the pulse power substation transformer, harmonic correction system, existing feeder cable ducts and many smaller items. New equipment will be added to reverse the dipole current to allow injecting either direction into the collider.

A summary of the Main Injector power supply requirements is given in Table 2-1. Power supply spacing for a minimum voltage to ground requires an equal number of magnets between power supplies on the dipole bus. The proposed system will have ten service buildings with two dipole supplies per building. The buildings are spaced so that there are 16 dipole magnets between each supply, with the magnets on a folded bus loop. There is a third supply in each of the ten buildings; four of these are in series with the focussing quadrupole magnet bus, four are similarly used with the defocussing quadrupole bus and two additional supplies are used in other systems.

Table 2-1: Main Injector Power Supply Requirements

	Power Supplies	Voltage	Current
Bend	20	850	2800 RMS
Quad F	4	850	2800 RMS
Quad D	4	850	2800 RMS
Other Equipment Needed			
Reversing switches	20		
Quad regulator	2	300	500 amps
Regulation			
Transductors	4		5000 amps
Bend-Quads	2		400 amps
Computer link	1		
Harmonic filter	1		

Criteria for Ramp and Power Supply Layout

The first for the power system is to use as much of the existing equipment as possible in the new Main Injector. Use of existing power distribution equipment sets the upper limit on the available power that can be delivered to the new ring. The cable ducts installed in the Main Ring currently have space for 5 new 13.8 kv feeder cables. Choosing four of the ducts for the Main Injector and one to supply the beam lines sets the upper power limit for the new injector at 1200 amps RMS in its feeders, with 300 amps of pulse power available for the beam lines. The next large item to consider in the power distribution system is the main pulse power transformer at the master substation. This is a 66 MVA power distribution transformer which is designed to run at 300 MVA peak. For reliable operation we will limit the peak power to less than 120 MVA.

Ramp Construction Upper Limits

The upper limit on ramp rate-of-rise is 120 GEV/sec due to the RF system capabilities. The use of twenty supplies on the dipole bus further limits the rate of rise at high currents; the 20 supplies give a total bus voltage of 17,000 volts, which yields the limits described below. The maximum ramp repetition rate is set by the 1200 Amp feeder current limit.

The impedance of the magnet load in the new injector dipole bus is 2.42 henries and, with the use of existing copper bus from the Main Ring, 2.4 ohms. The dipole configuration will be two bus's with a fold at the F0 location allowing for 10 upper bus supplies and 10 lower bus supplies. Each quadrupole magnet loop's impedance is .116 henries and, with the use of main ring bus, .44 ohms. The quadrupole configuration will be two separate buses in continuous loops around the injector, one focusing and one defocusing, each having four supplies for ramping and a transistor regulator supply for injection current regulation. With twenty power supplies on the dipole bus, the ramp rate of rise will need to decrease above 82 gev from 120 gev/s to 100 gev/s and at 146 gev to 80 gev/s. This lower rate will slightly increase the RMS current in the feeders. The feeder current limit sets the maximum repetition rate to seven seconds for a 150 GEV ramp. Power requirements for the 150 GeV ramp are given in Table 2-2 and the ramp is shown in Figure 2-3.

The closest two ramps can be spaced together will be 3.4 seconds, with a repetition rate of 14 seconds. This means that the injector will be able to supply two beam pulses 3.4 seconds apart every 14 seconds to the main accelerators. In the 8 seconds between pulse pairs the injector will be able to reverse the direction of current in the dipole bus for setup of injection into the other main accelerator.

Table 2-2: 150 GeV Ramp with a 7 Second Repetition Rate. Currents are rms values.

	Ramp Power	Feeder Current	Peak MVA	Peak Power	Current
Bend	5.9 MW	913.33 A	77.7	69.7 MW	1569.0 A
Quad ea.	1.1 MW	156.54 A	11.9	8.9 MW	1569.0 A
Totals	8.1 MW	1226.41 A	101.5	87.5 MW	

Antiproton Stacking Rate

For antiproton production the system described above will allow the same ramp and supplies on each of the quadrupole buses. The ramp is shown in Figure 2-4 and the power load given in Table 2-3.

Table 2-3: 120 GeV Antiproton Production Ramp with a 3 Second Repetition Rate. Currents are rms values.

	Ramp Power	Feeder Current	Peak MVA	Peak Power	Current
Bend	7.2 MW	903.24 A	49.4	24.0 MW	1729.6 A
Quad ea.	1.3 MW	126.13 A	6.4	2.9 MW	1729.6 A
Totals	9.8 MW	1155.50 A	62.2	29.8 MW	

For short periods of time a faster ramp can be run by using all the available dipole power supplies. This ramp consists of a .1 second injection time and a .116 second flat top time with a 2.2 second repetition rate. The RMS feeder current for this cycle time is in excess of the four feeder, 1200 amp, design submitted for the new injector. The peak MVA on the main transformer is still less than for the 150 GEV operation and the RMS bus current is still well below the 2800 amp rating of the power supplies.

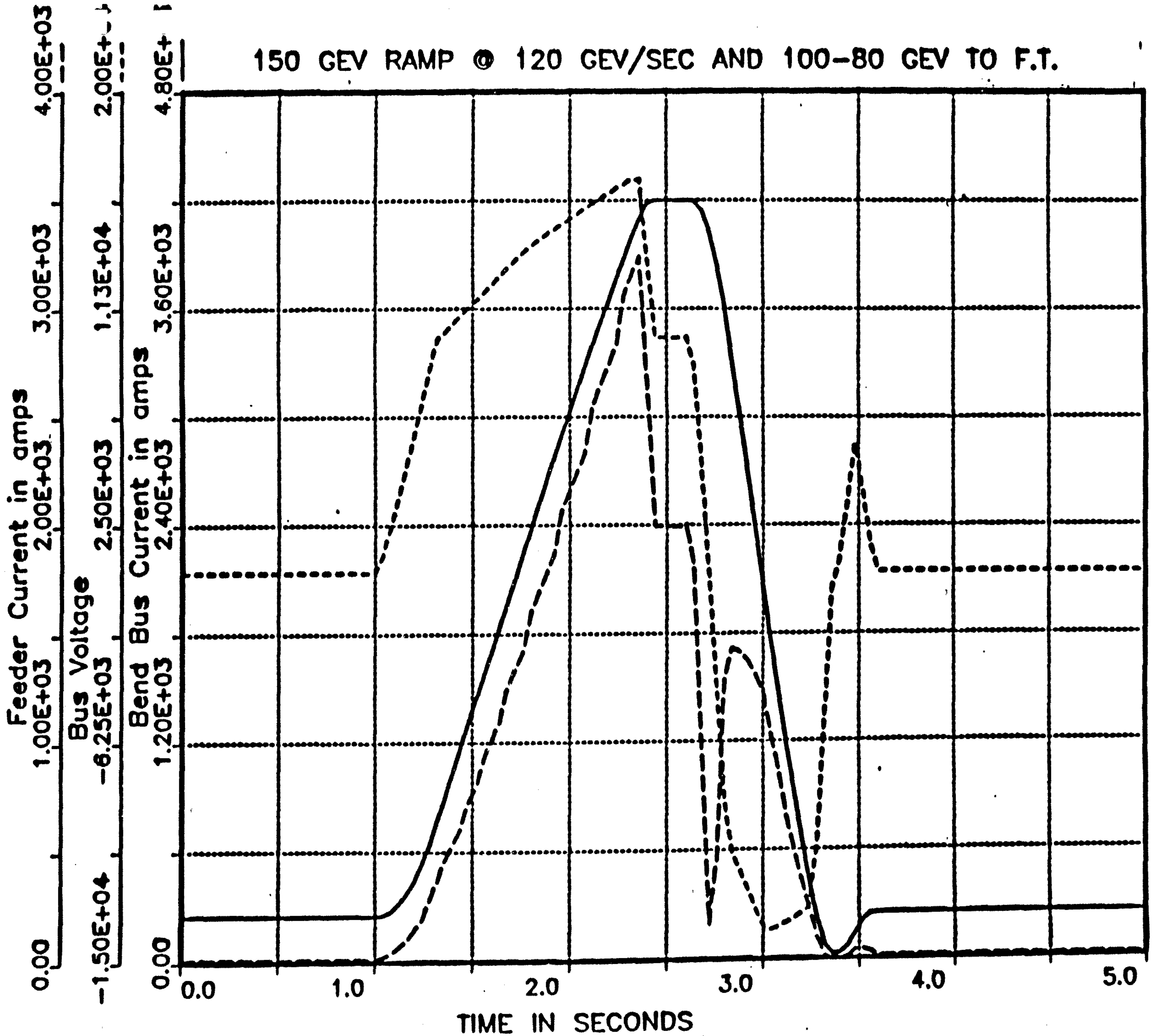


Figure 2-3: A 150 GeV ramp capable of being repeated every 7 seconds. The solid line is the dipole current and the dashed lines are the dipole bus voltage and feeder current.

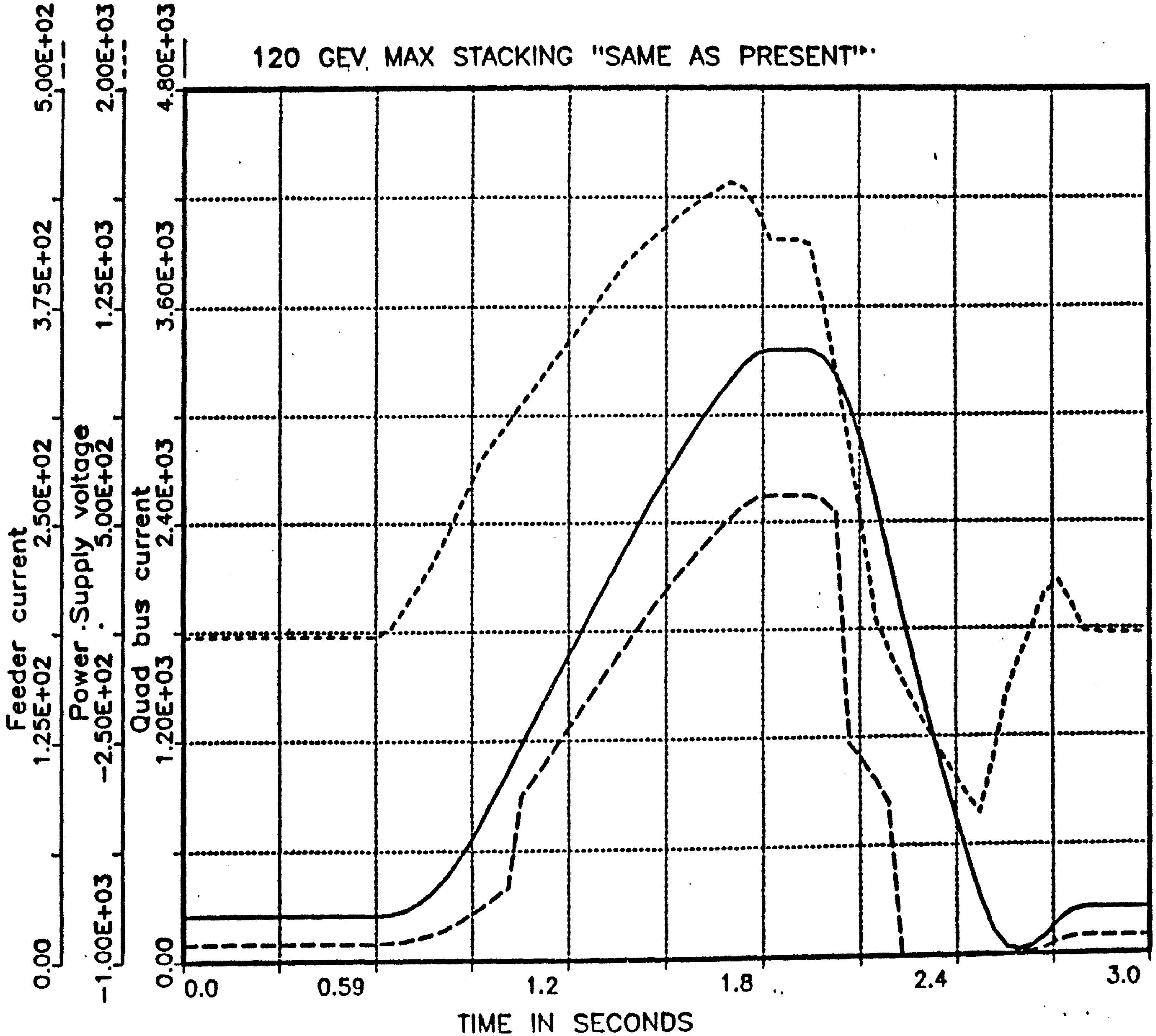


Figure 2-4: A 3 second 120 GeV ramp for antiproton production.

Power Feeder Loading

The main 13.8 KV power feeders have a usable limit of 300 amps RMS each. With the four cables called for in the installation of the new injector the total feeder current supplied to the ring will be 1200 amps. The power supplies around the ring will be supplied in a two feeder loop to ensure proper current sharing. Further details of the power distribution are given in Section 2-8.

The use of rectifier power supplies on this system draws current pulses from the feeders which then drive the harmonic resonances in the system causing higher voltages at the resonant frequencies to be imposed on the power equipment. The present Main Ring has an harmonic filter installed and operational to limit the peak voltages of higher frequencies superimposed on the 60 Hz line voltage. The Main Injector will run with the same number of power supplies at twice the current and will require the filter to damp twice the harmonic power it now has to. Therefore in the new injector design a second filter of the same size will be needed to correct for twice the harmonic driving force of the higher current injector. This new filter can be installed next to the existing system.

2.6 Abort Systems

The abort system for the Main Ring was totally redesigned in 1980-81. This new system was then implemented and has been functioning well since 1983. The abort system proposed here for the new Main Injector draws heavily on the ideas and technology of this Main Ring system, and, in fact, reuses nearly all of the hardware of the Main Ring system with the exception of the beam dump itself.

Briefly, it utilizes a fast-acting, single-turn extraction system that directs the beam to a beam dump external to the tunnel enclosing the ring. The system tracks the energy of the ring and is capable of aborting the beam anywhere in the 8.9-150 GeV/c range within about 50 μsec of the command. Full aperture kicker magnets with a peak field of 1.9 kG and a 1.5 μsec risetime are used as the first element in the system. The new Main Injector will normally be operated with at least a 1.5 μsec gap in the circulating beam to allow an extraction efficiency close to 100%.

Similar to the existing beam dump, the two new dumps will use a graphite core as the primary absorber; the maximum average power to the dump is ~35 kW. The specification for the dump is that it be capable of absorbing 1×10^{18} 150 GeV protons per year.

Abort System Geometry

In the Main Ring there are two 2.2 m-long kicker magnets located about 33 m upstream of a 51 m-long straight section: these magnets kick horizontally with an angle of 1.44 mrad resulting in a 44 mm displacement of the beam at the entrance to the Lambertson septum magnet, about 2.7 m into the long straight. A pair of 4.9 m-long Lambertsons then deflect the aborted beam downward so as to miss the quadrupole at the downstream end of the long straight section.

Given the constraints of using the same kicker and Lambertson magnets as in the Main Ring, an analogous solution adapted to the lattice of the new Main Injector is shown in Figure 2-5. Now, of course, there are two abort lines, one for the CCW operation of the ring and one for the CW operation. The minimum drift space between the Lambertson pairs (hence the maximum drift space between the last quadrupole and the Lambertson) is set by the vertical dimension of the Lambertson and the maximum bend angle of a pair of such magnets. The latter is determined by the maximum allowed power dissipation in the magnet coils; maximum dissipation occurs for the 120 GeV cycle with the 3 sec cycle time, which limits the bend angle to ~10 mrad. This allows an 11 m-long drift space before the Lambertsons. The 1.44 mrad kick is centered 12.8 m upstream of the long straight, just before the 7 ft F quadrupole. As a result of the kick, the aborted beam enters the long straight with a displacement of 15.8 mm and an angle of 2.19 mrad, hence by the time it reaches the septum 11 m downstream the aborted beam is separated by 40 mm from the closed orbit.

Figure 2-6 shows the cross section of the Lambertson magnet and the beam geometry at the entrance for 8.9 GeV/c. If the septum is made parallel to the aborted beam in the horizontal plane, then the closed orbit will move an additional 21 mm away from the septum at the exit from the Lambertsons.

The kicker magnet system requires relatively short cables (less than 25 m) between pulser and magnet, hence there will be two small kicker buildings (16 ft×14 ft) located on the berm directly above the kicker locations. The four Lambertson magnets will be connected in series and powered by the Transrex power supply that is used in the present Main Ring system; this supply would reside in the K-10 kicker building.

Beam Dumps

The location of the beam dumps is determined by the requirement that there be a 2 m transverse separation between the aborted beam and the closed orbit. This condition places the CCW dump 115 m from the center of the long straight and the CW dump 130 m as shown on Figure 2-5.

The dump structure is patterned after the existing Main Ring-Tevatron dump; taking into account beam energy and the maximum protons/year. A dump whose linear dimension is 0.8 times that of the existing dump will yield a similar acceptable level of soil activation. The condition of a maximum muon dose of 10 mRem/yr to ground level personnel requires an 8 m overburden of earth directly above the dump. Depending on the precise local topology, this may require adding a modest 2.5 m-high berm above the dump.

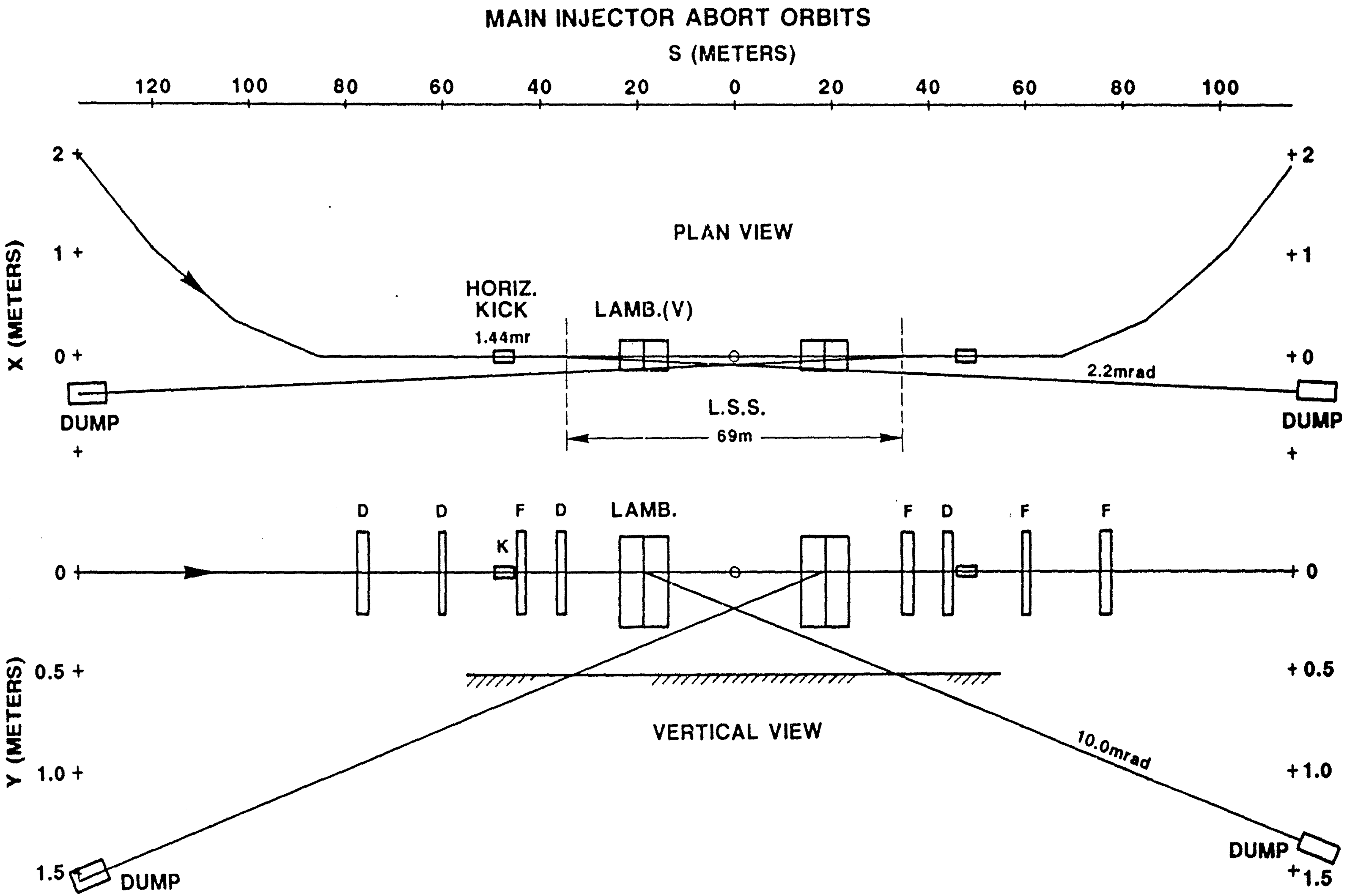


Figure 2-5: Plan and elevation views of the MI abort systems.

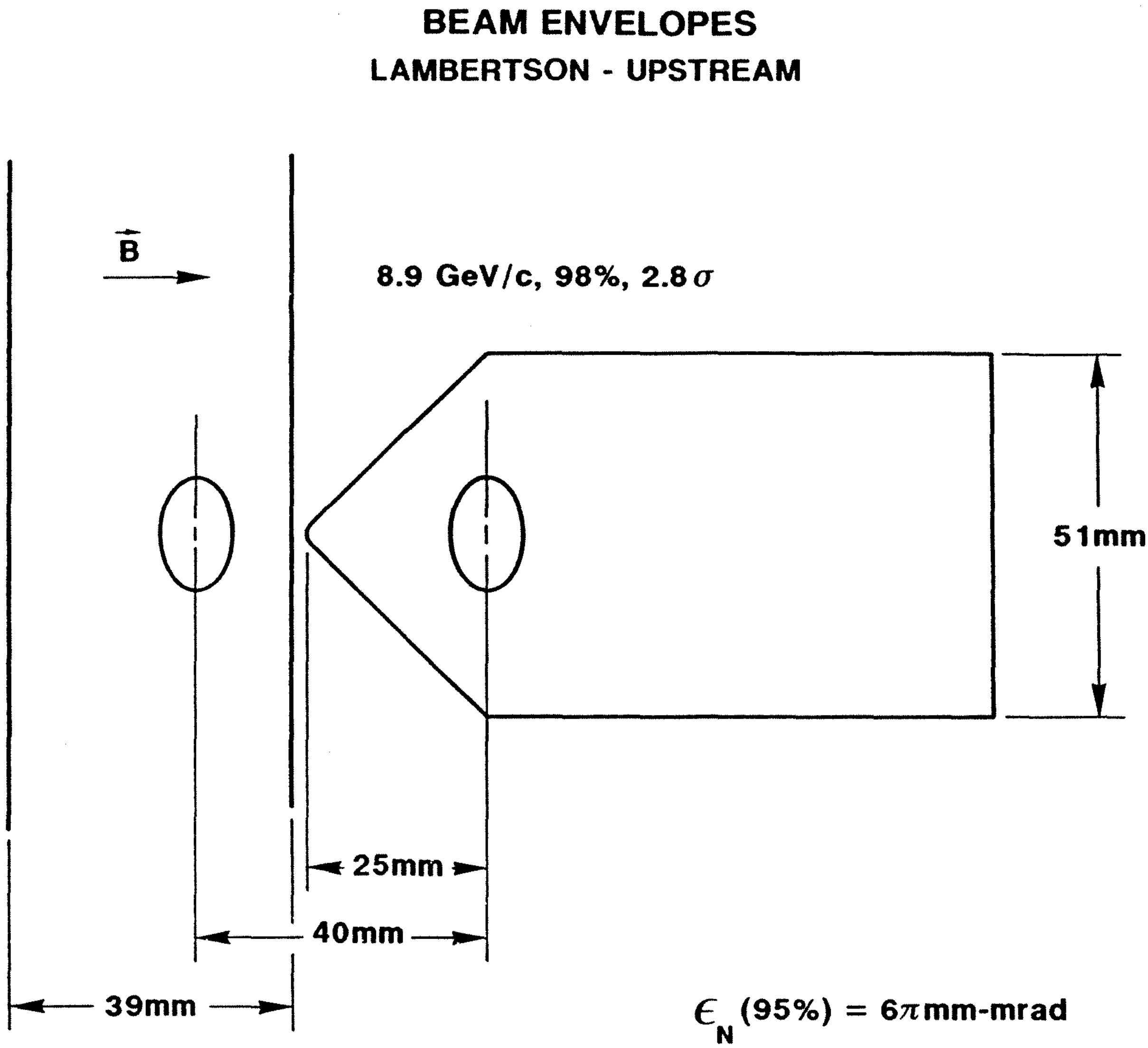


Figure 2-6: Beam profiles and positions at the MI abort Lambertsons.

Summary of Components Required

Table 2-4 is a listing of the components needed to implement both the CCW and CW abort systems for the new Main Injector.

Table 2-4: MI Abort Components

Item	Number Required	Number Reused
Kicker magnet and pulser	4	2
Lambertson magnet	4	2
Lambertson P.S.	1	1
Beam line (tunnel) 61 m long	2	0
Dump core box, instrumentation	2	0
Civil construction:		
Dump, iron, beam line	2	0
Kicker buildings	2	0

2.7 Environmental and Shielding Considerations

Environment

This section covers the environmental impact of the proposed construction of the Main Injector in the ~400 acres of the Fermilab site southwest of the existing Main Accelerator tunnel, between the FØ building and the site boundry. The additional components of the Proton-Proton Collider utilize the existing tunnels and service buildings, and thus will have minimal impact. Access to the construction project will be via the existing Kautz Road.

The area in question is a floodplain fed by Indian Creek, which originates in the Fermilab site and gives rise to a wetland region encircled by the proposed injector ring. There is a heron colony within this region. There is a certain amount of tree cover and no known sites of archaeological significance in the vicinity of the construction. We foresee, at some point, to review the need for an environmental assessment or an environmental impact statement as outlined in the NEPA requirements. We envisage no adverse environmental impact as a result of this project; efforts would be made throughout to protect and enhance the local conditions. The main environmental issues are as follows.

The proposed construction will come no closer than ~100 m to the heron rookery, which is located in a wetland region completely encircled by trees. The great blue heron is not an endangered or protected species. The mature tree cover in the region will not be affected. The herons are in residence during the period of April through August, and so construction in the vicinity will be scheduled to avoid this time interval. Access to the construction site, staging, and deposition of materials will take place from outside of the ring, away from the rookery.

The tree cover directly in the path of the tunnel, roads, and cooling ponds, represents a small percentage of the total tree cover in the region. The affected wooded areas are previously disturbed regions of young immature trees and do not need to be avoided. The higher quality forested regions will be undisturbed and protected from construction traffic and debris.

The tunnel with its underdrain system will affect the water levels inside the ring. The wetland character of the site is maintained by Indian Creek and the floodplain nature of the sheet drainage in this area. In order to maintain the features of the water flow we will install an active drainage system which will allow active control of the water level. The details of this drainage system are given in the civil construction section. It is changes of water levels over a long time period which affect the area; the dead trees in the rookery are the results of such changes. The ability to control the water level will ensure that existing flow patterns will be maintained inside and outside the ring. The project will add ~16 acres of surface water through the cooling pond system.

The construction goes through prairie plot #12. At the present time this plot does not contain any threatened or endangered plant species. Fifty acres of corn leases lie inside the proposed ring. These leases will be retired and the area could be used to enhance the prairie project acreage.

The construction area contains no known archaeological sites; however, some of the land adjacent to Indian Creek has not been surveyed. A study of this region has already been funded and will be completed by the end of 1988. There is sufficient time available in the schedule to allow any new sites uncovered by this survey to be examined, if desired. The Lorentz site does lie within the new ring but will be unaffected by the construction.

Any topsoil disturbed by the construction will be replaced, graded, and reseeded as part of the project. The visual impact of the project will be minimal. The highest item will be the tunnel berm, which is not expected to exceed 20 ft in height. The existing vegetation next to the bike path will be augmented to reduce the visual impact and restrict access.

Shielding

This section of the report deals with calculations of the radiation dose near the tunnel when the beam is lost on the magnets or dumped intentionally. We have estimated three cases: a worst case loss scenario, the exposure per hour on the surface of the earth berm, and the dose rates at the site boundary. The latter case is significant since the point of closest approach to the site boundary is ~74 m. We have assumed a constant berm thickness of 17 ft. We have also investigated the abort dump as described in the earlier section.

The calculations are done in two parts; the first calculates the dose per unit proton lost in the machine, the second then assumes certain loss rates and mechanisms which are then used to produce the final results. All values quoted in this section were obtained from the Monte-Carlo code CASIM [1] which compares well with the observations of dose for a variety of hadron and muon shielding arrangements under known beam loss conditions. The tunnel geometry consists of a close approximation to a continuous B2 dipole centered in a 1.5 m radius tunnel of circular cross section. The arc radius of the tunnel is 400 m and the dipole field is chosen so as to accommodate 150 GeV protons (1.25 Tesla) in the aperture. The field outside the dipole gap is supplied numerically and is adjusted to correspond to the central field value. The tunnel is completely and uniformly surrounded by soil with a (Fermilab standard) density of 2.24 g/cm^3. The model at this stage of development is somewhat idealized so the results quoted should be regarded as preliminary.

The operating scenario assumed is that a 150 GeV ramp at a 7 s cycle will have an operating intensity of 3×10^{13} ppp. The 120 GeV ramp at a 3 s cycle would have 4×10^{12} ppp. These cycle times represent the fastest ramp rate possible. The machine would run 60% of the time divided equally between 150 GeV and 120 GeV operation. Under these conditions, the number of protons accelerated per year would be $\sim 5 \times 10^{19}$. This corresponds closely to the yearly totals for the present Main Ring operating under similar conditions. We have further assumed that the machine efficiency will be 80% so that each cycle would lose 20% of the protons which would be spread uniformly around the ring. These losses can be expected to occur at low energy; i.e. 8-20 GeV. There is no a priori reason to expect any measurable beam loss at high field on a systematic basis. We have chosen to assume that a 1% beam loss occurs at high energy

Hadron Dose

A beam point loss is assumed to occur in the middle of the beampipe of the continuous B2 magnet. Since the hadron dose in the soil is mainly due to neutrons, it is quite insensitive to the lateral position of the beam loss. For the same reason it is acceptable to average the dose over the tunnel azimuth. Figures 2-7 and 2-8 show the isodose contours due to hadrons in the soil outside the tunnel for injection (8 GeV) and high field (150 GeV). The abscissa is the distance along the tunnel arc from the loss point. The curves are normalized to a single proton lost. For a worst case loss scenario we assume that all the beam is lost at one point in the ring at 150 GeV for 10 successive machine cycles (i.e. 3×10^{14} protons). In this case, with a 17 ft soil berm around the tunnel there would be an exposure at the surface of the soil of 3 mR. The existing Fermilab radiation guide would require this area to be defined as minimal occupancy, i.e. not restricted but no continual occupancy, equipment but not offices. Clearly there is no intention of constructing any permanently occupied buildings directly on top of the berm. The dose diminishes inversely with distance so that ~50 ft from the berm the dose has fallen below the level where regulations apply (1 mR). A systemic hadron dose can be estimated by assuming 20% losses at low energy spread uniformly around the ring and 1% high energy losses. Under this scenario the annual hadron exposure at the surface of the berm is 23 mR per year from 150 GeV beam and 107 mR from lower energies. These values are well below the laboratory standard for permanent occupancy of 500 mR.

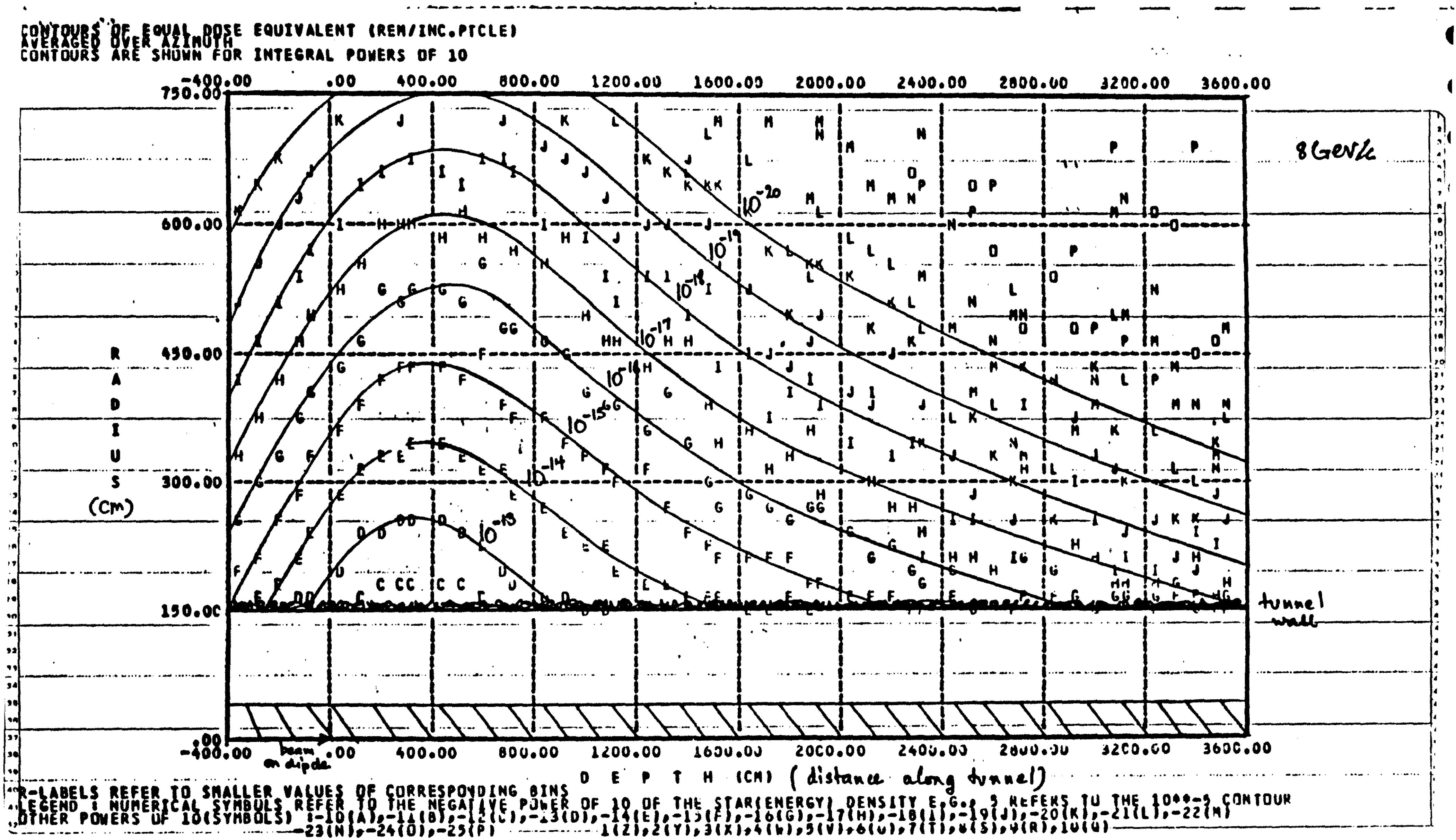


Figure 2-7: Isodose contours due to hadrons per 8 GeV proton lost in a MI dipole magnet. All distances are in centimeters.

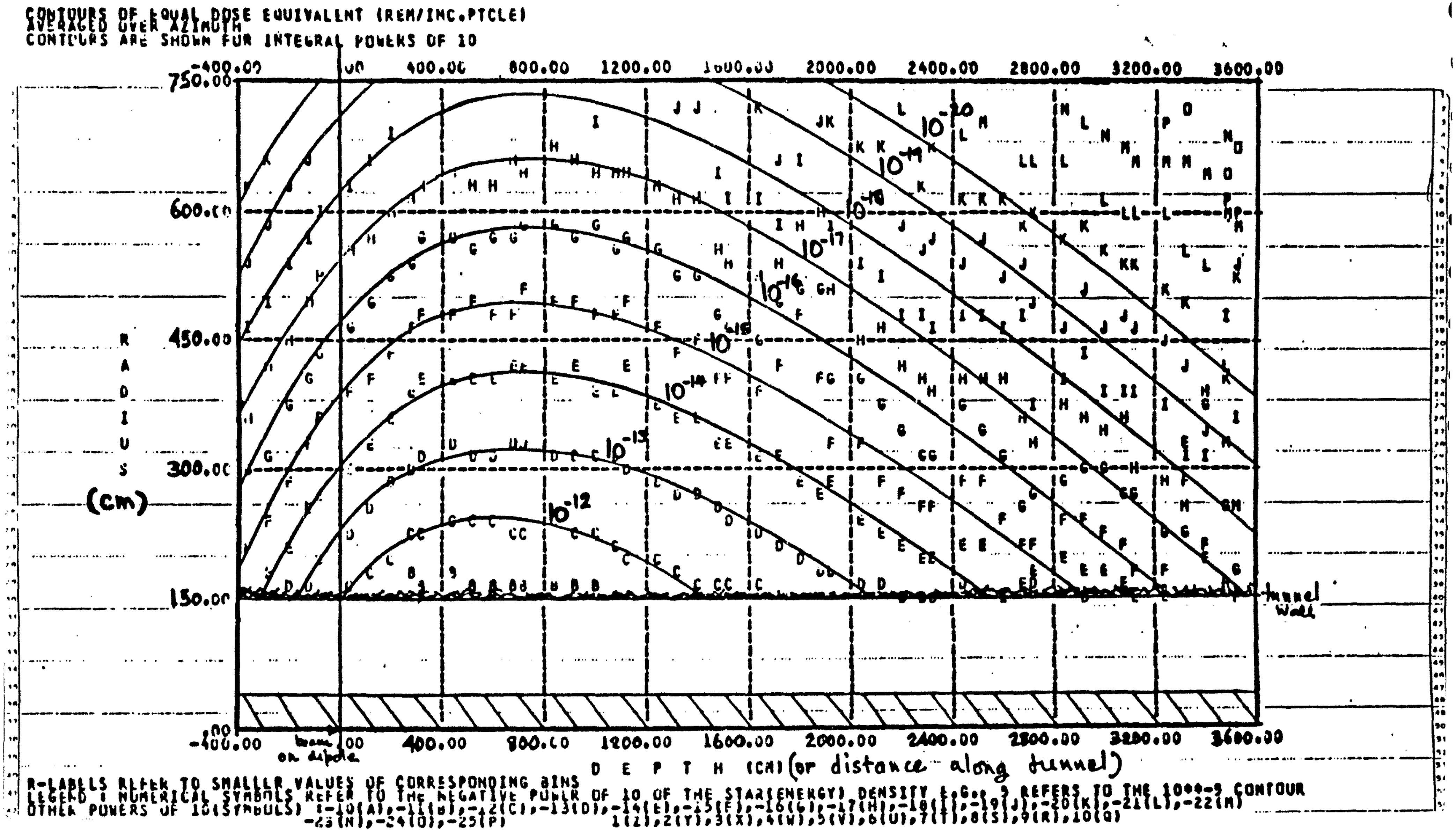


Figure 2-8: Isodose contours due to hadrons per 150 GeV proton lost in a MI dipole magnet.

The laboratory standard for site boundry exposure rates is 10 mR per year. The proposed Main Injector is ~75 m from the site boundry at the point of closest approach. In order to estimate this effect we have used a conservative approach in assuming that a linear region of 140 m of the ring contributes uniformly to the dose rate at the closest point. Clearly an exact calculation is required. The calculation is similar to that described in [2] which evaluates low energy neutrons from the tunnel "halo" scattered in the atmosphere, the so-called skyshine mechanism. Using the loss assumptions already outlined then we obtain a site boundry exposure of 12 mR per year from the high energy losses and 56 mR from the low energy ones. These values clearly exceed the existing guidelines. If the results of a more detailed calculation show similar exposure levels then it is possible that it may be necessary to increase the berm thickness for a certain region of the ring close to the site boundry. An increase in the berm of 3 ft would reduce these levels by an order of magnitude.

Muon Dose

For a circular ring the worst muon dose occurs along a line tangent to the loss point. In contrast to the hadron case the preferred coordinate system has the z-direction along this tangent. Averaging over the azimuth is no longer justified since the worst muon penetration is expected in the median plane. Up-down symmetry is still intact. Beam loss on the radial inside of the beampipe produces a larger muon flux by providing a relatively long pion decay length along the tangent inside the beampipe. This is demonstrated in Figures 2-9 and 2-10, which show isodose contours in the median plane for both cases. Since the ring elevation is such that the depth of the machine varies between 10 ft and 20 ft below the surface of the surrounding grade, the data shown in Figures 2-11 and 2-12 are more relevant in calculating muon dose rates at the surface. Here the isodose contours are averaged over the top and bottom quadrants. Since 8 GeV muons range out quickly (~20 m) it is only the high energy component which warrants consideration. Under the worst case loss condition, the highest muon dose is experienced on top of the berm ~20 m downstream of the loss point. The dose rate however is small and amounts to only 0.15 mR. The systematic exposure on the berm surface is also small and amounts to 1.7 mR per year. The dose at the site boundry is reduced from the hadron case by the tangential nature of the losses and the absence of the skyshine effect, these losses are estimated at 0.003 mR in the worst case scenario and 0.02 mR per year. Clearly muon losses should not pose a problem.

Abort Dump

The abort dump as already outlined is virtually identical to that currently in use in the Tevatron/Main Ring complex. The trajectory of the beam line to the dump is angled downwards by 10 mrad, which results in ~6 m of dirt coverage at the dump location from the existing grade level. In estimating the amount of beam hitting the dump, it seems reasonable to take the measured number from the Main Ring of 10^{18} per year since we estimated a similar integrated intensity of protons per year accelerated in the proposed machine.

The high density construction of the beam dump ensures that the hadron dose in the immediate vicinity of the dump will be negligible. The more stringent radiation problem associated with hadrons is that of ground water activation. The design of the current Tevatron dump fully

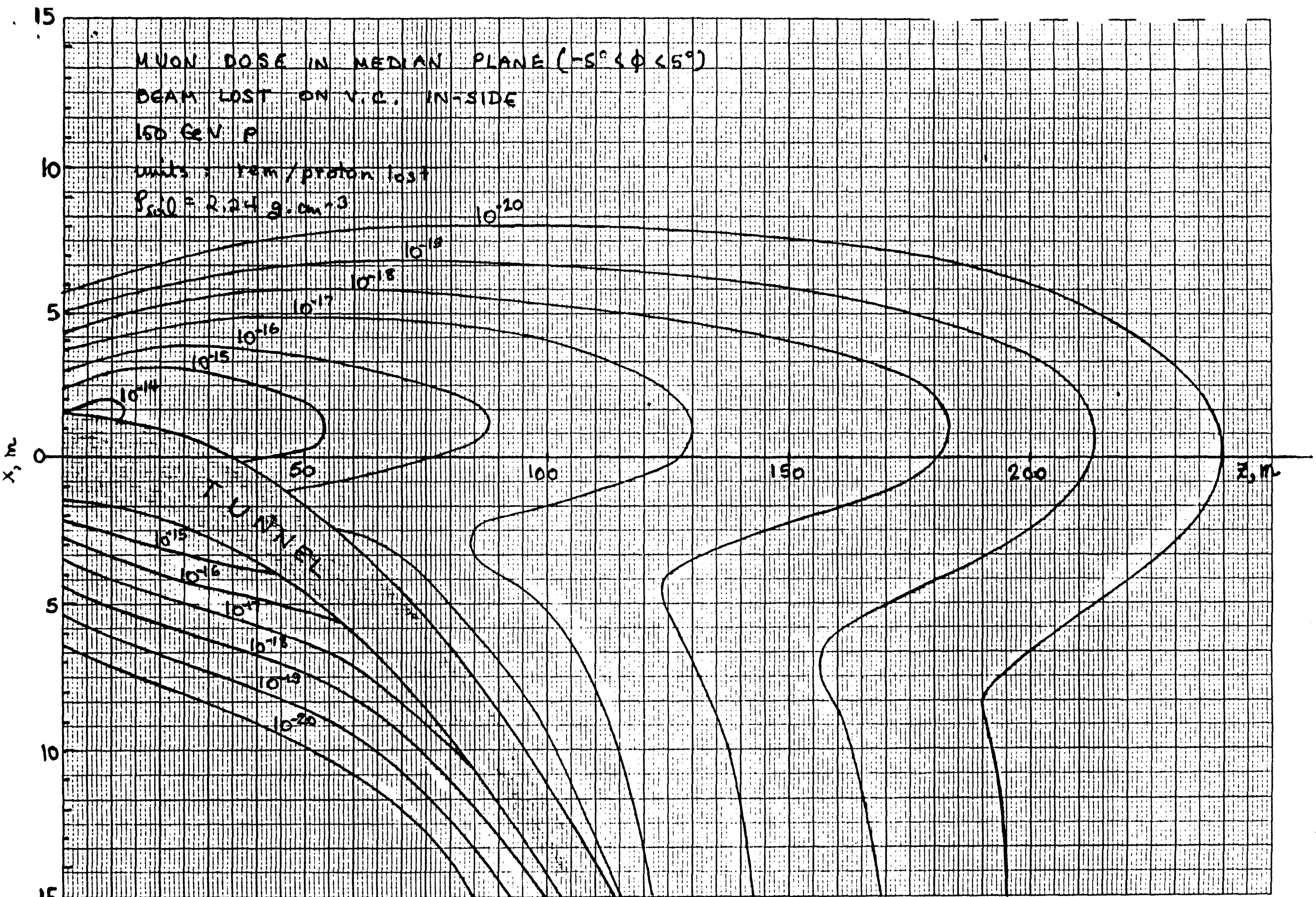


Figure 2-9: Isodose contours due to muons in the median plane for a 150 GeV proton lost on the inside of the vacuum chamber.

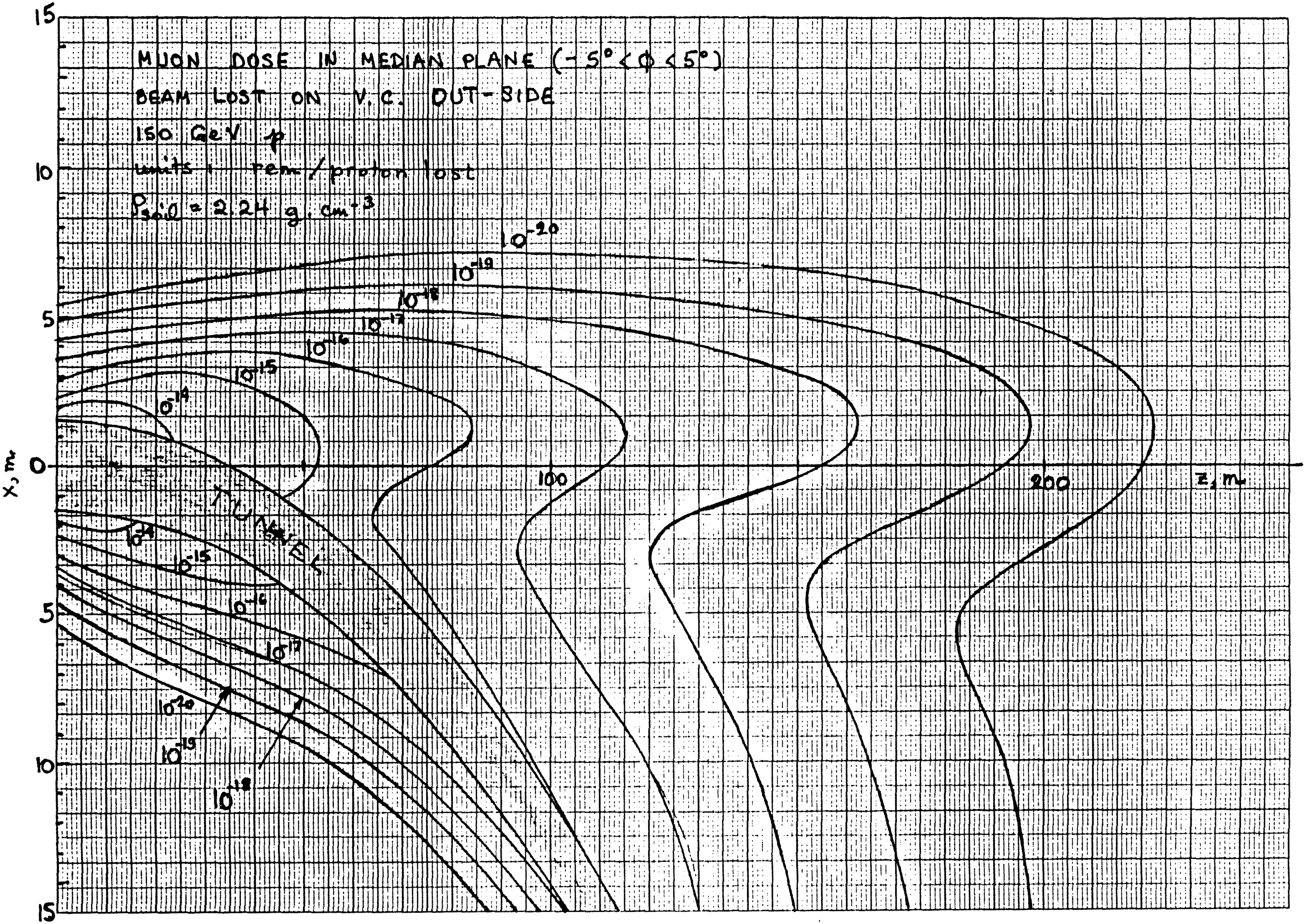


Figure 2-10: Isodose contours due to muons in the median plane for a 150 GeV proton lost on the outside of the vacuum chamber.

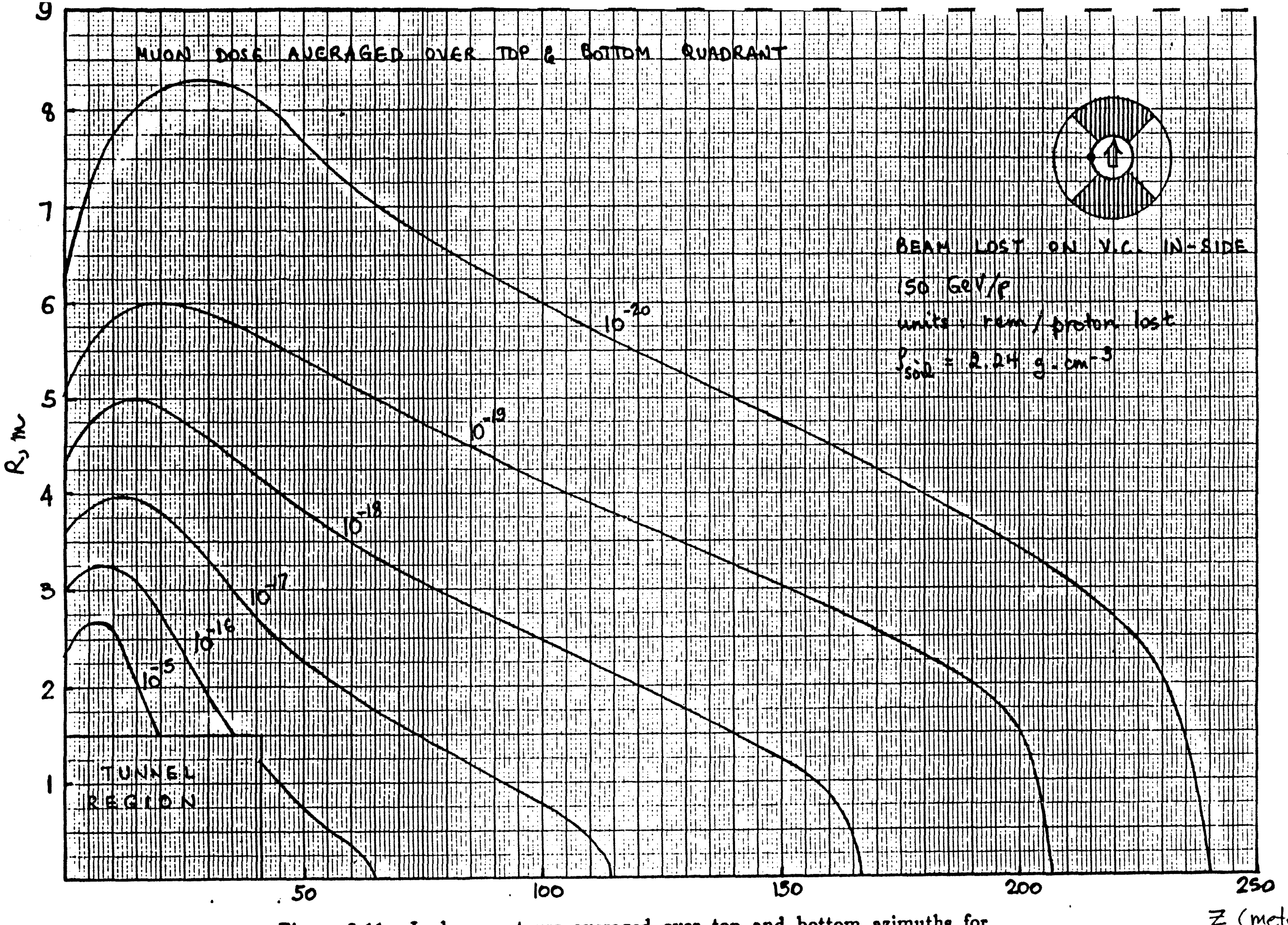


Figure 2-11: Isodose contours averaged over top and bottom azimuths for muons produced under the same conditions as 2-9.

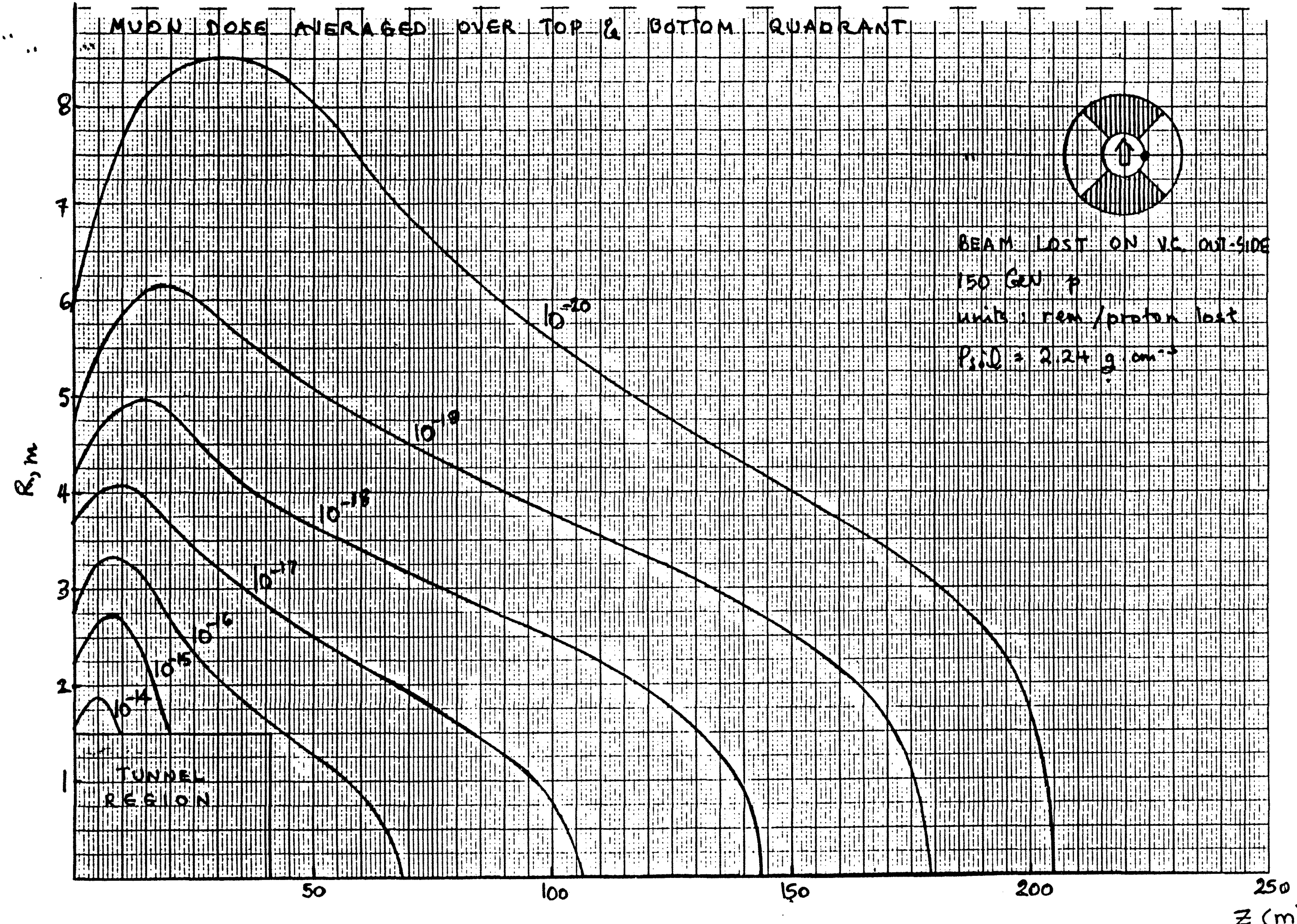


Figure 2-12: Isodose contours averaged over top and bottom azimuths for muons produced under the same conditions as 2-10.

incorporates these considerations along with questions of radiation heating and the material integrity of its components [3]. This beam dump has been in continuous operation for the last six years. The ground water activation is frequently monitored and results show that water immediately adjacent to the dump meets EPA release limits for unrestricted use.

The muon isodose contours for the projected abort dump are shown in Figure 2-13. From these data we estimate the maximum dose rate on the surface would be ~100 mR per year about 5 m downstream of the dump location, within the permanent occupancy limits. Continuous maximum intensity running to the dump would produce an exposure rate of 1.5 mR per hour in the same place. The trajectory of the abort line intercepts the site boundry some 425 m downstream of the dump. At this point the beam is ~10 m beneath the surface but the distance is sufficient to range out all the muons.

2.8 Utilities Distribution

Three distinct power systems are associated with the Main Injector complex: 1) Pulsed power for the Main Injector magnet strings; 2) Conventional power for controls, ion pumps, lights, pumps, etc.; and 3) Power distribution for the beamlines. A schematic diagram for the entire power distribution system is given in Figure 2-14.

Pulsed Power Distribution

The pulsed power distribution system consists of an existing 66 MVA transformer at the Master Substation (MSS) and a 13.8 KV distribution system. Four 13.8 KV feeders are used to meet the MI pulsed power demand. Each feeder consists of three 750 MCM aluminum power cables and has a power capacity of 7 MW. The 66 MVA transformer and the four 13.8 KV feeders from the MSS to the P71 manhole at the Main Ring are part of the original Main Ring pulsed power system. At the P71 manhole these feeders will be intercepted and new feeders will be extended from this point, through the existing ductbank, to the F2 manhole in the Main Ring. From F2 a new ductbank will be installed around the Main Injector ring. The new 13.8 KV feeders will be routed through this ductbank in a 2-loop feeder arrangement and will be connected to termination cubicles at the 10 MI service buildings.

Four 15 KV switches at the F2 area will be used to provide feeder backup as well as feeder isolation for maintenance purposes. At the midpoint around the MI there will be two additional 15 KV switches for the purpose of paralleling feeders in case of unequal loading. These switches can also be used for feeder islation for maintenance purposes. Through underground duct and manholes the feeders are connected to termination cubicles at the ten service buildings. Each termination cubicle feeds three pulsed power supplies through individual disconnect switches.

A harmonic filter will be installed at the P71 area from all four feeders to ground to prevent possible component damage due to excessive harmonic distortion caused by the nonlinear power supplies. The filter will be similar to the existing filter in the Main Ring pulsed power system and will be connected in parallel with it.

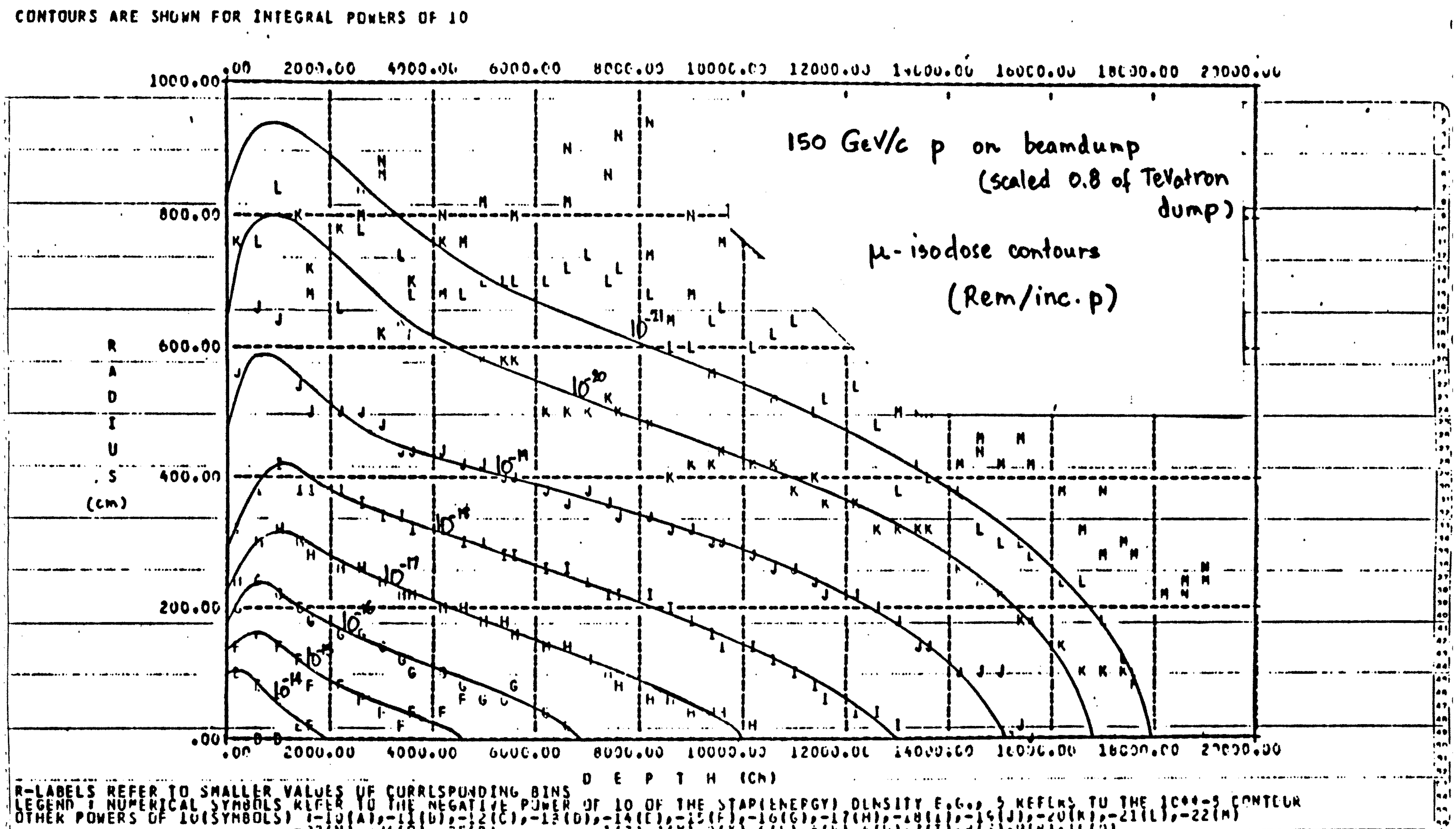


Figure 2-13: Isodose contours for muons produced in the MI abort dumps.

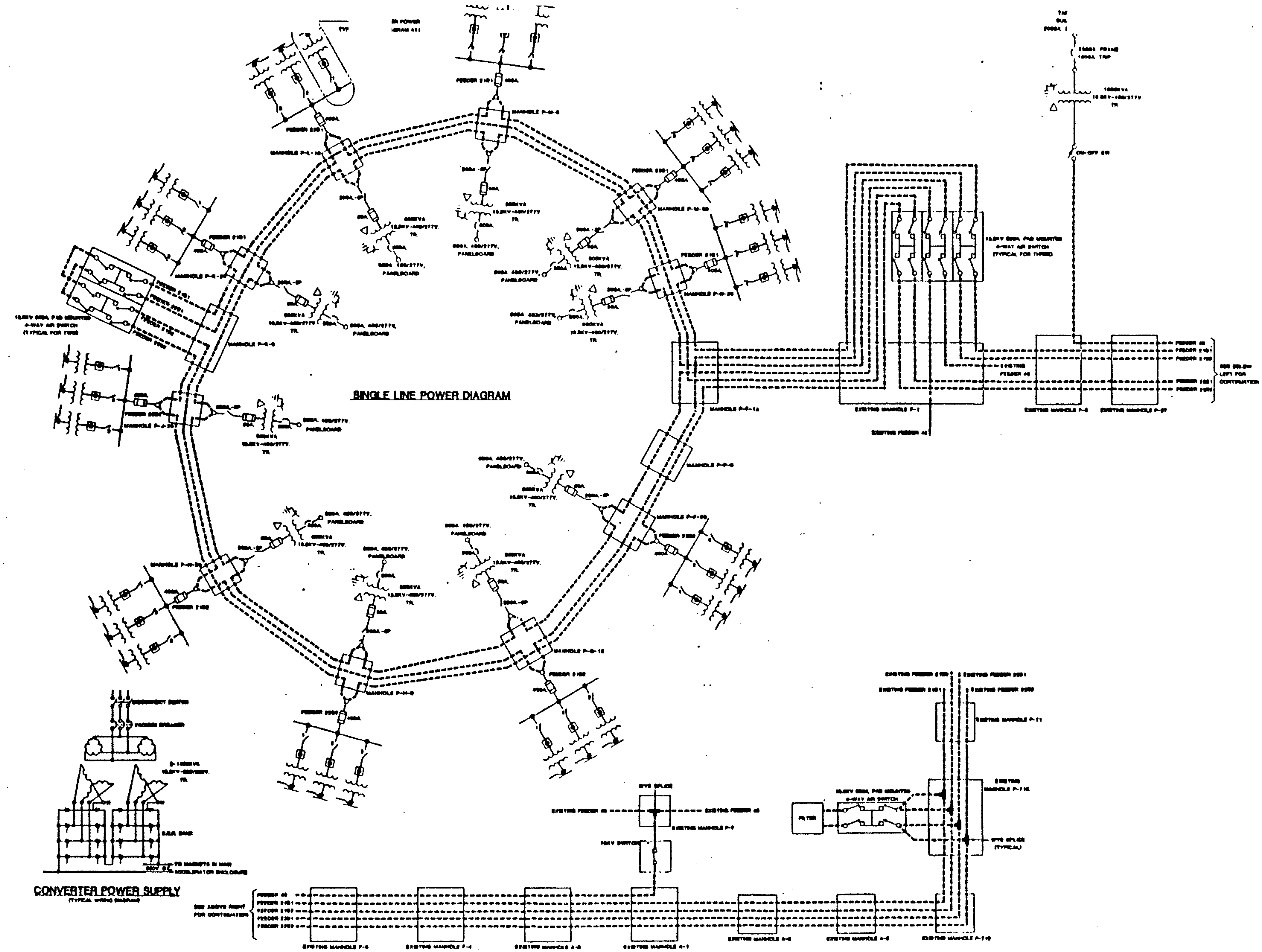


Figure 2-14: Primary power distribution schematic for the Main Injector and associated beamlines.

Conventional Power Distribution

The conventional power distribution system consists of one 13.8 KV feeder around the MI ring with a 500 KVA transformer at each of the ten service buildings. The conventional power will be used for building power, lights, pumps, etc. The existing Main Ring conventional feeder (feeder 45) will be intercepted at F2 and will be extended around the Main Injector ring through the undergroun ductbank. A 15 KV switch at F2 will provide a means of isolating the MI and Tevatron conventional power.

The 500 KVA transformer at each service building is used to step down the 13.8 KV to 480/277VAC, 3 Ph. and in turn feed a 480VAC, 600 Amp Circuit Breaker Panel in the service building. One circuit breaker from this panel will feed a 480 to 120/208VAC, 3 Ph. transformer and in turn feed a 208VAC, 225A 42 pole circuit breaker panel. Major 480 V loads are:

LCW Pumps
Pond water pumps
Pond pit Sump pump
Dipole and Higher Order correction Power supplies
Power supply for SCR firing circuits
120/208VAC, 3 Ph., 75kva Transformer
Heating and air conditioning
480VAC, 3 Ph., 60Amp Receptacle
Tunnel Services
Sump pump
120/208VAC, 3Ph., 30kva Transformer
480VAC, 3 Ph., 60Amp Receptacle

Beamlines Power Distribution

One 13.8 KV feeder, with a capacity of 7 MW, will be used to power the beamlines. An existing feeder, routed in a ductbank from the MSS to manhole P7 near the A1 service building, will be used. This feeder is presently unused. A new ductbank will be extended from manhole P7 to the A1 manhole in the Main Ring ductbank. A new feeder will be routed from manhole P7 through the Main Ring ductbank to F3 and F1. At F3 a 15 KV switch will be installed and the new feeder will connect through the switch to the AP0 service building. At AP0 a new 1500 KVA substation will be installed for power to the 8 GeV North beamline. At F1 the new feeder will be terminated at the termination cubicle of a relocated Main Ring pulsed power supply. This will supply power to the 120 GeV beamline. The 8 GeV West beamline will be powered from the new service building N20 via the MI feeders.

Transformers and Switch Gear

The Main Injector needs 20 power supplies for the dipole circuit and 8 power supplies for the quadrapole circuit. Each of the ten service buildings will accomodate three supplies. The layout of equipment in and around the service building is shown in Figure 2-15. As described above the Main Injector pulsed power supplies will be fed from four dedicated 13,800 VAC (15KV) feeders. The major components of each pulsed power supply are the Termination Cubicle, Manual No-load Break Disconnect, Vacuum Circuit Breaker, Transformer, and Power Supply.

The Main Injector Pulsed Power supplies have the following RMS ratings: an input voltage of 13,800 VAC, 3 phase, an output voltage of 850 DC, and a

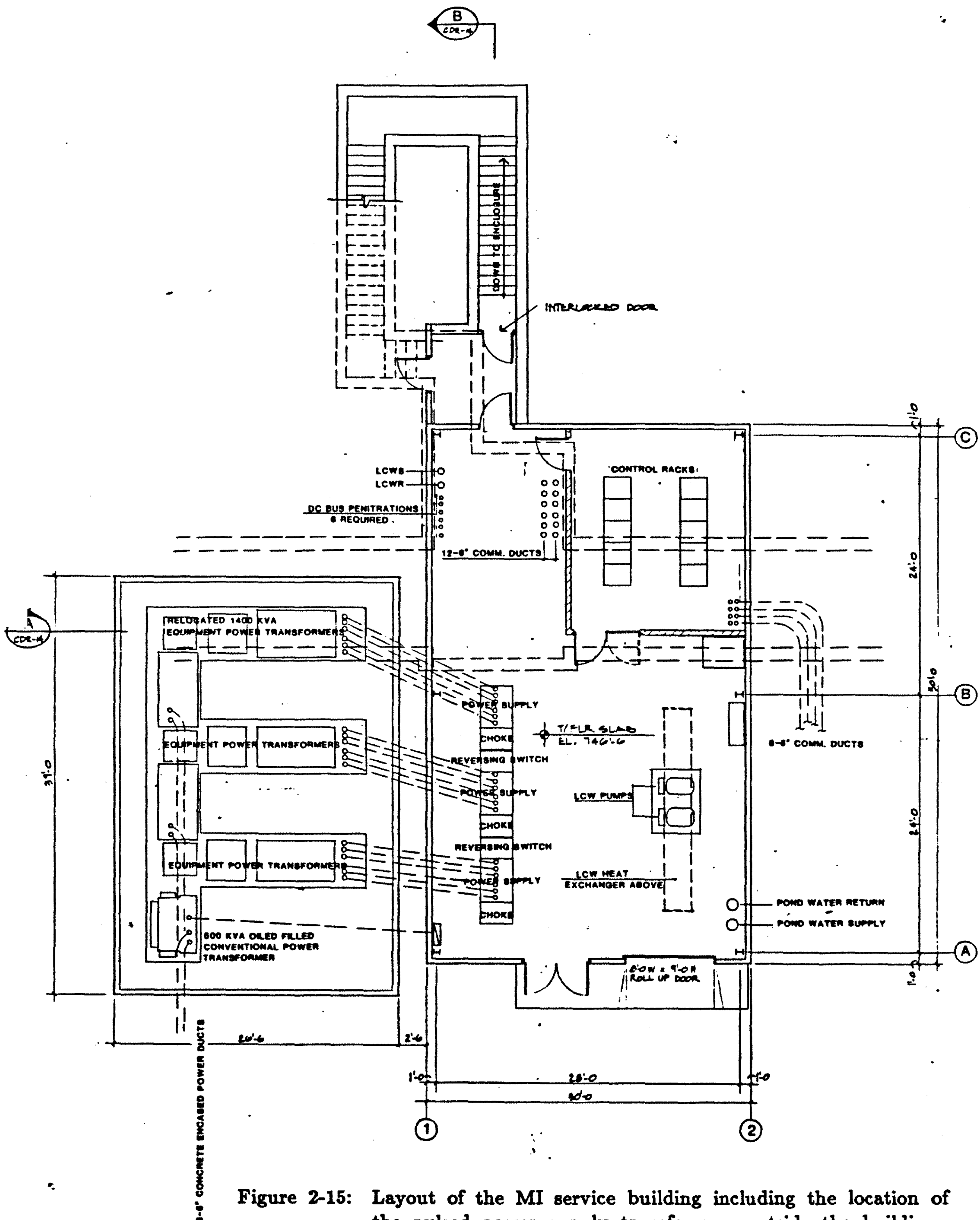


Figure 2-15: Layout of the MI service building including the location of the pulsed power supply transformers outside the building.

current of 2800 Amperes DC. The rectification consists of a 6 phase full wave Silicon Controlled Rectifier (SCR) bridge and is capable of being computer programmed from 0 volts to full output voltage. The 6 phases are generated from two transformers (in a single tank) with extended delta primaries resulting in secondary voltage vectors displaced $\pm$ 30 degrees with respect to the incoming line voltage (15 degrees leading and 15 degrees lagging).

The transformers used as part of the Main Injector Pulsed Power supply, need special attention. Presently, the transformers are contaminated with 2,5% Poly-Chlorinated Bi-phenols (PCB). Environmental considerations dictate that the transformers be placed on pads with containment. The criteria used for the containment volume is 2X plus 10% of the liquid capacity of the transformers

Tunnel Utilities: Low Conductivity Water System and Magnet Bus Connections

The proposed system for connecting the power and water to the Main Injector is similar to the Main Ring. This system requires a minimum of maintenance. Stainless steel headers supply low conductivity water (LCW) to copper pipes which conduct both power and cooling water to the magnets. Ceramic feedthroughs, with flexible metal braid hoses, electrically insulate the piping to the copper bus system. All connections are either brazed or welded.

As shown in Figure 1-5 the Main Injector components and utilities are grouped together at the outside wall leaving most of the enclosure space for servicing these components. All the connections to the magnets are designed so they are accessible from the inner space of the tunnel. Each of the ten service buildings will supply power and cooling water to about 1,050 feet of circumference in the Main Injector.

Two pumps per building will deliver 300 Gpm each of LCW with a pressure head of 162 psi. Each pump has a 50 HP motor. The heat from the magnets is transferred with the LCW and dissipated in a tube and shell heat exchanger placed over the pumps in each service building. Pond water is circulated in the tube side of the heat exchanger to remove the heat eventually by evaporation. From the existing LCW system in the Main Ring, 12 pumps with starters and controllers, and 7 heat exchangers will be reused for the Main Injector. The remaining equipment in the Main Ring will be used for the existing Tevatron and the New Tevatron. All of the copper bus (1.625 in O.D. by .187 in. wall) and the porcelain clamps will be reused from the Main Ring.

Two 4 inch stainless steel pipe headers will be installed over the magnets along the circumference (10,843 feet) of the Main Injector. A total of 20 pumps (300 Gpm each) will be connected in parallel across the supply and return pipes. All magnets and bus system are also connected in a parallel across the LCW headers. Flow control devices, used in the Main Ring, will be altered and can be reused in the new injector to limit the water flowing to 8 Gpm through the MR B2 magnets. For the 120 Gev operation (1730 Amp RMS), the water temperature rise across the magnets is calculated to reach about 10^{o}C. At each utility building, 460 Gpm of LCW will be required to cool magnets, bus, power supplies, chokes, and electronic equipment. The heat load removing capacity per building is about 1.3 MW limited by the cooling pond.

At each utility entrance, the enclosure will have an enlarged cross section (see Figure CDR-14 in Appendix D). The walls will extend one foot from the regular tunnel. The purpose of this extra space is to make room for expansion joints for the 4 inch stainless steel pipes, copper bus, and trays. At this section, the enlarged enclosure allows the utilities to cross over without obstructing the regular tunnel clearance for the magnet moving vehicle.

A net counter clockwise flow in the ring will be accomplished with restricting valves at each of the entrances. In one of the larger service buildings, a LCW processing system will be installed. A continuous polishing flow action is required to keep the low conductivity in the water. Two mixed bed deionizes are used with about 100 Gpm flow going through one of the beds. An average of 9 megohms-cm resistivity of the LCW is maintained in the ring. An expansion tank and a 3,000 gallons storage tank are also used. The New Main Injector will require an estimated 29,000 gallons of low conductivity water to fill the pipes, tanks, and magnets.

References

1. A. VanGinneken, Fermilab publication FN-272 (1975).

2. J. D. Cossairt, L. V. Coulson, Health Physics, Vol. 48 (1985).

3. A. VanGinneken, M. Awschalom, "High Energy Particle Interactions in Large Targets," Fermilab, Batavia.

3. BEAMLINES AND BEAM TRANSFERS

Five new beamlines are required to integrate the Main Injector and New Tevatron into the existing Fermilab accelerator complex. Included are two 8 GeV transfer lines between the 8 GeV Booster and the Main Injector, two 150 GeV transfer lines between the Main Injector and the Tevatrons, and a 120 GeV line connecting the Main Injector to the existing antiproton production target. The layout of the new beamlines is shown in Figure 3-1. The three long beamlines are designated **8 GeV North, 8 GeV West,** and **120 GeV** and are described in Section 3-1. The two short 150 GeV transfer lines are described in conjunction with the layout of the F0 straight section (Section 3-2). Longitudinal beamline sections showing the disposition of elements within the beam transfer lines are given in drawings CDR-10 to CDR-12 (Appendix D).

3.1 Beamline Layout

The location of the three new beamlines, 8 GeV North, 8 GeV West, and 120 Gev, has been shown in Figure 3-1. Site coordinates of all magnetic elements have been calculated. These three lines are capable of delivering protons at 8 GeV from the Booster for injection into the Main Injector in either the clockwise or counterclockwise direction, and at 120 GeV from the Main Injector to the existing antiproton production target. These beamlines ultilize existing portions of the Antiproton Source beamlines AP-1, AP-3, and AP-4 as well as the existing Booster extraction system at L3.

8 GeV Counterclockwise Injection into the Main Injector

Protons destined for clockwise circulation in the New Tevatron to be brought into collision with counterclockwise circulating protons in the old Tevatron, as well as protons to be used for antiproton production circulate counterclockwise in the Main Injector. These protons are delivered to the Main Injector from the 8 GeV Booster via the 8 GeV North and 8 GeV West lines.

Protons are extracted from the Booster at L3 and follow the existing AP-4 line for a short distance. They are then directed into the **8 GeV North** line by a horizontal bending magnet and are transported about 500 meters before joining the existing **AP-3** beamline. The AP-3 line transports protons around the antiproton production target and joins to AP-1 using the existing switching magnet 'EB6'. Approximately 6 meters downstream of EB6 the **8 GeV West** line diverges from AP-1 carrying the protons to the counterclockwise injection point of the Main Injector. The total length of beamline from the Booster to the Main Injector injection point is about 900 meters.

8 GeV Clockwise Injection into the Main Injector

Clockwise circulating protons are required in the Main Injector both for the purpose of loading the old Tevatron for p-p collisions and for delivery to fixed target experimental areas. These protons are delivered from the 8 GeV Booster via the 8 GeV North and 120 GeV beamlines. Protons are extracted from the Booster and transported through the **8 GeV North** and **AP-3** lines to AP-1 exactly as in the case of counterclockwise protons.

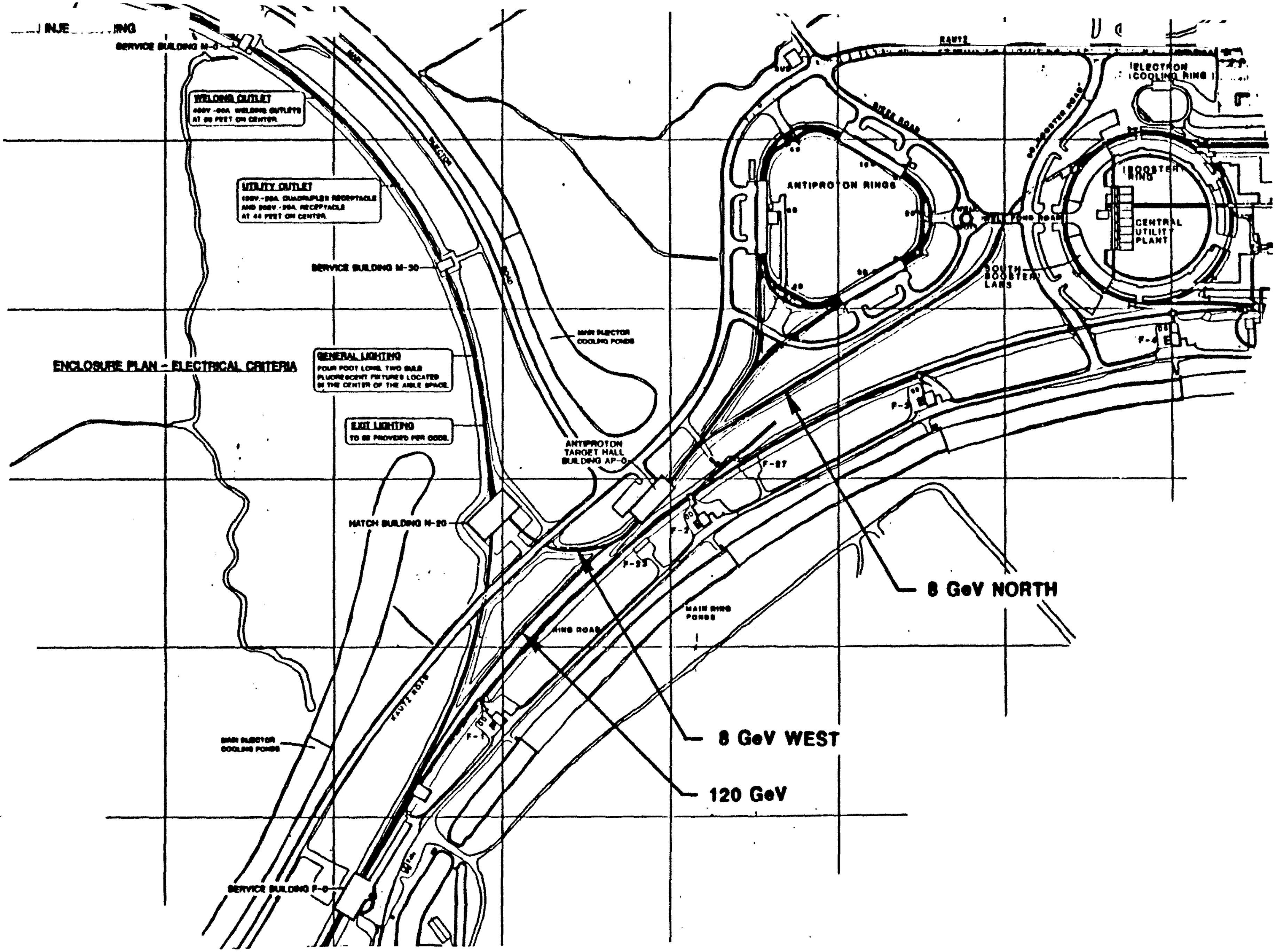


Figure 3-1: Site locations of the 8 GeV North, 8 GeV West, and 120 GeV beamlines.

However, the 8 GeV protons are not deflected into the 8 GeV West line, but rather continue straight ahead down the **120 GeV** line until reaching the Main Injector injection point at F0. The total length of beamline from the Booster to Main Injector is about 1000 meters.

120 GeV Extraction from the Main Injector

Protons are extracted from the Main Injector at 120 GeV for the production of antiprotons. Extraction is in F0 and utilizes the same Lambertson magnets as the 8 GeV clockwise injection. The 120 GeV protons travel up the **120 GeV** line in the opposite direction as 8 GeV (clockwise) injected protons. (Note that the **counterclockwise** proton injection is used when 120 GeV protons are to be targeted.) The switching magnet EB6 is deenergized in this mode so that the 120 GeV protons may be transported directly to the existing antiproton production target through the downstream section of the AP-1 beamline.

3.2 F0 Layout and Beam Transfers

Extraction from the Main Injector and injection into the two superconducting accelerators takes place in the F0 straight section region of the present Main Ring enclosure. The Main Injector extraction system must accomodate both 150 GeV beam transfers (counterclockwise and clockwise) as well as 120 GeV extraction to the antiproton source. The same system used for 120 GeV extraction will also be used for 8 GeV Main Injector injection in the clockwise direction. This region also contains the RF cavities for all three machines, as well as the electrostatic septa used for fixed target extraction from the present Tevatron.

One of the two long straight sections of the Main Injector is located at F0. To accomodate all of the functions mentioned in the paragraph above, the Tevatron long straight section is lengthened by replacing 24 standard 4.4 T dipole magnets with 16 6.6 T dipole magnets. Figure 3-2 displays the dipole changes. Moving the bend centers in this manner generates a radial excursion inward of the Tevatron F0 straight section of 59". In addition, special quad circuits are used to generate zero dispersion throughout the straight region. The lattice functions of the Main Injector and one of the superconducting rings are shown in Figure 3-3 and Figure 3-4.

Figure 3-5 shows a plan view of the F0 region. The 150 GeV transfer lines are approximately 80 m long and require 2 Lambertson-style magnetic septa and 2 C-style magnets at each end to generate the necessary 32 mr horizontal bends. As seen in Figure 3-6, the plane of the Main Injector is located midway between the planes of the two superconducting accelerators. To produce the necessary vertical deflection at each end of the beam lines, the C magnets are rotated by roughly 10^{o}. Four separately powered quadrupole magnets in each transfer line are used to provide a proper match of amplitude functions and dispersion functions. Figure 3-7 shows these lattice functions through one of the transfer lines. Kicker magnets located 90^{o} in betatron phase upstream of the extraction Lambertsons and 270^{o} downstream of the injection Lambertsons are used to begin and end the transfer process.

The Main Injector lattice across the F0 region is kept identical for both the clockwise and counterclockwise rotating beams by not reversing the

CONSOLE LOCATION 05, MCRLib 17-MAY-1988 12:15
Lex graphics editor

Tevatron F0 Straight Section Modification

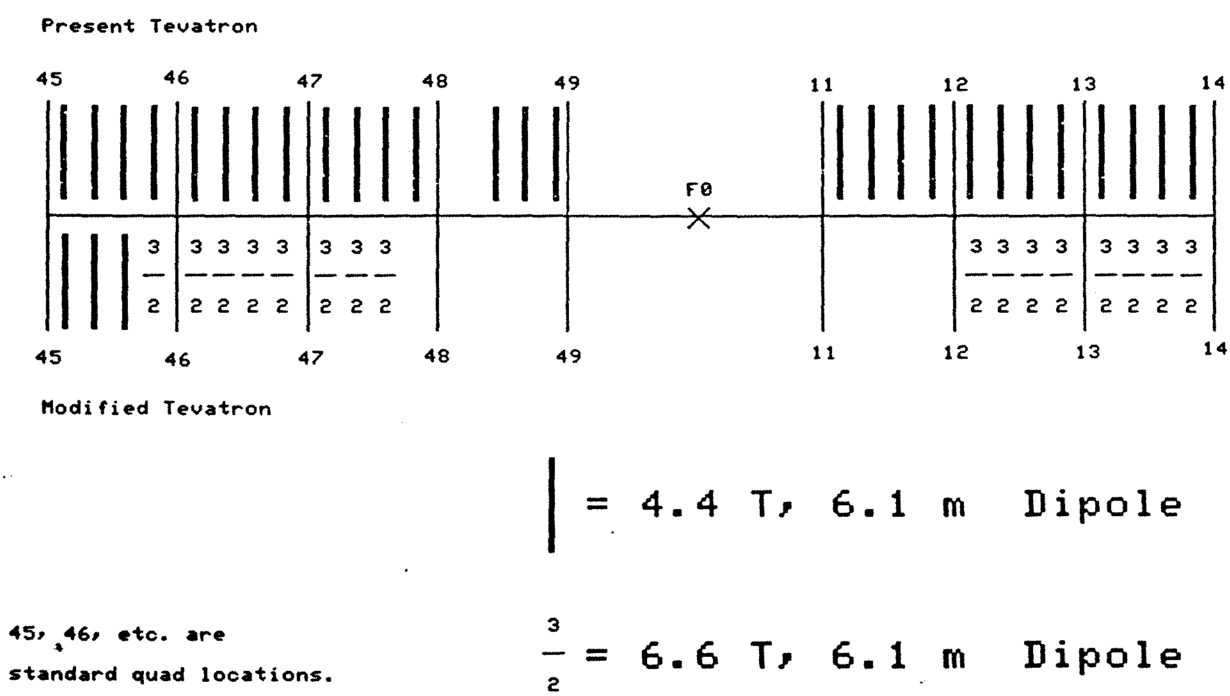


Figure 3-2: Location of 6.6 Tesla and 4.4 Tesla magnets in the vicinity of the F0 straight section.

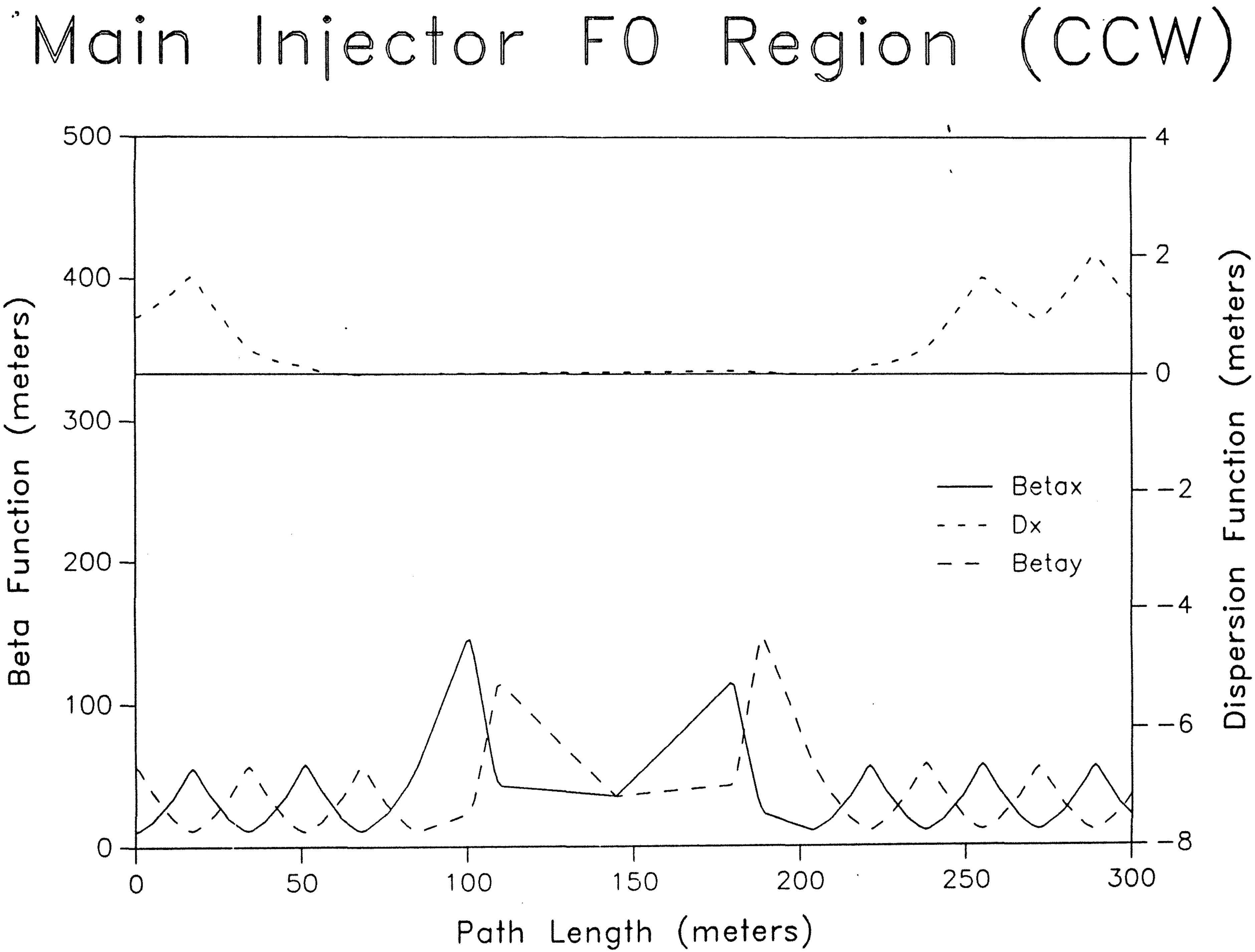


Figure 3-3: The Main Injector lattice through the F0 straight section.

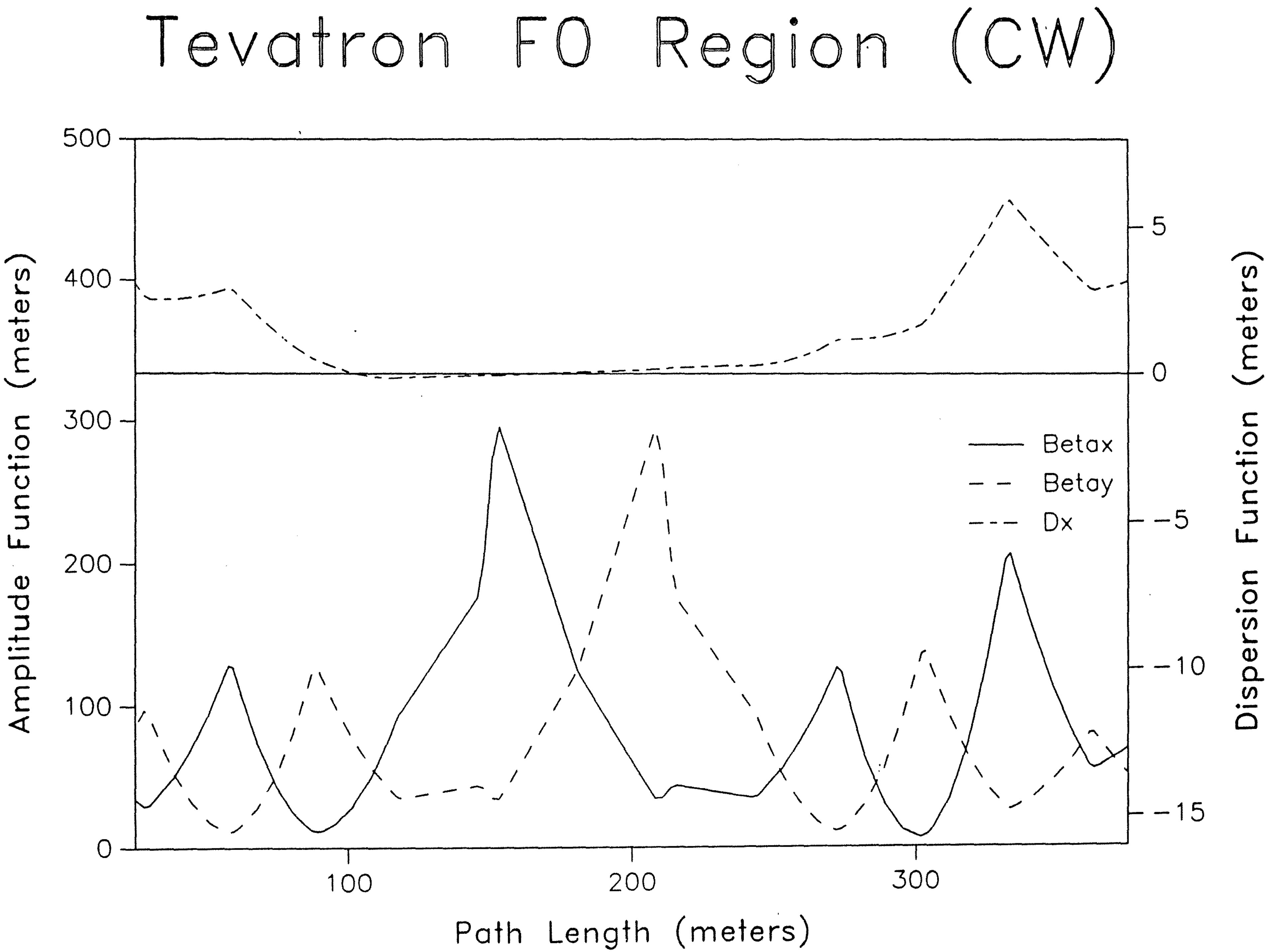


Figure 3-4: The Tevatron(s) lattice through the F0 straight section.

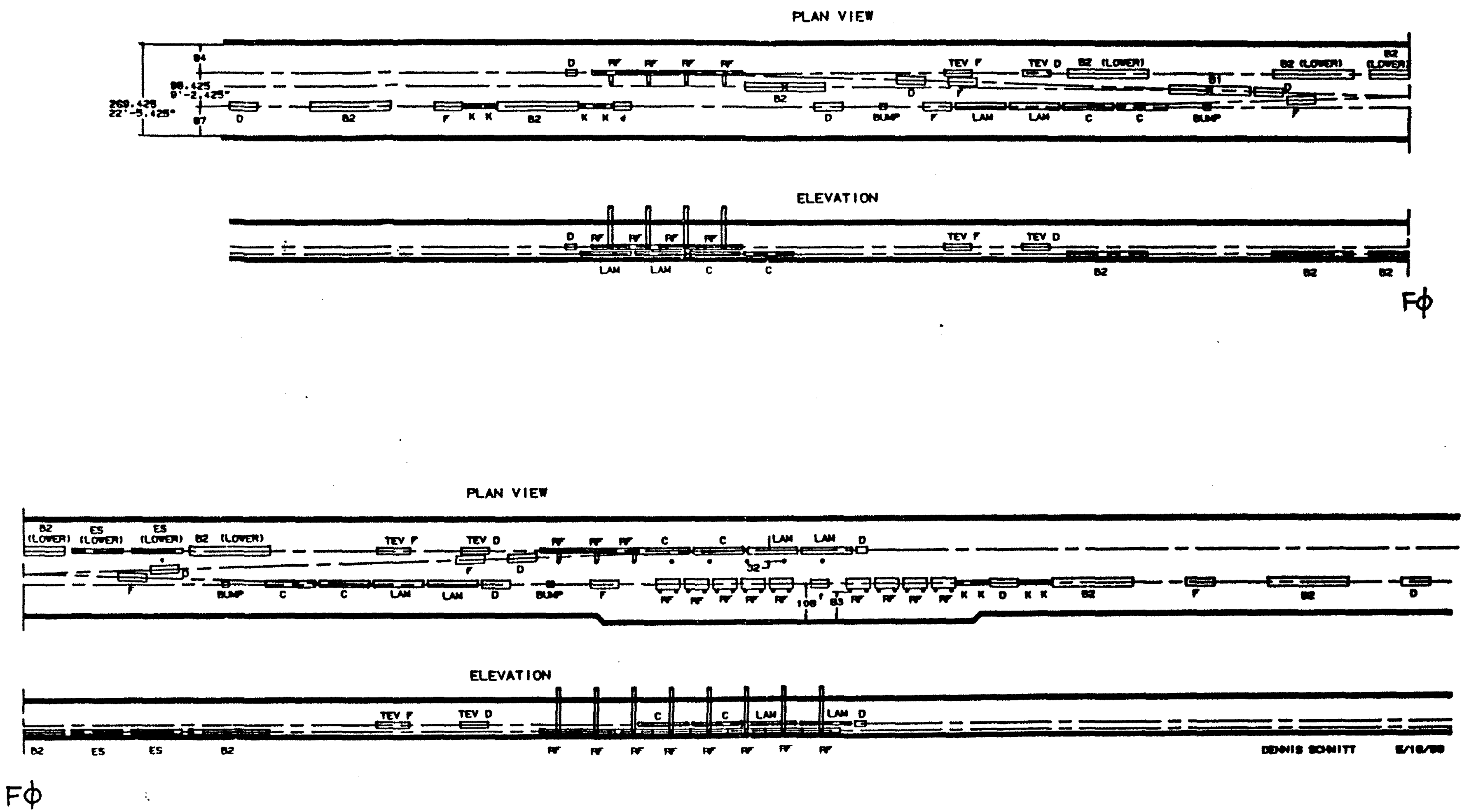


Figure 3-5: Plan and elevation views of the F0 straight section showing the New and Old Tevatrons, the new Main Injector, the two 150 GeV transfer lines, and the 120 GeV line.

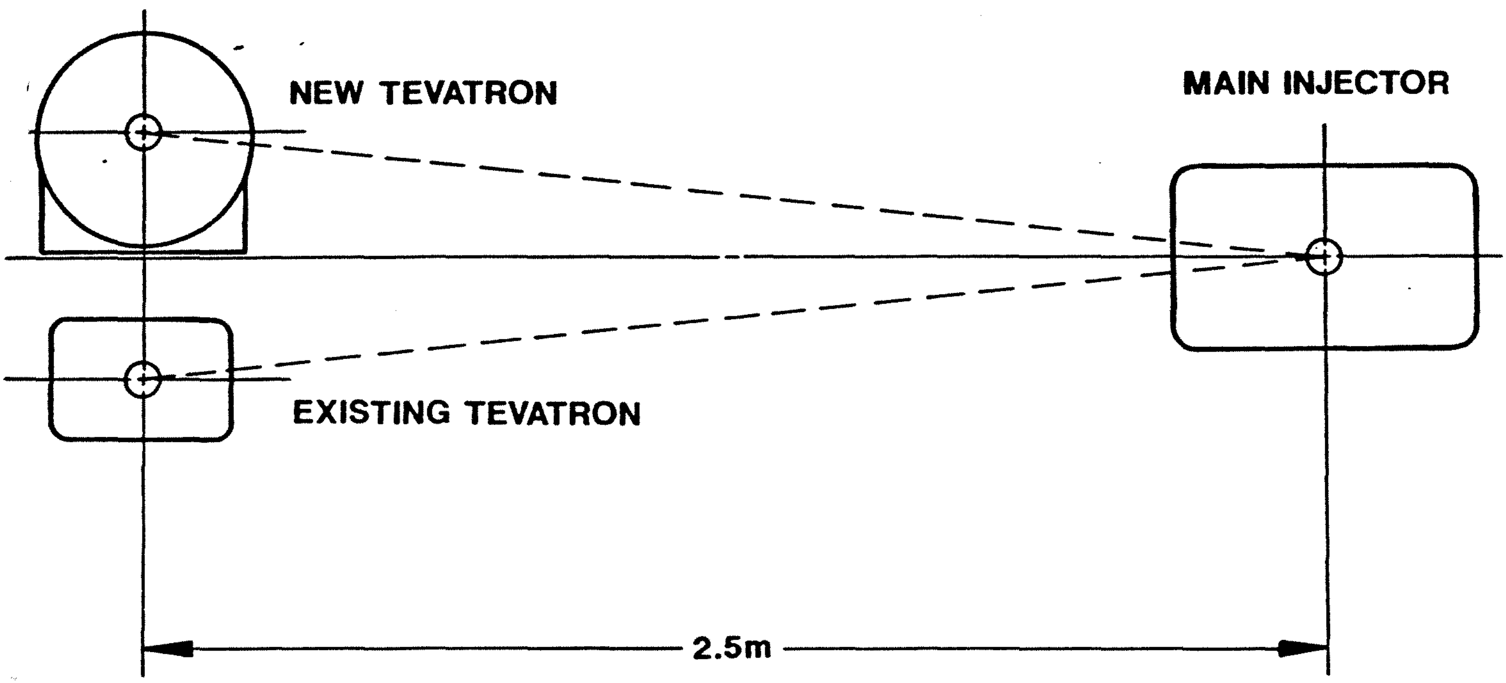


Figure 3-6: End view of the F0 straight section showing the Main Injector ring in relation to the two Tevatrons.

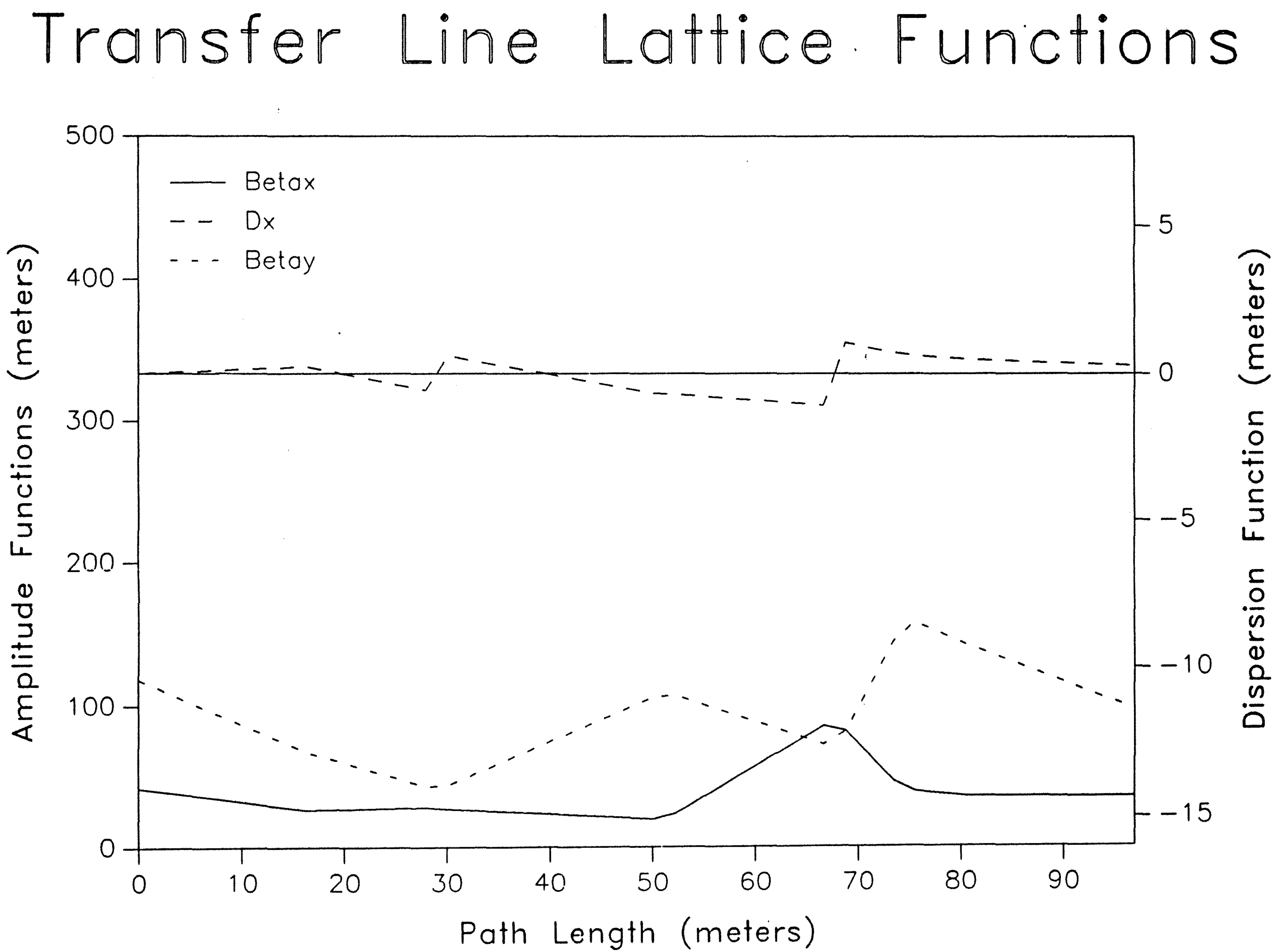


Figure 3-7: Lattice functions for the 150 GeV transfer lines.

quadrupole polarities when the bend field is reversed. Likewise, the two superconducting accelerators' lattices are identical across the straight section, as seen by the two beams. Therefore, the clockwise and counterclockwise extraction/injection systems are identical.

The Main Injector must also deliver 120 GeV protons to the antiproton production target. To do so, the counterclockwise system is used to extract the beam. A switching magnet, shown in Figure 3-5, is energized during this process to send beam toward the existing AP1 beamline. This switching magnet is also used to steer 8 GeV beam toward the Main Injector for clockwise injection. Because the kicker requirements for 150 GeV extraction and 8 GeV injection are very different, a separate kicker system is used for these two processes, though the components are physically located near each other. Also, since the Lambertson magnets involved in this process must have enough aperture to handle the larger 8 GeV beam, these magnets are different from the other sets.

Because 150, 120, and 8 GeV transfers already take place in the present Main Ring and Tevatron accelerators, much of this existing hardware can be used for the new systems. For instance, six of the eight Lambertson magnets presently at E0 can be used at F0. For the other two, where a larger aperture is needed, the magnets presently at F17 (used for antiproton injection into the Main Ring) can be used. The F17 system also employs two C magnets, which may be recovered. Duplicates of these C magnets need to be made for the remaining six necessary for the transfers. For the matching quadrupoles, existing 7' Main Ring quadrupoles will be used. The switching magnet is to be a Main Ring B1 magnet. The present 150 GeV kicker magnets are horizontally deflecting devices. The new design calls for vertical deflections. New kicker modules will be made, similar in style to the horizontal ones, but much of the power supply hardware may be reused.

The RF cavities for all three accelerators are located at F0. For the Main Injector to have the same acceleration rate of rise as the present Main Ring, only half of the Main Ring cavities are necessary. These cavities are situated at the South end of the F0 straight section, as indicated in Figure 3-5. The RF cavities for the two superconducting rings are also shown in this figure. The new ring will have only four cavities for use during collider operation, though space is available for more in the event that this machine would ever be used for fixed target operation. During fixed target operation the four cavities in the New Tevaron are moved to the old Tevatron giving the required number of eight. Each set of cavities is located on the opposite side of the straight section from the injection Lambertsons for that ring.

In the present Tevatron, the fixed target extraction electrostatic septa are located in the D0 straight section. These septa may be moved to the F0 region and still maintain the proper phase with respect to the A0 extraction Lambertsons. These devices, and their associated warm magnet dipole bump, are located in the middle of the straight section of the present Tevatron ring, as shown in Figure 3-5.

3.3 Magnets and Power Supplies

Specification of dipole magnet and power supply requirements for all beamlines has been done on the basis of generating the beamline geometries shown in Figure 3-1. For the two 150 GeV Main Injector-to-Tevatrons transfers the quadrupole magnet specification is based on an optical calculation of the beamlines (which are identical). For the 8 GeV North, 8 GeV West, and 120 GeV lines the specification is based on our experience with similar existing lines at Fermilab.

Magnet Requirements

Magnet requirements for the beamlines are summarized in Table 3-1. The two beamlines operating at 8 GeV require the construction of a new (for Fermilab) magnet type which is designated as "PSB Style". Cross sections of the PSB dipole and quadrupole are shown in Figure 3-8. The table indicates in which cases existing magnets recovered from the Main Ring, the existing 8 GeV line, or from the existing 120 GeV (AP-1) line can be used. The trim dipoles designated "Debuncher" style are copies of existing magnets used in the Antiproton Source.

Power Supply Requirements

Power supply requirements for the beamlines are given in Table 3-2. As in the case of the magnets some of these supplies already exist. Supplies will loacted as follows: 8 GeV North supplies in the existing Antiproton Target Hall (AP0), 8 GeV West supplies in the Main Injector service building N20, 120 GeV supplies in the existing Main Ring service building F1, and 150 GeV supplies in the new F0 service building. All dipole supplies will be ramped in order to limit the average power consumed by the beamlines to 1.2 MW. Not included in the table are existing power supplies used to power existing magnets in those portions of the AP-1, AP-3, and AP-4 lines used in this project.

Table 3-2: Beamline Power Supply Requirements

	Number	Peak Power(KVA)	Peak Current(Amps)	Exist
8 GeV North				
Dipole	1	219	2720	No
Dipole	1	17	1850	No
Dipole	1	97	3140	No
Quadrupole	6	2.5	500	No
Trims	9	0.4	20	No
8 GeV West				
Dipole	1	424	2720	Yes
Quadrupole	6	2.5	500	No
Trims	10	0.4	20	No
120 GeV				
Dipole	2	248	3360	Yes
Quadrupole	6	813	3360	Y(1)
Trims	9	2	100	No
150 GeV				
Dipole	1	90	3900	No
Quadrupole	4	63	3700	No
Lambertson	1	48	1555	Yes
C-Magnet	1	264	3300	No
Lambertson+C	1	294	3500	No

4. NEW TEVATRON

4.1 Lattice and Layout

The New Tevatron synchrotron will reside in the main accelerator enclosure directly above the present Tevatron. The separation of the two beams throughout most of the tunnel is 50 cm. As described in the Tevatron Design Report[1] the synchrotron lattice is divided into six arcs separated by long straight sections. The arcs are composed of FODO cells, 58.9 m long, with phase advance of 68° per cell. Each half cell of the new machine will contain three 4.4 T dipoles each of length 8.5 m in contrast to the present Tevatron which has four dipoles each of length 6.1 m. These new magnets are described in Section 4-3. Figure 4-1 shows the layout of a standard cell in the present Tevatron and in the New Tevatron, along with the cell's lattice functions.

A cross section of a typical arc location was shown in Figure 1-4. The medium straight sections (one per arc) will remain identical to the present Tevatron. The functions of the long straight sections are described in Table 4-1. Some of the more relevant machine parameters are listed in Table 4-2.

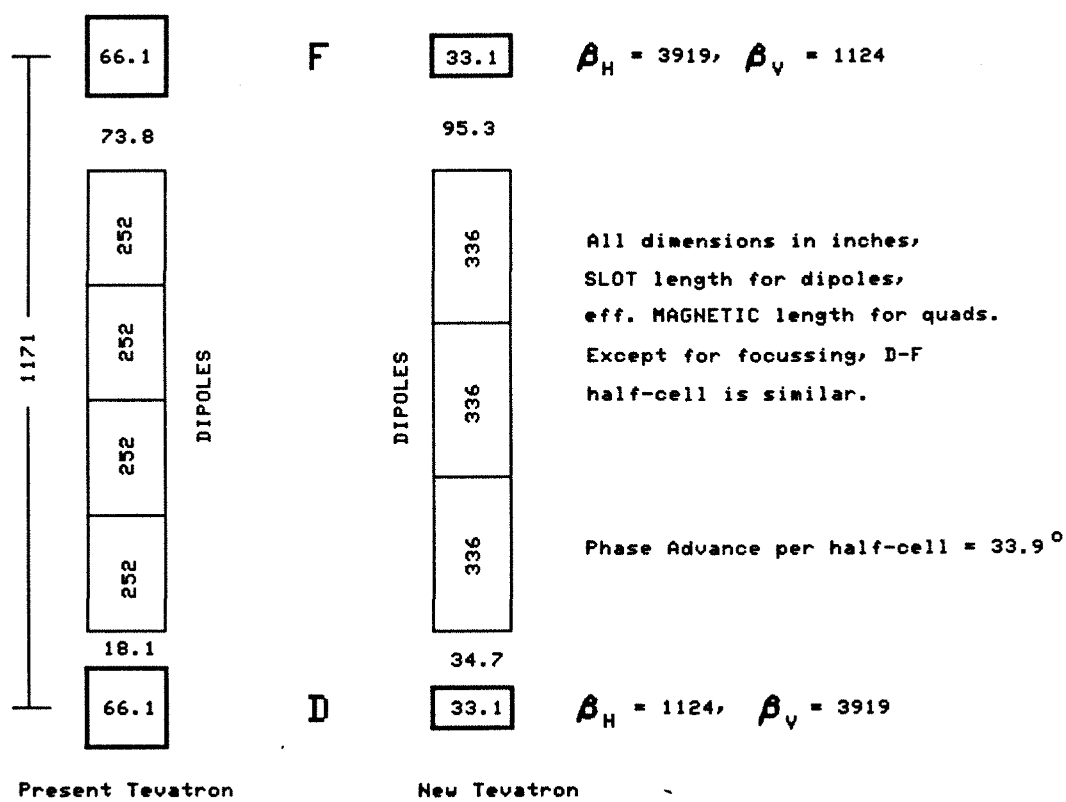
To make room for bringing the two vertically separated 1 TeV beams together in the interaction regions, the straight sections in these regions need to be made longer. To do so requires the use of stronger bending magnets just outside the interaction regions. This also moves the straight section radially inward by approximately 29 in. The interaction regions and the 6.6 T bending magnets are described in more detail in the following sections.

A similar strong dipole scheme is employed at the F0 straight section to make room for two injection lines and RF cavities. Here, the region shifts radially inward by 59 in. This area was described in detail in the previous chapter. Each of the revised straight sections is "matched" optically to the arcs of the accelerator lattice, which remain identical to the original Tevatron design. The A0 and C0 straight section regions also remain unmodified. Figure 4-2 and Figure 4-3 show the amplitude functions and dispersion functions of the new accelerator at injection and at high energy.

It should be noted that the above changes to the three straight sections must be performed on the present Tevatron as well as in the new machine. Table 4-3 lists the bending magnet requirements for the New Tevatron as well as magnet modifications to the present Tevatron. The circumference of each Tevatron accelerator is 21 cm shorter than the original Tevatron due to the radially inward displacements at the three long straight sections.

Within the interaction regions the counter-rotating beams share common focussing elements. The "clockwise" beam would see one triplet as FDF whereas the "counterclockwise" beam would see the same triplet as DFD. For

Figure 4-1 Tevatron Standard Cell



Long Straight Section	Function
A0	Remains available for fixed target extraction from New Tevatron
B0	CDF Interaction Region
C0	Abort systems for both Tevatron rings
D0	D0 Interacton Region
E0	Available for Future Interaction Region
F0	Injection Lines, RF stations, for both Tevatrons; Extraction septa for fixed target operation of present Tevatron

Table 4-1 New Tevatron Long Straight Sections

Table 4-2 New Tevatron Parameter List

Circumference	6283	meters
Injection Energy	150	GeV
Peak Energy	1000.0	GeV
Harmonic Number (@53 MHz)	1113	
Horizontal Tune	20.6	
Vertical Tune	20.6	
Transition Gamma	18.4	
Number of Bunches	996	
Protons/Bunch	2.0 E10	
Transverse Emittance (Normalized)	6 π	mm-mr
Longitudinal Emittance/Bunch	.25	eV-sec
β^*	0.25	meters
β_{max}(Arcs)	100.0	meters
β_{max} (IR at Injection)	280.0	meters
β_{max} (IR at Low-β)	1650.0	meters
Maximum Dispersion	9	meters
Number of Straight Sections	6	
Number of Possible Interaction Regions	3	
Length of Standard Cell	59.4	meters
Phase advance of Cell	68	degrees
RF Frequency	53.0	MHz
RF Voltage	1	MV
Number of dipoles in Standard Cell	6	
Dipole Field (Max)	4.4/6.6	Tesla
Number of 4.4 Tesla Dipoles	507 + 37	
Number of 6.6 Tesla Dipoles	46	
Dipole Length	up to 8.5	meters
Number of Standard Quadrupoles	180	
Number of Special Length Quadrupoles	28	
Number of Vertical Crossing Magnets	12	

MAGNET MODIFICATIONS TO OLD TEVATRON:

Number of 6.6 Tesla Dipoles	44	

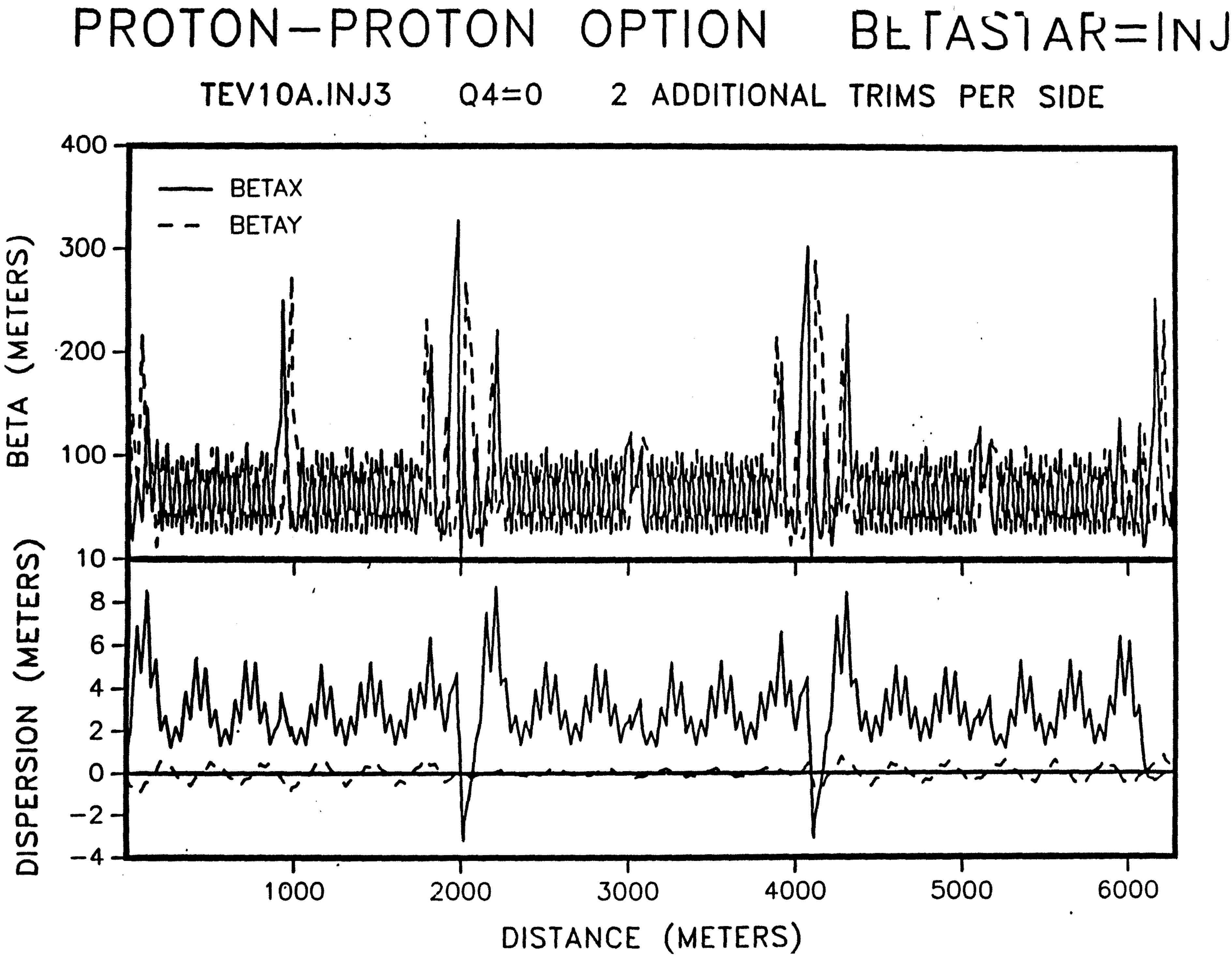


Figure 4-2. Tevatron Lattice Functions at Injection

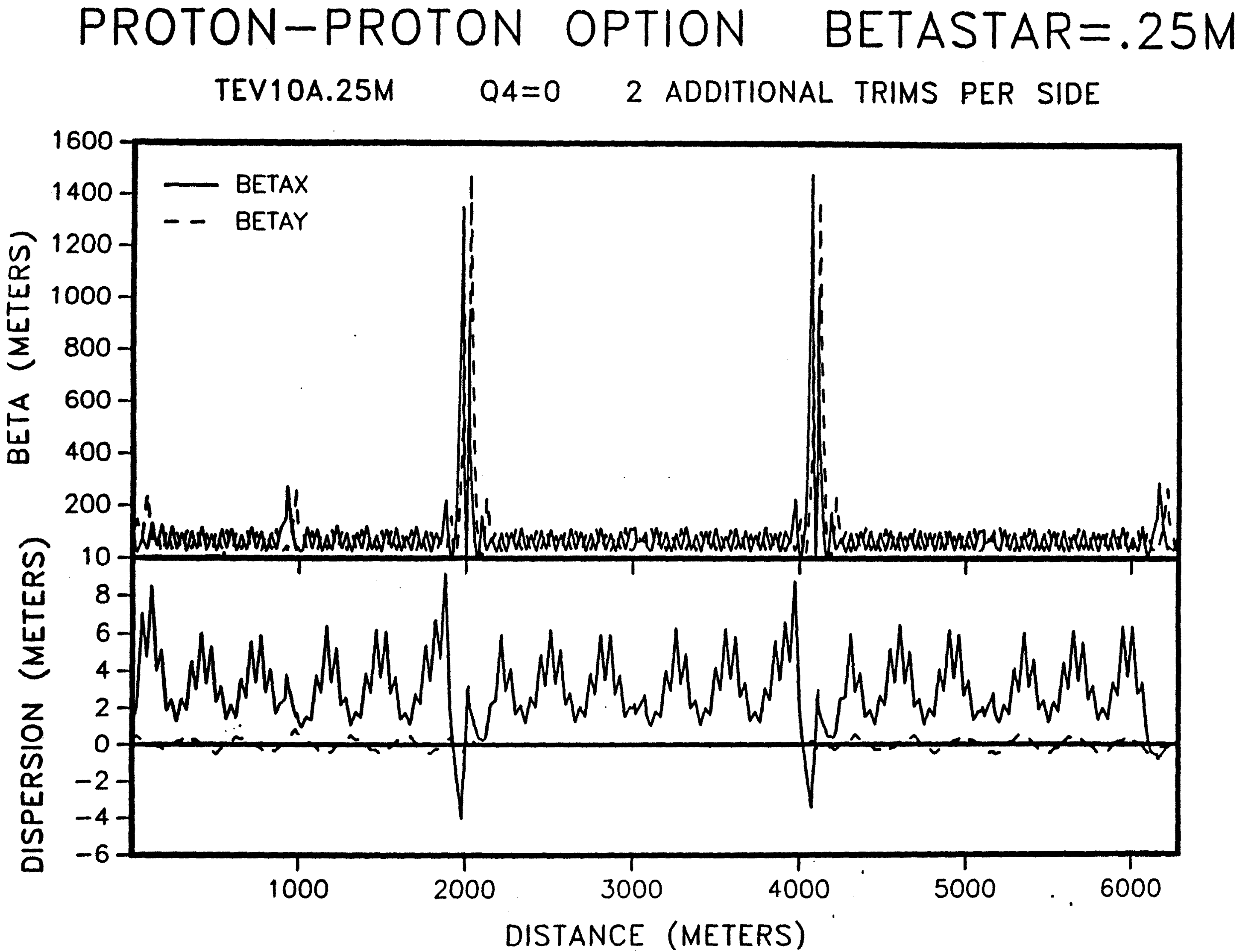


Figure 4-3. Tevatron Low-β Lattice Functions

Table 4-3 New Tevatron Magnet Count

A-Sector

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m
A0 - 11					
A11 - 12	3				2
A12 - 13	3				1
A13 - 14	3			1	
A14 - 15	3			1	
A15 - 16	3			1	
A16 - 17	3			1	
A17 - 18		2		1	
A18 - 19	3			1	
A19 - 21	3			1	
A21 - 22	3			1	
A22 - 23	3			1	
A23 - 24	3			1	
A24 - 25	3			1	
A25 - 26	3			1	
A26 - 27	3			1	
A27 - 28	3			1	
A28 - 29	3			1	
A29 - 32	3			1	
A32 - 33	3			1	
A33 - 34	3			1	
A34 - 35	3			1	
A35 - 36	3			1	
A36 - 37	3			1	
A37 - 38	3			1	
A38 - 39	3			1	
A39 - 42	3			1	
A42 - 43	3			1	
A43 - 44	3			1	
A44 - 45	3			1	
A45 - 46	3			1	
A46 - 47		1	3	1	
A47 - 48		1	2	1	
A48 - 49			1		1
A49 - B0					(4;common)
TOTALS:	87	4	6	30	4

Table 4-3 (cont'd)

B-Sector

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m	4.4 T 3.0 m
B0 - 11					(3;common)	
B11 - 12			1		(1;common)	
B12 - 13			4		1	
B13 - 14		3	1	1		
B14 - 15	3			1		
B15 - 16	3			1		
B16 - 17	3			1		
B17 - 18		2		1		
B18 - 19	3			1		
B19 - 21	3			1		
B21 - 22	3			1		
B22 - 23	3			1		
B23 - 24	3			1		
B24 - 25	3			1		
B25 - 26	3			1		
B26 - 27	3			1		
B27 - 28	3			1		
B28 - 29	3			1		
B29 - 32	3			1		
B32 - 33	3			1		
B33 - 34	3			1		
B34 - 35	3			1		
B35 - 36	3			1		
B36 - 37	3			1		
B37 - 38	3			1		
B38 - 39	3			1		
B39 - 42	3			1		
B42 - 43	3			1		
B43 - 44	3			1		
B44 - 45	3			1		
B45 - 46	3			1		
B46 - 47	3			1		
B47 - 48	3			1		
B48 - 49		2			1	1
B49 - C0					2	
TOTALS:	84	7	6	30	4	1

Table 4-3 (cont'd)

C-Sector

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m	4.4 T 3.0 m
C0 - 11						
C11 - 12			2		2	1
C12 - 13	3				1	
C13 - 14	3			1		
C14 - 15	3			1		
C15 - 16	3			1		
C16 - 17	3			1		
C17 - 18		2		1		
C18 - 19	3			1		
C19 - 21	3			1		
C21 - 22	3			1		
C22 - 23	3			1		
C23 - 24	3			1		
C24 - 25	3			1		
C25 - 26	3			1		
C26 - 27	3			1		
C27 - 28	3			1		
C28 - 29	3			1		
C29 - 32	3			1		
C32 - 33	3			1		
C33 - 34	3			1		
C34 - 35	3			1		
C35 - 36	3			1		
C36 - 37	3			1		
C37 - 38	3			1		
C38 - 39	3			1		
C39 - 42	3			1		
C42 - 43	3			1		
C43 - 44	3			1		
C44 - 45	3			1		
C45 - 46	3			1		
C46 - 47		1	3	1		
C47 - 48		1	2	1		
C48 - 49			1		1	
C49 - D0					(4;common)	
TOTALS:	84	4	8	30	4	1

Table 4-3 (cont'd)

D-Sector

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m
D0 - 11					(3;common)
D11 - 12			1		(1;common)
D12 - 13	3		4		1
D13 - 14	3	3	1	1	
D14 - 15	3			1	
D15 - 16	3			1	
D16 - 17	3			1	
D17 - 18		2		1	
D18 - 19	3			1	
D19 - 21	3			1	
D21 - 22	3			1	
D22 - 23	3			1	
D23 - 24	3			1	
D24 - 25	3			1	
D25 - 26	3			1	
D26 - 27	3			1	
D27 - 28	3			1	
D28 - 29	3			1	
D29 - 32	3			1	
D32 - 33	3			1	
D33 - 34	3			1	
D34 - 35	3			1	
D35 - 36	3			1	
D36 - 37	3			1	
D37 - 38	3			1	
D38 - 39	3			1	
D39 - 42	3			1	
D42 - 43	3			1	
D43 - 44	3			1	
D44 - 45	3			1	
D45 - 46	3			1	
D46 - 47	3			1	
D47 - 48	3			1	
D48 - 49		3			1
D49 - E0					2
TOTALS:	90	8	6	30	4

Table 4-3 (cont'd)

E-Sector

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m
E0 - 11					
E11 - 12	3				2
E12 - 13	3				1
E13 - 14	3			1	
E14 - 15	3			1	
E15 - 16	3			1	
E16 - 17	3			1	
E17 - 18		2		1	
E18 - 19	3			1	
E19 - 21	3			1	
E21 - 22	3			1	
E22 - 23	3			1	
E23 - 24	3			1	
E24 - 25	3			1	
E25 - 26	3			1	
E26 - 27	3			1	
E27 - 28	3			1	
E28 - 29	3			1	
E29 - 32	3			1	
E32 - 33	3			1	
E33 - 34	3			1	
E34 - 35	3			1	
E35 - 36	3			1	
E36 - 37	3			1	
E37 - 38		1	2	1	
E38 - 39		1	2	1	
E39 - 42	3			1	
E42 - 43	3			1	
E43 - 44	3			1	
E44 - 45	3			1	
E45 - 46		3	1	1	
E46 - 47			4	1	
E47 - 48			3	1	
E48 - 49	0	0	0		1
E49 - F0					2
TOTALS:	78	7	12	30	6

Table 4-3 (cont'd)

F-Sector	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m	Std Quads .84 m	Spc Quads .32-1.3 m
F0 - 11					
F11 - 12					2
F12 - 13			4		1
F13 - 14			4	1	
F14 - 15	3			1	
F15 - 16	3			1	
F16 - 17	3			1	
F17 - 18		2		1	
F18 - 19	3			1	
F19 - 21	3			1	
F21 - 22	3			1	
F22 - 23	3			1	
F23 - 24	3			1	
F24 - 25	3			1	
F25 - 26	3			1	
F26 - 27	3			1	
F27 - 28	3			1	
F28 - 29	3			1	
F29 - 32	3			1	
F32 - 33	3			1	
F33 - 34	3			1	
F34 - 35	3			1	
F35 - 36	3			1	
F36 - 37	3			1	
F37 - 38	3			1	
F38 - 39	3			1	
F39 - 42	3			1	
F42 - 43	3			1	
F43 - 44	3			1	
F44 - 45	3			1	
F45 - 46	3			1	
F46 - 47	3			1	
F47 - 48	3			1	
F48 - 49		3			1
F49 - A0					2
TOTALS:	84	5	8	30	6

Table 4-3 (cont'd)

SUB-TOTALS:

4.4 T , 8.5 m :	507
4.4 T , 6.1 m :	35
4.4 T , 3.0 m :	2
6.6 T , 6.1 m :	46
Std. Quad, .84 m :	180
Special Quads :	
.32 m	2
.41 m	6
.69 m	4
1.05m	6
1.15m	2
1.3 m	8
TOTAL:	28
New Spools :	204

Table 4-3 (cont'd)

BEND MAGNET MODIFICATIONS TO PRESENT TEVATRON:

	4.4 T 8.5 m	4.4 T 6.1 m	6.6 T 6.1 m
A46 - 47		-3	+3
A47 - 48		-3	+2
A48 - 49		-3	+1
B11 - 12		-4	+1
B12 - 13		-4	+4
B13 - 14		-1	+1
C46 - 47		-3	+3
C47 - 48		-3	+2
C48 - 49		-3	+1
D11 - 12		-4	+1
D12 - 13		-4	+4
D13 - 14		-1	+1
F18 - 19		-3	+2
F19 - 21		-3	+2
E45 - 46		-1	+1
E46 - 47		-4	+4
E47 - 48		-4	+3
E48 - 49		-3	--
F11 - 12		-4	--
F12 - 13		-4	+4
F13 - 14		-4	+4

New Spools at F0: 16

Table 4-3 (cont'd)

GRAND-TOTALS:

Horizontal Bending Magnets --	
4.4 T , 8.5 m :	507
4.4 T , 6.1 m :	35
4.4 T , 3.0 m :	2
6.6 T , 6.1 m :	90
Vertical Bending Magnets --	
6.6 T , 4.4 m :	12
Std. Quad, .84 m :	180
Special Quads :	
.32 m	2
.41 m	6
.69 m	4
1.05m	6
1.15m	2
1.3 m	8
Total:	28
Spools :	220
Spare Old Tevatron-Style:	
4.4 T , 6.1 m :	69

this reason, the focussing characteristics of the quadrupole magnets which lie one above the other in the remainder of the two superconducting rings must be opposite each other, as depicted in Figure 4-4. Therefore, whereas the dipole magnets in the two rings must produce fields of opposite signs, a quadrupole magnet in one ring must produce a field of the same sign as the quadrupole magnet in the other ring at the same azimuthal location.

Though the quadrupole optics are antisymmetric across each straight section of the two rings, the dipole geometry is not. This results in different dispersion functions for the two accelerators. To produce zero dispersion at the interaction points and through the F0 straight section, and to keep the dispersion wave minimal throughout the two rings, each ring uses different quadrupole settings surrounding these straight sections. A tabulation of lattice parameters for the New Tevatron may be found in Appendix C.

4.2 Interaction Regions

At each interaction region, the normally separate proton beams collide and β^* is adjusted down to 25 cm to raise the interaction luminosity. Interaction regions are required at the B0 and D0 detector locations. The interaction regions have identical optics. Each insert is nominally matched to the accelerator arcs, making them approximately independent except through the tunes. Each low-beta interaction region raises the accelerator tune nominally a half integer.

The beam crossing geometry of an interaction region is depicted in Figure 4-5. The beams are brought into collision with six 6.6 T, 4.44 m long vertical dipoles. The lattice elements Q4 through -Q4 are shared by the upper and lower ring. The physical aperture of Q4 limits the longitudinal center-to-center separation of the vertical dipoles to 28.37 m. The vertical orbit separation of the two rings is therefore 50 cm.

A horizontal crossing angle is used to reduce the beam-beam effects associated with adjacent collision points. A .3 mr crossing angle results in a 5σ or larger beam separation for 6π normalized emittance beams. The crossing angle is obtained with small trim magnets normally used to straighten the orbit through the straight section.

In order to make room in the lattice for the vertical bend magnets and at the orbit vertices, to eliminate the need for special two-in-one magnets, 3/2 strength dipoles are used to shift some of the horizontal bend magnets out of the half-cells adjacent to the interaction region. Unlike the F0 straight section, one 3/2 strength dipole per half-cell is retained in order to reduce the required radial position adjustment of the colliding beam detectors. Special cryostats will be required for these magnets to assure adequate vertical clearance.

A comparison of the pp interaction region and the p$\bar{p}$ interaction region as it will appear after the scheduled 1989 installation is shown in Figure 4-6. The p$\bar{p}$ insert retains the original dipole configuration of 4.4 T dipoles. The clockwise side of the pp insert determines the minimum radial orbit offset possible by placing 6 stronger dipoles - one between station 11 and 12, four between 12 and 13 and the last in the first slot between 13 and 14 - as close to the straight section as possible. The magnetic length and slot length of

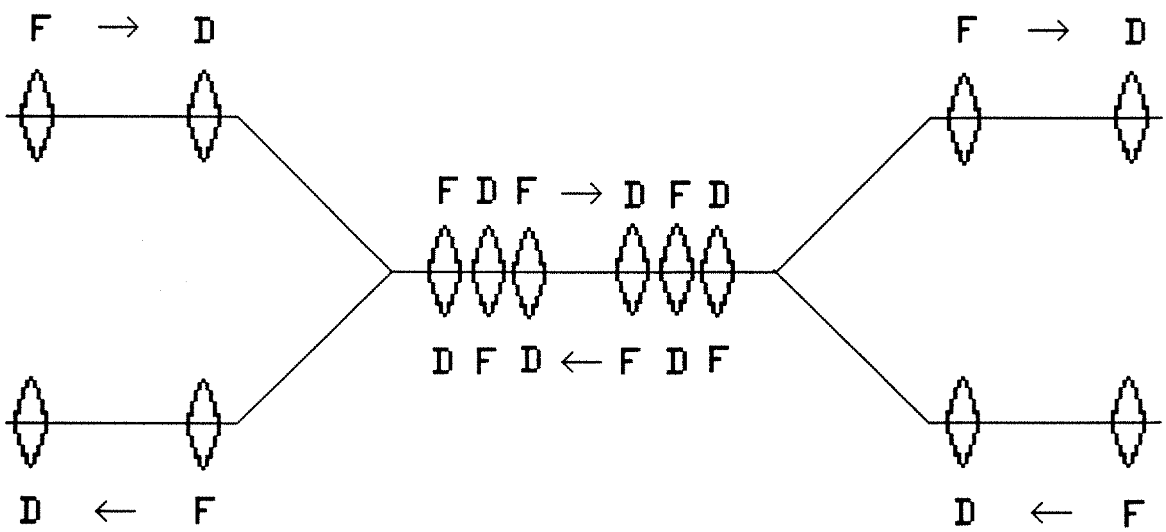


Figure 4-4 Quadrupole Focussing Scheme
at Interaction Region

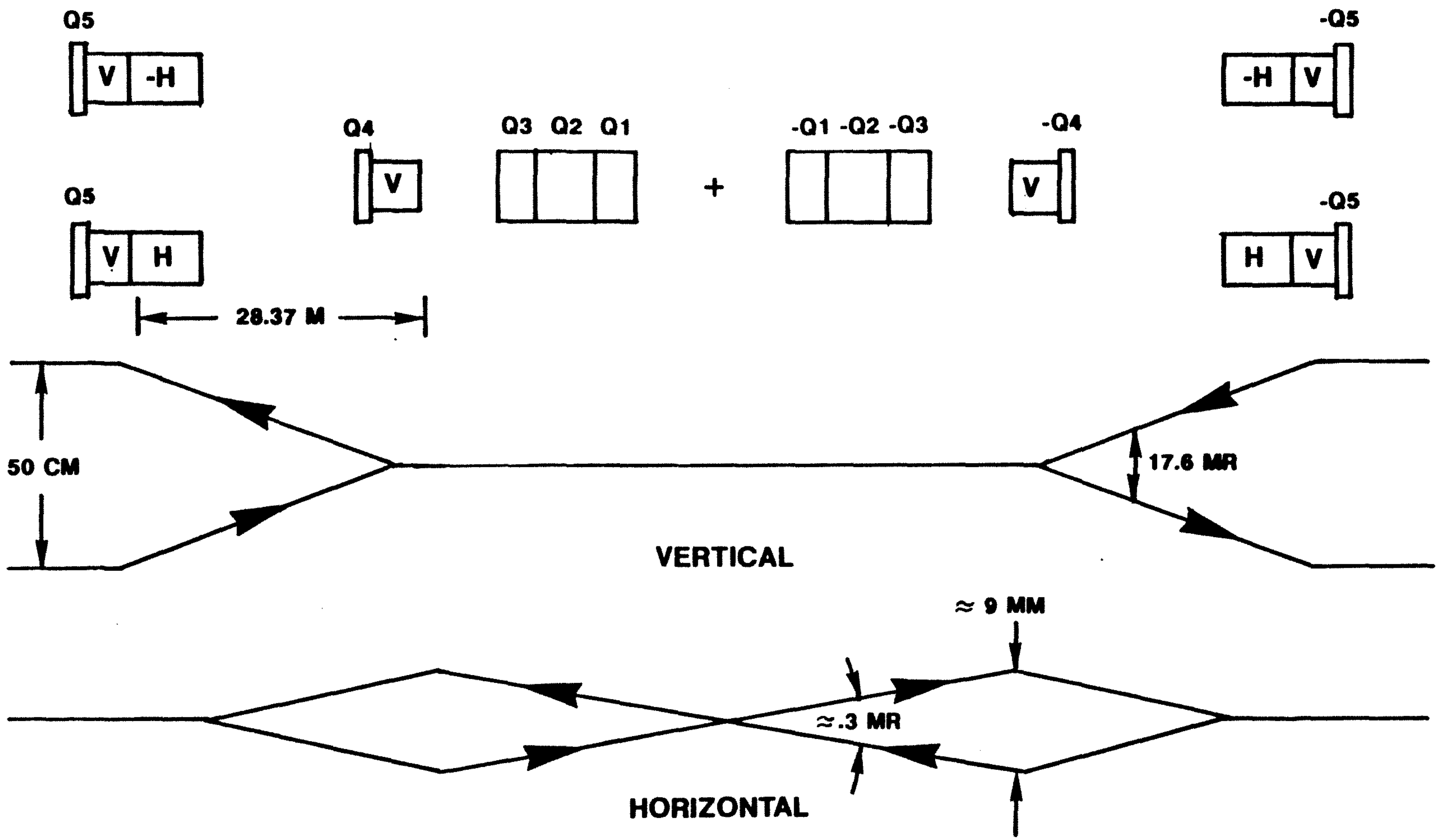


Figure 4-5. Tevatron Crossing Geometry

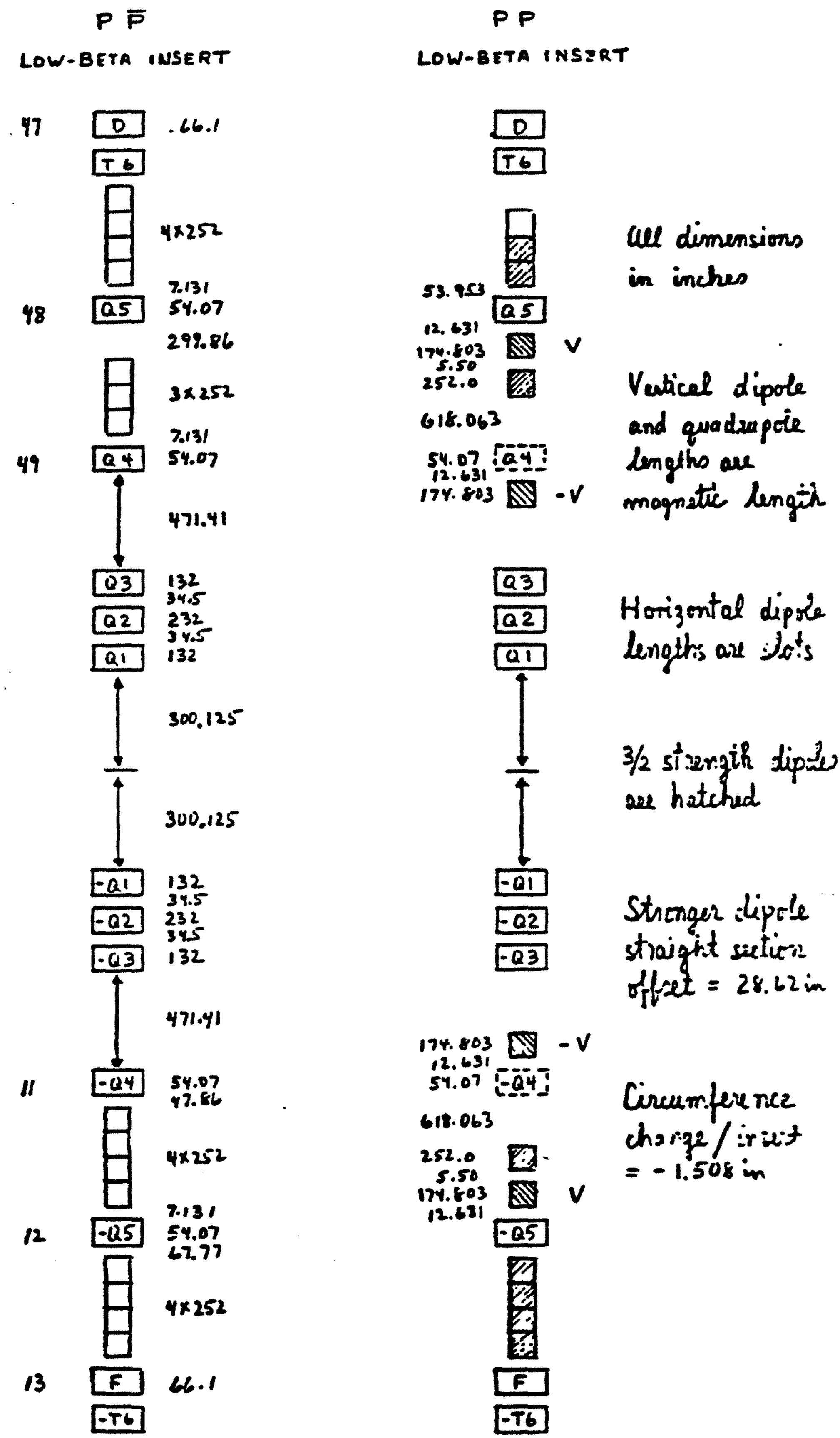


Figure 4-6. Tevatron Low-β Inserts

the stronger dipoles are identical to the replaced dipoles, 241 in and 252 in respectively. The opposite side has 6 high strength dipoles distributed as follows; 3 in the last three slots between 46 and 47, 2 between 47 and 48 and the last between 48 and 49. The new magnet geometry maintains bend angles and both sides have the same radial orbit offset.

The low-beta quadrupole geometry of the two inserts shown in the figure is identical. This allows the use of existing components for the new interaction region and the additional required components to complete the second ring, excepting the higher field dipoles, are duplicates of previously proven equipment.

The inner low-beta quadrupoles - Q1 throught Q5 - are symmetrically placed relative to the interaction point and asymmetric in gradients. These magnets are 1.4 T/cm at 5 kA, 2-shell, cold iron superconducting magnets with 3 in id coils and a physical aperture of 2.6 in. The Q1-Q2-Q3 triplets tightly focus the beams at the center of the straight section; Q4 and Q5 program β^* from a high of 1.7 m at injection to a low of .25 m during colliding beam operation. In addition, high gradient trim quadrupoles (QT6, QT7, QT8, QT9,-QT6,-QT7,-QT8 and -QT9) which replace weaker tune correction quadrupoles in the spools located at the 43, 44, 46, 47, 13, 14, 16 and 17 locations of the ring, are used to match the low-beta insert to the adjacent arcs. QT6 and -QT6 are shorter versions of the 2-shell low-beta quadrupole design. The remaining trim quadrupoles are a .7 T/cm, single-shell, 5-in -1 conductor, cold iron design that operates at a peak current of 1.5 kA. The low-beta quadrupoles including trim quadrupoles are independently powered. The higher field horizontal and vertical dipoles are powered as part of the Tevatron bus.

The new dipole geometry in the pp interaction regions and the reversed proton velocity in the second ring means that the low-beta gradients of the $p\bar{p}$, forward pp and reversed pp inserts will be different if the dispersions are matched. In principle, this should be feasible as only 4 low-beta quadrupole circuits are common to the two rings. In practice, a 1 m vertical dispersion wave is tolerable and only the horizontal dispersion will be rematched. Figure 4-7 shows the beta functions of the forward pp low-beta insert for β^* equal to 25 cm. The vertical and horizontal dispersion at the interaction point are 13 cm and 8 cm respectively.

4.3 Magnets

4.3.1 4.4 T Dipoles.

The bulk of the magnets for the proposed New Tevatron are 4.4 Tesla dipoles. These magnets are installed in a lattice virtually identical to that of the present Tevatron, i.e., a half-cell worth of dipoles occupies 1008 inches of beam line, just like the present machine. Existing Tevatron dipoles occupy a slot length of 252 inches each (6.4 m). In the New Tevatron, 3 dipoles will be installed for every 4 Tevatron dipoles resulting in a new dipole length of 8.5 m (4/3 times 6.4 m). The increased length strikes a compromise between ease of installation in the existing tunnel and minimization of magnet end effects and number of magnet interconnections.

Unlike the existing warm-iron dipoles, the New Tevatron dipoles employ cold-iron. Cold iron allows the iron to be brought closer to the collared

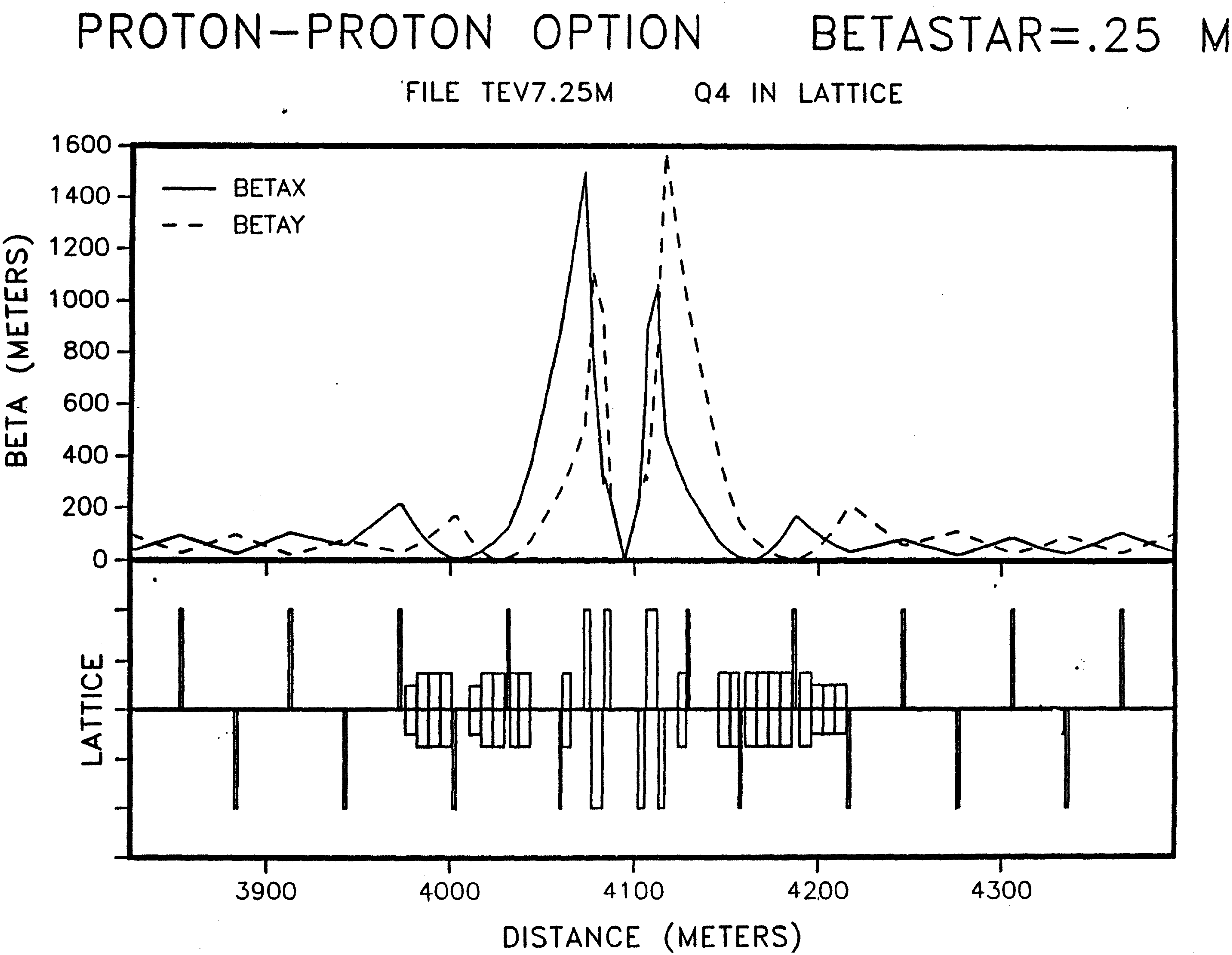


Figure 4-7. Interaction Region Low-β Lattice Functions

coil assembly which minimizes the amount of iron required and affords space for installation of a thermally efficient magnet suspension system.

Figure 4-8 shows a cross section of the proposed 4.4T dipole design at a cold mass suspension point. The collared coil assembly is 5.9 inches in diameter surrounded by a two-phase helium annular shell acting as a counterflow heat exchanger with the single-phase helium bathing the coil assembly. The cold iron is immediately adjacent to the two-phase shell and is 6.4 inches inside diameter, 13.0 inches outside diameter. The cold iron is sheathed in a 0.125 inch thick stainless steel skin serving as the single-phase helium containment. The next shell outboard from the cold mass assembly is an 80K LN2 shield which serves to intercept heat radiating from the inner surface of the vacuum vessel at 300K. The 80K shield is cooled by LN2 flowing in two 1 inch tubes. The 4.5K and 80K surfaces are wrapped with aluminized mylar multi-layer insulation. The entire cold assembly (cold mass and 80K shield) is installed in an 18 inch OD, 1/4 inch wall, carbon steel vacuum vessel.

Figure 4-9 illustrates the cryogenic piping at the interface region between magnet assemblies. Each service pipe; single and two-phase helium, LN2 shield, and bore tube terminate at a welded stainless steel bellows. The connections between all magnet assemblies are welded.

The cold mass assembly is supported at three points along its length by composite, re-entrant post assemblies. The support post at the center acts to restrain vertical, lateral, and axial motion of the cold mass. The two outboard supports provide vertical and lateral support only. They are connected to the cold mass with joints that are free to slide axially, allowing free contraction of the cold assembly during cooldown. Figure 4-10 illustrates a cross section through a support post for the 4.4T dipole.

Each dipole contains a single phase helium relief tube assembly, an insulating vacuum relief, and an insulating vacuum pumpout port.

4.3.2 6.6 T Dipoles. High field horizontal bending dipoles are required at 46 places around the proposed New Tevatron and are required as replacements for 44 dipoles in the existing Tevatron. In addition, 12 high field vertical bending dipoles are required to bring the beams together at the interaction regions. Due to the increased iron size required by the higher field, it is not possible to simply scale up the 4.4T dipole design. It is possible, however, to take advantage of the lesser need for iron along the vertical parting plane.

Figure 4-13 shows a cross section of the proposed 6.6T dipole, again at a suspension point. The collared coil is 6.6 inches in diameter and is surrounded by a two-phase annular shell. The iron is 7.1 inches inside diameter. Unlike the 4.4T dipole with circular iron, the 6.6T version uses a truncated iron yoke, 18.1 inches in diameter at the horizontal parting plane and 12.6 inches in height at the vertical parting plane. In order to fit in the existing tunnel, this configuration requires a rectangular vacuum vessel. The 6.6T dipoles uses an 80K LN2 shield identical in function, but different in shape to the 4.4T version. The vacuum vessel is 22 inches wide, 18-1/2 inches high, 1/2 inch thick, fabricated from carbon steel.

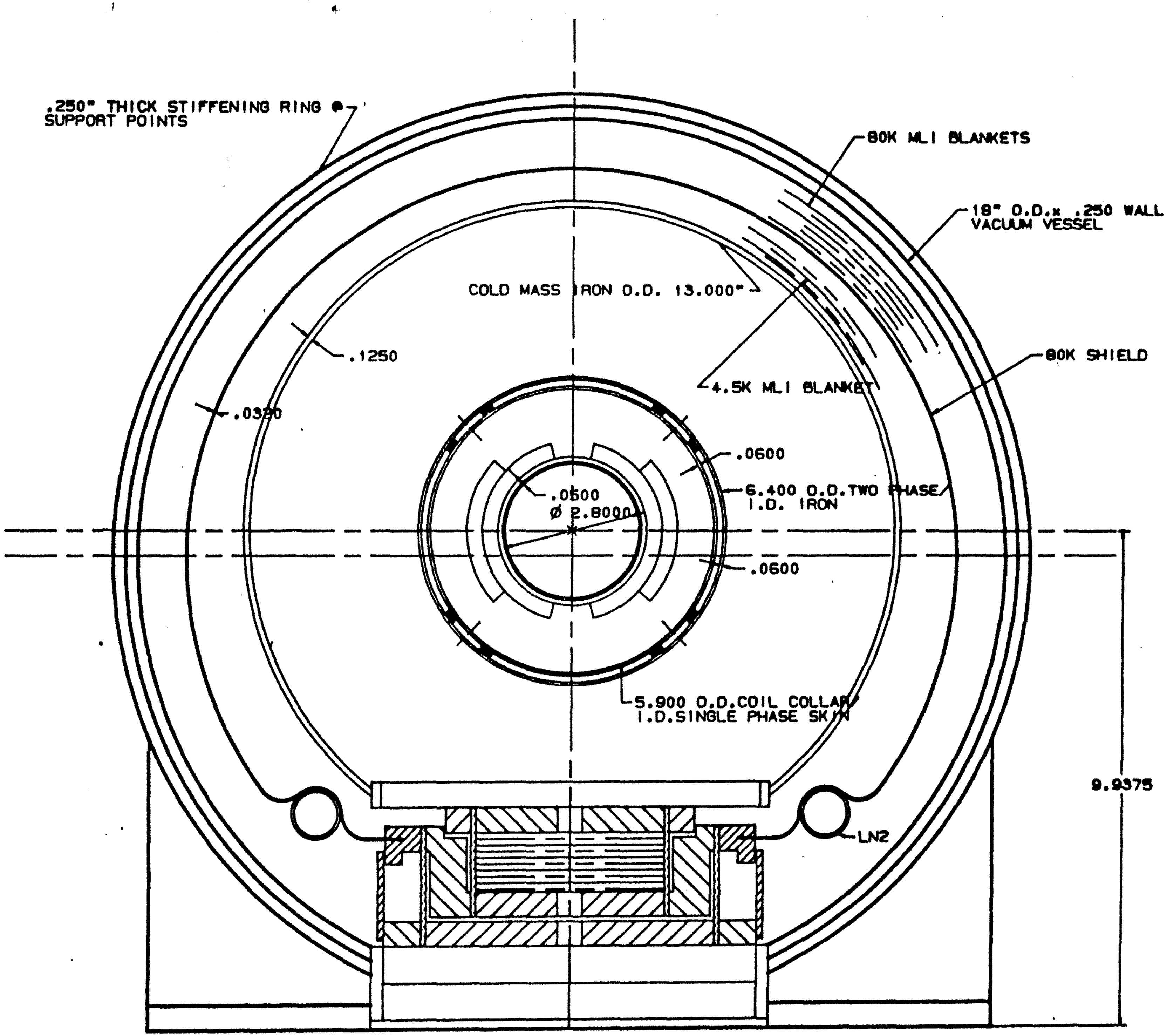


Figure 4-8. 4.4 Tesla Dipole Cross Section

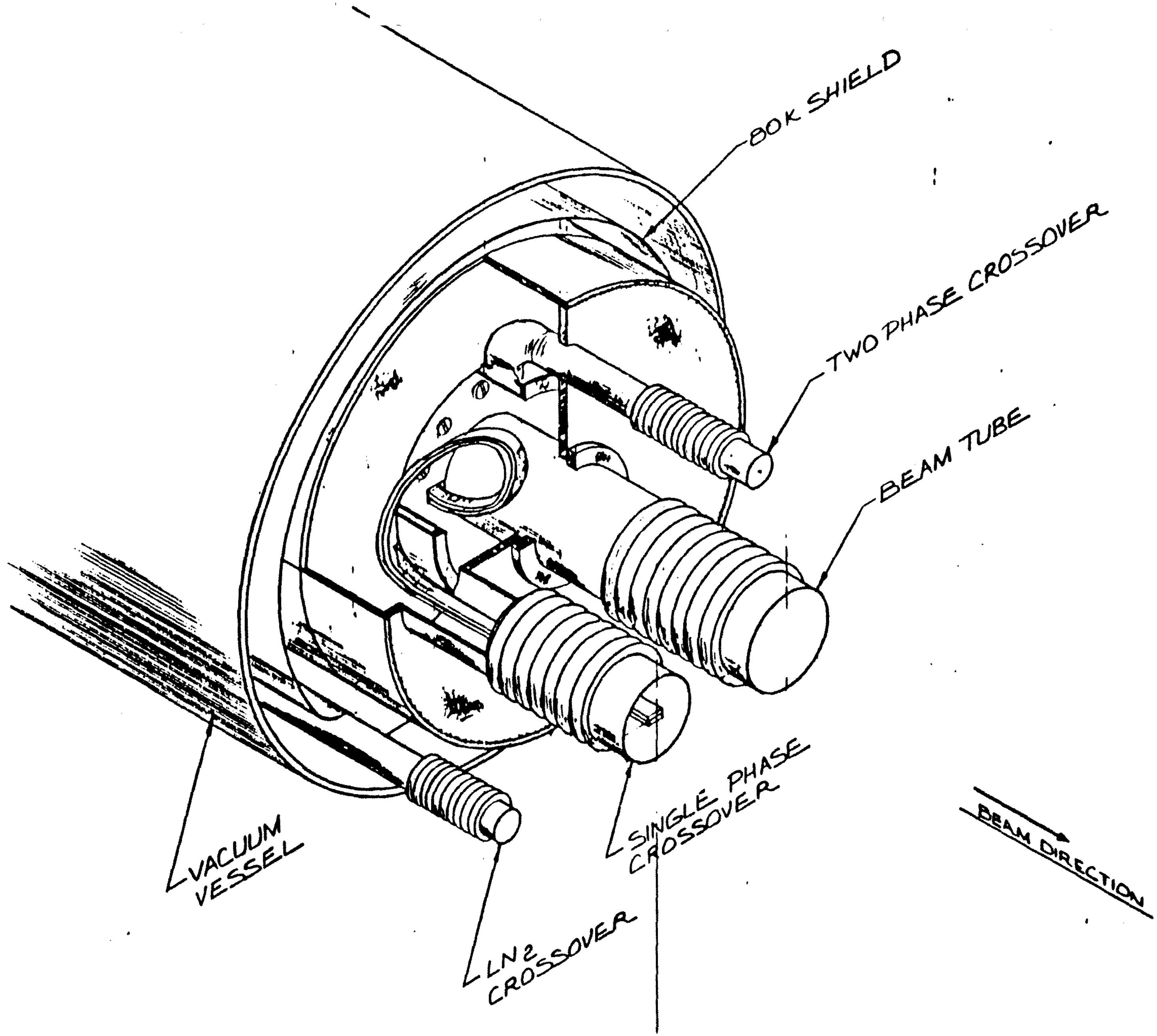


Figure 4-9. 4.4 Tesla Dipole Interconnection Piping View

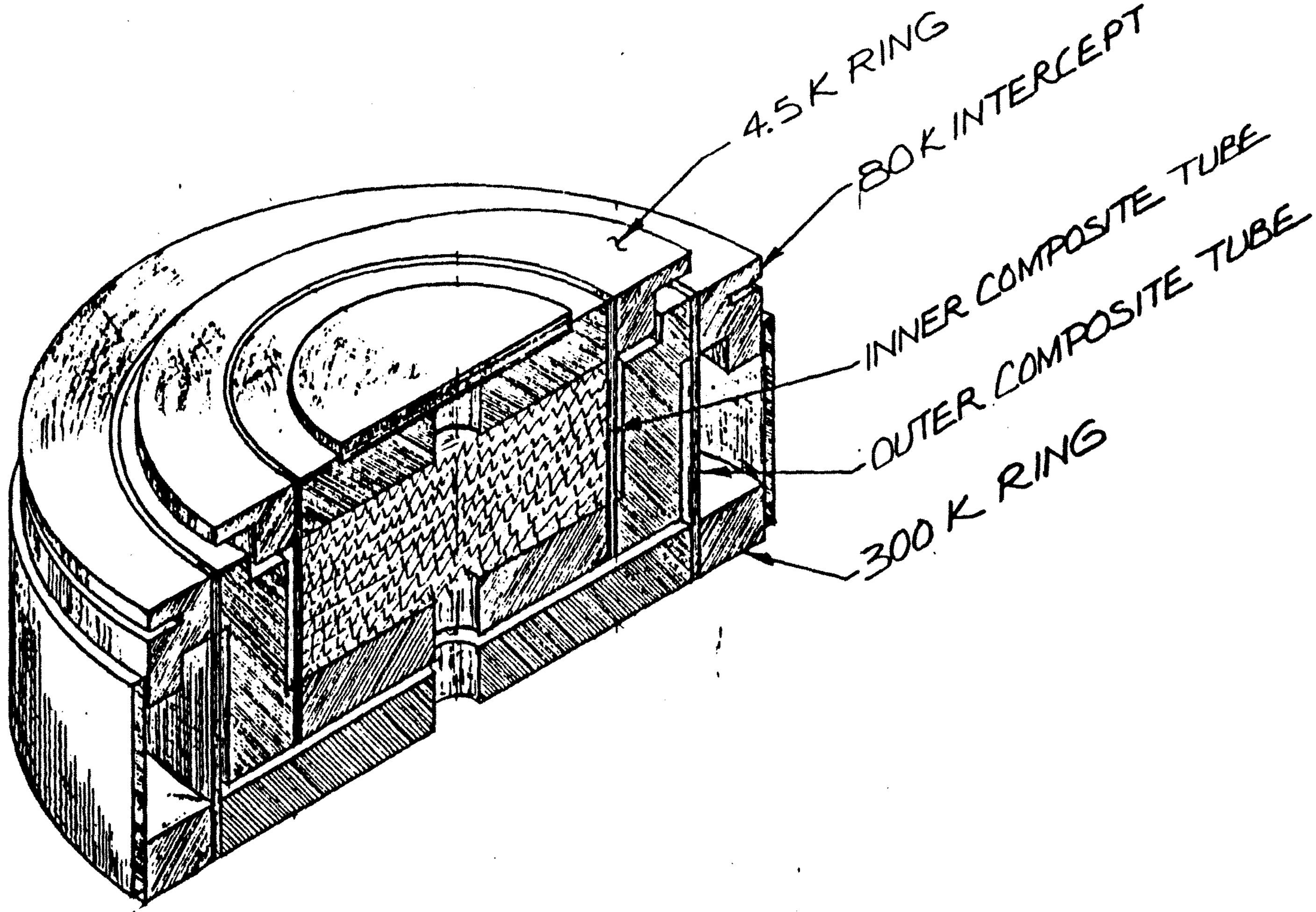


Figure 4-10. 4.4 Tesla Dipole Support Post

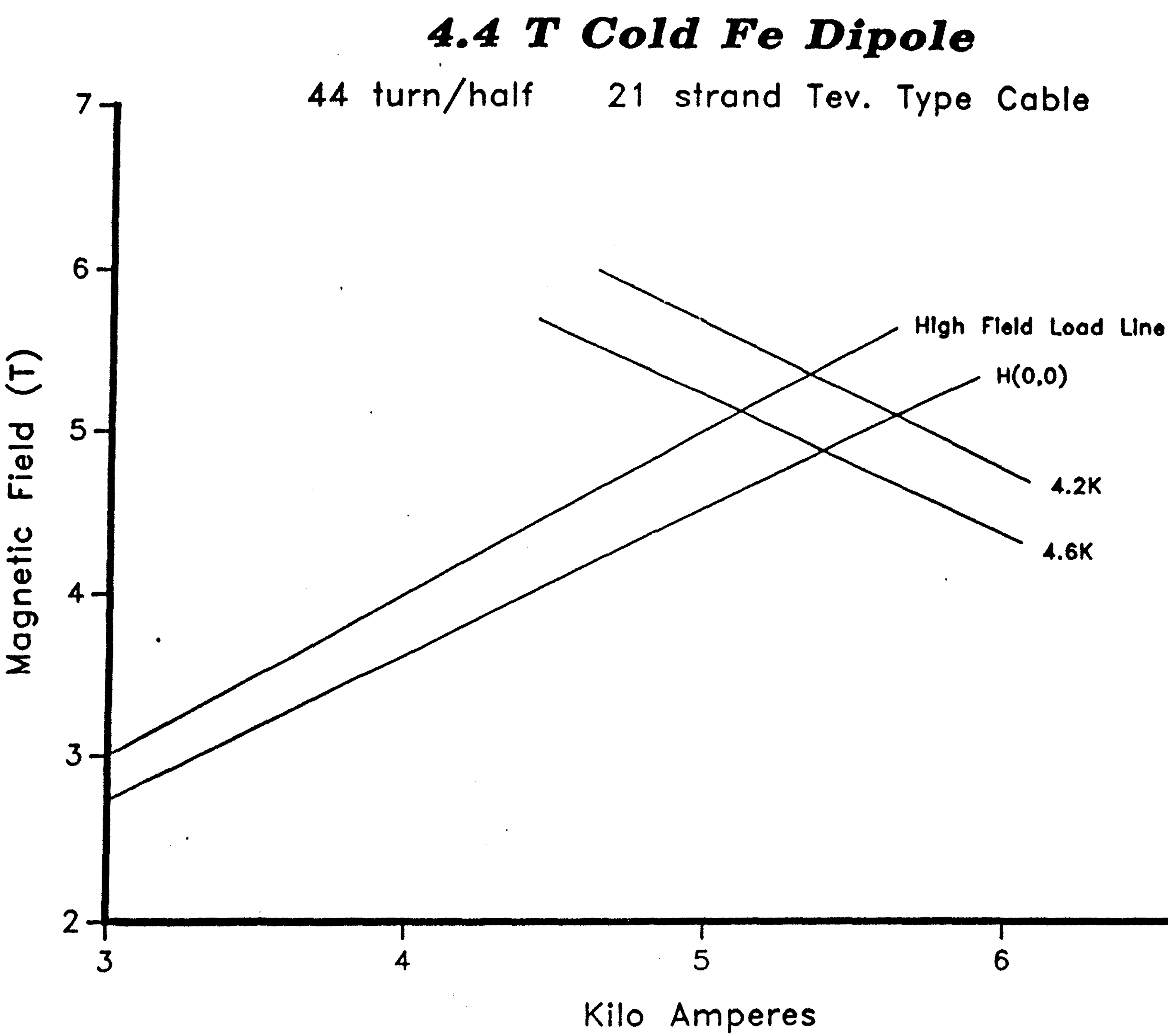


Figure 4-11. 4.4 Tesla Dipole Conductor Load Line

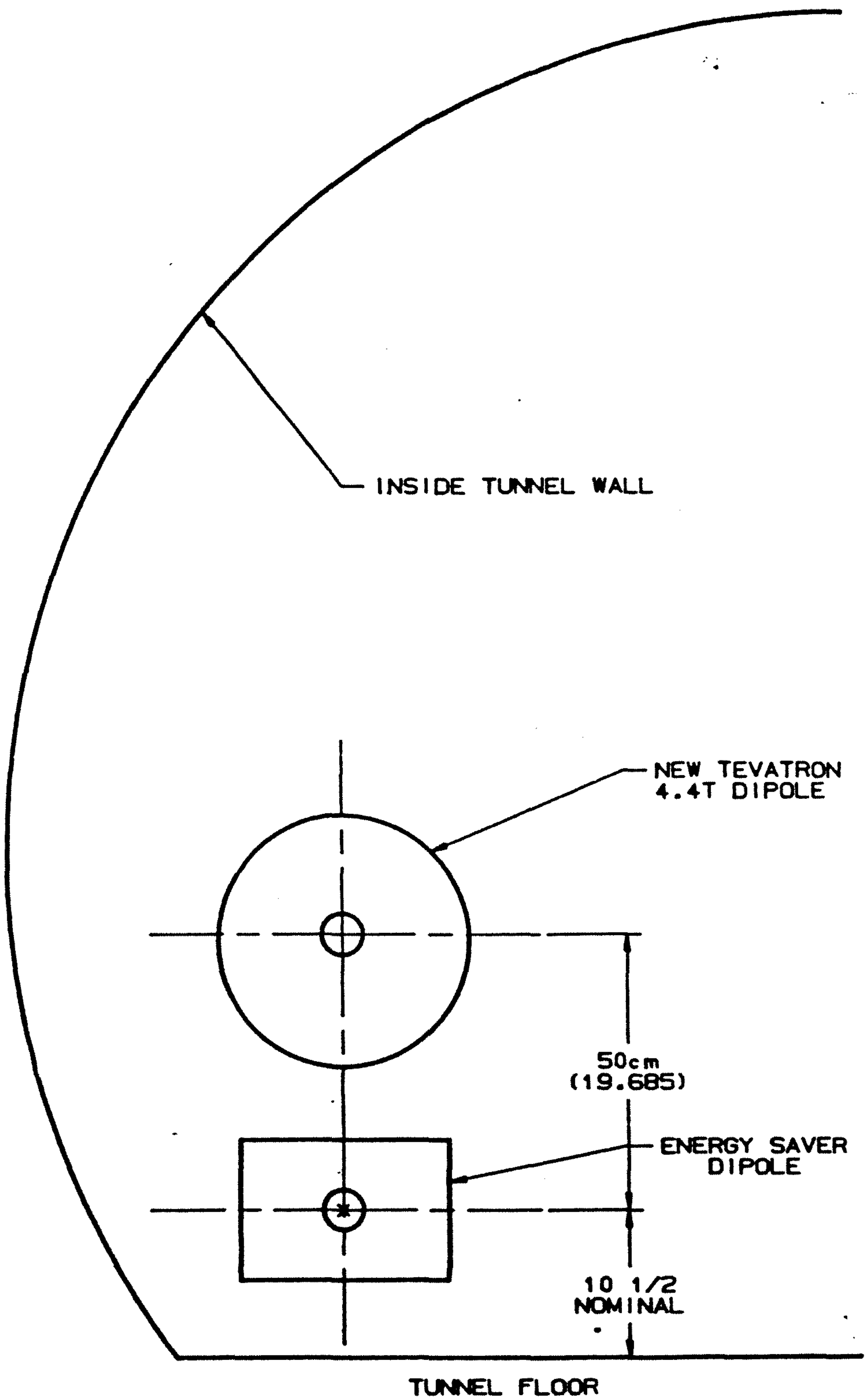


Figure 4-12. Tevatron Tunnel Section at Dipole Location

Table 4-4. 4.4 Tesla Dipole Acceptance Criteria

Quench Current	> 4850 A @ ≥ 200 A/s
AC Loss	< 500 J/cycle @ 4000 A and 200 A/s
Relative Variation of Integral Field	< ±10^{-3} about mean @ 2000 A
Magnetic Vertical Axis	<1/2 x 10^{-3} rad from vertical measured and marked absolute accuracy @ 2000 A

Outside Physical Dimensions

Curvature	±15 mil from nominal
Flatness and Twist	within 30 mil envelope
Relative Twist	2 mr

Integral Multipole Fields (B_n/B_o at 1 in.) at ≥ 2000 A

	Normal	Skew
Quadrupole	±2.5 x 10^{-4}	±2.5 x 10^{-4}
Sextupole	±6.0 x 10^{-4}	±2 x 10^{-4}
Octopole	±2 x 10^{-4}	±2 x 10^{-4}
Decapole	±2 x 10^{-4}	±2 x 10^{-4}

Hipot

Coil, bus, heater to ground	< 5μA @ 5kV

Electrical Parameters

(acceptable tolerance about mean)	R ± 0.3%	(dc)
	C ± 10%	
	L ± 2%	(at 1kHz)
	Q ± 10%	(at 1kHz)

Vacuum

(maximum leak room temp.)	5 x 10^{-9} atm-cc/s

COIL SUPERCONDUCTOR

Cross Section (In.):

Width - 0.2760 $^{+0.0005}_{-0.000}$

Thickness: 0.054 $^{+0.000}_{-0.0005}$ Outer Edge

0.044 $^{+0.0005}_{-0.0000}$ Inner Edge

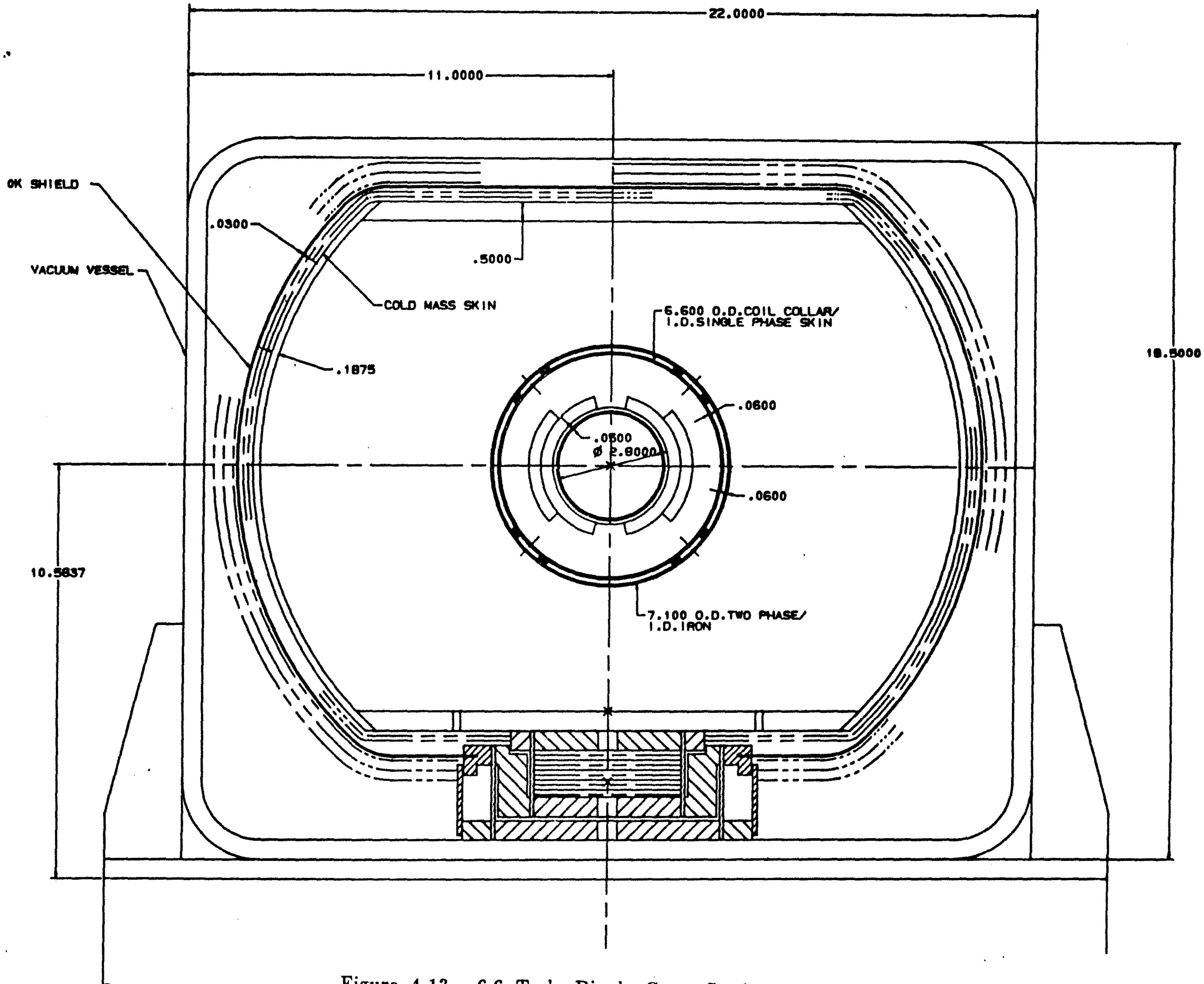


Figure 4-13. 6.6 Tesla Dipole Cross Section

Table 4-5. 6.6 Tesla Dipole Acceptance Criteria

Quench Current: > 4450 A @ ≥ 200 A/s

AC Loss: < 1000 J/cycle @ 4000 A and 200 A/s

Relative Variation of Integral Field: $<\pm 10^{-3}$ about mean @ 2000 A

Magnetic Vertical Axis: $<1/2 \times 10^{-3}$ rad from vertical measured and marked absolute accuracy @ 2000 A

Outside Physical Dimenstions:

Curvature	±15 mil from nominal
Flatness and Twist	within 30 mil envelope
Relative Twist	2 mr

Integral Multipole Fields (B_n/B_o at 1 in) at ≥ 2000 A:

	Normal	Skew
Qudrupole	$\pm 2.5 \times 10^{-4}$	$\pm 2.5 \times 10^{-4}$
Sextupole	$\pm 6.0 \times 10^{-4}$	$\pm 2 \times 10^{-4}$
Octopole	$\pm 2 \times 10^{-4}$	$\pm 2 \times 10^{-4}$
Decapole	$\pm 2 \times 10^{-4}$	$\pm 2 \times 10^{-4}$

Hipot: Coil, buss, heater to ground < 5 μA @ 5kV

Electrical Parameters:

(acceptable tolerance about mean)	R ± 0.3%	(dc)
	C ± 10%	
	L ± 2%	(at 1 kHz)
	Q ± 10%	(at 1 kHz)

Vacuum: (max leak room temp) 5×10^{-9} atm-cc/s

Coil Superconductor

Cross Section (In):

Width - $0.3850\,^{+0.0000}_{-0.0005}$ = Thickness =

Cable Average

Thickness	$0.0353\,^{-0.0000}_{+0.0005}$
Keystone Angle	1.06° ±.03°

Strand Diameter: $0.0208\,^{+.0002}_{-.0000}$

No. Strands/Cable: 36

Filaments: 5μm diameter Nb-Ti Alloy
4140 filaments/strand

Copper to Superconductor Ratio: 1.5/1 by volume

Strand Twist Pitch: 0.4 in

Cable Twist Pitch: 2.95 in
Cable Short-Sample Current (min) 6600 A @ 60 kG and 4.2K

Strand Short-Sample Current (min) 193 A @ 60 kG and 4.2K

Copper Resistivity Ratio: R(9.5K)/R(273K) = 0.023 ± 0.002
Insulation: 3 wraps of 0.001 thick x 0.375 wide Kapton,
(In) spiral wrap

RETURN BUS SUPERCONDUCTOR
(Same parameters as above)

Insulation: 4 layers - 0.001 in thick x 0.375in wide Kapton
spiral wrap, butted (no gap), (alternate
spirals dry and B-staged)

COILS

Conductor placement computer printout reference: 523 HF

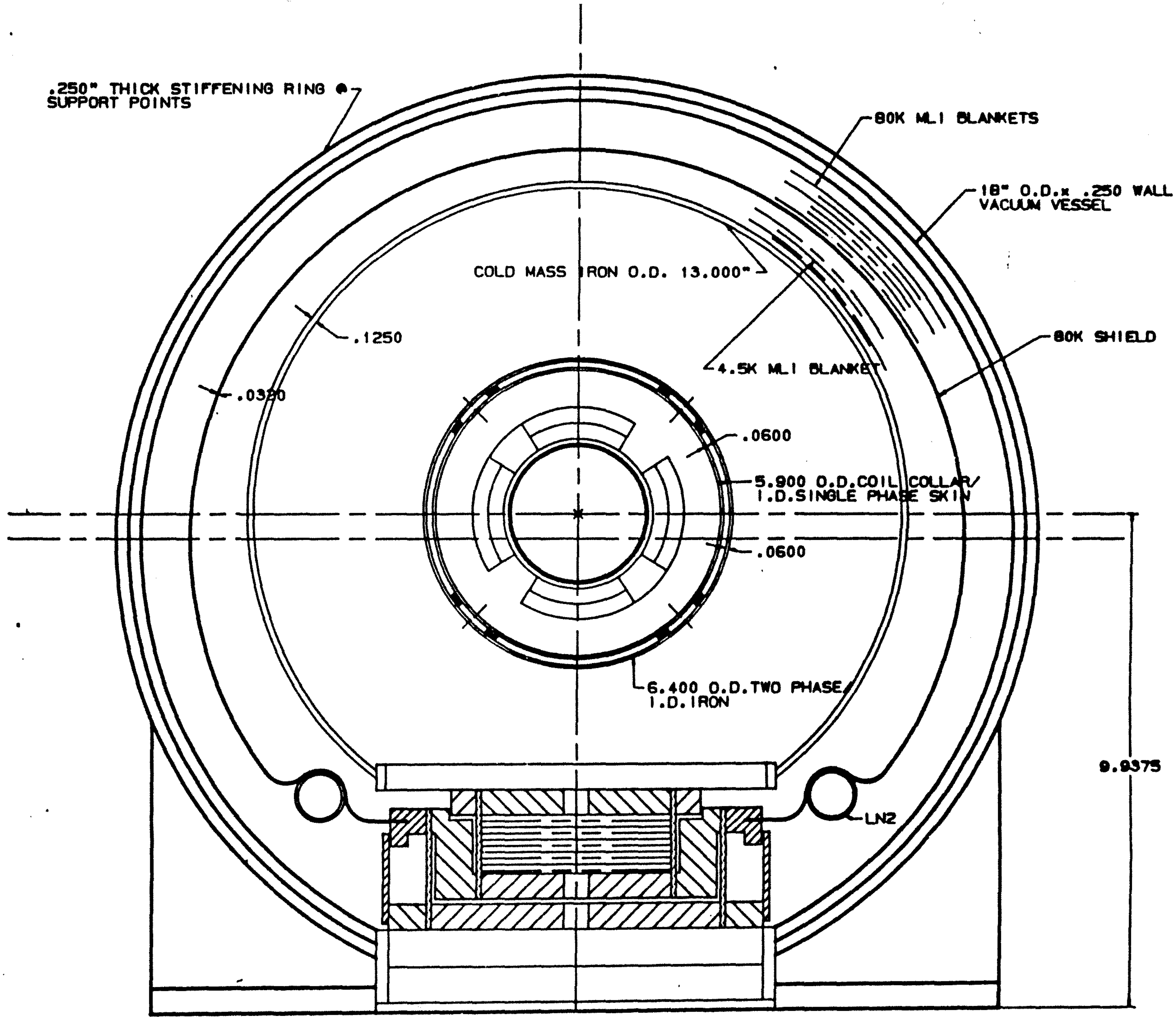


Figure 4-15. Quadrupole Cross Section

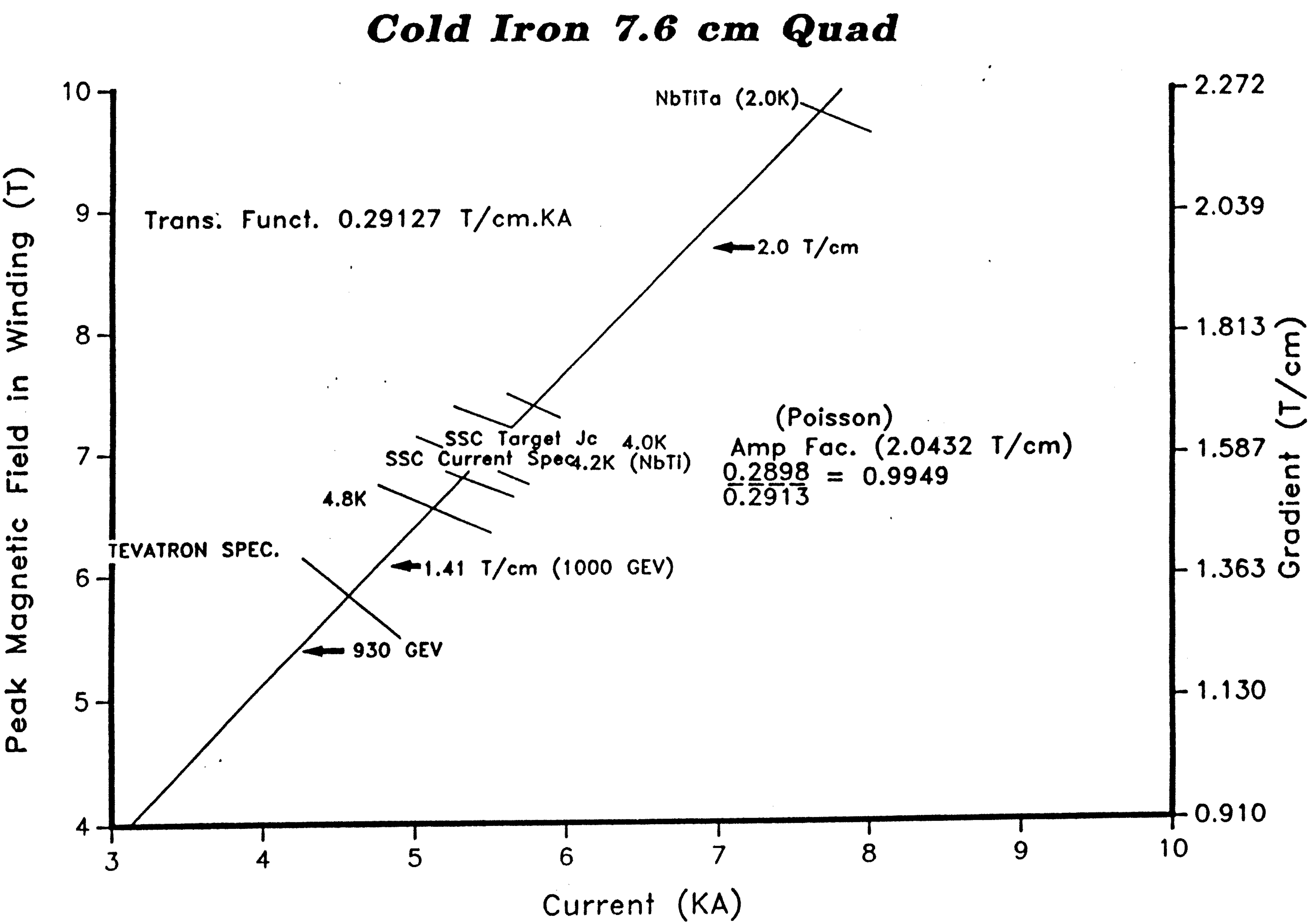


Figure 4-16. Quadrupole Conductor Load Line

Table 4-6. Quadrupole Acceptance Criteria

	Inner Coil	Outer Coil	
Inner Radius	**1.504**	**1.907**	**in.**
Outer Radius	**1.889**	**2.292**	**in.**
Wedges	**1**	**1**	
No. Turns	**19**	**28**	

Assembly Dimensions (all in in.):

Outer Collar Radius:	**3.346**
Ground Wrap Material/Thickness:	**Kapton/0.028**
Coil Length (Actual):	**36.95**
Coil Length (Magnetic):	**33.05**
Yoke Length:	**37**
Yoke Outside Diameter:	**10.5**

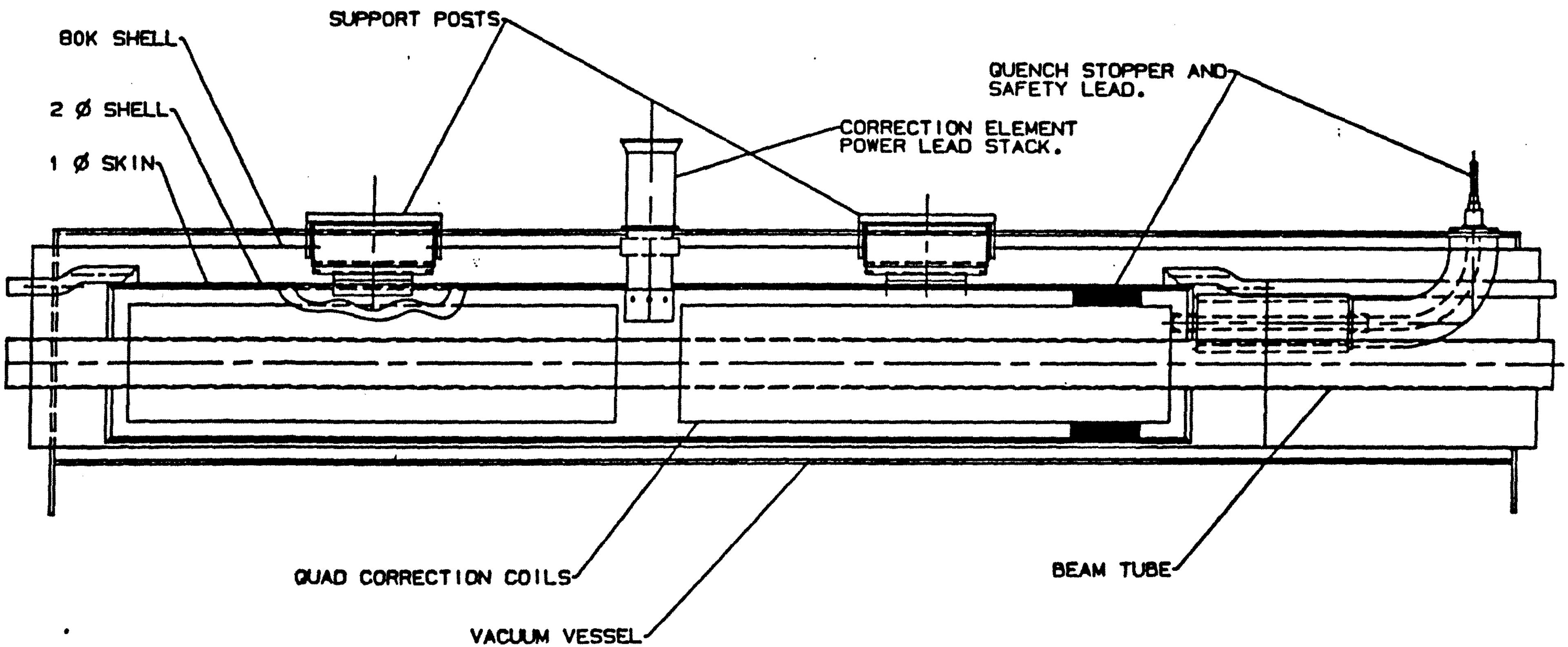


Figure 4-17. Spool Side Elevation View

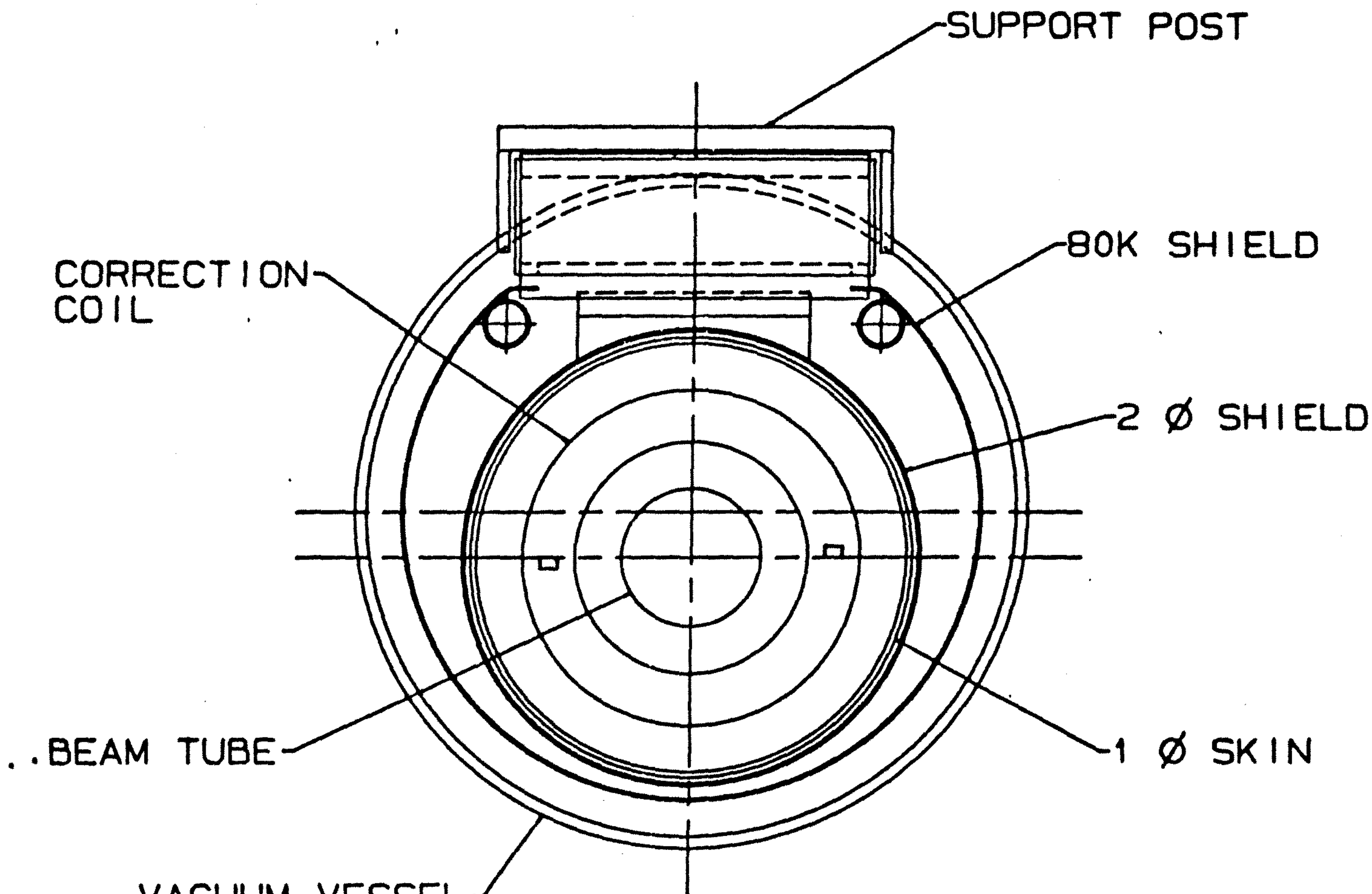


Figure 4-18. Spool Cross Section through a Support

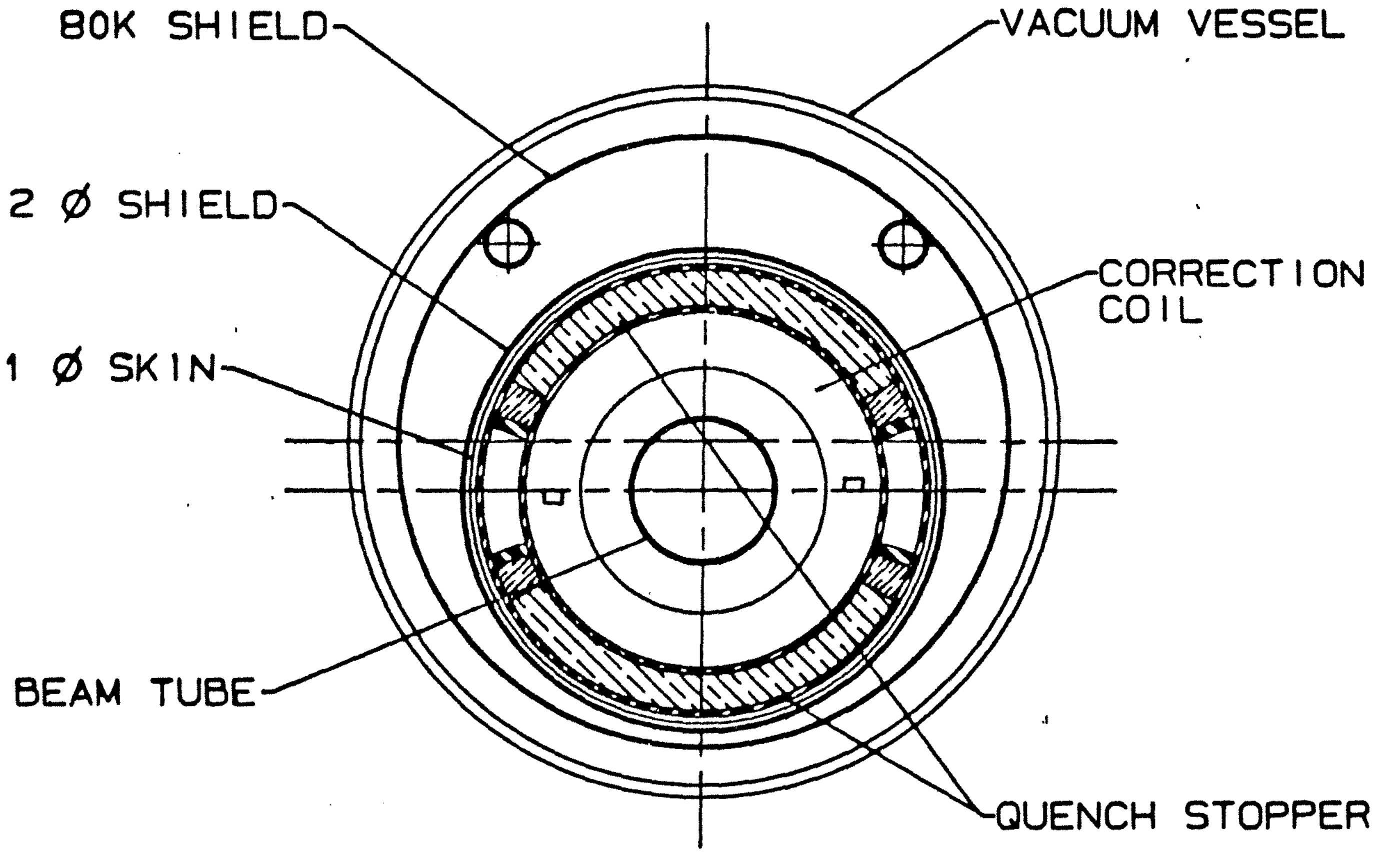


Figure 4-19. Spool Cross Section through the Quench Stoppers

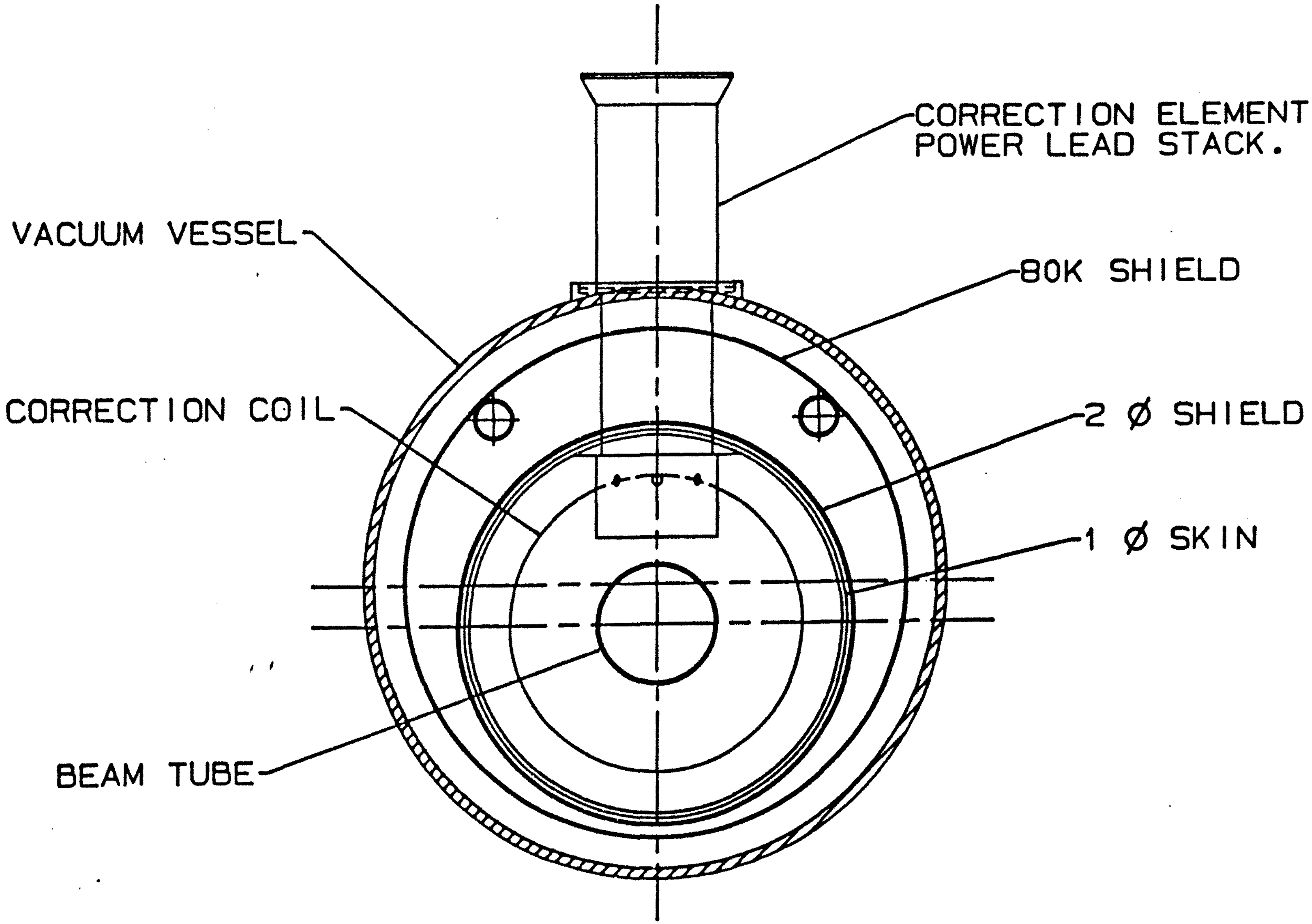


Figure 4-20. Spool Cross Section at the Correction Power Lead Stack

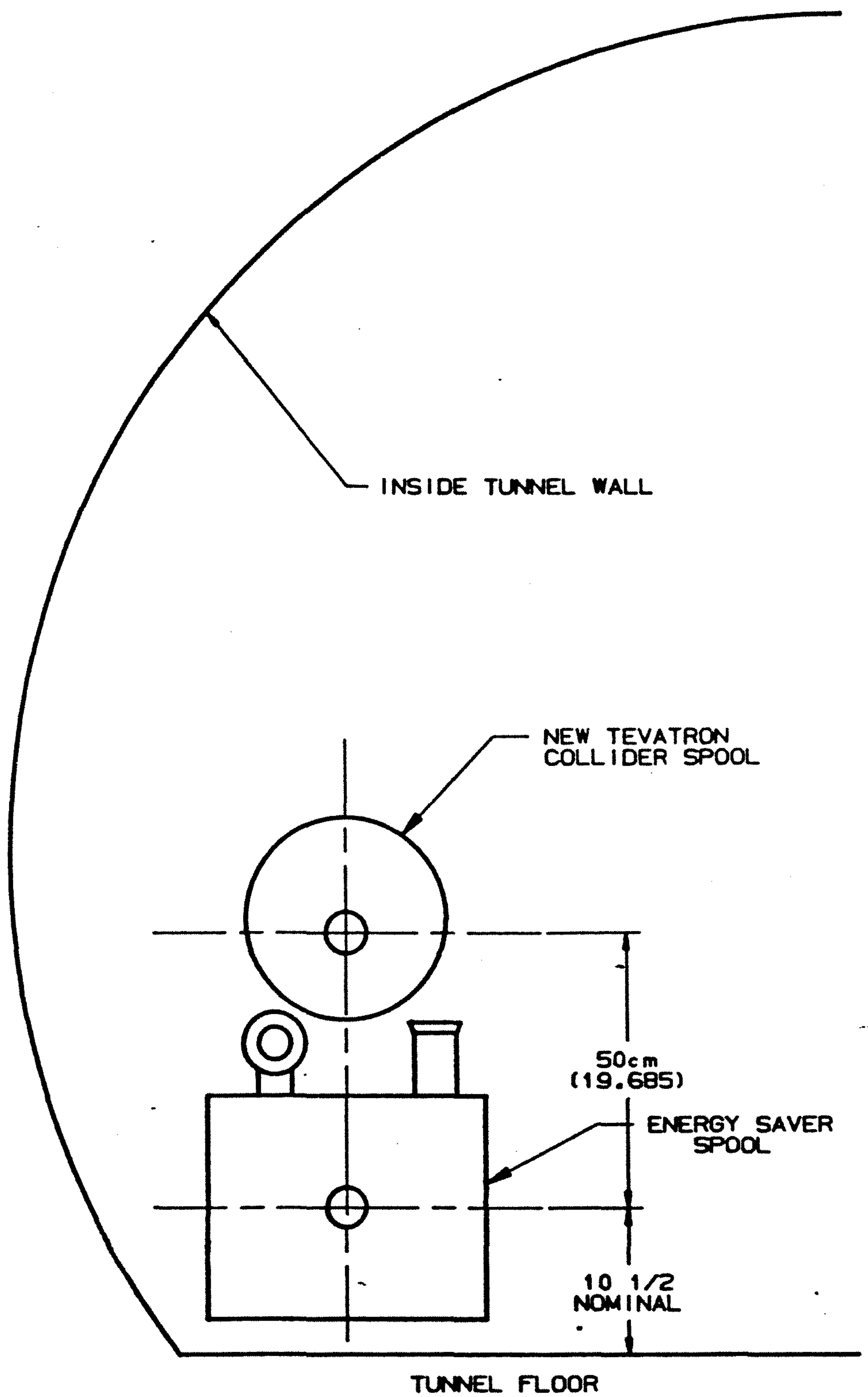


Figure 4-21. Tunnel Section at a Spool Location

Table 4-7. Estimated Heat Loads

	To 80K (W)	To 4.5K (W)
4.4T DIPOLE		
Radiation	7.2	0.1
Gas Conduction	0.2	0.1
Support Conduction	11.5	1.9
Relief Tube	1.3	0.1
4.4T Dipole Total	20.2	2.2
QUADRUPOLE		
Radiation	1.7	0.03
Gas Conduction	0.1	0.02
Support Conduction	7.6	1.3
Quadrupole Total	9.4	1.4
SPOOL		
Radiation	3.0	0.05
Gas Conduction	0.1	0.02
Support Conduction	7.6	1.3
Safety Leads	—	3.0
Power Leads	5.0	2.0
Vacuum Break	3.9	0.5
Relief Tubes	3.0	0.2
Spool Total	22.6	7.1
Total Per Half-Cell	92.6	15.1
Total Per 8 Half-Cells	740.8	120.8

Existing Tevatron spools occupy considerable space both above and to the sides of beam center. In order for the new spools to fit within the same lattice, their overall envelope has been reduced in size. This is made possible by the ability to shorten the quads and thus gain space along the beam line for safety leads.

The correction element assemblies are virturally identical to those used in the existing Tevatron spools. Each contains three coils which may be a trim dipole, quadrupole, sextupole or octupole depending on the location of the spool in the lattice. The overall correction package diameter is 7.25 inches. Overall length is 30 inches.

Quench stoppers are large copper heat sinks and heat exchangers which are connected between the superconducting cable and the safety leads. During a magnet quench they conduct current out of the superconducting cable to the safety leads. During quench recovery, they prevent heat conducting from the safety leads from initiating a quench in the cable.

As in the dipoles and quads, a two phase annular shell provides counterflow heat exchange with the single-phase tube containing the correction coils and safety leads.

The safety leads provide the means of dumping the energy out of a magnet string in the event of a quench. One is attached to the main superconducting cable, the other to the return bus. Each safely lead has an equivalent cross-sectional area of 3.35 square cm, an equivalent length of approximately 127 cm, and are fabricated from stainless steel. They penetrate the insulating vacuum space through a high voltage ceramic feed-through.

The vacuum break assembly is a mechanism which isolates the upstream and downstream insulating vacuum spaces. It serves to greatly facilitate initial leak checking and subsequent isolation of vacuum leaks.

4.4 Cryogenics

4.4.1 Overview. Refrigeration for the existing Tevatron is supplied by a hybrid system consisting of a Central Helium Liquefier (CHL) connected to 24 satellite refrigerators by a 7 km LHe, LN_2 transfer line.[1] This system provides redundancy by relying more heavily on one system should a problem develop in the other. Also, large inventories of liquid helium stored at the CHL dewar system are available for fast magnet quench recovery or cooldown following magnet repair. Capacities of the refrigerator system, including the Central Nitrogen Reliquefier (CNL), are shown in Table 4-8.

Table 4-8 Tevatron Refrigeration System Capacities

CHL 4000 liters/hour	@ 3 atm, 4.6K	
CNL 4600 liters/hour	@ 4 atm, 82K	
Satellite	966 watts	@ 4.6K

Each Satellite refrigerator cools two 125m long magnet string in the existing Tevatron.[2] The superconducting magnets are of the warm iron type. Since it is desirable from a magnet field view point to have the iron as close as possible to the superconducting coils, warm iron magnets typically have a high static heat load to 4.6K.

The superconducting coils are bathed in subcooled (single-phase) liquid helium. At the end of the 125m magnet string, the liquid helium is expanded through a Joule-Thomson valve where it becomes a colder mixture of gas and liquid (two-phase). This two-phase mixture counterflow heat exchanges with the collared coil assembly on its way back to the refrigerator (Figure 4-22). The static and dynamic losses (hysterisis and eddy current) of the 4.6K system is then absorbed by the latent heat in the liquid of the two-phase mixture. The advantage of a continuous two-phase cooling system is that it results in a uniform temperature in the coils through the magnet string.

The new Tevatron will utilize the same continuous two-phase cooling scheme. Cryogenically, the main difference in the new Tevatron is in the cold iron magnet design. A cold iron magnet allows for a thermally efficient suspension system design. As a result, a magnet string with a low heat leak to 4.6K can be built.

This allows the new Tevatron accelerator to be added without any major upgrade to the refrigeration system capacity.

4.4.2 Refrigeration Loads. During fixed target physics protons are injected, magnets ramped to full field, protons "spilled" to the experimental areas, magnets ramped down, and the cycle repeats. The cycling of the magnets means that the refrigeration systems must satisfy both the static heat load of the magnets as well as dynamic losses within the collared coils (predominantly hysterisis).

During collider physics, magnets are ramped to full field and remain there for many hours. This reduces the refrigeration load by "eliminating" dynamic losses, but increases the liquefier load necessary for vapor cooled power leads. Liquefier loads tend to not be seen by the satellite refrigerators, only by the central liquefier.

Average cooling requirements at 4.6K during a recent 800 GeV fixed target physics run are shown in Table 4-9. The average static heat load per refrigerator is shown to be 560 watts. The dynamic loss (predominantly hysterisis in the conductor) is 200 watt, for a total refrigerator requirement of 760 watts. Typically, a satellite refrigerator was tuned for 850 watts in order to dampen out system oscillations (such as magnet turn on and turn off). Tuning a refrigerator for a higher capacity than required should have no effect on CHL since the satellite consumption of LHe is based on the actual load (refrigeration and power lead flow). The average requirement for LHe from CHL is this mode is just under 3400 liters/hour.

Table 4-9 Tevatron Heat Loads for 800 GeV Fixed Target Physics

	SATELLITE			CHL	
	Static loss watts	Dynamic Loss watts	Comp. g/s	Ref. liters/hr	Leads liters/hr
	560	200	49.3	107	23
Ref. Req.	760		49.3	130	
Ref. Tune	850 watts		54.5 g/s		
Ring Totals	22,100 watts		1418 g/s	3389 liters/hr	

Totals include switchyard refrigerators

Table 4-10 P-P Upgrade Heat Loads for 900 GeV Collider Physics.

	SATELLITE			CHL	
	Static Loss watts	Dynamic Loss watts	Comp. g/s	Ref liters/hr	Leads liters/hr
Existing TeV	560	0	36.6	79	27
New TeV	200	0	13.6	28	24
Ref. Req.	760		50.2	158	
Ref. Tune	850 watts		55.5 g/s		
Ring Totals	20,400 watts		1333 g/s	3800 liters/hr	

The addition of a new Tevatron for P-P collider physics without increasing the refrigeration requirements can be accomplished by trading the dynamic losses in Table 4-9 for static losses of the new ring as shown in Table 4-10. Although this mode adds no refrigeration load, a 12% increase in liquefaction load is realized in order to support the added vapor cooled power leads. A steady state requirement of 3800 liters/hr on CHL will not be a problem following the completion of the second CHL. This second facility is being built for redundancy but also offers a greater than 35% increase in capacity through larger turbines.

Operating in a fixed target physics mode will be possible using the existing Tevatron Table 4-9 or the new Tevatron Table 4-11. The new Tevatron will offer two advantages; a lower overall heat load as shown in Table 4-11 and an increase in reliability over the existing Tevatron.[3] While one of the Tevatrons operate in fixed target physics mode, the other accelerator will be kept at 80K.

One possible upgrade to a dual Tevatron system would be to operate both accelerators in fixed target physics. This would allow beam to be injected and accelerated in one machine while beam was being spilled to experiments from the other. A 100% duty cycle (i.e., continuous beam to experiments) could be achieved with this scheme. Since the refrigeration requirement would be based on the static and dynamic losses of both Tevatrons, an upgrade in the refrigeration system would be necessary as shown by comparing Table 4-12 with Table 4-8. The liquefaction loads could be met by operating both CHLs simultaneously. However, refrigeration loads would require a 50% increase in satellite refrigerator and compressor capacity.

Increases in refrigeration operating cost for p-p collider physics will be from two sources; liquid nitrogen consumption and additional compressor operation. Liquid nitrogen consumption will increase 25% due predominantly to magnet shield cooling in the new Tevatron and partially due to an increase in CHL production. This nitrogen load will be purchased, since our nitrogen reliquefier is currently running at full capacity. An increase in compressor operation (~1MW) is necessary to achieve the increase in CHL production.

4.4.3 System Interface. The new Tevatron will interface to the satellite refrigeration system in the same manner as the existing accelerator, as shown in Figure 4-22. Isolation bayonets between the refrigerator and magnet strings will allow independent warmup, cooldown, and operation of the two accelerators. New or modified refrigerator components necessary to accomplish this include:

1. Dual vertical transfer lines to transport cryogens from the refrigerator to each accelerator in the tunnel.

2. Modification to the refrigerator end box to supply additional valving necessary for the new Tevatron connections. Also, a subcooling dewar will be built into this component to dampen out magnet turn on/off effects. This may allow the refrigerator "tune" to more closely match the load.

Table 4-11 New Tevatron Heat Loads for 1 TeV Fixed Target

	SATELLITE			CHL	
	Static Loss watts	Dynamic Loss watts	Comp. g/s	Ref liters/hr	Leads Leads liters/hr
	200	395	38.9	84	27
Ref. Req.	595		38.9	111	
Ref. Tune	700 watts		45.1 g/s		
Ring Totals	18,200 watts		1171 g/s	2887 liters/hr	

Totals include switchyard refrigerators

Table 4-12 Heat loads for 100% Duty Cycle Fixed Target

	SATELLITE			CHL	
	Static Loss watts	Dynamic Loss watts	Comp. g/s	Ref liters/hr	Leads liters/hr
Existing TeV	560	177	48.0	104	30
New TeV	200	304	33.1	71	27
Ref. Req.	1241		81.1	232	
Ref. Tune	1400 watts		90.5 g/s		
Ring Totals	36,400 watts		2352 g/s	6038 liters/hr	

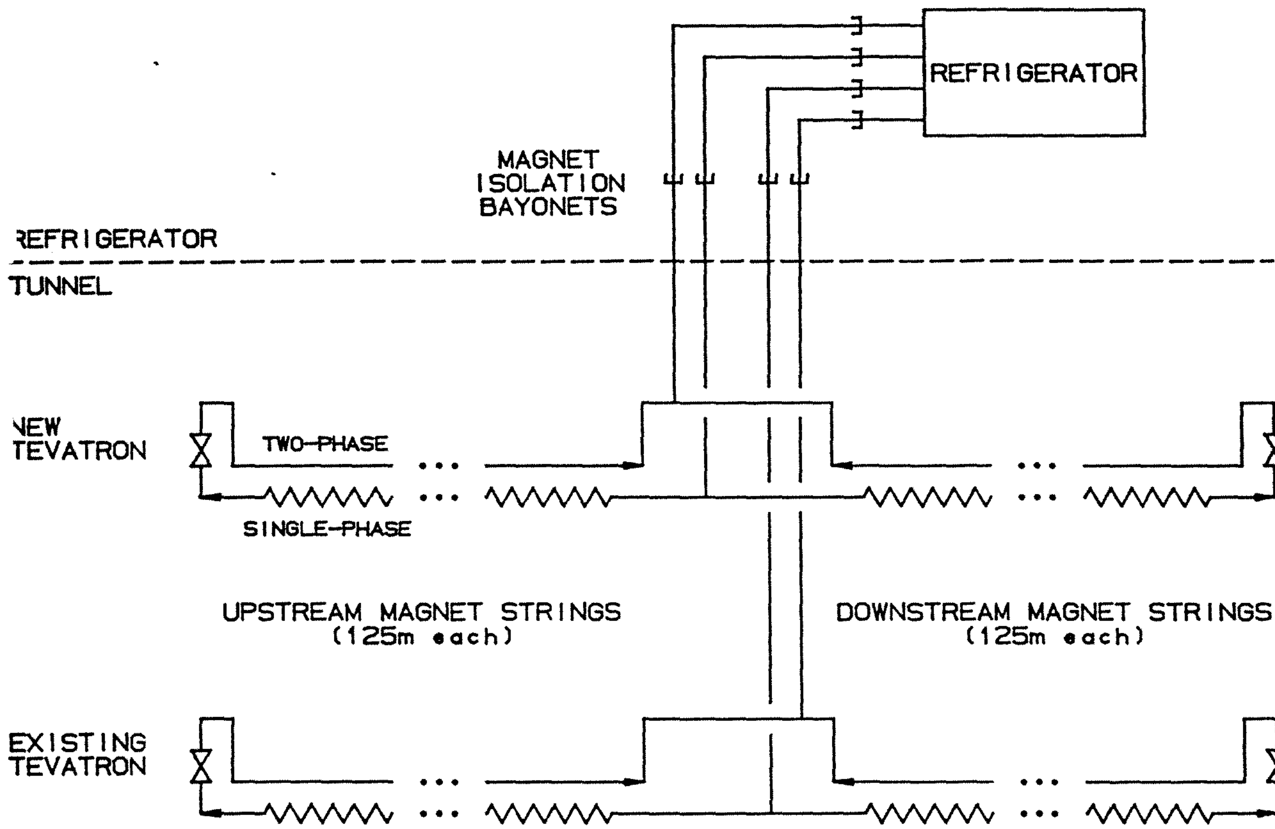


Figure 4-22 Cryogenic/Refrigerator Interface

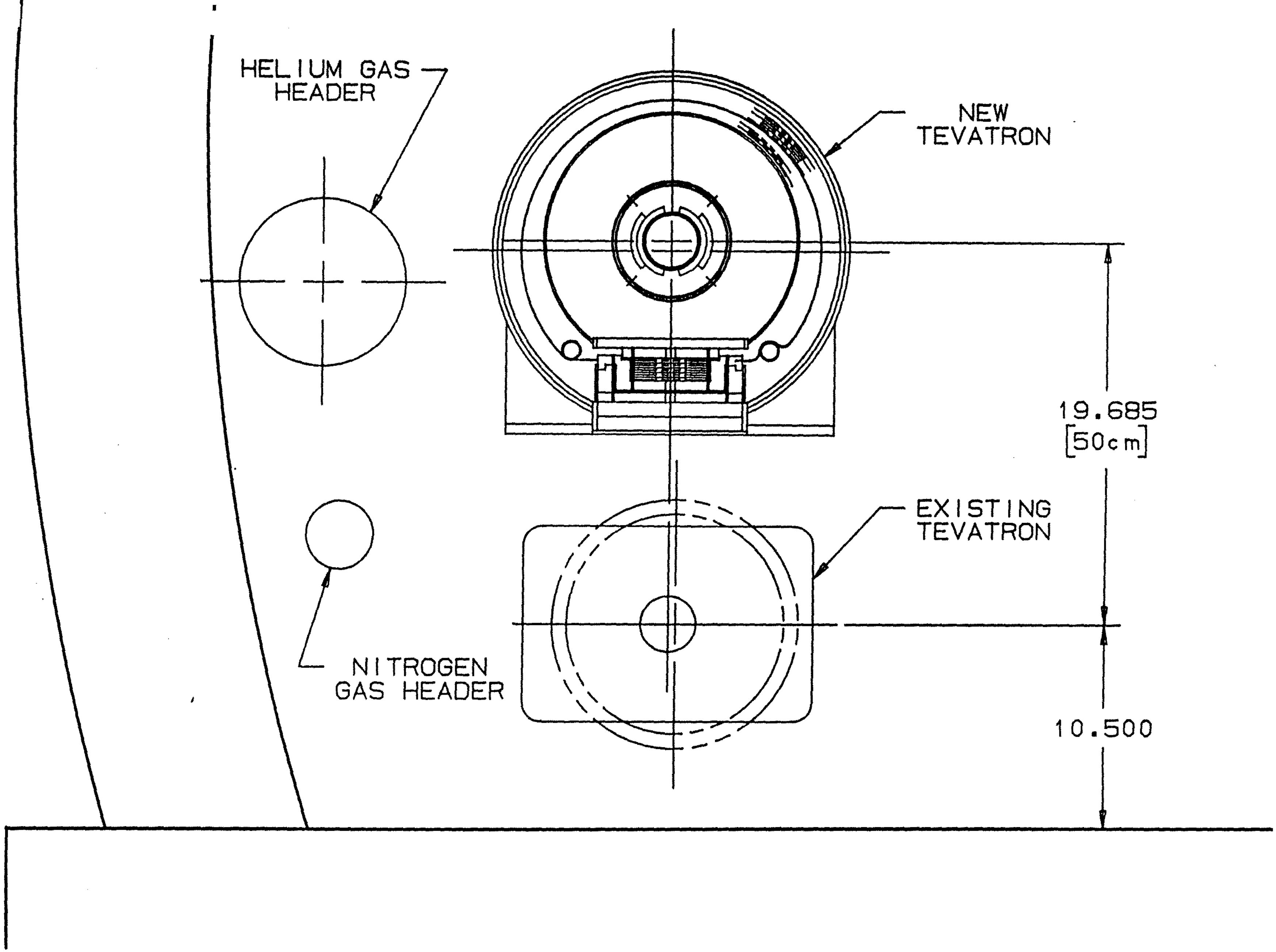


Figure 4-23 Main Ring Cross Section

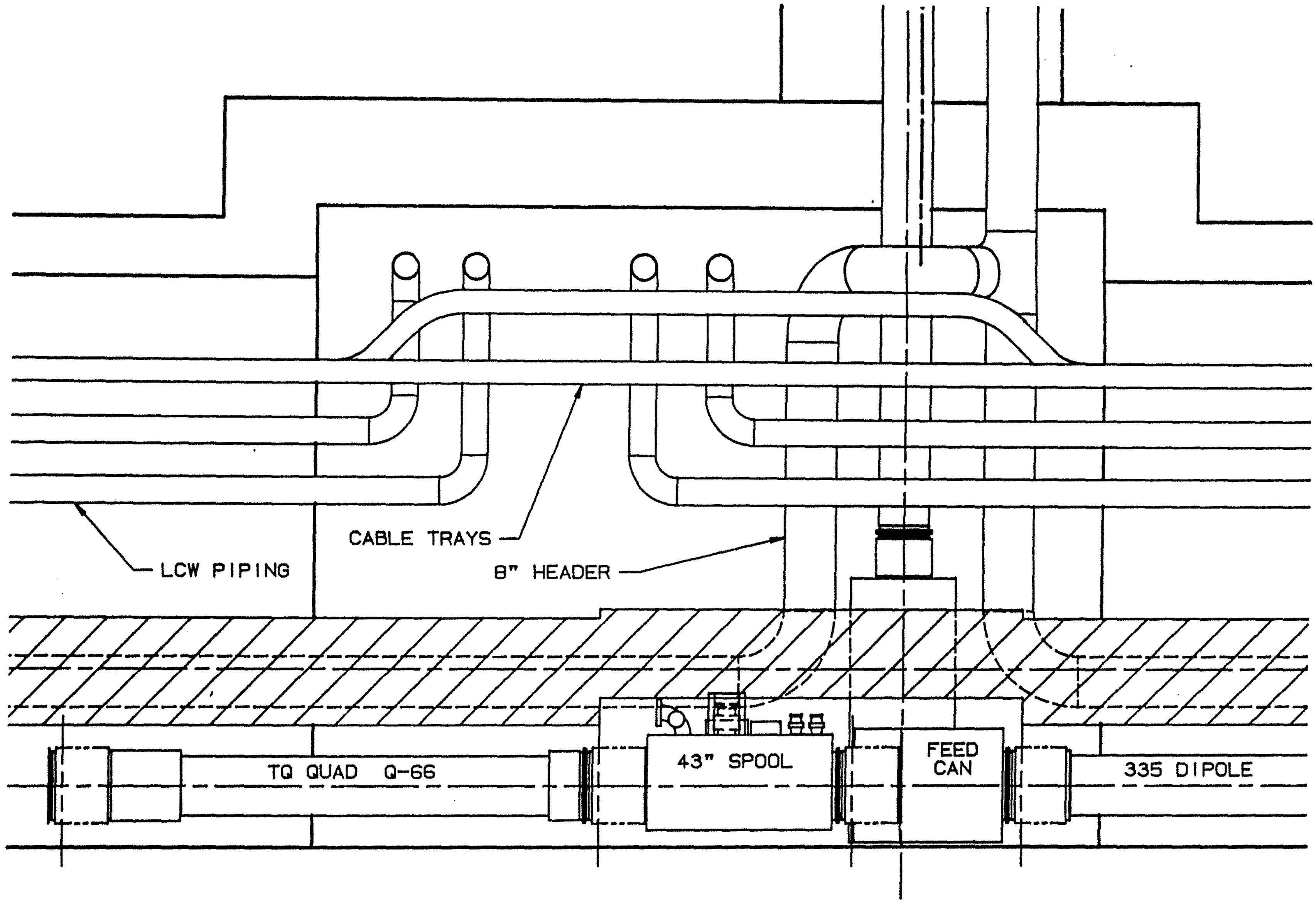


Figure 4-24 Main Ring Elevation View at Refrigerator Location

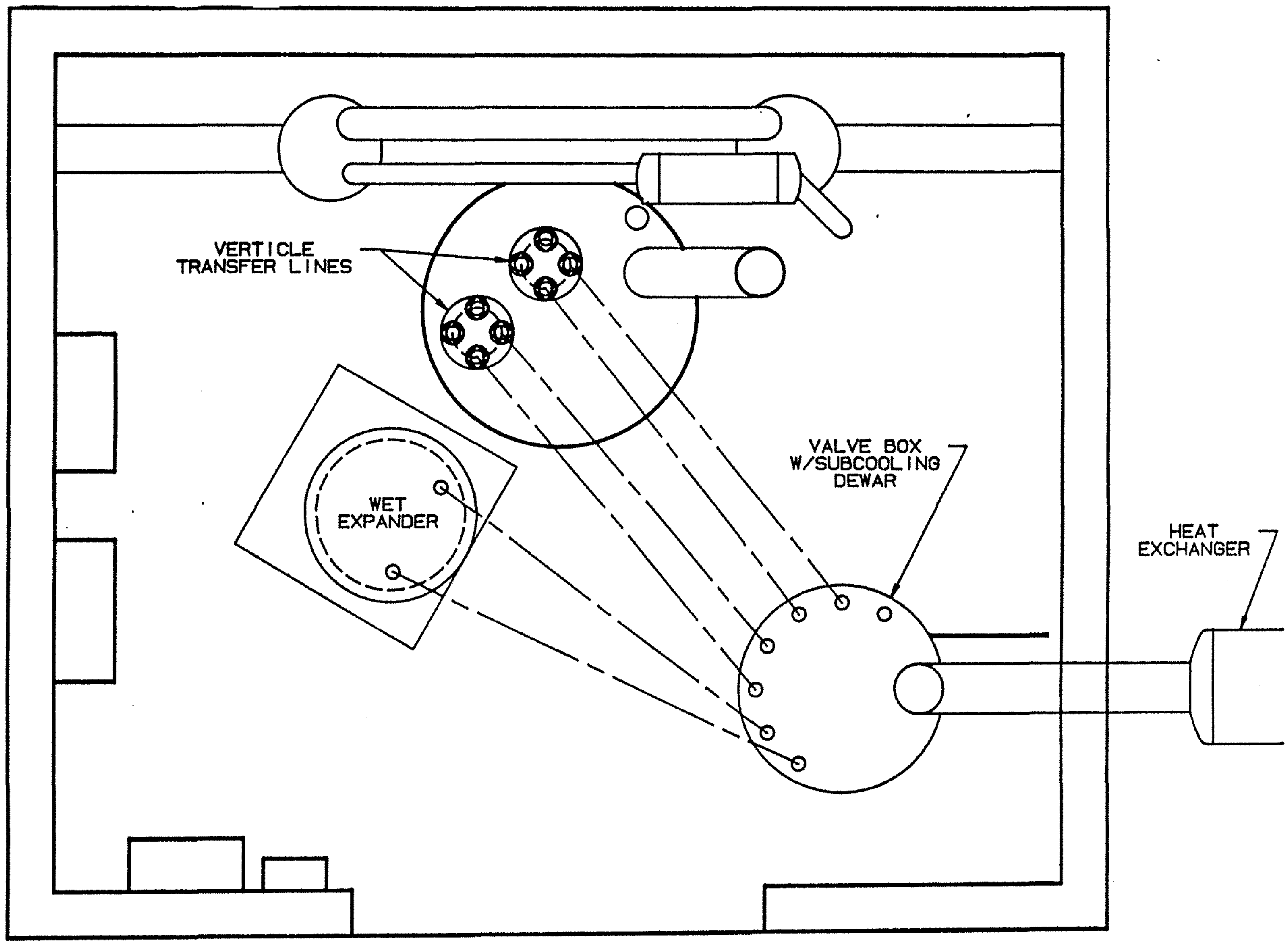


Figure 4-25 Satellite Refrigerator Plan View

3. Modification and addition of new connection U-tubes to accommodate the new accelerator and refrigerator end box.

Lattice components associated with the cryogenic system will function identically to their counterparts in the existing Tevatron.[1] The physical shape and end connections will differ to reflect available space allowances and the new magnet interconnect design. These "nonmagnetic" lattice components and their functions are as follows:

1. Feedcans - Distributes the cryogens from the vertical transfer lines to the beginning of the two magnet strings. Includes cryogenic instrumentation and, in half the locations, includes the main 5000 ampere power leads.

2. Turnarounds - Represents the end of a magnet string. Includes a Joule-Thomson valve and cryogenic instrumentation.

3. Bypasses - Bypasses cryogens around a section to allow for a warm beam tube area. This allows special room temperature components such as beam detectors or kicker magnets to be installed.

A cross-section of the Main Ring tunnel showing the placement of the new Tevatron above the existing Tevatron is given in Figure 4-23. Available space between the Tevatron is tightest in locations of spool pieces, feedcans, and turnaround boxes, as shown in Figure 4-24. Clearance between new and existing components in these areas will be accomplished by a vertical displacment in the outer vacuum vessel, and associated internal plumbing, in the new Tevatron as shown. Figure 4-25, is a layout of the existing Tevatron Satellite refrigerator building showing the location of the two new vertical transfer lines to individually feed the accelerator, Also shown is the new valve box with subcooling dewar attached to the end of the heat exchanger.

<u>4.4.4 System Operation</u>. The design and layout of the new Tevatron was purposely made to operate identically to the existing Tevatron from a cryogenic standpoint. Control valve function, instrumentation location, quench relieving and recovery, and cooldown from 80K will all be a duplication of the existing accelerator. Currently, each refrigerator is controlled and monitored by a Z80 based microprocessor system. The additional requirements of the new Tevatron will push this system beyond its limits. As a result a new refrigerator controls system will be incorporated based on a 32 bit microprocessor and bus. This system will utilize a standard Fermilab controls group operating system and will be programmed in a high level language (as opposed to the current assembly language which greatly restricts the personnel capable of upgrading and maintaining programs). The new refrigerator controls will communicate to the existing ACNET system via a token ring. Design and development of this controls system is already underway for a different application at Fermilab.

Cooldown of a magnet string following magnet repair in the existing Tevatron is accomplished using a LHe cooldown wave. The large amount of stored thermal energy in a cold iron magnet will make this method impractical in the new Tevatron. Cooldown to 80K will first be accomplished using a portable He/LN_2 heat exchanger. Three exchanger units on trailers will be constructed for this purpose. Liquid nitrogen will be supplied by existing Tevatron liquid nitrogen semi trailers currently used during mobile purifier operation. Table 4-13 shows the cooldown specifications for the two 125m magnet strings associated with a given refrigerator.

The cold iron magnet design requires an active warmup heater system to facilitate warmup for a magnet change in a reasonable length of time. Four resistive heater cables will be installed in the cold iron yoke. They will be wired as two parallel circuits per half cell, with all four leads exiting the magnet string through 50 amp correction element type leads (Figure 4-26). Having two parallel circuits allows for warmup in twice the time in the event of an element failure. Helium is circulated during the warmup in order to distribute heating to the collared coil assembly and to achieve an accurate temperature measurement.

Three complete portable warmup systems will be constructed, allowing simultaneous fast warmup of one eighth of the ring. Each system consists of two power supplies and two reels of power distribution cabling. In order to minimize the current through the heater power leads, 480VAC will be rectified to 600 VDC. Two 100 ampere 480 VAC outlets with disconnects will be added in he tunnel below each service building to supply the necessary power for a 24 hour warmup times. Low conductivity water (LCW) will be tapped off the existing LCW system in the main ring tunnel to cool the power supplies. Specifications are included in Table 4-13.

Table 4-13 Dual Magnet String Cooldown and Warmup Specifications

Specifications (two 125m magnet strings)	Cooldown
General	
Fast Cooldown Time	36 hours
300K - 80K	
Stored Energy	10,570 MJ
Time Required	24 hours
Method	LN_2 Exchanger
LN_2 Consumption	33,000 liters
Helium flow	110 g/s
80K - 4.5K	
Stored Energy	540 MJ
Time Required	12 hours
Method	Satellite + CHL
Helium Flow	40 g/s

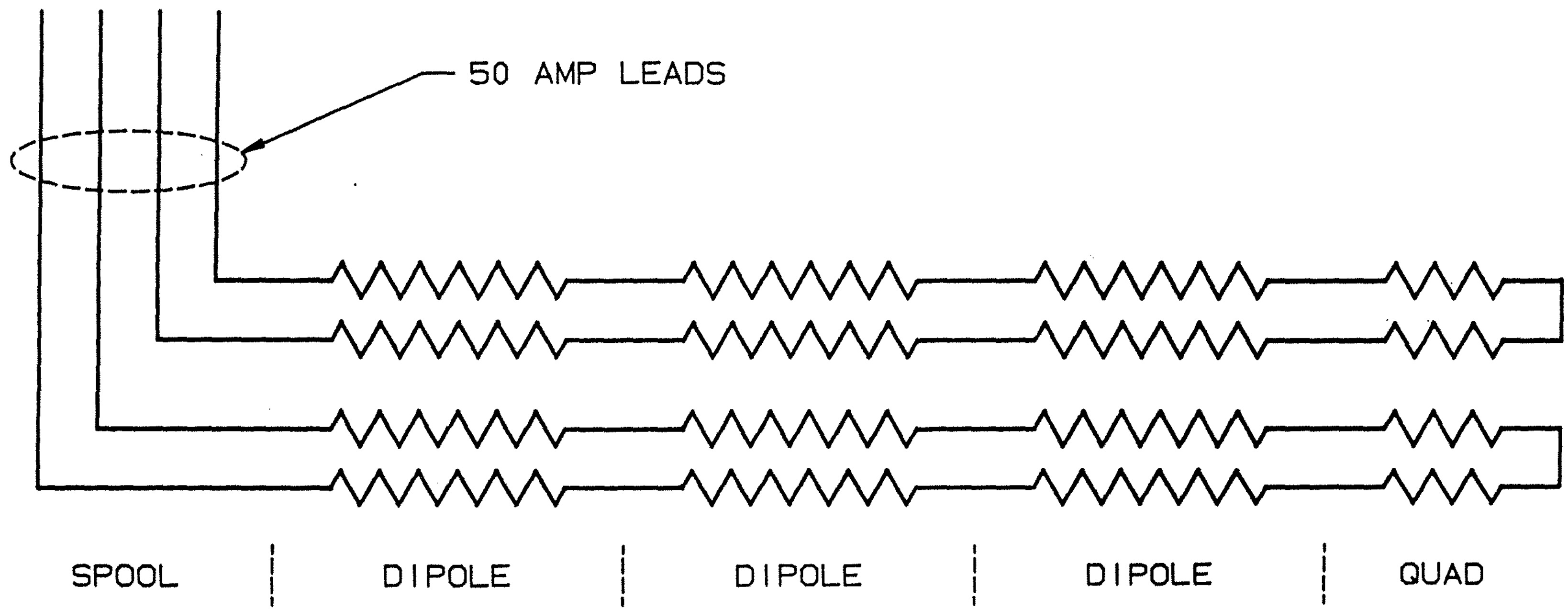


Figure 4-26 Half Cell Warmup Heater Configuration

Specifications Warmup

General

Warmup Time	24 hours

Half Cell

Heating Requirement	1400 MJ
Heating Rate	16 kW
Operating Voltage	600 VDC
Number of Circuits	2
Current per Circuit	13.4 amps
Active Heater Length (per circuit)	55m
Heater Resistance	0.81 ohms/m

Service Building

Power Supply per Magnet String	1
Number of Magnet Strings	2
Required 480 VAC per Power Supply	80 amps

Protection per power supply system

* Overcurrent.
* Overtemperature (power supply).
* Overtemperature (magnets)(measured at upstream end of each spool piece).
* Underpressure (helium gas in single-phase for heater lead cooling).

4.5 New Tevatron Magnet Power Supply and Protection

4.5.1 Requirements. The main magnet circuit of each Tevatron ring is an independent series circuit containing the 4.4 T dipoles, the 6.6 T dipoles and the main quadrupoles distributed around the 1 km radius ring. Each circuit consists of two loops around the enclosure; one loop is known as the "lower bus", the other as the "upper bus". The loops are broken at the B0 straight section where the two busses are connected to each other to make a complete series circuit. This is shown schematically in Figure 4-27 for the present Tevatron ring including the power supplies that power the main circuit. Each of the 204 magnet lattice half-cells has approximately half of its coils on each of these buses arranged in "Quench Protection Units". The arrangement will be similar to that used in the present Tevatron which is shown schematically in Figure 4-28. A large number of correction elements are powered separately from the main circuits.

The main power supply for each ring must be capable of pulsing its entire series circuit, whose total distributed inductance is 36 H, from 400 A to 4440 A at ramp rates up to 120 A/sec during collider operation. In fixed target operation, a ramp rate of 240 A/sec is required in order to maximize the number of ramp cycles per day commensurate with the rf power available for acceleration. The power supply must also have invert capability so that the 350 MJ of energy stored in the magnetic field of each ring can be returned to the power line during de-excitation. The supply must be capable of dc operation at maximum current and provide a current regulation on the order of .001% during beam storage.

Since the cable used in the magnets has a low copper-to-superconductor ratio and is not cryogenically stable, a magnet will quench if a normal (non-superconducting) region develops in the cable. Hence, a fail-safe mechanism for removing stored energy from the system, as well as a reliable quench detector to trigger this protection system must be provided.

4.5.2 Power Supply. The present Tevatron contains twelve 1 kV, 4500 A power supplies in series with the magnet load. This complement of supplies is used in the present fixed target operation, but only half this number (six) is used during collider operation. In the new Tevatron configuration of two rings, six of these supplies will be used in each of the rings. Hence, no new power supplies are required for the new Tevatron main magnet circuits. Even though each ring only requires six power supplies in collider operation, there must be twelve evenly spaced energy dumps in each ring, hence twelve new power feed cans are required. This also allows for all twelve power supplies to be used in either ring for fixed target operation.

A schematic of the power supply and dump equipment required in each building is shown in Figure 4-29. In order to provide a symmetric voltage-to-ground profile in both rings, the power supplies shown in Figure 4-27 in service buildings A2, B3, C2, D3, E2, and F3 will be used in one ring and those in the other '2' and '3' buildings will be used in the second ring. The '2' building supplies are wired into the "lower bus" and the '3' building supplies are wired into the "upper" bus of the appropriate ring. During changeover of operating modes, the buswork will be reconfigured with bolted-in links.

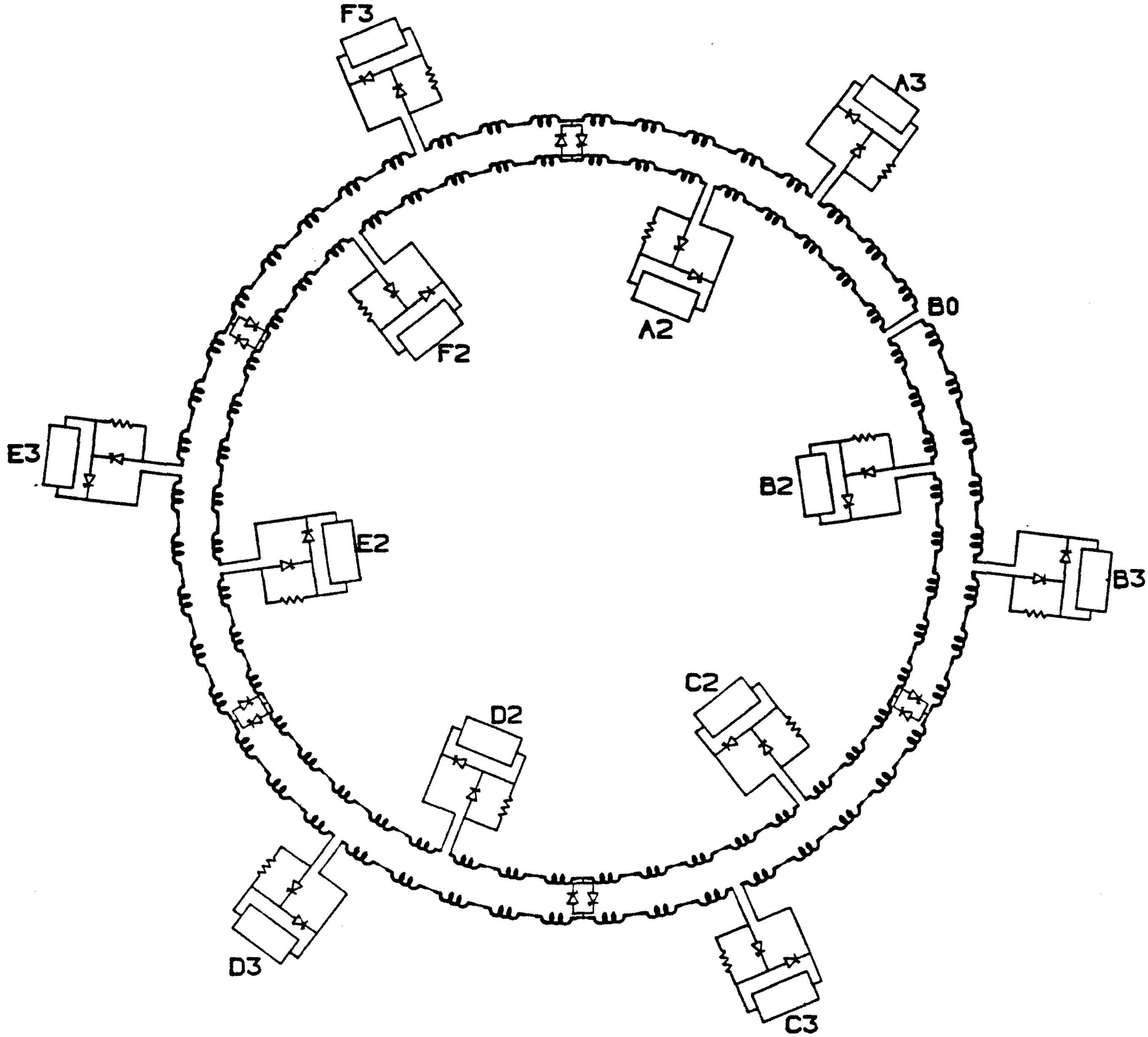


Figure 4-27. Tevatron Power Supply Locations

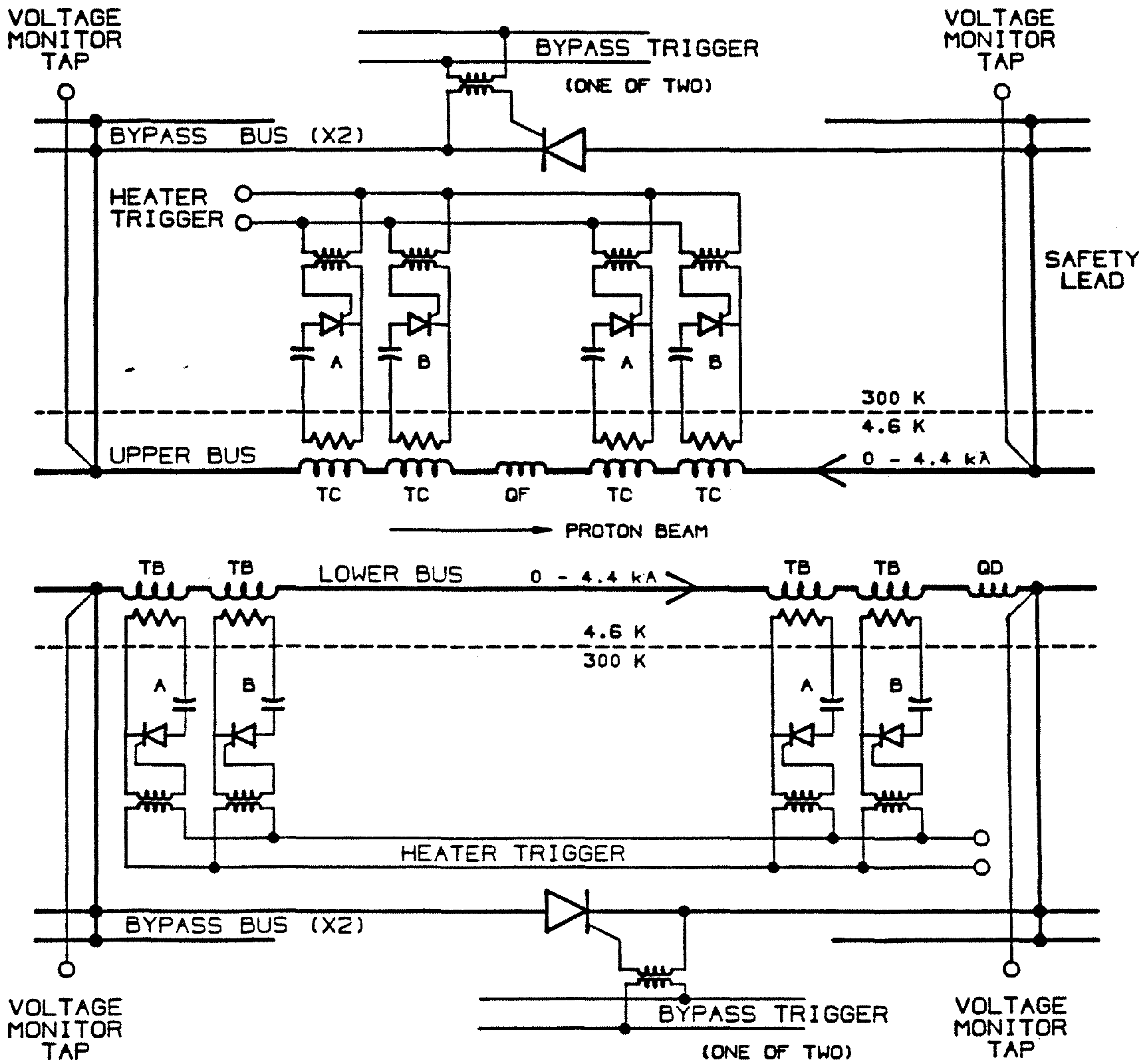


Figure 4-28. Tevatron Quench Protection Unit

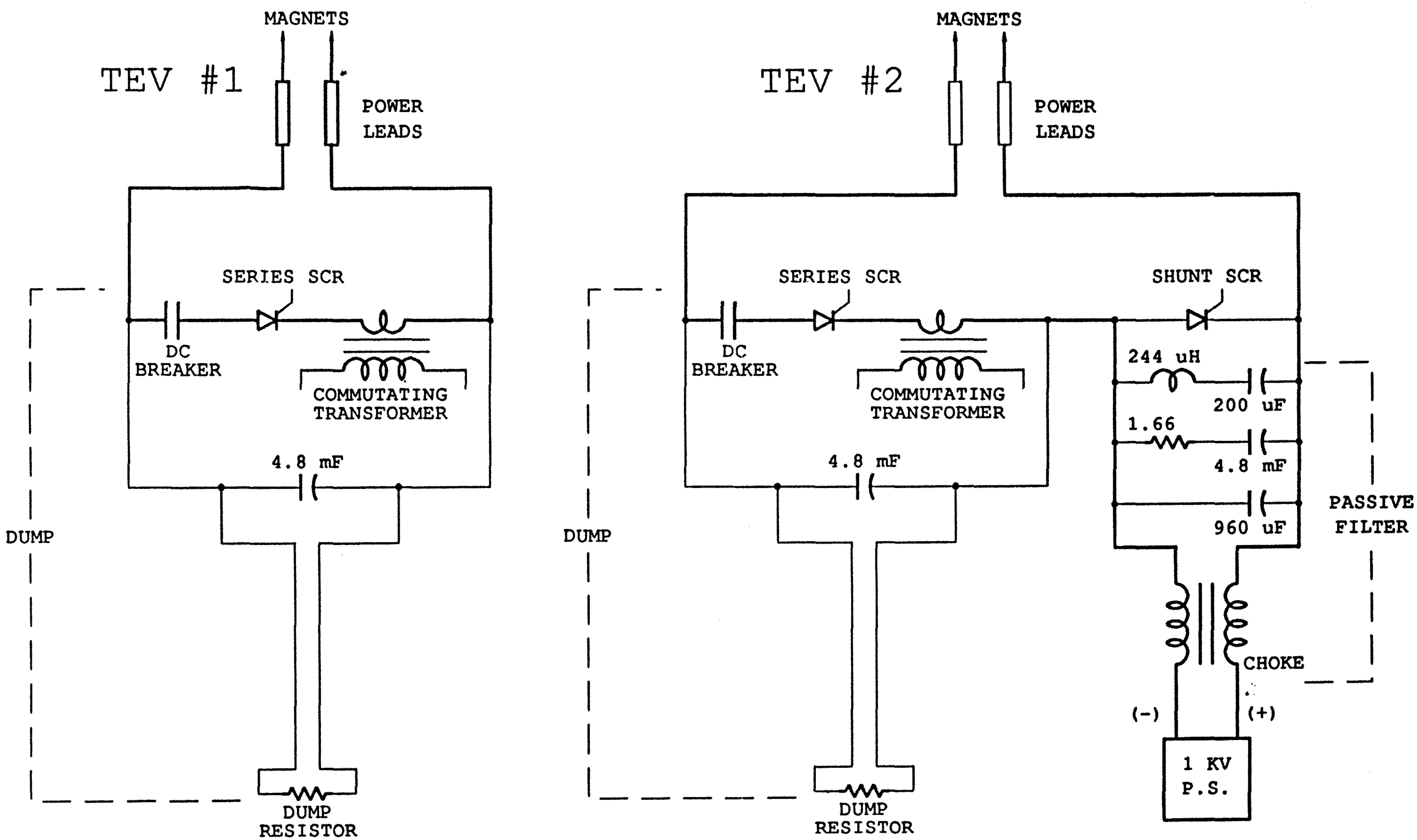


Figure 4-29. New Tevatron Main Power Circuit

The requirements made upon the new power supply usage are essentially identical to the present single ring Tevatron requirements. One added requirement is that two of the twelve power supplies must be capable of dc operation at full current, whereas in the present Tevatron only one power supply must operate in this mode. It is fortunate that when providing this facility in the Tevatron, a second supply was outfitted with this capability for redundancy, so that in the new collider operation, each of the rings will have a holding supply capable of continuous operation at full current.

4.5.3 Energy Extraction Dumps. Super-conductiong machines of the Tevatron type require some means of removing the stored energy in the magnets in the event of a quench. In the Tevatron this is accomplished by inserting high power resistors in series with the magnets when a quench occurs. The resistors and the corresponding high current switches constitute the "Dump" system. In the present Tevatron a dump is installed at each of the 12 power supply locations. Because the dump system is sized for the total magnet energy, the 12 dumps cannot be divided up between the old and new Tevatrons as in the case of the main power supplies. This will require building 12 new dumps for the new Tevatron.

The electrical requirements for the new dumps should differ very little from the original dumps and will therefore not require any new design. The new dumps will be located at the same service buildings as the old ones, that is, the '2' and '3' buildings. Both (new and old) Tevatron buses will be brought up into these service buildings. One bus will have both a power supply and a dump connected to it. As shown in Figure 3, the other bus will have just a dump. There appears to be ample room in the service buildings for the additional dump equipment if the old conventional magnet power supplies are removed. Since these power supplies are needed for the new main injector ring, the space will be available for no added cost.

4.5.4 Power Supply and Dump Control. It will be necessary to replicate the old Tevatron Power Supply and Dump control system to use in the new Tevatron to allow independent operation of the two machines. This will require new Safety Coordinators and Dump Controllers in every '2' and '3' building. In addition, two QBS Controllers in each '3' building will be necessary for control of the second ring's Quench By-pass System. The Safety Coordinators perform the functions of personnel safety, hipot control, and hardwire loop back-up for the Quench Protection System. The Dump Controllers are an integral part of the 12 new dumps required as mentioned above. The already installed battery-backup power (UPS'S) is sufficient to handle the needs of the second ring.

Some additional equipment will be needed in the Main Control Room. Another Dump/Fast-bypass Loop Controller and another Hipot Controller will be necessary to operate the second machine. The present power supply safety system key tree will be split in two to allow independent operation of the rings.

4.5.5 Quench Protection and Detection. The present Tevatron Quench Protection and Detection system has proven to be effective and reliable. In order to provide this function for a second ring, a duplication of the present system is proposed. Small changes will occur due to the use of new 6.6 T magnets in both rings and slightly different 4.4 T magnets in the new ring, but these changes should only be in minor details of the design. Each ring will be operable and protected independently of the other in order to minimize the cryogenic impact of the response to a quench in one of the rings. The use of identical equipment in the two rings will ease operation, maintenance and spares inventory problems.

Voltage monitoring, quench propagation via heaters installed in the dipoles and by-passing of current around quenching magnets will be handled as in the present Tevatron and as shown schematically in Figure 4-28.

4.5.5.1 Quench By-pass System. During a quench, the affected magnets must have the ring current bypassed around them to avoid over-heating the conductor and causing a catastrophic magnet failure. In the Tevatron this is accomplished by the Quench Bypass System. The major element in this system is the SCR switches. "Quench Bypass Switches" located in the tunnel are connected across a magnet half-cell and are turned on in the event of a quench. To prevent radiation damage to the SCR silicon junctions, these switches are installed in holes drilled in the tunnel walls. This complete system will be duplicated for the new Tevatron.

4.5.5.2 Quench Propagation Heaters. When a quench is detected in a magnet, it is essential to involve more than the initial superconductor volume in order to safely dissipate the energy stored locally in a quench protection unit. This is done by discharging energy stored in capacitor banks into "heater" strips installed in each dipole of the quench protection unit. In addition to spreading the energy deposition over a larger volume, this action increases the speed with which energy from the rest of the ring bypasses the quenching magnets by forcing a forward bias across the QBS at an earlier time than would occur if the initial quench simply propagated by itself. The Heater Firing Unit system used in the present Tevatron will be duplicated for the second ring.

4.5.5.3 Quench Detection and Protection Control. The present Tevatron uses a network of microcomputers known as Quench Protection Monitors to monitor the voltage across the magnets, determine when a quench has occurred, and orchestrate the activity of the other quench protection equipment. This system which has been designed and operationally proven to be "fail-safe" will be duplicated for the second ring. Each QPM monitors 1/24 of the magnets in the ring and controls equipment in its own service building. Global actions are provided by an additional microcomputer known as TECAR which is also responsible for controlling the main magnet power supply ramping.

4.5.6 Correction Element Power Supplies. The requirements for correction element power supplies are similiar to the present Tevatron:

Correction Dipole Power Supplies - approx. 250
Correction Quad Power Supplies
  Tune Quads - 2
  Skew Quads - 1
Correction Sextupole Power Supplies - 2

These power supplies will be identical to the present correction element power supplies requiring only duplication of present designs.

The location and lay-out of these power supplies for the new Tevatron will be as in the present Tevatron. There will be a standard relay rack in every service building for housing the dipole correction power supplies. The remaining five correction element power supplies will be installed in five of the service buildings.

4.6 Vacuum System

The vacuum system of the New Tevatron synchrotron is similar to that of the present Tevatron, which consists of three subsystems, namely

1. Cold beam tube, vacuum sections in which the beam tube is at cryogenic temperature (about 4.6 K).

2. Warm beam tube, vacuum sections in which the beam tube is at room temperature.

3. The cryostat insulating vacuum which is completely separate from the two systems above.

The beam tube is, of course continuous around the ring, approximately 6 km in length. Contrary to that of the original Tevatron, the beam tube of the New Tevatron will be welded together rather than using vacuum seals. The beam tube vacuum around the ring is conveniently divided into 24 sections which coincide with the 24 cryoloops. Each section terminates in a turnaround box at either end. At each of these points there is a short (about 10 cm) warm section of the beam tube with isolation valve (section valve).

The beam tube is cold except in the six long straight sections and the 12 medium straight sections at locations 17 and 48. Additional warm space will be provided between the quadrupole doublets at the ends of the long straight sections where necessary. Each of these warm sections of the beam tube has an isolation valve at each end. Vacuum barriers built into the superconducting quadrupoles subdivide the insulating vacuum into approximately 200 sections, each about 30 m long.

A more detailed description of the original Tevatron vacuum system may be found in Section 5 of the Tevatron Design Report.[1] There are four noticeable differences between the system described in the 1979 Design Report and the New Tevatron vacuum system. First, it was found to be unnecessary to install titanium getter pumps and heater tapes in the warm beam tube areas. Secondly, the existing Tevatron turbomolecular and roughing pumps serve to evacuate both the present Tevatron and the new machine through a completely redesigned manifold, as depicted in Figure 4-30.

Thirdly, in addition to the gauging and interlocking features described in the 1979 Design Report an additional interlock is necessary to prevent warm air from entering one accelerator while the other is cold. This is accomplished by using temperature sensors in both accelerators for comparison and interlocking the roughing valves

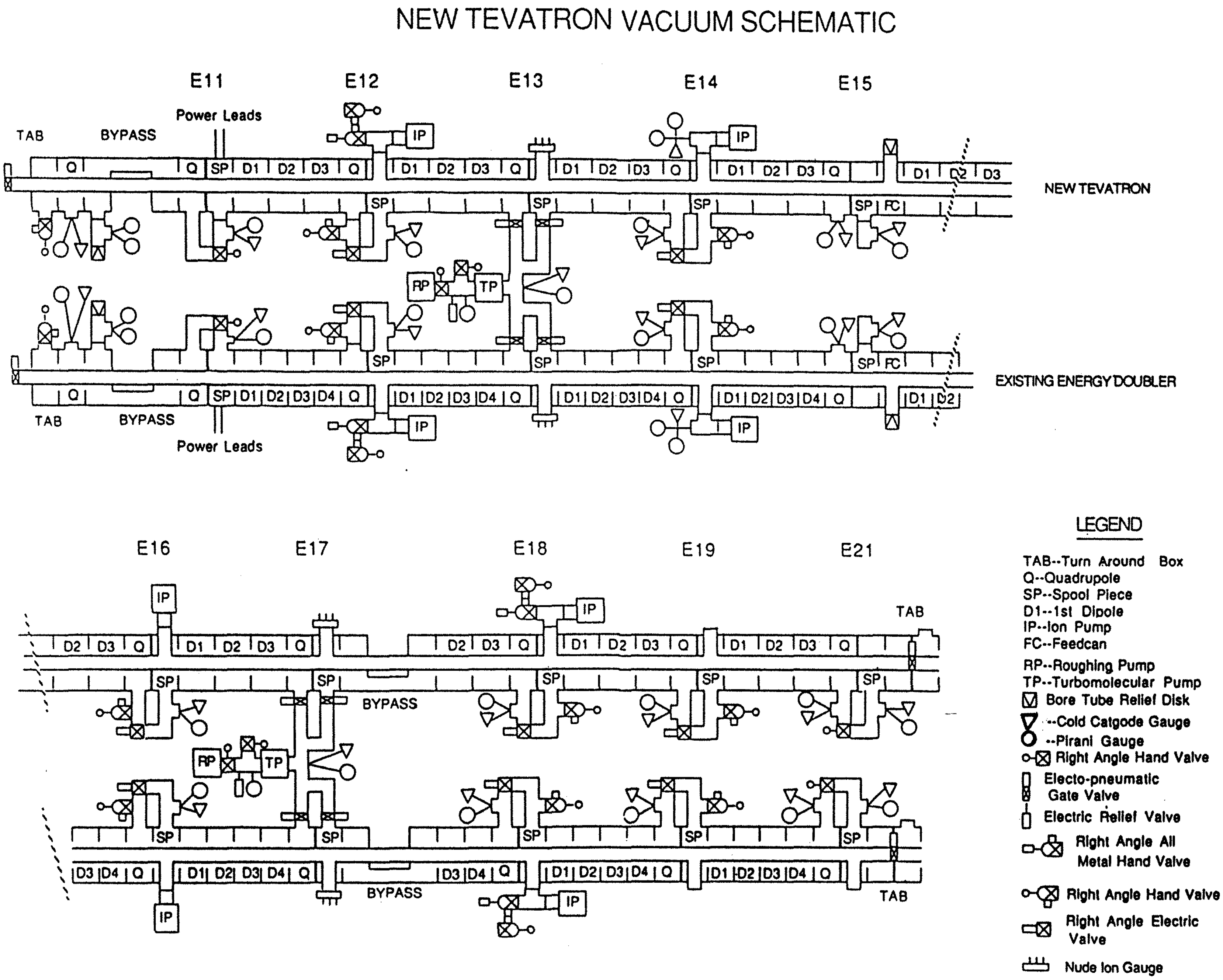


Figure 4-30. New Tevatron Vacuum Schematic

ENERGY DOUBLER VACUUM COMPONENTS (low beta excluded)

SECTOR	CRYOLOOP	roughing pump	turbo pump	bore tube relief disk	cold cathode gauge	Pirani gauge	right angle hand valve	gate valve	relief valve	right angle metal valve	right angle elect.valve	ion gauge	ion pump
A	1	2	2	2	17	25	16	10	2	5	5	2	6
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	13	24	13	9	2	5	5	2	4
B	1	2	2	2	15	21	15	8	2	4	5	2	6
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	13	20	11	7	2	3	4	4	7
C	1	2	2	2	13	19	16	8	2	3	5	2	5
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	13	24	11	9	2	3	4	2	4
D	1	2	2	2	14	20	17	8	2	3	5	2	5
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	13	20	11	7	2	3	4	2	4
E	1	2	2	2	14	22	16	8	2	4	5	2	6
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	14	24	11	9	2	3	4	2	4
F	1	2	2	2	13	23	17	8	2	6	5	2	6
	2	2	2	1	11	16	11	5	2	2	4	2	4
	3	2	2	1	11	16	11	5	2	2	4	2	4
	4	2	2	2	13	24	11	9	2	3	4	2	4
TOTAL		48	48	36	297	458	297	160	48	69	103	50	109

Table 4-15. Tevatron Vacuum Components
(a) Present Tevatron

NEW TEVATRON VACUUM COMPONENTS

SECTOR	CRYOLOOP	roughing pump	turbo pump	bore tube relief disk	cold cathode gauge	Pirani gauge	right angle hand valve	gate valve	relief valve	right angle metal valve	right angle elect.valve	ion gauge	ion pump
A	1	0	0	2	15	21	12	10	0	5	5	2	6
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	11	20	9	9	0	5	5	2	4
B	1	0	0	2	13	17	11	8	0	4	5	2	6
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	11	16	7	7	0	3	4	2	7
C	1	0	0	2	11	15	12	8	0	3	5	2	5
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	11	20	7	9	0	3	4	2	4
D	1	0	0	2	12	16	13	8	0	3	5	2	5
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	11	16	7	7	0	3	4	2	4
E	1	0	0	2	12	18	12	8	0	4	5	2	6
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	12	20	7	9	0	3	4	2	4
F	1	0	0	2	11	19	13	8	0	6	5	2	6
	2	0	0	1	9	12	7	5	0	2	4	2	4
	3	0	0	1	9	12	7	5	0	2	4	2	4
	4	0	0	2	11	20	7	9	0	3	4	2	4
TOTAL		0	0	36	249	362	201	160	0	69	103	48	109

Table 4-15. Tevatron Vacuum Components
(b) New Tevatron

therby. The final difference is that the existing Tevatron is supported by one pump station per four half-cells, not one pump station per two half-cells as described in the 1979 Design Report. Since both accelerators use the same pump stations, as shown in Figure 4-30, the New Tevatron also has one pump station per four half-cells. Table 4-15 is a summary of vacuum components for the New Tevatron.

4.7 New Tevatron Abort System

4.7.1 Overview. Design of the new Tevatron proton beam abort relies heavily on the technology and design ideas utilized in the existing Tevatron proton beam abort system.[4] Commissioned in 1983, this system has successfully provided clean single turn abort capability for all Tevatron proton beam operations.

The abort system for the new Tevatron ring differs primarily in that it's geometry is reflected about the center of the CØ straight section due to the opposite proton beam direction; and that space for the abort kickers in the C11 dipole cell is created by replacement of three standards 4.4. Tesla dipoles with two new 6.6 Tesla magnets.

A comparison of the abort geometry is shown in Figure 4-31.

Most components require new construction, but utilize existing and well understood technology.

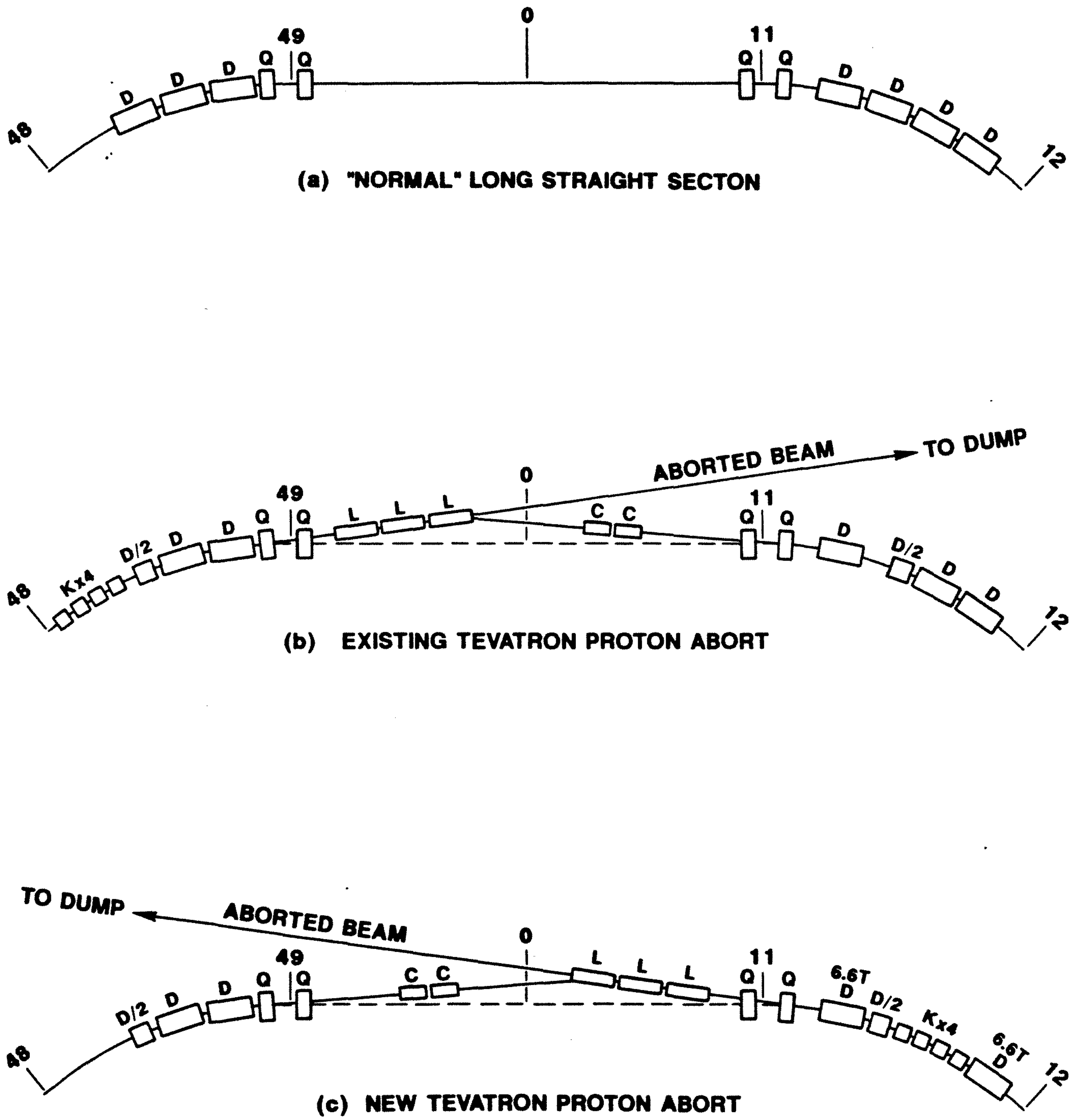
4.7.2 Abort System Function. Activation of the beam abort is by a single turn kicker magnet extraction system which tracks the Tevatron beam energy. As in the existing abort system,[5] four kicker magnets are used, with a pulse rise time of 1.5 μsec. The kickers vertically position the beam to be aborted into the field free region of a string of Lambertson magnets.

As with the existing Tevatron proton beam abort, the horizontal kick toward the abort channel is provided by a missing half dipole, this time in the C11 cell, with a compensating missing half dipole at B48.

The Lambertson magnets and two additional C-magnets in the CØ straight section provide the necessary compensating 8.1 mrad of horizontal bend for the Tevatron beam. These are powered with the main Tevatron bus. Space for the four kicker magnets, a total of 8.8 meters, is achieved by replacing the remaining three 6.1 meter 4.4 Tesla dipoles in the C11 cell with two 6.1 meter 6.6 Tesla dipoles. Along with space made available by the missing half dipole, adequate beam distance is provided for a new warm mini straight kicker region.

The aborted beam separates horizontally from the Tevatron trajectory at the Lambertson magnets, and continues transport to a new

Figure 4-31. C0 Abort Geometry



external high intensity beam dump with graphite core. Design of this dump is again very similar to that of the existing Tevatron proton beam dump.[6]

4.7.3 Major System Components. The following major components need be constructed for the new Tevatron abort systems. Of existing components, from the present low intensity Pbar abort, only the kicker pulsing units can be reused. However, with the exception of the high field 6.6T dipoles, all new components are of well tested design, currently used in the existing Tevatron proton beam abort system.

a) Two 6.1 meter 6.6 Tesla dipoles. These are identical to the high field bends to be used in many other locations for the pp collider.

b) Three 5.6 meter symmetric Lambertson magnets with 11.1 kG peak field excitation.

c) Two 3.6 meter 13.3 kG current septum or C-magnets.

d) Four 1.9 meter 3.7 kG kicker magnets.

e) One 23 Kamp kicker pulsing unit. Three additional required Kicker pulsing units are obtained by upgrading and reusing units presently used for the existing antiproton abort system.

f) Construction of a new 20 ft x 15 ft kicker building on the berm near C12. This is necessary to maintain short pulsed high voltage cable runs, as is standard for existing kicker systems.

g) A new graphite core external high intensity beam dump. As for the existing TeV dump at C14, the new dump is specified for a yearly maximum proton flux of 3.5×10^{17} p/year at 1 TeV, and 2×10^{13} protons for a single pulse.

Location of the dump, 70 meters beyond the B48 end of the C∅ long straight section is symmetrically opposite that of the existing dump at C14.

As with other components, design and construction are based on well understood existing technique.

References

1. "A Report on the Design of the Fermi National Accelerator Laboratory Superconducting Accelerator," Fermilab, May, 1979.

2. J.C. Theilacker, et al., "Commissioning of the Tevatron Satellite Refrigeration System," Advances in Cryogenic Engineering, Vol. 29, p. 429, (1983)

3. J.C. Theilacker, "Operational Experiences of the Tevatron," Presented at the Conference on Superconductivity and Applications, Buffalo, NY, June (1988).

4. M. Harrison, "The Tevatron Abort System," FNAL Report UPC-153, (1981).

5. G. Krafczyk, et.al., A 3 Kg Kicker Magnet System for the Tevatron beam Abort System, IEEE, Trans. Nucl. Sci., N5-28, P2769(1981).

6. J. Kidd, et.al., A High Intensity Beam Dump for the Tevatron Beam Abort System, IEEE Trans. Nucl. Sci., NS-28, P2774 (1981).

5. CIVIL CONSTRUCTION

5.1 Overview

The civil construction for the Main Injector includes all below-grade beamline enclosures, shielding, above-grade buildings, roads, parking, ponds, utilities and services to accommodate the equipment for, and operation of, the Main Injector. The civil construction also includes remodeling work in the existing Tevatron Ring Enclosure to accommodate the new configuration of the Main Injector.

New construction is similar to presently used and proven construction methods at Fermilab. The architectural style of the new buildings reflects, and is harmonious with, existing adjacent buildings. Existing topography, vegetation, natural habitat and site boundaries have been carefully observed in the layout of the new construction.

Safety provisions for radiation, fire protection and conventional safety are included in this conceptual design. Energy efficient construction techniques will be incorporated into all new structures. Quality assurance provisions will be part of all project phases, conceptual, preliminary and final design, construction and construction management.

5.2 Beam Geometrics and General Layout

Beamline geometrics of the new Main Injector, the associated beam transport lines and the present Fermilab Tevatron are illustrated on Drawing No. CDR-7. (All civil construction drawings are included in Appendix D.) These geometrics are the definition about which the beam enclosures, radiation shielding, service buildings, roads and utility extensions are designed relative to the Fermilab site. Drawing No. CDR-1 shows the Main Injector on the Fermilab site relative to the present Tevatron, experimental areas, industrial area and Fermilab village. Drawing No. CDR-2 illustrates the Main Injector on the Fermilab site as an aerial perspective. This design and general layout is compatible with the Fermilab Site Development and Utilization Plan.

5.3 Radiation Shielding and Life Safety Criteria

All new construction will provide adequate personnel shielding. Consideration has been given to various operational conditions as well as fault conditions in determining shielding designs.

Areas of specific shielding design include beam enclosures, service buildings, labyrinth accesses, stairways, drop hatches and cable/pipe penetrations. Another area of design is access to adjacent rings or transport lines while other lines are operational.

Shielding will be done with compacted earth, regular density concrete and steel plate. Various combinations and thicknesses of these materials will be proportioned according to the limitations of economic design and space.

Life Safety access control into the various beam enclosures, labyrinths, stairs and buildings is maintained by a series of locked and interlocked barriers. Solid partitions with doors will separate the Tevatron Oxygen Deficient Hazardous (ODH) areas in the F-0 Enclosure from the Main Injector areas in the F-0 Enclosure.

5.4 Main Injector Ring Enclosure

The Main Injector Ring Enclosure is a race track shaped, below-grade enclosure, approximately 10,700 ft. long with 9'-0" wide and 8'-0" high cross sections. The enclosure plan and sections are shown on Drawing Nos. CDR-4, CDR-5, CDR-19 and CDR-20. The floor of the enclosure is at Elevation 722'-6" or 11' to 23' below existing grade. The Main Injector ring equipment is centered on Elevation 724'-2" or 1'-8" above the floor and is positioned 1'-9" from the outer curved wall. Earth shielding berms over the Main Injector Enclosure provide the required 17' earth equivalent shielding.

The Main Injector Ring Enclosure is constructed on a reinforced concrete cast-in-place (CIP) base slab over compacted granular fill bearing on undisturbed glacial till. Both CIP and precast reinforced concrete wall and roof construction are used. More than 9,400' of ring will be built with precast concrete inverted "U" wall/roof sections which are welded to a CIP base slab. Nearly 26,000' of this type precast have been economically constructed at Fermilab during the past two decades. The enclosures and alcoves beneath Service Buildings will be CIP base slab, walls and roof. Footing drains, moistureproofing and granular backfills are used to insure a dry enclosure.

Cable trays, power bus, piping, lighting and other utilities are ceiling or wall-mounted on both inner and outer walls. Numerous penetrations connect to the service buildings constructed above the Main Injector enclosure.

Personnel access stairs to the Main Injector are provided at ten service buildings and the F-0 Service Building. No stairs occur at the two Abort Service Buildings. Ventilation equipment is near these stairs and is described in Section 5.11 below.

A common earth berm above the Main Injector Enclosures defines the location of the below-grade ring enclosure. Top of berm is approximately 1'-2" above the Service Building floor.

5.5 Beam Transport Enclosures

The Beam Transport Enclosures connect the Booster Accelerator, Target Hall and the Main Injector and contain the 8 GeV North, 8 GeV West and 120 GeV Beamlines. These enclosures total 2,515' in length, are 8'-0" or 9'-0" wide and 8'-0" to 11'-6" high. Floors are at Elevation 722'-6" or 726'-0" to meet existing enclosure conditions near the Target Hall. Beam transport equipment varies in elevation from 724'-2" to 732'-6". Drawings Nos. CDR-8, CDR-9 and CDR-20 show the various beam and equipment configurations in plans and sections. Drawings Nos. CDR-10, CDR-11 and CDR-12 illustrate a longitudinal cut through these beam lines.

The 8 GeV North Beam Enclosure connects on the upstream end to the Booster Enclosure and passes under Well Pond Road. Existing buried steel shielding above the beam pipe to Antiproton Rings Enclosure will be removed and later replaced after new enclosure construction.

Construction details of the Beam Transport Enclosures are very similar to the Main Injector Ring Enclosure. Equipment access is from hatches in the N-20 Hatch Building, the Target Hall or the Booster Enclosure. Additional personnel stairs are provided on very long enclosure lengths.

5.6 Main Injector Service Buildings

Twelve service buildings in three size configurations contain equipment, services and utilities for the Main Injector and Beam Transport Lines. Other equipment for the Beam Transport Lines will be contained in the existing Tevatron F-2 Service Building and in the existing Target Hall. Locations of the twelve service buildings are shown on Drawing No. CDR-5.

Nine of the twelve service buildings are identical to each other and are illustrated on Drawing Nos. CDR-13 and CDR-14. These buildings are located atop the shield berm approximately 1000' apart. Since the buildings house the magnet power supplies, the location matches the midpoint of a 32 dipole magnet dc bus in the beam enclosure below. The buildings also contain control racks, pumps and heat exchangers, and provide personnel stairs and equipment access to the beam enclosure. Conduits to a utility alcove off the beam enclosure below provide for dc buss, power cable, control cable and LCW piping.

The nine buildings are 30'-0" wide and 50'-0" long in plan with 10'-0" clear interior heights. Construction is insulated metal siding on a steel frame with built-up roof and concrete floor. During Title I design, precast wall panel buildings will be investigated together with precast subgrade beams to reduce construction times and possible settlements. The electrical and mechanical systems for these service buildings are described in Sections 5.10 and 5.11 below.

Two of the twelve service buildings are small, single-purpose buildings containing the pulsed power supplies for the Main Injector Beam Abort. These buildings are 20'-0" square with 10'-0" clear interior height. There is no stair access to the beam enclosure below. Construction will be similar to the other service buildings.

N-20 Hatch Service Building is the twelfth building and has multi-purpose use. Refer to Drawings Nos.-CDR-15 and CDR-16. Like the nine service buildings, N-20 will contain a full complement of control racks, magnet power supplies and cooling system equipment for the Main Injector, as well as power supplies for the adjacent 8 GeV West Beam. In addition, N-20 Hatch Service Building, as its name typifies, contains equipment access hatches above a curved labyrinth leading to the inner aisle of the Main Injector and a drop hatch with removable shield blocks above the 8 GeV West Enclosure. Personnel stairs to both enclosures are provided.

The N-20 Hatch Service Building is a high bay 50'-0" wide, 150'-0" long with 24'-0" clear interior height. Two 30'-0" wide, 50'-0" long, 10'-0" height low bays attach to the high bay. The high bay is served by a 20 ton bridge crane with full coverage above both hatches and a central off-loading area at a 16'-0" wide equipment door. An 8'-0" x 9'-0" freight elevator with 5 ton capacity also serves the Main Injector labyrinth from the N-20 high bay floor. The construction is similar to the other service buildings.

5.7 F-0 Beam Enclosure and F-0 Service Building Addition

The F-0 Beam Enclosure contains components of three accelerators, the Main Injector, Tevatron A and Tevatron B. In addition, the magnets which transfer beam between the accelerators, kickers and RF cavities also are contained in this enclosure.

The existing F-0 Enclosure has insufficient space for the new beams and must be completely demolished and rebuilt. In order to do this construction work, a portion of the F-0 Service Building above must also be demolished and rebuilt. Refer to Section 5.9 for a description of the earth retention system planned to accomplish this work. Plans and sections for the F-0 Enclosure and Service Building are shown on Drawgings Nos. CDR-8, CDR-17 and CDR-18.

The F-0 Enclosure is a below-grade enclosure, 690'-0" long, varying in width from 22'-0" to 38'-0" and has 8'-0" clear height. The southeast end connects to the Main Injector and existing Tevatron enclosures; the northwest end connects to 120 GeV Beam, the Main Injector and the existing Tevatron enclosures. The enclosure floor is at Elev. 722'-6" which matches floors of both the Main Injector and the Tevatron enclosures. The 120 GeV Beam enclosure floor steps down from Elev. 726.-0".

The F-0 Enclosure is constructed of CIP reinforced concrete. Since no portion of the existing base slab can be reused due to the increased span loads, a completely new base slab will be poured. The glacial till and the existing granular sub-base is adequate. Underdrains from the existing Tevatron enclosure and the new Main Injector enclosure underdrains will be routed to new sump pits. Moistureproofing and granular backfills will be used similar to the Main Injector.

An existing freight elevator, stairs and curved labyrinth from the reused portion of the F-0 Service Building will be reconnected to the new beam enclosure on the Tevatron side. New stairs and a dumb waiter are provided from the F-0 Service Building Addition down to the beam enclosure on the Main Injector side. Numerous penetrations connect the building and enclosure below and are shown in the drawing sections.

The F-0 Service Building Addition can be built only after the F-0 Beam Enclosure below is completed and backfilled. A 50'-0" wide, 150'-0" long, 10'-0" clear height addition is added on the southeast end and in back of the existing building. On the northwest end, two additions are added. A 50'-0" square addition is added in line with the southeast area and a 25'-0" wide, 88'-0" long, 11'-2" clear height addition aligns with the existing service building.

The construction of the addition is similar to the existing structure, with insulated metal siding over a steel frame, built-up roof and concrete floor. Equipment access doors are provided to all large equipment areas.

The F-0 Service Building contains the RF cavity power supplies for the three accelerators, magnet power supplies, an existing helium compressor room, LCW cooling systems, control racks, test areas and small technical work areas. The space allocation is shown on the drawings.

5.8 B-45 Tevatron Enclosure Modifications for Beam Abort

Modifications to the existing Tevatron enclosure at B-45 are required to install a beam abort for the new Tevatron B beam. Construction is identical to the Tevatron A abort constructed in 1980. After excavation down to the base slab level, the base slab concrete is extended and two precast arch section are shifted laterally. A third precast is removed and a new transition collar is poured to accommodate the abort pipe. Foundations and a steel shield stack are installed around the abort core. Backfilling completes the modifications

5.9 Structural Foundation Systems and Earth Retention

All base slabs and piers under Main Injector enclosures will be founded on glacial till with high bearing capacity. Soil boring logs near the Main Injector perimeter indicate the unsuitability of shallow foundations if founded on the high water bearing strata above this glacial till. Soil boring locations, elevations of glacial till and unconfined compressive strengths are shown on Drawing No. CDR-3. During Title I, additional borings will be made to better define the sub-surface conditions.

Although the till varies in depths of 4 to 21 feet below grade, the requirements for the various beam enclosure structures place the base slab excavation well into the till except at a very few isolated areas. In these areas, a compacted granular backfill or lean concrete will replace the several additional feet required to reach glacial till.

The Main Injector enclosures may also serve as the foundations for the twelve Service Buildings around the ring. Piers will extend above the enclosure roof and precast grade beams will support the CIP service building floors. Similar techniques have been successfully used for the Antiproton Source Service Building construction in quite similar sub-grade conditions.

Earth retention systems are planned for two locations where new construction comes close to existing Tevatron enclosures and buildings. Along the F-19 to F-23 Tevatron enclosure section, sheet piling or soldier beam/lagging will be used to retain sufficient earth shield around the Tevatron. This is shown on Drawing Nos.-CDR-8 and CDR-9. During a short accelerator maintenance period, a portion of the existing Pretarget Enclosure will be demolished and the earth retention system installed. Acclerator operations may then continue with construction of the new 120 GeV Beam Enclosure.

An earth retention system will also be used at the F-0 Service Building Addition and Beam Enclosure. Only the southwest longitudinal half of the existing F-0 Service Building need be demolished in order to excavate down and reconstruct the F-0 Beam Enclosure below. Sheet piling or soldier beams/lagging will be driven along the northeast half of F-0 Service Building so that a large accelerator equipment installation can be reused. Refer to Drawing No. CDR-18. This F-0 construction is on the critical construction path prior to accelerator installation.

5.10 Primary Power, Secondary Power and Distribution

The Main Injector and Beam Transport Lines will be powered from six existing 13.8 kV primary feeders which are accessible at Tevatron Manhole F-1. Refer to Drawing No. CDR-23. These feeders will be extended through the new power duct bank system in the Main Injector Road. Four pulsed feeders, Feeders 21B1, 21B2, 22B1 and 22B2, are used for the existing Main Ring and will be reconnected to the relocated power supply substations for the Main Injector magnets. Feeder 49 (old 46 renamed) will power the Beam Transport Lines by connecting to power supplies in the F-0 Service Building, Target Hall and the Tevatron F-1 Service Building. Feeder 45 is a non-pulsed feeder for in-house loads at all Main Injector Service Buildings.

New substations for the in-house power will be installed at each service building along with the relocated power supply substations. Four-way air switches are used in the feeder network to isolate any faulted 13.8 kV feeder cable and minimize outage due to cable failure.

The 12-phase power from the relocated power supply substation will be brought in directly to the relocated power supply equipment in each service building.

Conventional power will be connected to power distribution panelboards in each service building. 480 volt, 3 phase branch circuits will power the water pumps, heating and ventilating equipment, control racks and service outlets. Stepdown transformers and panelboards provide 208/120 volt power for lighting and outlets. Refer to Drawings Nos. CDR-24 and CDR-25.

5.11 Primary Cooling, Distribution and Mechanical Systems

The primary heat rejection medium for the 12 MW generated by the Main Injector is cooling pond water (PW). Drawing No. CDR-22 shows the two new interconnected cooling ponds that roughly encirlce the Main Injector Road and provide 16.0 acres of cooling surface. The ponds total 11,650' in length, are 60' wide and the average to maximum depth is 4'-6" to 7'-0". Transverse concrete dams near each service building provide intake and discharge piping separation and elevation control. Pond water level varies from Elev. 739' matching the Tevatron ponds at F-0 down to Elev. 735'. Cross connect piping between the Main Injector ponds and the Tevatron Ponds allow load shedding and water level control.

The Low Conductivity Water (LCW) system is a closed piping loop exchanging heat from the Main Injector magnets and power supplies to the pond water. Most of the equipment now in the present Tevatron service buildings will be reinstalled in the Main Injector service buildings and perform in a similar capacity. New LCW piping will be installed in the Main Injector Beam Enclosure. A system-wide deionizer is located in N-20 service building for slip stream polishing.

Existing chilled water (CW) in the F-0 Service Building which comes from the Central Utility Building will be retained and reused. The new combined loads on the chilled water system are less than present loads.

The underdrain system for all new beam enclosures is similar to the design used for the Antiproton Rings. Perforated drain piping surrounded by granular material and covered with geotextile fabric is installed on both sides of the enclosure base slabs. Duplexed pump sump pits connect to the underdrain piping and discharge to surface ditches.

The fire detection/suppression systems used for the Main Injector are similar to those systems used for the Tevatron enclosures and buildings. Industrial Cold Water (ICW) will serve fire hydrants and hose cabinets in the F-O and N-20 Service Buildings. These buildings will also be equipped with smoke detectors which report to the site-wide FIRUS system. In all other beam enclosures and service buildings, conditions of fire are monitored by the operational characteristics of the beam line equipment and scientific instrumentation.

Moderate ventilation rates with dehumidification will be used in the Main Injector Beam Enclosure. Refer to Drawing No. CDR-21. Ventilation fans will be placed in alternate service buildings to supply/exhaust air through the stairway and alcove openings. Two air changes per hour will be used when needed during non-operating periods. Periodically placed dehumidifiers about the beam enclosure will control humidity. At the F-0 Enclosure, a duct will allow the Main Injector air circulation through the ODH partitioned area of the Tevatron enclosure.

The Main Injector Service Buildings are equipped with a variety of HVAC equipment to accommodate the required occupancies. Local, self-contained air conditioners will be used to cool the Control Rack areas. Unit heaters will heat the power supply and water system areas when operations are off. Roof fans and wall louvers will provide ventilation to these areas when the temperature requires.

5.12 Underground Utilities and Services

Power ducts, communication ducts, industrial cold water (ICW) piping and pond water (PW) piping will be extended from existing utility corridors along South Booster Road, Kautz Road and Main Ring Road. Utility routings and connection points are shown on Drawing Nos.-CDR-4 and CDR-6.

A new 13.8 kV power duct bank loop encircling the Main Injector will be installed below the new Main Injector Road. This new duct bank will connect to the existing Main Ring 13.8 kV power duct bank at Manhole F-1 on the Main Ring Road.

At each of the ten Main Injector Service Buildings, the new duct bank will connect through concrete power manholes to the substation foundations supporting three Main Injector pulsed power substations and one conventional power substation. The substation foundations will provide transformer oil containment reservoirs. Three additional power manholes in the Main Injector Road will facilitate the pulling of the 13.8 kV feeder cables.

A new communication duct bank loop also encircling the Main Injector will be installed along the inside shoulder of the the Main Injector road. The communication duct bank will be branched through concrete manholes into each of the ten Main Injector Service Buildings and the F-0 Service Building. This new duct bank will be extended along the 120 GeV Beamline and the 8 GeV North Beamline with branches into these beam enclosures. The duct bank will connect to the existing Manhole C-33 near the Southwest Booster Laboratory. The existing duct bank for Manhole C-33 into the existing Central Utility Building/Utility Tunnel will be increased in capacity. Existing cable trays in the Utility Tunnel complete the communications route back to the Tevatron Main Control Room in the Cross Gallery.

Industrial cold water (ICW) piping will be extended along Kautz Road to serve fire hydrants and hose cabinets in the new N-20 Hatch Service Building.

No additional toilet facilities are planned for the Main Injector project since facilities are available in nearby buildings. Extensions to domestic water (DOM) piping or sanitary sewers (SAN) are not required. Existing septic systems at the existing Antiproton Target Hall and F-O Service Building will be retained and any portions of the field damaged during construction will be replaced.

5.13 Survey and Alignment Control

A coordinated system of monuments, benchmarks and working points is planned for complete geometric control of the Main Injector during all phases of construction. Deep concrete piers will be set at construction start to define ring centers and major baselines. This control will be extended onto enclosure base slabs as construction progresses and will be tied into control of the existing survey systems of the Tevatron, Booster and Antiproton accelerators. Provision will be made for survey sighting tubes in addition to available equipment hatches to facilitate survey checks to accelerator equipment after all construction is completed.

5.14 Roads, Drainage and Landscaping

Road access to the Main Injector site is from existing Kautz Road. A new loop road around the site, Main Injector Road, will connect to Kautz Road at two places. Early construction of this new road will maintain access to the existing Antiproton Target Hall and will provide direct construction access via Kautz Road from Illinois Highway 56, Butterfield Road. Refer to Drawing No. CDR-1 and CDR-4.

A portion of existing Kautz Road, between the Main Injector Road intersections, will be rebuilt to the alignment required by the Main Injector cooling ponds and new service buildings. Refer to Drawing No. CDR-5. Service drives with small parking areas are provided at each service building with access to either Kautz Road or the new Main Injector Road.

The construction site is mainly open cropland with approximately one third in current leased cultivation. The overall drainage pattern is to the southwest into Indian Creek. There are isolated areas of trees and fence rows, shallow ditches meander the site and abandoned agricultural tiles are in evidence. A small area of dead timber has provided an unusually fine nesting habitat for great blue herons.

The Main Injector impacts the site with three salient features, the shielding berm, the new road and the cooling ponds. The site drainage will be designed to minimize this impact according to the following design goals:

1. Maintain the existing watershed characteristics within the project area and the surrounding topography.

2. Control surface runoff into Indian Creek so as to create no adverse impact on downstream off-site residential areas.

3. Provide for collection of excess surface runoff when required for pond level maintenance.

Drainage structures will be placed through and under the shield berms, road beds and ponds to maintain the normal surface water flow through the interior ring area of the Main Injector. Pump stations, control dams and weirs will be provided for seasonal adjustment of the drainage patterns needed to maintain the heron nesting habitat. Operations of these controls will be coordinated with the existing Swan Lake and Booster Pond cooling systems which also connect to Indian Creek.

Special precautions will be made to protect large trees that are adjacent to the construction site. Within the construction site, topsoil will be segregated and later replaced. Crown vetch will be used on berm slopes and crests. The ring interior area will be returned to natural field grasses. Grass seed will be planted adjacent to roads and building areas.

The southwestern boundary of Fermilab abuts to an abandoned railroad right-of-way, now converted into the Illinois Prairie Path. The existing railroad berm and ditch, together with the new ponds and adjacent pond berms, create a significant barrier to any errant cyclist/hiker along the Prairie Path. In addition, appropriate shrubbery and thicket-type vegetation will be planted along the site boundary as a further visual screen and natural fence row.

5.15 Construction Packages and Schedules

The Main Injector civil construction work has been grouped into the following four general categories for the preparation of cost estimates and construction schedules.

> Site Preparations: (WBS 1.4.1) Site development including mobilization, site protection, survey control, temporary utilities, rough roads, major excavation and backfills, most underground utilities, site drainage, ponds and dams.
>
> Beam Enclosures and Service Buildings: (WBS 1.4.2) Construction of all underground enclosures, surface buildings, utilities and services that can be done simultaneously with Fermilab colliding beam or fixed target operations. Included is 90% of the 10,700' Main Injector Enclosure, 95% of the 2,515' Beam Transport Enclosures, 12 of the 13 various sized Service Buildings, substation foundations, the remaining underground utilities and some of the earth retention systems.
>
> F-0 Service Building and Beam Enclosure: (WBS 1.4.3) Construction that requires Tevatron operations be off. Included is earth retention systems, demolition and rebuilding of the F-0 Beam Enclosure and F-0 Service Building, completion of the remaining Main Injector and Beam Transport Enclosures, extension of the Booster Beam Enclosure and the constructon of the B-45 Abort in the Tevatron Enclosure.
>
> Landscaping and Paving: (WBS 1.4.4) Site clean-up, road regrading, paving and landscaping work to complete the project.

During development of Title I and Title II these four categories will be divided into the actual constructon packages tailored to the detailed design, operational conditions and early occupancy requirements. Some of the site construction work adjacent to the great blue heron habitat will be scheduled after the spring/early summer nesting season.

6. COST ESTIMATE

The total estimated cost for construction of the Proton-Proton Collider Upgrade is $215 million (then year). The cost estimate is summarized in Table 6-1. An additional $70 million will be required for direct R&D, pre-operating, and capital equipment costs to support the project.

6.1 Methodology

The cost estimate methodology is adapted from that used to estimate the Superconducting Super Collider (SSC). Our recent experience with the TeV I (Antiproton Source) and Energy Saver (Tevatron) construction projects forms the basis for a large fraction of the cost estimate of this project.

A Work Breakdown Structure (WBS) was set up in order to identify all required components of the Proton-Proton Collider Upgrade project and to insure that each component was adequately specified and incorporated into the estimate. The WBS through third level is shown in Table 6-1. The actual WBS used for the cost estimate extended through the seventh level for some components.

All components are estimated at the lowest applicable level in 1988 dollars and then summed upwards. At the lowest level material costs and labor (fabrication) hours are entered separately along with the basis for the estimate. Labor estimates are also associated with a craft code specifying the type of labor to be used. When material costs are based on previous purchases of identical components they are escalated to 1988 prices using standard DOE inflation factors. The translation of craft codes into hourly costs is on the basis of local labor rates and is given in Table 6-2. Through this approach a categorized estimate of the total manpower required for completion of the project is created at the same time as the cost estimate.

Table 6-3 gives the manpower estimate for the project with a breakdown for individual craft codes. A total of about 850 man-years is required (over a five year period) for the project.

The cost estimate is produced in 1988 dollars. Escalation to then year dollars is accomplished through a convolution of the spending profile with DOE construction project escalation rates. (See Appendix A - Schedule 44.)

Labor rates have been obtained in a number of ways. For Fermilab chargeback codes, present chargeback rates have been used. These include supervisory and incoming parts inspection overhead. It is expected that magnet labor rates will become less during the project as temporary labor is brought onboard. For Fermi accelerator technicians and professional rates, average S-W-F rates for the appropriate groups have been used. No supervisory overhead is included. For trade codes, present Fermi T&M contract rates have been used. (Note however, most work will be carried out by fixed price contracts.) In one case a vendor quote ("estimate") for trade labor was used and is higher than the T&M rate.

6.2 Brief Project Description

This project provides for the construction and installation of an approximately 1 TeV superconducting accelerator in the existing tunnel in order to achieve high luminosity collisions between protons in this new superconducting ring and protons in the existing Tevatron ring. A new tunnel for the existing 150 GeV Main Ring accelerator (Main Injector), with beamlines and abort systems, will be constructed adjacent to the existing Tevatron tunnel.

About 13,500 ft of tunnel and 35,000 sq ft of service building will be constructed. Technical components for the superconducting accelerator include superconducting magnets and other cryogenic and accelerator components. Technical components for the beamlines and beam transfers include conventional magnets and accelerator components.

The Main Injector will reuse technical components from the existing Main Ring. Included in the project for the Main Injector are only building and tunnel construction, and standard and accelerator utilities. Specifically, Main Ring magnets, power supplies, transformers and rf systems will be reused. The relocation of the technical components of the Main Injector will be performed with operating funds. This includes all necessary reinstallation costs and modifications or improvements to present systems that have been in service for, in some cases, 18 years.

All necessary modifications to the Tevatron and its enclosure (except for the new beam dump) to accommodate the new superconducting ring will be accomplished with operating funds. The capability of utilities and the cryogenics plant already in existence will be used to the greatest extent possible. One half of the Tevatron main power supplies and rf systems will be used in the new superconducting ring during collider operation and reinstalled in the Tevatron during fixed target operation.

6.2.1 Technical Components. The total estimate for technical components for this project is $97,380K (1988). Of this the major fraction, or $82,876K, is in the new superconducting synchrotron (Tev B). Superconducting magnet components alone represent $66,654K. Other accelerator and cryogenic systems for TeV B are estimated at $16,222K.

The beam line technical components are estimated at $7,829K and include conventional magnets, vacuum systems, injection and extraction systems, power supplies, etc. About half of the cost in this category are for magnets.

The Main Injector system included in the project provide primarily accelerator utilities needed for the relocation of the present technical Main Ring components. The total cost in this category is estimated at $6,675K, of which all but $476K for the beam abort system represents costs for utilities and their installation. Included in this utilities category are power and water systems, safety and controls communication links, cables, cable tray, and bus for major tunnel components. The power system includes the feeder distribution for both conventional and magnet power, the relocation and reconnection of transformers for the main magnet excitation power supply system. The water system includes both pond water, pump system, and the LCW system with relocation of heat exchangers and pumps and installation of LCW tunnel header. The ring-wide links for the safety and control systems are provided for.

6.2.2 Conventional Construction. The conventional construction cost is estimated at $25,380K (1988). About $19,000K of this provides for about 13,500 ft of tunnel with associated ponds and roads, and for about 25,000 sq ft of new service building and hatch building with associated conventional utilities. In addition to this about $6,000K is estimated for the construction work required at the FØ straight section to connect the two ring enclosures together. Demolition of a large fraction of the present FØ (rf) building and associated tunnel enclosure is required. About 8,000 sq ft will be demolished and 10,000 rebuilt resulting in a total net of service building addition of 27,100 sq ft for this project.

6.3 Engineering Design Inspection & Administration (EDIA)

EDIA is estimated at 16% of total costs. The basis of this percentage is the Fermilab TeV I project. For this project, 4% of the total has been allocated to conventional construction, 1% to management, and 11% to technical components.

6.4 Contingency

The contingency factor used is 25%. This is an overall factor and has not as yet been split for varying degrees of certainty in the different components of the work breakdown structure. This overall contingency is appropriate for the present level of the conceptual design. As the design continues, it will probably become appropriate to allocate a larger % fraction of the contingency to the superconducting magnet effort.

6.5 Other Project Costs

Other project related costs total $70 million (then year). This includes $50 million for R&D, $14 million for pre-operating expenses and $6 million for capital equipment. Numbers include a 37% G&A surcharge where appropriate.

6.5.1 R&D. R&D will be carried out to obtain tooling and to prototype new magnets and cryogenic/accelerator components. In particular, R&D effort will be directed toward the development of the superconducting magnets and systems tests.

Both the 4.4 T and 6.6 T dipole will be developed under R&D and a number of prototypes will be assembled and tested.

The R&D program provides for the fabrication, installation, and test of about 1/12th of the superconducting ring and associated systems. These components will be assembled and tested in the Tevatron tunnel at the BØ overpass region which is free of Main Ring magnets.

The 6.6 T magnets needed for installation in the present Tevatron will be produced with R&D funds. This program should ensure success of the construction of the 6.6 T magnets needed for this construction project.

Prototypes for all aspects of the technical program will be developed on R&D. This will include conventional magnet development and required tooling for the beamlines, cryogenic component development and tooling for TeV B, electrical and power supply prototypes. Software will be developed on R&D as well as special purpose diagnostic instrumentation.

6.5.2 Pre-operations. Systems tests will be performed with about 1/12th of the new Tevatron installed at the BØ overpass region. Two houses worth of components will be fabricated on R&D and installed for complete systems tests. Past experience has indicated that such total systems tests are invaluable in achieving successful and efficient final installation and commissioning.

Final commissioning is envisaged in two phases. First, the Main Injector will be commissioned as rapidly as possible after the conventional construction and installation is complete at FØ. Fixed target physics will resume using the present Tevatron (TeV A).

During the fixed target run, sections of the new Tevatron will be cooled down and tested separately. Then, only after all individual sections have been tested will the fixed target run be interrupted for a commissioning run of TeV B. It is expected that major commissioning effort will take place in 1994.

6.5.3 Capital Equipment. Capital Equipment funds will be used for cost of general equipment needed in association with the project. Also included are any necessary modifications to the cryogenic plant and the control computers directly associate with this project. Magnet movers, leak detectors, welding machines, test instruments and power supplies will be provided with capital equipment funds.

Table 6-1 Proton-Proton Collider Cost Estimate
(1988 Costs - Dollar amounts in thousands)

WBS	Description			Total
1.	Project Cost Estimate			215000
1.1	Main Inj Abort & Utilities		6675	
1.1.5	Main Inj Abort System	476		
1.1.8	Main Inj Controls Links	295		
1.1.9	Main Inj Safety System	189		
1.1.10	MI Utilities and Install'n	5714		
1.2	Beamlines Tech Components		7829	
1.2.1	Beamlines Magnets	2926		
1.2.2	Beamlines Vacuum Sys	194		
1.2.3	Beamlines Mag Power Sup	287		
1.2.5	Injection/120 GeV Extract	549		
1.2.6	Extraction Systems	929		
1.2.7	Beamlines Instrumentation	673		
1.2.8	Beamlines Controls	88		
1.2.9	Beamlines Safety System	140		
1.2.10	Utilities and Installation	2044		
1.3	Tevatron B Technical Comp		82876	
1.3.1	Tev B Magnets	66654		
1.3.2	Tev B Cryogenics	5539		
1.3.3	Tev B Warm Vacuum	1188		
1.3.4	Tev B Mag Power Supplies	2070		
1.3.6	Tev B Abort System	726		
1.3.8	Tev B Controls	874		
1.3.9	Tev B Safety System	20		
1.3.10	Tev B Utilities and Inst.	5806		
1.4	Main Inj Civil Construction		25380	
1.4.1	Site Preparation	2438		
1.4.2	Enclosures/Service Bldgs	15917		
1.4.3	F0 Enclosure/Service Bldg	6019		
1.4.4	Landscaping and Paving	1006		
1.5	EDIA (16%)		19642	
1.6	Contingency (25%)		35600	
1.7	G&A (0.7%)		1246	
	Escalation		35752	

Table 6-2 Cost Estimate Labor Codes and Rates
(Dollars per hour)

<u>Fabrication</u>		
Technician, superconducting magnets	T1	25.50*
Technician, conventional magnets	T2	28.50*
Shops, average capability (Fermilab)	S1	31.00*
Shops, specialized/precision	S2	35.70
<u>Installation</u>		
Pipe/steam fitter, sheet metal	IP	29.40
Electrician	IE	34.10
Millwright	IM	31.00
Rigger, crane operator	IG	36.00
Laborer	IL	26.00
Accel Div Technician	IT	19.60
Vendor's Quote	IV	40.00
<u>EDIA</u>		
Physicist	PH	31.00
Accel Div Engineers	EN	28.60
CES Engineers	CE	36.00*
Designer/Drafter	DC	30.00*
Accel Div Drafter	DR	19.80

*Fermilab Service Centers chargeback rates

Table 6-3 Manpower Estimate

Category		Total Man Years
Fabrication		
Technician, superconducting magnets	T1	244
Technician, conventional magnets	T2	30
Shops, average capability (Fermilab)	S1	13
Shops, specialized/precision	S2	24
Installation		
Pipe/steam fitter, sheet metal	IP	28
Electrician	IE	53
Millwright	IM	20
Rigger, crane operator	IG	7
Laborer	IL	0
Accel Div Technician	IT	74
Vendor's Quote	IV	4
EDIA		
Physicist	PH	60
Accel Div Engineers	EN	60
CES Engineers	CE	56
Designer/Drafter	DC	60
Accel Div Drafter	DR	121
Total		854

7. SCHEDULE

It is proposed that the Proton-Proton Collider construction project be carried out over the period October 1, 1989 through September 30, 1994. An R&D phase will commence approximately one year before the construction project start. The schedule for conventional construction has already been presented in Section 5 of this report. Charts showing R&D, conventional construction, and technical component aspects of the project are presented in Appendix E.

The construction schedule falls into two distinct phases. During the first, magnet fabrication is the critical path. A large fraction of the magnets must be complete before the shutdown of the High Energy Physics program on January 1, 1993. Conventional construction of most of the Main Injector and Beamline enclosures and ground-level facilities will be performed during this phase.

During most of the second phase, the accelerator complex will of necessity be shut down. Construction of the area which connects the Main Injector to the Tevatron is on the critical path. Installation of technical components in both the Tevatron and the Main Injector can proceed in parallel. Reinstallation of components at the juncture of the two rings must waid for completion of conventional construction.

Major project and R&D milestones are enumerated in Table 7-1. As noted above, in the first phase of the project, magnet production is on the critical path and this circumstance is reflected in the R&D milestones in the FY1990 through FY1992 period. The intent to limit the shutdown to the shortest feasible period places conventional construction on the critical path beginning January 1, 1993. Accelerator commissioning time will be minimized by resuming Fixed Target Physics with the old Tevatron, thus injection of beam into Tevatron B is deferred until the Summer of 1994.

Table 7-1 Major Project Milestones

Year	Milestone	Date	Description
FY1990			
	1	1 Oct 89	Start Project
	2	1 July 90	4.4 T Magnet Prototype Measured (R&D)
FY1991			
	3	1 Nov 90	6.6 T Magnet Prototype Measured (R&D)
	4	1 May 91	Install A4 Systems Test (R&D)
FY1992			
	5	1 Jan 92	Beneficial Occupancy, Main Injector Enclosure, N20 Service Building
	6	1 Apr 92	Install B1 Systems Test (R&D)
	7	1 June 92	Main Injector Enclosure, Service Building Contract Complete
FY1993			
	8	1 Jan 93	Start Shutdown (3/4 TevB Magnets complete)
	9	1 July 93	Start TevB Cooldown
FY1994			
	10	1 Oct 93	Beneficial Occupancy, F0 Tunnel
	11	1 Dec 93	Beneficial Occupancy, F0 Bldg 8 GeV Beam in Main Injector
	12	1 Mar 94	Accelerate in Main Injector TevB Installation Complete
	13	1 Apr 94	Start HEP Fixed Target
	14	1 Aug 94	TevB Commissioning with Beam
	15	30 Sep 94	Project Complete

APPENDIX A

Schedule 44

DEPARTMENT OF ENERGY
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
FY 1990 BUDGET REQUEST
(TABULAR DOLLARS IN THOUSANDS. NARRATIVE MATERIAL IN WHOLE DOLLARS.)
CONSTRUCTION PROJECT DATA SHEETS

CHICAGO OPERATIONS
Field Office

HIGH ENERGY PHYSICS
FERMI NATIONAL ACCELERATOR

1. Title and location of Project:
Proton-Proton Collider Upgrade
(New Main Injector, New Tevatron)
Fermi National Accelerator Laboratory, Batavia, Illinois

2. Project No. 90-CH-400

3. Date A-E work initiated: 1st Qtr. FY 1990

3a. Date physical construction starts: 2nd Qtr. FY 1990

4. Date construction ends: 4th Qtr. FY 1994

5. Previous cost estimate: None

6. Current cost estimate: $215,000

Date: May 20, 1988

7. Financial Schedule:

Fiscal Year	Authorization	Appropriation	Obligation	Costs
1990	$215,000	$ 50,000	$ 50,000	$30,000
1991		60,000	60,000	50,000
1992		60,000	60,000	60,000
1993		40,000	40,000	55,000
1994		5,000	5,000	20,000
Total	$215,000	$215,000	$215,000	$215,000

8. Brief Physical Description of Project

This project provides for the construction and installation of an approximately 1 TeV superconducting accelerator in the existing tunnel in order to achieve high luminosity collisions between protons in this new superconducting ring and protons in the existing Tevatron ring. A new tunnel for the existing 150 GeV Main Ring accelerator, with beamlines and abort systems, will be constructed adjacent to the existing Tevatron tunnel.

9. Purpose, Justification of Need for, and Scope of Project

The purpose of this project is to provide a facility for high luminosity collisions (about 10^{32} per cm^2 sec) at an energy of about 1 TeV per beam for use by the high energy physics community in the pre-SSC era. This program will be complementary to the SSC program, and is also expected to have unique capabilities for new physics that will last into the SSC era.

To this end, this project provides for the conversion of the present Fermilab Antiproton-Proton Collider into a Proton-Proton Collider, and thus provide for a factor of ~40 improvement over what is expected from the present Antiproton Collider, with minor planned improvements. Even with a significant upgrade of the existing Antiproton-Proton Collider, probably a peak luminosity of 10^{32} could not be achieved. The potential reliability of a proton-proton collider should exceed that of the much more complicated antiproton-proton collider, giving more running time and simpler maintenance. In addition, the ready availability of protons leads to the easy attainment of high luminosity.

High luminosity opens up new fields of physics. It will extend the potential search for new high mass states by a factor somewhere between 1.5 and 2 to about 1/10 the potential range for the SSC. As a result it may bring into view new heavy bosons, some of the lighter proposed technicolor particles, or perhaps some of the supersymmetric particles. In addition, the increased luminosity makes plausible the development of a "beauty factory". This would allow the extension of the study of CP violating decays into new areas - a very exciting possibility.

Finally, a technological benefit of this upgrade is that it will provide a much needed test bed for SSC detector development. Some of the needed techniques will have to be applied to the present detectors if they are to benefit from the luminosity increase, thus ensuring early development of the required SSC technology.

The two major areas of activities are:

1. Superconducting Accelerator Ring: New Tevatron (TeV B)
   a. Superconducting magnets - dipoles, quadrupoles, spoolpieces, correction, and trim elements.
   b. Technical cryogenic components - feed, bypass, and turn-around boxes. Feed and valve boxes will be suitably designed to accommodate connection to both the Tevatron and the new ring. Warm gas header connections.
   c. Accelerator systems-vacuum systems, quench protection systems, power supplies for trim and corrector magnets, basic instrumentation and component control.
   d. An abort system and dump.

2. New tunnel for 150 GeV Main Ring (Main Injector), beamlines and abort systems.
   a. Construction of approximately 13,500 linear feet of tunnel (11,000 ft for the Main Injector and 2500 ft for the beamlines), cooling pond, service road, and service buildings for utilities and magnet staging

access. The utilities include primary and low conductivity water for cooling system, primary and secondary power distribution system, communication, electronic computer link and safety systems.

b. The beam transport lines allow for (1) 8 GeV injection from the existing Booster to the Main Injector in both beam circulation directions, (2) 120 GeV extraction from the Main Ring to the existing Antiproton Source target area and for potential extension of test beams, (3) 150 GeV extraction to the present Tevatron ring, and (4) 150 GeV extraction to the new superconducting ring (TeV B). The abort systems included are for dumping up to 150 GeV protons from the Main Injector and 1 TeV protons from the new superconducting ring. The technical components of the beamlines and abort system include magnets, power supplies, vacuum systems steering systems, control and diagnostic equipment, etc.

10. Details of Cost Estimate

a. Engineering, design, inspection & administration at 16%			$ 24,000
b. Construction costs			$148,000
1. Superconducting Accelerator Ring		$100,000	
(a) Magnets	$80,000		
(b) Technical components	20,000		
2. Tunnels for Main Injector and beamlines		48,000	
(a) Tunnels and service buildings	31,000		
(b) Accelerator utilities	8,000		
(c) Beamlines and abort system	9,000		
c. Contingency at approximately 25%			43,000
Total			$215,000

11. Method of Performance

Design of facilities will be by the operating contractor and subcontractors as appropriate. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	TOTAL
a. Total project cost							
1. Total facility costs							
(a) Construction line item	$ 0	$50,000	$60,000	$60,000	$40,000	$ 5,000	$215,000
Total facility cost	$ 0	$50,000	$60,000	$60,000	$40,000	$ 5,000	$215,000

2. Other project costs

(a) Direct R&D costs necessary to complete construction	$10,000	$12,000	$12,000	$12,000	$ 4,000	$ 0	$ 50,000
(b) Pre-operating costs	$ 0	$ 0	$ 0	$ 2,000	$ 2,000	$10,000	$ 14,000
(c) Capital Equipment	$ 400	$ 1,000	$ 1,500	$ 1,500	$ 1,000	$ 600	$ 6,000
Total other project cost	$10,400	$13,000	$13,500	$15,500	$ 7,000	$10,600	$ 70,000*
Total project costs	$10,400	$63,000	$73,500	$75,500	$47,000	$15,600	$285,000

*G&A included where appropriate

b. Total related incremental annual funding requirements (estimated life of project: 10 years)

1. Facility operating cost, cryogens, power	$ 1,000
2. General M&S operating and AIP funds	$ 2,900
3. Personnel operating funds	$ 800
Total incremental annual funding	$ 4,700**

**G&A included where appropriate (FY88$)

13 Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project costs

1. Total facility costs
(a) Construction line item - explained in items 8, 9, and 10.

2. Other project funding OP-R&D, CE.

Necessary R&D for technical components will provide for design and development of components and fabrication and testing of prototypes. R&D on all elements of the project to optimize performance and minimize costs of various subsystems will continue through early stages of construction.

Specifically, R&D will be required for the development of the superconducting components of the new superconducting rings, and for the development of beam line magnets and beam transfer-injection and extraction elements.

All necessary modifications to the Tevatron and its enclosure to accommodate the new superconducting ring will be accomplished with operating funds. R&D funds will be used to develop and fabricate the high field dipoles (6.6T) necessary in the present Tevatron in order to provide straight section space for injection and to bring the two rings together for collisions.

R&D funds will be used to develop, fabricate, and install components for 1/12th of the new superconducting ring, including additional magnets that can be mounted in drift spaces for test purposes. These systems will be installed in the Tevatron| tunnel (in the area of the BØ overpass), and systems tests will be carried out on preoperating funds.

The relocation of the technical components of the Main Injector and present Tevatron will be performed with operating funds. This includes all necessary reinstallation costs and modifications or improvements to present systems that have been in service for, in some cases, 18 years.

(b) Pre-operating costs - Includes operating costs for a commissioning period and the systems test operation.
(c) Items included in these costs are test instruments, power supplies, electronics, computers, and magnet movers, other general equipment to support 12.a.2.(a) and (b).

Any necessary modifications to the cryogenic plant will be provided out of Equipment funds.

b. Total related incremental funding requirements - It is assumed that the Fermilab complex will operate with alternate fixed target and collider programs. Runs are expected to extend for about nine months with two month maintenance and change-over periods between alternate modes of operation. In addition, it is assumed that the Antiproton Source will only operate occasionally, depending on programmatic needs.

Incremental costs for the new superconducting ring will include cryofluids, associated power, and operating and maintenance expenses. The new ring is expected to operate only during collider running and be held at nitrogen temperature at other times. Nitrogen usage is expected to increase by 30% (about 20M SCF/month). Helium refrigeration requirements are expected to be no greater than during fixed target operation and make-up gas demands will not increase more than 20% because the basic plant and distribution system is not affected. Other incremental operating expenses include personnel and materials for the new ring. It is estimated that 17 additional people and an annual material and services cost increase of $2.4M will be required. With reduction in programing demand for the operation of the Antiproton Source, people will become available from this activity.

No significant incremental funding is expected for the new Main Injector and associated beam lines. The utilities have been sized for a maximum cycle rate of 20 per minute. Power usage for this mode in the smaller, more strongly bending new Main Injector configuration, will be about what it is at present, with twice the cycle rate. The new location of the Main Injector tunnel and utilities will require some additional facilities management personnel. Incremental funding G&A covers about seven such additional people.

14. Incorporation of Fallout Shelters in Future Federal Buildings

Not applicable.

15. Incorporation of Measures for the Prevention, Control, and Abatement of Air and Water Pollution at Federal

Facilities

The total estimated cost of this project includes the cost of those measures necessary to assure the facility will comply with Executive Order 12088.

16. Evaluation of Flood Hazards

This project will be located in the area of Indian Creek. Construction will be in accordance with the requirements of Executive Order 11988.

17. Environmental Impact

This project is in compliance with the National Environmental Policy Act.

18. Accessibility to the Handicapped

Not applicable.

Appendix B

PROTON-PROTON COLLIDER UPGRADE
(NEW MAIN INJECTOR, NEW TEVATRON)

PROJECT BASIC DATA
FOR
FY90 VALIDATION
AND
PROJECT VALIDATION REVIEW CHECKLIST

PROJECT BASIC DATA
for
FY90 VALIDATIONS

Program: High Energy Physics/
Fermi National Accelerator
Project: Proton-Proton Collider Upgrade
(New Main Injector, New Tevatron)
Project No.: BAKALID 90-CH-400
(Program Office assigned number only, if available)

Status of Design:
Conceptual - 100%
Title I - 0%
Title II - 0%

TEC:

The TEC is $215M
ED&I: 11% of Construction Cost
(Excluding construction management and project management and project management at 4% and 1%).
Contingency: 25% of Design and Construction Cost

Proj. Description/Background:

This project provides for the construction and installation of an approximately 1 TeV superconducting accelerator in the existing tunnel in order to achieve high luminosity collisions between protons in this new superconducting ring and protons in the existing Tevatron ring. A new tunnel for the existing 150 GeV Main Ring accelerator (Main Injector), with beamlines and abort systems, will be constructed adjacent to the existing Tevatron tunnel.

About 13,500 ft of tunnel and 35,000 sq ft (net 27,100 sq ft) of service building will be constructed. Technical components for the superconducting accelerator include superconducting magnets and other cryogenic and accelerator components. Technical components for the beamlines and beam transfers include conventional magnets and accelerator components. The Main Injector will reuse technical components from the existing Main Ring. Included in the project for the Main Injector are only building and tunnel construction and standard and accelerator utilities.

FY90 Budget Authority (B/A):

The request is $50M for FY90.
This request is to cover initial procurement of long term magnet, cryogenic and accelerator systems components for the superconducting accelerator. Of particular importance is the procurement of superconducting alloy and cable.

The request also covers authority to release the bid package for the Main Injector, site prep, beam enclosures and service buildings, and to start site prep construction.

The FY89 request was $0M; prior year funding was $0M.

Technical/R&D:

The superconducting magnets are the most unconventional part of this construction project. The project calls for the building of a second superconducting Tevatron ring. The first ring has been in operation since 1983. Most of the magnets in the second ring will be of a similar strength to those already in operation. The project does call for additional magnets with 50% stronger fields. These fields have been achieved elsewhere, and though challenging, they are probably not so extremely difficult as to be considered of significant risk to the project.

Other technical components of the superconducting ring are similar to those already under development or in operation. There is no unusual construction in the beamlines. The Main Injector uses as much as possible the existing components. R&D will be carried out to obtain tooling and to prototype new magnets and cryogenic/accelerator components. In particular, R&D effort will be directed toward the development of the superconducting magnets and systems tests.

Both the 4.4 T and 6.6 T dipole will be developed under R&D and a number of prototypes will be assembled and tested.

The R&D program provides for the fabrication, installation, and test of about 1/12th of the superconducting ring and associated systems. These components will be assembled and tested in the Tevatron tunnel at the BØ overpass region which is free of Main Ring magnets.

The 6.6 T magnets needed for installation in the present Tevatron will be produced with R&D funds. This program should ensure success of the construction of the 6.6 T magnets needed for this construction project.

The risk of this project is low for a project of this type. The Fermilab staff is experienced in all aspects of the project and to a large extent it represents a second generation of the Energy Saver project. The most risky aspects are the 6.6 T high field magnets discussed above, and the achievement of luminosity goals once the new accelerators are operational. This last uncertainty is typical of all such projects.

If 6.6 T magnetic field is not achieved the beam energy can be lowered with minor experimental impact. The present Tevatron now operates at 0.9 TeV. Were no energy increase realized this would require the 6.6 T magnets to operate at 6.0 T in the Proton-Proton Collider Upgrade.

Schedule:

Title I design start scheduled: 1QFY90.
Title I and II design duration: 36 months total.
Procurement and construction start scheduled: 1QFY90, 3QFY90.
Procurement and construction completion: 3QFY94.

Status of Documentation (For major projects and major systems Acquisitions only:)

Justification for New Start:	Approved	__/__/__	(mm/dd/yy)
Project Charter:	Approved	__/__/__	(mm/dd/yy)
Project Plan:	Approved	__/__/__	(mm/dd/yy)

Additional Information:

Environmental assessment may be required.

(State programmatic and/or congressional budgetary restraints.)

Contingency factor used is 25%. This is an overall factor and has not as yet been split for varying degrees of certainty in the different components of the work breakdown structure. This overall contingency is appropriate for the present level of the conceptual design. As the design continues, it will probably become appropriate to allocate a larger percentage fraction of the contingency to the superconducting magnet effort.

13. Space Requirements

Space for tunnel and equipment enclosures is in addition to current space. Where possible current equipment and tunnel enclosures will be utilized.

At the FØ (RF) straight section part of the rf building must be demolished in order to construct the modified tunnel enclosure at the junction of the Main Injector and Tevatron tunnels. The rf building will be replaced with two buildings so as to house not only rf systems, but also beam transfer equipment and extraction equipment that is to be relocated in the FØ straight section of the Tevatron tunnel.

Space in the Tevatron service buildings, which is freed up by the relocation of the Main Ring (Main Injector), will be used for technical components of the new Tevatron (Tev B).

B. Design (Conceptual)

1. Design Status

All designs, at this point, are at the conceptual level. Studies have been made based upon current experience, and general civil engineering practices. All major items have been scoped. The scope has been well defined from the programmatic requirements of the Laboratory. The Proton-Proton Collider Upgrade project has been included in the current Fermilab Site Development and Facility Utilization Plans. The schedule has been developed using time estimates based on similar work performed at Fermilab on projects of comparable nature. Part of this project is very similar in nature to the recently completed Energy Saver project. Some of the technical systems are nearly identical. The other part of the project (Main Injector) is a relocation of existing Main Ring components, and is similar in nature to numerous modifications made to the Main Ring in recent years. Cost and schedule projections are thus based heavily on recent experience.

2. Site Conditions

Soil borings are available for areas in close proximity to the site considered. Recent nearby construction experience (TeV 1) has been used to prepare cost estimates.

3. Safety Hazards and Risks

Hazards and risks are characteristic of those already encountered in the accelerator complex and in its construction. No new unique hazards are expected.

4. Solar Energy Applications

Solar energy applications were considered but no application was found to be appropriate.

5. Design Cost Effectiveness

The design is cost effective at a conceptual design level. Further studies to minimize cost and lifecycle costs will be carried out in parallel with the Title I design. In particular, specific attention will be paid to the design of the area which connects the Tevatron to the Main Injector Ring (FØ) and to optimum beam line design. Optimization of superconducting magnet design will continue.

6. Environmental Assessment

The environment surrounding the proposed construction site has been characterized to the extent that the entire Laboratory site is characterized. Topology and hydrology are documented. The impact of the proposed facility on the environment will be no different from the existing facility; no unique hazards are expected. To be noted is the flow of Indian Creek through the proposed site of the Main Injector, and the heron rookery located inside the Injector Ring. Care will be taken to provide proper creek drainage and avoid disturbing the herons during breeding season.

7. Prerequisite R&D

The necessary R&D required to design and specify the basic system has been done. Additional R&D is in progress to refine the design. R&D will be required to work out detailed designs and prototype fabrication of special components. These activities will continue to help refine the requirements that are necessary for specifying and accomplishing the construction of the special facilities.

In conjunction with the construction, R&D for the development and fabrication of the superconducting magnets and systems will be necessary. Schedule of the required R&D costs has been provided in the project data sheets. R&D funding will be required for detailed design, tooling, and prototype fabrication, and for development of the high field (6.6 T) magnets which enable beams from the two Tevatron rings to be brought into collision as well as for the more standard 4.4 T dipoles and quadrupoles/spools.

8. Participants

The conceptual designs presented to the Validation Review Committee have been prepared by Fermilab staff members. In particular, members of the Accelerator Division, Technical Support Section and Construction Engineering Services have participated.

9. Uncertainties

Major area of uncertainty is in the development of the high field superconducting magnets (6.6 T). For this reason, the major portion of these magnets for both Tevatron rings are to be developed and funded on R&D. If 6.6 T cannot be initially obtained, operation at lower than 1 TeV energy is acceptable. In addition, systems which control beam instabilities and emittance growth will need to be developed on R&D.

10. Energy Conservation Report

An Energy Conservation Report will be prepared during Title I/II.

III. Schedule

All of the following factors have been considered at a depth appropriate at this conceptual design level in developing the schedule:

- budget cycle timing
- contractor selection duration
- Headquarters review and approvals
- prerequisite R&D schedule constraints
- dependency upon timing and amount of operating funds
- historical experience on design, procurement, and construction durations
- procurement lead times for equipment (particularly reflecting vendor quotes)
- logical sequence of design, procurement, and construction
- reasonable manpower levels, buildup and ramp down
- reasonable obligation and costing rates
- shift work or overtime work requirements
- work space constraints
- exposure constraints

The construction schedule falls into two distinct phases. During the first phase magnet fabrication is the critical path. A large fraction of magnets must be complete prior to the second phase. Conventional construction of most of the Main Injector and beam line tunnel and above ground facilities will be performed during this phase.

During the second phase the accelerator complex will be shutdown. Construction of the area which connects the Main Injector to the Tevatron is on the critical path. Installation of technical components in both the Tevatron and Main Injector can proceed in parallel. Reinstallation of components at the juncture of the two rings must wait for completion of conventional construction.

IV. Estimate

A. General

1. Estimate Preparation

The estimates presented were prepared in May 1988. The cost estimate is done in FY88 base year dollars with the escalation shown in "year of expenditure" dollars.

2. Estimate Basis

Estimates are based on conceptual design layouts, preliminary engineering calculations, experience with similar projects done at Fermilab. Our recent experience with the Energy Saver construction project forms the basis for a large fraction of the cost estimate for this project. For construction, estimates are based on quantity take-offs where available and square foot estimates. Cost comparisons have been made with specific portions of recent similar Fermilab construction such as Transfer Hall Addition, Booster Laboratories, Industrial Center Building, and several of the Tevatron I and II buildings. The cost estimate methodology is adapted from that used to estimate the Superconductor Super Collider (SSC) Injection System as incorporated into the SSC Conceptual Design Report. Manpower estimates where appropriate have been derived from the TeV I and Energy Saver projects. Recent experience (1988) on modification and reinstallation of Main Ring has been used for the Main Injector.

3. Support of Estimates

Vendor quotes are not appropriate at conceptual level for this design. Catalogue prices have been used for components where appropriate. Manpower rates are based on present Fermilab Accelerator tech experience, Fermi chargeback rate, or T&M trade rates. Commercially published construction data bases such as R.S. Means, have been used very successfully at Fermilab for cost estimation.

4. Contingency

The contingency reflects the degree of confidence in the scope of work, development features, pricing methodology and complexity of the project. The contingency analysis provides for but does not presently utilize varying degree of certainty in the different components of the Work Breakdown Structure.

5. Escalation Rates

Escalation rates provided by DOE were used. The most recent information obtainable was dated August 1987.

6. <u>Project Reviews</u>

This is the first cost estimate for this project and is a bottoms up estimate. It has been reviewed by knowledgeable Fermilab staff and management.

7. <u>Uniqueness</u>

The unique features of this facility are the superconducting magnets and cryogenic systems. Fermilab has pioneered this technology and operates the only large superconducting accelerator in the world. Other technical components and civil construction are similar to work that has already been done at Fermilab and are not unique.

8. <u>Estimating Guides</u>

Conventional construction items and standard equipment estimates were made using standard estimating guides. Square foot estimating data available from commerical publishers (Means & Richardson) have been used where applicable.

9. <u>Indirect Costs</u>

All known indirect costs have been included in the estimate.

10. <u>Title I/Title II Estimates</u>

Not applicable.

11. <u>Experimental Components</u>

Experimental detector improvement costs are not included in the estimate. Detector upgrades are usually incorporated in the ongoing laboratory capital equipment expenditure profile.

12. <u>Procurement Strategy</u>

To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids. As presently planned, final magnet assembly will take place at Fermilab, as in the case of the Energy Saver project.

B. <u>Construction</u>

1. <u>Bulk Materials</u>

Both engineering drawings and past experience were used to estimate the bulk material quantities.

2. <u>Quantity Growth</u>

Normal estimating methods for conceptual estimates allow for quantity growth.

3. Bulk Material Pricing

The bulk material costs are current and reflect local conditions.

4. Labor Costs

Labor estimates are based on (Davis-Bacon) at local rates where applicable and at an actual average rate for component fabrication and include applicable fringe and other hidden costs. Costs have been derived from the Tevatron I Project. The local labor market has critical skill construction labor available.

5. Equipment Pricing

Equipment pricing is based upon actual experience in the Tevatron I and Energy Saver Projects, other Fermilab construction, and on commercially published cost data.

6. Special Process Spares

Not applicable.

7. Indirect Costs

Indirect construction costs have been included.

8. Labor Productivity

Labor productivity is based on much local experience.

9. Labor Availability

All necessary craft labor is available in the Chicago area.

10. Pricing Variants

To the extent required for the conceptual design, the cost estimate reflects code, QA, scheduling, climatic, geographic, and other unique specification requirements.

11. Unitized Pricing

Not applicable.

C. Engineering and Management

1. Contractor Project Management

Contractor project management and engineering costs are included in the EDIA.

2. EDIA Estimate

EDIA costs are estimated at the same percentage of construction costs as those for the recently completed Tevatron I Project at Fermilab.

3. Inspection

Inspection, QA and QC costs have been included. Magnetic measurements and magnet assembly inspection are provided in the laboratory through G&A.

4. Management

FNAL has considerable experience with Program Management Control systems as used in TeV I and II. We consider the management system responsible for this activity is mature and reasonable. Adequate personnel will be made available.

V. Funding and Costs Status

1. Basis for Planned Authorization, Appropriation, and Cost Schedule
The programmatic goal of the Proton-Proton Collider Upgrade project is to achieve an improvement in the Collider luminosity and the Fixed Target intensity. This goal has been set by the demands of the physics experimental program. Increased luminosity in the mid 1990's time scale is crucial to productive utilization of the Tevatron. This increased potential is necessary for a viable national high energy physics program in the pre-SSC era. The authorization of the proposal at the earliest possible time is urged. The appropriation and obligation schedule is predicated on issuing the long-lead contracts at the earliest possible time. The costing is based on an estimate of the effort done as a function of time. The schedule calls for a shutdown of the order of one year for moving Main Ring components to the new Main Injector tunnel, and for installing the new Tevatron above the present Tevatron in the existing tunnel. In order for this shutdown to be effectively utilized most of the conventional construction and at least half of the superconducting magnets must be complete prior to shutdown. Thus, the significant fraction of funding is required prior to shutdown. Any delay in authorization or appropriation will result in extending the time to operation of one or both rings.

2. Other Associated Project Costs

Other associated project costs include $70M R&D, preoperation, and capital equipment costs. When the project is complete there is expected to be a related annual funding increase for operating and improvement costs. These include cryogenic and power costs, personnel and M&S costs totaling $4.7M. It is estimated that 17 additional people will be required to maintain and operate the facility.

3. Funding Consistency

The annual funding proposed is consistent with the project schedule. The schedule has been developed on the basis of a preliminary Critical Path Network (CPN). The CPN will be revised, updated, and expanded as the R&D, design, and project advances.

4. Continuing Resolution Alternatives

In the event of a continuing resolution, the project will be delayed proportionally.

5. Contributing Funding

External contributory funding is not considered for this project.

6. Incrementally Funded Construction Contracts

None.

7. Funding By Client or Consultant Agencies

Not applicable.

50 QF	296.4180	0.87896	0.90664	91.04359	27.60806	2.48650	0.23022	1.1508	1.91591	-0.61121	-0.03678	0.01091
51 OC	296.6720	0.87941	0.90810	90.07361	27.92176	2.47716	0.23299	1.1508	1.90288	-0.62385	-0.03678	0.01091
52 QFC	297.4340	0.88078	0.91237	87.25758	28.88385	2.44989	0.24123	1.1508	1.79345	-0.63847	-0.03479	0.01072
53 HCN	324.4825	0.97777	0.99675	25.59098	99.00520	1.93956	0.53099	1.2193	0.48643	-1.95290	-0.00232	0.01070
54 QD	326.1614	0.98831	0.99942	25.70416	99.19941	1.99821	0.53182	1.2193	-0.55527	1.83972	0.07256	-0.00972
55 OC	326.4154	0.98987	0.99983	25.98952	98.26768	2.01665	0.52935	1.2193	-0.56820	1.82849	0.07256	-0.00972
56 QDC	327.1774	0.99446	1.00108	26.86776	95.56932	2.07128	0.52211	1.2193	-0.58410	1.71343	0.07082	-0.00928
57 HCN	354.2259	1.08439	1.08110	94.98575	32.95839	4.41745	0.27096	1.3227	-1.93429	0.60049	0.10329	-0.00929
58 QF	355.9048	1.08716	1.08928	95.37621	33.13481	4.44799	0.26393	1.3227	1.70672	-0.70781	-0.06710	0.00088
59 OC	356.1588	1.08759	1.09049	94.51184	33.49730	4.43095	0.26415	1.3227	1.69630	-0.71931	-0.06710	0.00088
60 QFC	356.9208	1.08889	1.09405	92.00753	34.59880	4.38117	0.26474	1.3227	1.59087	-0.72594	-0.06355	0.00066
61 HCN	383.9693	1.16920	1.16770	34.02305	106.07683	3.09295	0.28257	1.4410	0.55287	-1.91557	-0.03108	0.00065
62 QD	385.6482	1.17709	1.17020	34.42775	105.69397	3.14002	0.27463	1.4410	-0.79905	2.13871	0.08744	-0.01006
63 OC	385.9022	1.17826	1.17058	34.83674	104.61091	3.16223	0.27208	1.4410	-0.81114	2.12531	0.08744	-0.01006
64 QDC	386.6642	1.18168	1.17176	36.07740	101.46906	3.22783	0.26450	1.4410	-0.81668	1.99873	0.08472	-0.00983
65 HCN	413.7127	1.25095	1.25433	114.06056	29.31157	5.95007	-0.00142	1.5883	-2.06644	0.66800	0.11719	-0.00983
66 QF	415.3916	1.25327	1.26360	113.66731	29.03553	5.95478	-0.01815	1.5883	2.29563	-0.50008	-0.11161	-0.01021
67 OC	415.6456	1.25363	1.26498	112.50468	29.29235	5.92643	-0.02075	1.5883	2.28162	-0.51102	-0.11161	-0.01021
68 QFC	416.4076	1.25473	1.26907	109.12724	30.07782	5.84319	-0.02852	1.5883	2.15162	-0.51957	-0.10687	-0.01019
69 HCN	443.4561	1.33243	1.35660	30.47303	89.00796	3.38322	-0.30395	1.7347	0.75630	-1.65822	-0.07440	-0.01018
70 QD	445.1350	1.34137	1.35957	29.97026	88.86466	3.36614	-0.31116	1.7347	-0.45047	1.74173	0.05394	0.00164
71 OC	445.3890	1.34271	1.36003	30.20169	87.98279	3.37984	-0.31074	1.7347	-0.46066	1.73020	0.05394	0.00164
72 QDC	446.1510	1.34668	1.36143	30.90713	85.42830	3.41985	-0.30959	1.7347	-0.46492	1.62287	0.05105	0.00138
73 HCN	473.1995	1.43525	1.45336	84.84531	28.71301	5.23122	-0.27210	1.8730	-1.52923	0.47316	0.08352	0.00139
74 QF	474.8784	1.43837	1.46271	84.54106	29.06098	5.20294	-0.27852	1.8730	1.70655	-0.68484	-0.11702	-0.00908
75 OC	475.1324	1.43885	1.46410	83.67711	29.41214	5.17322	-0.28082	1.8730	1.69480	-0.69767	-0.11702	-0.00908
76 QFC	475.8944	1.44032	1.46815	81.17148	30.48624	5.08563	-0.28765	1.8730	1.59410	-0.71161	-0.11289	-0.00885
77 HCN	502.9429	1.53867	1.54744	26.85302	105.05498	2.46287	-0.52679	1.9921	0.41411	-2.04412	-0.08042	-0.00883
78 QD	504.6218	1.54865	1.54995	27.28880	105.16428	2.40588	-0.52464	1.9921	-0.67919	1.98042	0.01216	0.01138
79 OC	504.8758	1.55012	1.55034	27.63729	104.16124	2.40896	-0.52175	1.9921	-0.69280	1.96853	0.01216	0.01138
80 QDC	505.6378	1.55443	1.55152	28.70581	101.25471	2.41745	-0.51325	1.9921	-0.70915	1.84665	0.01011	0.01094
81 HCN	532.6863	1.63626	1.62879	105.37184	33.17054	3.12151	-0.21720	2.0796	-2.12527	0.66955	0.04258	0.01095
82 QF	534.3652	1.63877	1.63694	105.73067	33.12579	3.09258	-0.20563	2.0796	1.91614	-0.64233	-0.07685	0.00291
83 OC	534.6192	1.63915	1.63815	104.76012	33.45484	3.07306	-0.20489	2.0796	1.90492	-0.65316	-0.07685	0.00291
84 QFC	535.3812	1.64032	1.64173	101.94587	34.45405	3.01544	-0.20261	2.0796	1.78907	-0.65787	-0.07440	0.00308
85 HCN	562.4297	1.71476	1.71777	35.30998	100.38922	1.43373	-0.11931	2.1487	0.67453	-1.77880	-0.04193	0.00308
86 QD	564.1086	1.72240	1.72041	35.38101	99.91684	1.40884	-0.11038	2.1487	-0.71774	2.05411	0.01212	0.00750
87 OC	564.3626	1.72354	1.72082	35.74839	98.87672	1.41192	-0.10847	2.1487	-0.72861	2.04084	0.01212	0.00750
88 QDC	565.1246	1.72688	1.72206	36.85998	95.85965	1.42070	-0.10279	2.1487	-0.72985	1.91942	0.01092	0.00741
89 HCN	592.1731	1.79783	1.80994	106.76332	27.73168	2.14666	0.09758	2.2042	-1.85455	0.59840	0.04339	0.00741

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
90 QF	593.8520	1.80031	1.81971	106.13435	27.59482	2.15020	0.11330	2.2042	2.22112	-0.51515	-0.03919	0.01142
91 OC	594.1060	1.80070	1.82117	105.00962	27.85948	2.14025	0.11620	2.2042	2.20692	-0.52680	-0.03919	0.01142
92 QFC	594.8680	1.80187	1.82546	101.74190	28.67149	2.11103	0.12487	2.2042	2.08231	-0.53862	-0.03748	0.01132
93 HCN	621.9165	1.88735	1.91444	27.46656	90.66166	1.52788	0.43093	2.2605	0.66372	-1.75226	-0.00501	0.01131
94 QD	623.5954	1.89726	1.91735	27.09346	90.72453	1.56868	0.43595	2.2605	-0.43676	1.71561	0.05387	-0.00535
95 OC	623.8494	1.89875	1.91780	27.31817	89.85581	1.58237	0.43459	2.2605	-0.44793	1.70457	0.05387	-0.00535
96 QDC	624.6114	1.90313	1.91917	28.00831	87.34049	1.62290	0.43066	2.2605	-0.45756	1.59708	0.05251	-0.00498
97 HCN	651.6599	1.99706	2.00672	84.35063	30.64073	3.47376	0.29561	2.3412	-1.62547	0.49838	0.08498	-0.00500
98 QF	653.3388	2.00019	2.01548	84.39755	31.02134	3.50402	0.29666	2.3412	1.59813	-0.72991	-0.04913	0.00626
99 OC	653.5928	2.00067	2.01678	83.58841	31.39532	3.49154	0.29825	2.3412	1.58743	-0.74246	-0.04913	0.00626
100 QFC	654.3548	2.00214	2.02057	81.24399	32.53577	3.45517	0.30293	2.3412	1.48986	-0.75388	-0.04633	0.00602
101 HCN	681.4033	2.09505	2.09578	29.64137	108.50276	2.63261	0.46554	2.4371	0.41795	-2.05352	-0.01386	0.00600
102 QD	683.0822	2.10408	2.09822	30.23505	108.42234	2.69404	0.46065	2.4371	-0.77908	2.10039	0.08743	-0.01180
103 OC	683.3362	2.10541	2.09859	30.63425	107.35856	2.71625	0.45766	2.4371	-0.79258	2.08772	0.08743	-0.01180
104 QDC	684.0982	2.10929	2.09974	31.85260	104.27418	2.78198	0.44881	2.4371	-0.80595	1.96090	0.08509	-0.01141

105	HCN	711.1467	2.18361	2.17710	113.33961	32.13947	5.51402	0.13993	2.5700	-2.20671	0.70500	0.11756	-0.01142
106	QF	712.8256	2.18594	2.18554	113.45815	31.91131	5.53325	0.12506	2.5700	2.13762	-0.56621	-0.09477	-0.00639
107	OC	713.0796	2.18630	2.18680	112.37541	32.20162	5.50918	0.12344	2.5700	2.12515	-0.57672	-0.09477	-0.00639
108	QFC	713.8416	2.18739	2.19051	109.23292	33.08442	5.43865	0.11853	2.5700	1.99969	-0.58158	-0.09036	-0.00648
109	HCN	740.8901	2.25997	2.27106	34.53683	94.06574	3.42534	-0.05688	2.7107	0.76190	-1.67202	-0.05788	-0.00648
110	QD	742.5690	2.26782	2.27388	34.26417	93.64414	3.43764	-0.06583	2.7107	-0.59604	1.91773	0.07262	-0.00413
111	OC	742.8230	2.26900	2.27431	34.56951	92.67315	3.45609	-0.06688	2.7107	-0.60609	1.90504	0.07262	-0.00413
112	QDC	743.5850	2.27246	2.27564	35.49332	89.85778	3.51029	-0.07005	2.7107	-0.60600	1.79047	0.06965	-0.00418
113	HCN	770.6335	2.34894	2.36776	96.45767	27.20047	5.82484	-0.18318	2.8603	-1.64792	0.52517	0.10212	-0.00418
114	QF	772.3124	2.35169	2.37768	95.80323	27.27939	5.80851	-0.19618	2.8603	2.02933	-0.57317	-0.12147	-0.01139
115	OC	772.5664	2.35212	2.37915	94.77578	27.57370	5.77766	-0.19908	2.8603	2.01576	-0.58554	-0.12147	-0.01139
116	QFC	773.3284	2.35342	2.38348	91.79176	28.47703	5.68687	-0.20770	2.8603	1.90106	-0.59969	-0.11685	-0.01123
117	HCN	800.3769	2.44737	2.47011	25.72622	95.77862	2.95702	-0.51124	2.9972	0.54145	-1.88748	-0.08438	-0.01121
118	QD	802.0558	2.45789	2.47286	25.66110	95.96243	2.90925	-0.51355	2.9972	-0.50183	1.78035	0.02717	0.00848
119	OC	802.3098	2.45945	2.47329	25.91918	95.06081	2.91615	-0.51139	2.9972	-0.51423	1.76932	0.02717	0.00848
120	QDC	803.0718	2.46406	2.47458	26.71402	92.45015	2.93591	-0.50509	2.9972	-0.52865	1.65749	0.02468	0.00805
121	HCN	830.1203	2.55685	2.55685	90.35221	32.39128	4.03412	-0.28711	3.1080	-1.82412	0.56212	0.05715	0.00807
122	QF	831.7992	2.55977	2.56516	90.67391	32.66305	4.00026	-0.28268	3.1080	1.63663	-0.72744	-0.09727	-0.00277
123	OC	832.0532	2.56022	2.56639	89.84513	33.03561	3.97556	-0.28339	3.1080	1.62632	-0.73933	-0.09727	-0.00277
124	QFC	832.8152	2.56159	2.57000	87.44437	34.16878	3.90265	-0.28541	3.1080	1.52492	-0.74746	-0.09409	-0.00254
125	HCN	859.8637	2.64589	2.64346	32.77357	107.89565	1.78832	-0.35389	3.1971	0.49632	-1.97716	-0.06162	-0.00252
126	QD	861.5426	2.65407	2.64592	33.29346	107.60066	1.74146	-0.34679	3.1971	-0.81257	2.14908	0.00550	0.01094
127	OC	861.7966	2.65528	2.64629	33.70947	106.51229	1.74285	-0.34401	3.1971	-0.82524	2.13582	0.00550	0.01094
128	QDC	862.5586	2.65881	2.64745	34.97366	103.35536	1.74648	-0.33578	3.1971	-0.83345	2.00803	0.00401	0.01065
129	HCNS	889.3277	2.72838	2.72626	114.31580	30.69012	2.27550	-0.05048	3.2601	-2.13053	0.70553	0.03649	0.01066
130	OS2	889.6071	2.72877	2.72772	115.51012	30.29968	2.28569	-0.04750	3.2601	-2.14407	0.69190	0.03649	0.01066
131	QH1	890.2548	2.72966	2.73116	117.19014	29.70860	2.29838	-0.04082	3.2601	-0.44150	0.22359	0.00265	0.01001
132	DH1	898.2348	2.74016	2.77547	124.88582	28.39083	2.31954	0.03906	3.2601	-0.52287	-0.05845	0.00265	0.01001
133	B	904.3562	2.74776	2.80886	131.66920	30.42890	2.36062	0.10034	3.2791	-0.58529	-0.27448	0.01077	0.01001
134	O	904.6356	2.74810	2.81031	131.99706	30.58503	2.36363	0.10314	3.2791	-0.58813	-0.28435	0.01077	0.01001

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
135	B	910.7570	2.75528	2.84010	139.57945	35.38841	2.45440	0.16440	3.2986	-0.65055	-0.50031	0.01889	0.01001
136	O	911.0364	2.75560	2.84135	139.94377	35.67073	2.45967	0.16720	3.2986	-0.65340	-0.51018	0.01889	0.01001
137	B	917.1578	2.76236	2.86626	148.32519	43.23808	2.60013	0.22846	3.3191	-0.71581	-0.72599	0.02701	0.01001
138	OOO	917.7581	2.76300	2.86845	149.18838	44.12256	2.61635	0.23446	3.3191	-0.72194	-0.74720	0.02701	0.01001
139	QH2	920.0489	2.76533	2.87672	171.37188	42.39158	2.83735	0.24306	3.3191	-9.34451	1.47248	0.16786	-0.00258
140	DH2	923.9008	2.76829	2.89335	251.00673	32.15677	3.48392	0.23314	3.3191	-11.32966	1.18460	0.16786	-0.00258
141	QH3	926.4256	2.76979	2.90641	271.26005	30.97735	3.64771	0.24361	3.3191	3.69988	-0.69508	-0.03968	0.01097
142	LSA1	953.1750	2.79430	2.98516	112.06787	102.42134	2.58632	0.53696	3.3191	2.25136	-1.97579	-0.03968	0.01097
143	.A0	953.1750	2.79430	2.98516	112.06787	102.42134	2.58632	0.53696	3.3191	2.25136	-1.97579	-0.03968	0.01097
144	LSA2	979.6196	2.86853	3.01212	30.86410	240.40094	1.53701	0.82697	3.3191	0.81935	-3.24190	-0.03968	0.01097
145	-QH3	982.1444	2.88177	3.01381	31.37819	222.28138	1.54730	0.79470	3.3191	-1.03273	10.06786	0.04793	-0.03623
146	DH2	985.9963	2.89904	3.01715	40.31126	151.55321	1.73193	0.65516	3.3191	-1.28641	8.29404	0.04793	-0.03623
147	-QH2	988.2871	2.90779	3.01978	41.45015	131.81141	1.73710	0.61005	3.3191	0.80921	0.66441	-0.04347	-0.00355
148	DH3	989.8663	2.91404	3.02171	38.99390	129.74021	1.66846	0.60445	3.3191	0.74617	0.64714	-0.04347	-0.00355
149	B	995.9877	2.94205	3.02945	31.35479	122.21886	1.42724	0.58271	3.3317	0.50178	0.58151	-0.03535	-0.00356
150	O	996.2671	2.94347	3.02981	31.07751	121.89477	1.41736	0.58171	3.3317	0.49063	0.57846	-0.03535	-0.00356
151	B	1002.3885	2.97764	3.03803	26.56686	115.21533	1.22583	0.55993	3.3423	0.24624	0.51267	-0.02723	-0.00356
152	O	1002.6679	2.97932	3.03842	26.43238	114.92971	1.21822	0.55894	3.3423	0.23509	0.50961	-0.02723	-0.00356
153	B	1008.7893	3.01755	3.04713	25.05020	109.09402	1.07639	0.53712	3.3516	-0.00929	0.44369	-0.01911	-0.00357
154	O	1009.0687	3.01932	3.04753	25.05851	108.84694	1.07105	0.53612	3.3516	-0.02045	0.44062	-0.01911	-0.00357
155	B	1015.1901	3.05727	3.05670	26.80481	103.85661	0.97890	0.51427	3.3599	-0.26483	0.37458	-0.01099	-0.00357
156	OS1	1015.5111	3.05917	3.05719	26.97893	103.61727	0.97537	0.51312	3.3599	-0.27765	0.37106	-0.01099	-0.00357
157	OS2	1015.7905	3.06081	3.05762	27.13720	103.41078	0.97230	0.51212	3.3599	-0.28880	0.36799	-0.01099	-0.00357
158	-QH1	1016.4382	3.06457	3.05863	27.79058	101.95693	0.96982	0.50737	3.3599	-0.72318	1.86950	0.00332	-0.01110
159	OSD3	1017.1901	3.06880	3.05982	28.90899	99.17072	0.97231	0.49902	3.3599	-0.76438	1.83635	0.00332	-0.01110

160	HCDS	1044.5027	3.14865	3.14078	111.54385	31.69881	1.49356	0.19570	3.3975	-2.26117	0.63312	0.03579	-0.01111
161	QF	1046.1816	3.15102	3.14930	111.95868	31.68669	1.50532	0.18316	3.3975	2.01940	-0.62575	-0.02185	-0.00391
162	OC	1046.4356	3.15138	3.15057	110.93575	32.00740	1.49977	0.18216	3.3975	2.00788	-0.63690	-0.02185	-0.00391
163	QFC	1047.1976	3.15249	3.15431	107.96901	32.98348	1.48358	0.17913	3.3975	1.88628	-0.64377	-0.02065	-0.00405
164	HCN	1074.2461	3.22306	3.23272	36.81368	99.10736	1.35578	0.06940	3.4409	0.74441	-1.79987	0.01183	-0.00406
165	QD	1075.9250	3.23041	3.23539	36.74141	98.78686	1.41960	0.06044	3.4409	-0.70045	1.98666	0.06460	-0.00655
166	OC	1076.1790	3.23150	3.23580	37.09985	97.78087	1.43601	0.05878	3.4409	-0.71075	1.97394	0.06460	-0.00655
167	QDC	1076.9410	3.23473	3.23706	38.18205	94.86384	1.48476	0.05380	3.4409	-0.70914	1.85501	0.06336	-0.00651
168	HCN	1103.9895	3.30485	3.32374	105.34089	28.71956	3.62906	-0.12219	3.5220	-1.77379	0.58949	0.09583	-0.00651
169	QF	1105.6684	3.30737	3.33316	104.53544	28.67278	3.67238	-0.13717	3.5220	2.24322	-0.56103	-0.04450	-0.01144
170	OC	1105.9224	3.30776	3.33456	103.39961	28.96074	3.66107	-0.14008	3.5220	2.22856	-0.57268	-0.04450	-0.01144
171	QFC	1106.6844	3.30895	3.33869	100.09895	29.84197	3.62828	-0.14875	3.5220	2.10390	-0.58356	-0.04157	-0.01132
172	HCN	1133.7329	3.39800	3.42387	25.94599	94.20500	2.93464	-0.45481	3.6257	0.63761	-1.79501	-0.00909	-0.01131
173	QD	1135.4118	3.40849	3.42668	25.56974	94.18252	3.01390	-0.45907	3.6257	-0.40874	1.80811	0.10402	0.00626
174	OC	1135.6658	3.41006	3.42711	25.78033	93.26693	3.04032	-0.45748	3.6257	-0.42033	1.79660	0.10402	0.00626
175	QDC	1136.4278	3.41471	3.42843	26.43040	90.61460	3.11859	-0.45286	3.6257	-0.43260	1.68490	0.10140	0.00587
176	HCN	1163.4763	3.51290	3.51456	82.69320	30.41605	6.29179	-0.29388	3.7768	-1.64749	0.53987	0.13387	0.00589
177	QF	1165.1552	3.51610	3.52341	82.91986	30.64152	6.31329	-0.29337	3.7768	1.51539	-0.67703	-0.10840	-0.00528
178	OC	1165.4092	3.51659	3.52472	82.15261	30.98852	6.28575	-0.29471	3.7768	1.50529	-0.68911	-0.10840	-0.00528
179	QFC	1166.1712	3.51808	3.52857	79.93117	32.04689	6.20508	-0.29865	3.7768	1.41057	-0.69954	-0.10336	-0.00504
1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
180	MS1	1179.6780	3.55283	3.57865	48.65032	59.42252	4.80896	-0.36675	3.7768	0.90537	-1.32726	-0.10336	-0.00504
181	B	1185.7994	3.57528	3.59304	38.96773	77.40895	4.20108	-0.39760	3.8133	0.67641	-1.61093	-0.09525	-0.00504
182	O	1186.0788	3.57643	3.59361	38.59268	78.31276	4.17447	-0.39901	3.8133	0.66596	-1.62390	-0.09525	-0.00504
183	B	1192.2002	3.60436	3.60463	31.84111	99.92835	3.61629	-0.42983	3.8449	0.43700	-1.90713	-0.08713	-0.00503
184	MS2	1193.2197	3.60953	3.60622	30.98896	103.86515	3.52746	-0.43496	3.8449	0.39887	-1.95444	-0.08713	-0.00503
185	QD	1194.8986	3.61814	3.60877	31.73143	103.75283	3.49343	-0.42944	3.8449	-0.85052	2.01990	0.04638	0.01158
186	OC	1195.1526	3.61941	3.60916	32.16700	102.72988	3.50521	-0.42650	3.8449	-0.86431	2.00746	0.04638	0.01158
187	QDC	1195.9146	3.62310	3.61036	33.49430	99.76431	3.53941	-0.41781	3.8449	-0.87717	1.88521	0.04338	0.01122
188	HCN	1222.9631	3.69338	3.69100	119.59533	31.12825	5.14327	-0.11413	3.9838	-2.30607	0.65138	0.07585	0.01123
189	QF	1224.6420	3.69559	3.69970	119.64326	31.01924	5.10506	-0.09875	3.9838	2.27814	-0.58507	-0.12112	0.00718
190	OC	1224.8960	3.69593	3.70099	118.48930	31.31925	5.07429	-0.09693	3.9838	2.26500	-0.59606	-0.12112	0.00718
191	QFC	1225.6580	3.69697	3.70481	115.13889	32.23316	4.98354	-0.09142	3.9838	2.13276	-0.60305	-0.11707	0.00726
192	HCN	1252.7065	3.76700	3.78573	35.02102	95.73443	2.24769	0.10496	4.0977	0.82928	-1.74367	-0.08460	0.00726
193	QD	1254.3854	3.77477	3.78850	34.55105	95.44355	2.17666	0.11367	4.0977	-0.54340	1.91320	-0.00047	0.00306
194	OC	1254.6394	3.77593	3.78892	34.82951	94.47480	2.17654	0.11444	4.0977	-0.55292	1.90080	-0.00047	0.00306
195	QDC	1255.4014	3.77938	3.79023	35.67096	91.66641	2.17548	0.11681	4.0977	-0.55110	1.78554	-0.00232	0.00316
196	HCN	1282.4499	3.85753	3.87904	92.22248	28.45740	2.54334	0.20209	4.1718	-1.53967	0.55048	0.03015	0.00315
197	QF	1284.1288	3.86041	3.88852	91.48056	28.52685	2.51223	0.21396	4.1718	1.97207	-0.59272	-0.06702	0.01106
198	OC	1284.3828	3.86086	3.88993	90.48220	28.83100	2.49520	0.21677	4.1718	1.95849	-0.60475	-0.06702	0.01106
199	QFC	1285.1448	3.86222	3.89407	87.58288	29.76206	2.44490	0.22513	4.1718	1.84717	-0.61685	-0.06502	0.01088
200	HCN	1312.1933	3.96143	3.97802	24.51262	96.99535	1.11674	0.51930	4.2265	0.48460	-1.86779	-0.03255	0.01087
201	QD	1313.8722	3.97244	3.98074	24.56738	97.03564	1.09754	0.52077	4.2265	-0.51792	1.84431	0.00955	-0.00912
202	OC	1314.1262	3.97408	3.98116	24.83381	96.10166	1.09996	0.51845	4.2265	-0.53103	1.83279	0.00955	-0.00912
203	QDC	1314.8882	3.97889	3.98244	25.65660	93.39601	1.10688	0.51166	4.2265	-0.54852	1.71870	0.00861	-0.00868
204	HCN	1341.9367	4.07261	4.06574	92.42393	31.34531	1.77046	0.27651	4.2708	-1.91994	0.57452	0.04108	-0.00870
205	QF	1343.6156	4.07547	4.07434	92.93138	31.51025	1.78218	0.27066	4.2708	1.62419	-0.67485	-0.02720	0.00170
206	OC	1343.8696	4.07590	4.07561	92.10881	31.85605	1.77527	0.27110	4.2708	1.61425	-0.68659	-0.02720	0.00170
207	QFC	1344.6316	4.07724	4.07936	89.72703	32.90923	1.75509	0.27231	4.2708	1.51209	-0.69525	-0.02577	0.00148
208	HCN	1371.6801	4.15775	4.15607	34.72472	103.41824	1.48858	0.31228	4.3207	0.52140	-1.91045	0.00670	0.00147
209	QD	1373.3590	4.16547	4.15863	35.28065	103.18854	1.54798	0.30475	4.3207	-0.85958	2.04432	0.06444	-0.01039
210	OC	1373.6130	4.16661	4.15902	35.72050	102.15327	1.56435	0.30212	4.3207	-0.87210	2.03157	0.06444	-0.01039
211	QDC	1374.3750	4.16994	4.16023	37.05443	99.15128	1.61294	0.29430	4.3207	-0.87809	1.90890	0.06308	-0.01013
212	HCN	1401.4235	4.23655	4.24264	119.52372	30.10469	3.74991	0.02007	4.4058	-2.17088	0.64286	0.09556	-0.01014
213	QF	1403.1024	4.23877	4.25164	119.12749	29.96182	3.78892	0.00351	4.4058	2.40181	-0.55596	-0.04934	-0.00969
214	OC	1403.3564	4.23911	4.25298	117.91104	30.24707	3.77639	0.00105	4.4058	2.38738	-0.56706	-0.04934	-0.00969

215 QFC	1404.1184	4.24016	4.25694	114.37664	31.11770	3.73995	-0.00634	4.4058	2.25188	-0.57526	-0.04631	-0.00969
216 HCN	1431.1669	4.31469	4.34054	31.39059	93.45795	2.91805	-0.26839	4.5110	0.81620	-1.72855	-0.01384	-0.00968
217 QD	1432.8458	4.32339	4.34337	30.74246	93.26276	2.98873	-0.27591	4.5110	-0.42193	1.84231	0.09848	0.00078
218 OC	1433.0998	4.32470	4.34381	30.95927	92.32990	3.01374	-0.27571	4.5110	-0.43167	1.83035	0.09848	0.00078
219 QDC	1433.8618	4.32858	4.34514	31.61900	89.62655	3.08780	-0.27521	4.5110	-0.43394	1.71813	0.09588	0.00054
220 HCN	1460.9103	4.41735	4.43431	82.58844	28.89712	6.11191	-0.26038	4.6587	-1.45046	0.52626	0.12835	0.00055
221 QF	1462.5892	4.42056	4.44363	82.16778	29.07566	6.12999	-0.26784	4.6587	1.69562	-0.63486	-0.10693	-0.00949
222 OC	1462.8432	4.42106	4.44501	81.30945	29.40128	6.10283	-0.27025	4.6587	1.68365	-0.64712	-0.10693	-0.00949
223 QFC	1463.6052	4.42257	4.44907	78.81988	30.39704	6.02322	-0.27740	4.6587	1.58417	-0.65938	-0.10204	-0.00927
224 HCN	1490.6537	4.52519	4.53043	25.69791	100.52562	3.69379	-0.52792	4.8131	0.37980	-1.93226	-0.06957	-0.00925
1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
225 QD	1492.3326	4.53561	4.53306	26.18072	100.55367	3.69492	-0.52644	4.8131	-0.67350	1.91591	0.07093	0.01101
226 OC	1492.5866	4.53714	4.53346	26.52644	99.58339	3.71293	-0.52364	4.8131	-0.68760	1.90411	0.07093	0.01101
227 QDC	1493.3486	4.54162	4.53470	27.58891	96.77189	3.76577	-0.51542	4.8131	-0.70641	1.78631	0.06774	0.01057
228 HCN	1520.3971	4.62518	4.61578	105.55451	31.77331	6.02868	-0.22928	4.9702	-2.17606	0.61585	0.10021	0.01059
229 QF	1522.0760	4.62768	4.62428	106.07065	31.82433	6.00268	-0.21871	4.9702	1.87525	-0.64689	-0.13103	0.00207
230 OC	1522.3300	4.62806	4.62554	105.12077	32.15583	5.96940	-0.21819	4.9702	1.86443	-0.65821	-0.13103	0.00207
231 QFC	1523.0920	4.62923	4.62925	102.36754	33.16465	5.87138	-0.21655	4.9702	1.74947	-0.66543	-0.12625	0.00224
232 HCN	1550.1405	4.70192	4.70667	36.74848	100.91322	2.88709	-0.15578	5.1088	0.67654	-1.83825	-0.09378	0.00225
233 QD	1551.8194	4.70926	4.70929	36.90236	100.60440	2.82111	-0.14707	5.1088	-0.77015	2.01824	0.01476	0.00807
234 OC	1552.0734	4.71035	4.70970	37.29638	99.58239	2.82486	-0.14502	5.1088	-0.78111	2.00543	0.01476	0.00807
235 QDC	1552.8354	4.71355	4.71093	38.48714	96.61873	2.83519	-0.13892	5.1088	-0.78123	1.88473	0.01235	0.00795
236 HCN	1579.8839	4.78133	4.79614	111.35922	29.08527	3.59987	0.07616	5.2109	-1.91293	0.61111	0.04482	0.00795
237 QF	1581.5628	4.78372	4.80544	110.62996	28.98760	3.55940	0.09211	5.2109	2.33795	-0.55170	-0.09278	0.01115
238 OC	1581.8168	4.78408	4.80683	109.44605	29.27077	3.53583	0.09494	5.2109	2.32311	-0.56313	-0.09278	0.01115
239 QFC	1582.5788	4.78521	4.81091	106.00539	30.13676	3.46621	0.10341	5.2109	2.19312	-0.57312	-0.08996	0.01107
240 HCN	1609.6273	4.86878	4.89608	27.46208	93.32057	1.46373	0.40276	5.2877	0.71071	-1.76187	-0.05748	0.01106
241 QD	1611.3062	4.87872	4.89891	26.93089	93.24478	1.41342	0.40827	5.2877	-0.38758	1.80605	-0.00277	-0.00453
242 OC	1611.5602	4.88022	4.89935	27.13053	92.33025	1.41271	0.40712	5.2877	-0.39842	1.79444	-0.00277	-0.00453
243 QDC	1612.3222	4.88464	4.90068	27.74466	89.68083	1.41014	0.40380	5.2877	-0.40734	1.68325	-0.00398	-0.00418
244 HCN	1639.3707	4.98160	4.98822	80.52485	29.84985	1.73323	0.29047	5.3362	-1.54400	0.52794	0.02850	-0.00420
245 QF	1641.0496	4.98488	4.99724	80.54693	30.08109	1.72523	0.29272	5.3362	1.53113	-0.66860	-0.03798	0.00689
246 OC	1641.3036	4.98539	4.99857	79.77180	30.42385	1.71559	0.29447	5.3362	1.52058	-0.68082	-0.03798	0.00689
247 QFC	1642.0656	4.98693	5.00249	77.52662	31.47023	1.68717	0.29964	5.3362	1.42645	-0.69210	-0.03660	0.00665
248 HCN	1669.1141	5.08355	5.08118	28.99925	103.21671	1.12775	0.47939	5.3791	0.36766	-1.95933	-0.00413	0.00664
249 QD	1670.7930	5.09275	5.08374	29.72560	103.16217	1.15713	0.47510	5.3791	-0.80950	1.99111	0.03931	-0.01171
250 OC	1671.0470	5.09410	5.08413	30.14042	102.15379	1.16711	0.47213	5.3791	-0.82365	1.97889	0.03931	-0.01171
251 QDC	1671.8090	5.09804	5.08534	31.40789	99.23092	1.19669	0.46336	5.3791	-0.83933	1.85773	0.03831	-0.01131
252 HCN	1698.8575	5.17182	5.16569	116.51621	31.50231	2.66350	0.15723	5.4395	-2.30721	0.64533	0.07078	-0.01132
253 QF	1700.5364	5.17409	5.17427	116.76524	31.43676	2.69603	0.14308	5.4395	2.16207	-0.60545	-0.03223	-0.00561
254 OC	1700.7904	5.17443	5.17555	115.67004	31.74714	2.68785	0.14166	5.4395	2.14973	-0.61650	-0.03223	-0.00561
255 QFC	1701.5524	5.17550	5.17932	112.49182	32.69203	2.66411	0.13734	5.4395	2.02202	-0.62326	-0.03007	-0.00573
256 HCN	1728.6009	5.24516	5.25886	36.20201	97.40569	2.28137	-0.01758	5.5171	0.79850	-1.76827	0.00240	-0.00573
257 QD	1730.2798	5.25265	5.26158	35.90883	97.08934	2.35906	-0.02654	5.5171	-0.62015	1.95264	0.09064	-0.00488
258 OC	1730.5338	5.25377	5.26200	36.22635	96.10060	2.38208	-0.02778	5.5171	-0.62994	1.94005	0.09064	-0.00488
259 -TBC	1731.2958	5.25708	5.26328	37.18485	93.23386	2.45037	-0.03150	5.5171	-0.62765	1.82289	0.08858	-0.00491
260 HCN	1758.3443	5.33079	5.35118	98.56421	28.49958	5.27696	-0.16415	5.6408	-1.64161	0.56950	0.12105	-0.00490
261 QF	1760.0232	5.33348	5.36066	97.75426	28.50711	5.30956	-0.17776	5.6408	2.11365	-0.57408	-0.08242	-0.01140
262 OC	1760.2772	5.33390	5.36207	96.68414	28.80175	5.28863	-0.18066	5.6408	2.09945	-0.58593	-0.08242	-0.01140
263 TBB	1761.0392	5.33518	5.36621	93.57517	29.70371	5.22745	-0.18929	5.6408	1.98140	-0.59752	-0.07818	-0.01125
264 HCN	1788.0877	5.42984	5.45104	24.90148	95.38019	3.54350	-0.49351	5.7800	0.55754	-1.82959	-0.04571	-0.01124
265 QD	1789.7666	5.44073	5.45381	24.73274	95.39719	3.58028	-0.49643	5.7800	-0.45489	1.81968	0.08975	0.00779
266 OC	1790.0206	5.44236	5.45423	24.96697	94.47571	3.60307	-0.49445	5.7800	-0.46729	1.80820	0.08975	0.00779
267 -TBA	1790.7826	5.44714	5.45554	25.74230	91.61950	3.67395	-0.48818	5.7800	-0.55067	1.93839	0.09629	0.00867
268 HCN	1817.8311	5.54061	5.55175	92.57006	24.70893	6.70899	-0.25343	5.9469	-1.92002	0.53443	0.12876	0.00869
269 QF	1819.5100	5.54346	5.56271	93.06837	24.60677	6.70868	-0.24686	5.9469	1.62960	-0.47228	-0.12913	-0.00083

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
270	OC	1819.7640	5.54389	5.56435	92.24307	24.84989	6.67588	-0.24707	5.9469	1.61962	-0.48491	-0.12913	-0.00083
271	TB9	1820.5260	5.54522	5.56916	90.29436	25.47925	6.59568	-0.24703	5.9469	0.94240	-0.33952	-0.08149	0.00095
272	HCN	1847.5745	5.60815	5.67465	54.61213	75.81459	4.82225	-0.22125	6.1291	0.37681	-1.52065	-0.04902	0.00096
273	QD	1849.2534	5.61300	5.67813	56.93355	76.06214	4.89468	-0.21259	6.1291	-1.78893	1.37638	0.13575	0.00930
274	OC	1849.5074	5.61370	5.67866	57.84709	75.36539	4.92916	-0.21023	6.1291	-1.80767	1.36671	0.13575	0.00930
275	-TB8	1850.2694	5.61575	5.68029	60.64482	73.30461	5.03261	-0.20315	6.1291	-1.86389	1.33772	0.13575	0.00930
276	HCN	1877.3179	5.65377	5.78057	215.44884	28.73967	9.13516	0.04838	6.3578	-3.85938	0.30928	0.16823	0.00930
277	QF	1878.9968	5.65500	5.78983	214.52752	29.65057	9.12295	0.06572	6.3578	4.39633	-0.86339	-0.18269	0.01147
278	OC	1879.2508	5.65519	5.79118	212.30030	30.09297	9.07655	0.06863	6.3578	4.37227	-0.87834	-0.18269	0.01147
279	TB7	1880.0128	5.65577	5.79511	204.16762	31.69415	8.90417	0.07763	6.3578	6.27437	-1.22810	-0.26947	0.01217
280	OOC	1881.1371	5.65668	5.80052	190.30925	34.55564	8.60120	0.09132	6.3578	6.05208	-1.31707	-0.26947	0.01217
281	B	1887.2585	5.66303	5.82322	123.62435	53.64293	6.97650	0.16584	6.4210	4.84178	-1.80095	-0.26136	0.01217
282	O	1887.5379	5.66340	5.82405	120.93420	54.65548	6.90348	0.16924	6.4210	4.78653	-1.82305	-0.26136	0.01217
283	BH	1893.6593	5.67401	5.83881	69.74351	79.92916	5.34091	0.24375	6.4954	3.57625	-2.30538	-0.24918	0.01217
284	O	1893.9387	5.67466	5.83936	67.76053	81.22358	5.27129	0.24715	6.4954	3.52101	-2.32746	-0.24918	0.01217
285	BH	1900.0601	5.69562	5.84955	32.06304	112.66446	3.78327	0.32161	6.5505	2.31073	-2.80839	-0.23700	0.01216
286	O	1900.3395	5.69704	5.84994	30.78724	114.23995	3.71705	0.32501	6.5505	2.25548	-2.83043	-0.23700	0.01216
287	BH	1906.4609	5.75210	5.85734	10.58294	151.82854	2.30356	0.39943	6.5871	1.04520	-3.30964	-0.22483	0.01215
288	OOO	1907.0613	5.76169	5.85796	9.39918	155.83101	2.16858	0.40673	6.5871	0.92649	-3.35691	-0.22483	0.01215
289	-QB6	1908.7402	5.79444	5.85965	7.33901	157.05323	1.85703	0.41393	6.5871	0.32672	2.64458	-0.14828	-0.00362
290	OC	1908.9942	5.80001	5.85991	7.18276	155.71306	1.81937	0.41301	6.5871	0.28841	2.63166	-0.14828	-0.00362
291	-TB6	1909.7562	5.81724	5.86071	6.96644	148.77034	1.72376	0.40624	6.5871	-0.00268	6.42030	-0.10307	-0.01411
292	OOC	1910.8805	5.84269	5.86197	7.15391	134.69264	1.60789	0.39038	6.5871	-0.16407	6.10123	-0.10307	-0.01411
293	GP9	1916.0920	5.93451	5.87002	12.76274	78.80699	1.07074	0.31685	6.5871	-0.91217	4.62223	-0.10307	-0.01411
294	B	1922.2134	5.98576	5.88922	29.30887	32.84887	0.46467	0.23048	6.5933	-1.79086	2.88530	-0.09495	-0.01411
295	O	1922.4928	5.98725	5.89061	30.32081	31.25872	0.43815	0.22654	6.5933	-1.83097	2.80599	-0.09495	-0.01411
296	BH	1928.6142	6.01054	5.95588	58.11507	7.54071	-0.10580	0.14015	6.5952	-2.70965	1.06833	-0.08277	-0.01412
297	O	1928.8936	6.01130	5.96202	59.64043	6.96589	-0.12893	0.13620	6.5952	-2.74976	0.98899	-0.08277	-0.01412
298	BH	1935.0150	6.02401	6.18849	98.68298	5.49853	-0.59834	0.04978	6.5907	-3.62844	-0.74930	-0.07060	-0.01412
299	GP10	1936.2043	6.02585	6.21778	107.51639	7.68240	-0.68229	0.03300	6.5907	-3.79916	-1.08702	-0.07060	-0.01412
300	GAP2	1936.5251	6.02632	6.22413	109.96896	8.40913	-0.70494	0.02847	6.5907	-3.84521	-1.17813	-0.07060	-0.01412
301	QB5	1937.8985	6.02820	6.24600	124.74508	11.82643	-0.81421	0.00871	6.5907	-7.03296	-1.28242	-0.08897	-0.01457
302	GAP2	1938.2193	6.02860	6.25017	129.29953	12.67233	-0.84276	0.00404	6.5907	-7.16274	-1.35416	-0.08897	-0.01457
303	BV	1942.6593	6.03298	6.28730	200.86678	29.10536	-1.23775	-0.04105	6.5905	-8.95538	-2.34702	-0.08895	-0.00574
304	O	1942.9387	6.03320	6.28880	205.90260	30.43433	-1.26261	-0.04265	6.5905	-9.06832	-2.40949	-0.08895	-0.00574
305	BH	1949.0601	6.03693	6.31023	332.06833	68.30590	-1.76984	-0.07777	6.5720	-11.54279	-3.77680	-0.07678	-0.00574
306	GP11	1964.8986	6.04182	6.32980	799.11617	244.00215	-2.98584	-0.16862	6.5720	-17.94537	-7.31620	-0.07678	-0.00574
307	QB4	1966.2720	6.04209	6.33066	849.17019	264.51945	-3.09129	-0.17650	6.5720	-18.50055	-7.62310	-0.07678	-0.00574
308	GAP2	1966.5928	6.04215	6.33086	861.08297	269.43394	-3.11592	-0.17834	6.5720	-18.63024	-7.69480	-0.07678	-0.00574
309	GP20	1966.5928	6.04215	6.33086	861.08297	269.43394	-3.11592	-0.17834	6.5720	-18.63024	-7.69480	-0.07678	-0.00574
310	-BV	1971.0328	6.04290	6.33318	1034.41494	342.16810	-3.45668	-0.22342	6.5737	-20.40697	-8.68698	-0.07672	-0.01457
311	O	1971.3122	6.04294	6.33331	1045.84986	347.03983	-3.47811	-0.22749	6.5737	-20.51972	-8.74942	-0.07672	-0.01457
312	GP21	1978.2458	6.04387	6.33602	1349.80097	479.11260	-4.01004	-0.32850	6.5737	-23.31781	-10.29886	-0.07672	-0.01457
313	QB3	1981.5986	6.04431	6.33693	922.68374	838.76280	-3.33847	-0.46183	6.5737	130.02230	-113.32610	0.46145	-0.06807
314	OB3	1982.4749	6.04448	6.33708	708.87731	1049.13683	-2.93409	-0.52148	6.5737	113.96541	-126.74470	0.46145	-0.06807

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
315	QB2	1988.3677	6.04718	6.33783	268.83553	885.76218	-1.88257	-0.50239	6.5737	-6.62678	139.76186	-0.06294	0.07376
316	OB3	1989.2440	6.04769	6.33802	280.57792	657.75066	-1.93773	-0.43776	6.5737	-6.77318	120.43616	-0.06294	0.07376
317	QB1	1992.5968	6.04976	6.33952	201.81319	222.75212	-1.69329	-0.27792	6.5737	26.45057	29.08878	0.20298	0.02531
318	LB0	2000.2200	6.29609	6.56870	0.28811	0.26540	-0.14597	-0.08499	6.5737	-0.01472	0.09679	0.20298	0.02531
319	.B0	2000.2200	6.29609	6.56870	0.28811	0.26540	-0.14597	-0.08499	6.5737	-0.01472	0.09679	0.20298	0.02531
320	LB0	2007.8432	6.53774	6.82855	202.26209	219.80071	1.40136	0.10794	6.5737	-26.48001	-28.89520	0.20298	0.02531
321	-QB1	2011.1960	6.53940	6.83045	598.09255	306.21369	2.48032	0.16181	6.5737	-109.58142	7.30709	0.46574	0.00555
322	OB3	2012.0723	6.53960	6.83091	805.56364	293.54369	2.88845	0.16667	6.5737	-127.17664	7.15143	0.46574	0.00555

323 -QB2	2017.9651	6.54043	6.83338	954.83973	776.02358	3.18929	0.34215	6.5737	115.28280	-124.84192	-0.37613	0.06095
324 OB3	2018.8414	6.54059	6.83354	763.48408	1010.24490	2.85968	0.39556	6.5737	103.08493	-142.44248	-0.37613	0.06095
325 -QB3	2022.1942	6.54159	6.83394	436.49971	1478.50169	2.19837	0.49455	6.5737	9.31158	25.46032	-0.03373	-0.00424
326 GP21	2029.1278	6.54456	6.83479	317.03411	1146.54944	1.96448	0.46517	6.5737	7.91842	22.41570	-0.03373	-0.00424
327 O	2029.4072	6.54470	6.83483	312.62498	1134.05783	1.95506	0.46398	6.5737	7.86228	22.29301	-0.03373	-0.00424
328 -BV	2033.8472	6.54724	6.83551	246.74729	944.75471	1.80521	0.42556	6.5698	6.97446	20.34338	-0.03377	-0.01307
329 GP20	2033.8472	6.54724	6.83551	246.74729	944.75471	1.80521	0.42556	6.5698	6.97446	20.34338	-0.03377	-0.01307
330 GAP2	2034.1680	6.54745	6.83556	242.29273	931.74625	1.79438	0.42137	6.5698	6.90991	20.20250	-0.03377	-0.01307
331 -QB4	2035.5414	6.54839	6.83581	223.69238	877.08316	1.74800	0.40342	6.5698	6.63360	19.59943	-0.03377	-0.01307
332 GP11	2051.3799	6.56951	6.84025	64.03005	366.38702	1.21321	0.19640	6.5698	3.44706	12.64456	-0.03377	-0.01307
333 BH	2057.5013	6.59206	6.84362	29.36800	227.99354	1.04379	0.11638	6.5834	2.21552	9.96190	-0.02159	-0.01307
334 O	2057.7807	6.59360	6.84382	28.14567	222.46115	1.03776	0.11273	6.5834	2.15931	9.83906	-0.02159	-0.01307
335 BV	2062.2207	6.63098	6.84777	12.93572	143.75845	0.94187	0.07428	6.5842	1.26622	7.88700	-0.02161	-0.00424
336 GAP2	2062.5415	6.63505	6.84814	12.14394	138.74288	0.93494	0.07292	6.5842	1.20165	7.74594	-0.02161	-0.00424
337 -QB5	2063.9149	6.65603	6.84982	8.89142	122.50312	0.88990	0.06828	6.5842	1.14025	4.20976	-0.04380	-0.00253
338 GAP5	2065.7759	6.69873	6.85240	5.54326	107.36321	0.80838	0.06357	6.5842	0.65881	3.92534	-0.04380	-0.00253
339 BH	2071.8973	6.91023	6.86408	7.17113	65.02048	0.57754	0.04805	6.5926	-0.92474	2.99131	-0.03162	-0.00254
340 O	2072.1767	6.91621	6.86477	7.70807	63.36088	0.56871	0.04734	6.5926	-0.99702	2.94857	-0.03162	-0.00254
341 BH	2078.2981	6.98261	6.88614	29.60738	32.98850	0.41240	0.03182	6.5985	-2.58057	2.01274	-0.01945	-0.00254
342 O	2078.5775	6.98408	6.88751	31.06960	31.87574	0.40697	0.03111	6.5985	-2.65285	1.96996	-0.01945	-0.00254
343 BH	2084.6989	7.00456	6.93520	73.24037	13.49255	0.32520	0.01558	6.6029	-4.23639	1.03292	-0.00727	-0.00254
344 O	2084.9783	7.00515	6.93857	75.62786	12.92732	0.32317	0.01487	6.6029	-4.30867	0.99012	-0.00727	-0.00254
345 BH	2091.0997	7.01469	7.05446	138.07008	6.54473	0.31594	-0.00066	6.6067	-5.89222	0.05247	0.00491	-0.00254
346 000	2091.7001	7.01537	7.06909	145.23847	6.53695	0.31889	-0.00218	6.6067	-6.04754	-0.03952	0.00491	-0.00254
347 QB6	2093.3790	7.01712	7.10793	156.27584	7.54528	0.31686	-0.00656	6.6067	-0.38520	-0.57385	-0.00731	-0.00270
348 OC	2093.6330	7.01738	7.11319	156.47200	7.84817	0.31500	-0.00725	6.6067	-0.38707	-0.61860	-0.00731	-0.00270
349 TB6	2094.3950	7.01816	7.12764	154.22661	9.04912	0.30658	-0.00938	6.6067	3.31586	-0.96701	-0.01475	-0.00290
350 OOC	2095.5193	7.01935	7.14522	146.86902	11.49381	0.29000	-0.01264	6.6067	3.22842	-1.20743	-0.01475	-0.00290
351 BH	2101.6407	7.02701	7.19511	110.25934	34.28651	0.23698	-0.03040	6.6098	2.75234	-2.51573	-0.00257	-0.00290
352 O	2101.9201	7.02741	7.19638	108.72741	35.70899	0.23626	-0.03121	6.6098	2.73061	-2.57546	-0.00257	-0.00290
353 B	2108.0415	7.03798	7.21522	78.21175	75.24616	0.24535	-0.04897	6.6117	2.25452	-3.88317	0.00554	-0.00290
354 O	2108.3209	7.03856	7.21580	76.95800	77.43276	0.24690	-0.04978	6.6117	2.23279	-3.94288	0.00554	-0.00290
355 B	2114.4423	7.05390	7.22538	52.53691	133.70504	0.30568	-0.06754	6.6140	1.75671	-5.24954	0.01366	-0.00290
356 O	2114.7217	7.05476	7.22571	51.56133	136.65516	0.30950	-0.06835	6.6140	1.73498	-5.30921	0.01366	-0.00290
357 B	2120.8431	7.07838	7.23147	33.23481	209.64705	0.41797	-0.08610	6.6169	1.25890	-6.61445	0.02178	-0.00290
358 000	2121.4435	7.08132	7.23192	31.75121	217.66636	0.43105	-0.08784	6.6169	1.21220	-6.74260	0.02178	-0.00290
359 QD	2123.1224	7.09010	7.23311	29.81046	226.26361	0.48192	-0.08985	6.6169	-0.03164	1.73200	0.03914	0.00052

1

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
360 OC	2123.3764	7.09146	7.23329	29.82870	225.38489	0.49186	-0.08972	6.6169	-0.04017	1.72751	0.03914	0.00052
361 -TB7	2124.1384	7.09551	7.23383	30.13412	221.08883	0.52357	-0.08899	6.6169	-0.36164	3.89625	0.04414	0.00140
362 HCN	2151.1869	7.19030	7.27041	77.15115	63.74651	2.14800	-0.05118	6.6581	-1.37663	1.91866	0.07661	0.00140
363 QF	2152.8658	7.19373	7.27472	76.83452	61.41639	2.20667	-0.05046	6.6581	1.56116	-0.50124	-0.00709	-0.00053
364 OC	2153.1198	7.19426	7.27538	76.04434	61.67234	2.20487	-0.05060	6.6581	1.54980	-0.50642	-0.00709	-0.00053
365 TB8	2153.8818	7.19588	7.27733	73.70842	62.45595	2.19947	-0.05100	6.6581	1.51571	-0.52194	-0.00709	-0.00053
366 HCN	2180.9303	7.30584	7.33139	24.44257	105.49804	2.43838	-0.06541	6.7308	0.30570	-1.06867	0.02538	-0.00053
367 QD	2182.6092	7.31675	7.33393	25.10328	102.36245	2.56014	-0.06420	6.7308	-0.70761	2.89613	0.12043	0.00196
368 OC	2182.8632	7.31835	7.33433	25.46660	100.89714	2.59073	-0.06370	6.7308	-0.72279	2.87284	0.12043	0.00196
369 -TB9	2183.6252	7.32302	7.33556	26.44267	97.17349	2.67447	-0.06240	6.7308	-0.55552	2.02381	0.09926	0.00145
370 HCN	2210.6737	7.41501	7.42594	92.69980	26.01582	5.79004	-0.02306	6.8666	-1.89408	0.60597	0.13174	0.00146
371 QF	2212.3526	7.41785	7.43638	93.10339	25.75024	5.82402	-0.02134	6.8666	1.65886	-0.44441	-0.09148	0.00061
372 OC	2212.6066	7.41829	7.43795	92.26329	25.97900	5.80078	-0.02118	6.8666	1.64863	-0.45622	-0.09148	0.00061
373 TBA	2213.3686	7.41962	7.44255	89.62002	26.74635	5.72615	-0.02073	6.8666	1.81826	-0.55137	-0.10436	0.00056
374 MS1	2226.8754	7.45220	7.50242	49.26792	50.53514	4.31655	-0.01311	6.8666	1.16928	-1.20988	-0.10436	0.00056
375 B	2232.9968	7.47517	7.51918	36.75315	67.17057	3.70256	-0.00966	6.8991	0.87517	-1.50761	-0.09624	0.00056
376 O	2233.2762	7.47639	7.51983	36.26786	68.01683	3.67567	-0.00950	6.8991	0.86174	-1.52123	-0.09624	0.00056

377	B	2239.3976	7.50743	7.53241	27.51823	88.46163	3.11137	-0.00605	6.9266	0.56762	-1.81855	-0.08813	0.00056
378	MS2	2240.4171	7.51345	7.53420	26.41080	92.22019	3.02153	-0.00547	6.9266	0.51864	-1.86819	-0.08813	0.00056
379	QD	2242.0960	7.52367	7.53706	26.46409	92.56845	2.96948	-0.00436	6.9266	-0.55106	1.66522	0.02579	0.00075
380	OC	2242.3500	7.52519	7.53750	26.74721	91.72515	2.97603	-0.00417	6.9266	-0.56357	1.65487	0.02579	0.00075
381	-TBB	2243.1120	7.52965	7.53884	27.61696	89.28525	2.99472	-0.00360	6.9266	-0.57759	1.54779	0.02325	0.00075
382	HCN	2270.1605	7.61862	7.62139	94.19105	33.33063	4.05424	0.01669	7.0388	-1.88373	0.52014	0.05572	0.00075
383	QF	2271.8394	7.62142	7.62944	94.46435	33.80384	4.01736	0.01850	7.0388	1.72445	-0.80800	-0.09941	0.00142
384	OC	2272.0934	7.62185	7.63063	93.59104	34.21746	3.99211	0.01886	7.0388	1.71376	-0.82042	-0.09941	0.00142
385	TBC	2272.8554	7.62316	7.63411	91.06014	35.47464	3.91758	0.01994	7.0388	1.60831	-0.82908	-0.09622	0.00140
386	HCN	2299.9039	7.70547	7.70368	32.87278	115.03664	1.74555	0.05787	7.1274	0.54294	-2.11118	-0.06375	0.00140
387	QD	2301.5828	7.71364	7.70598	33.23976	114.72935	1.69369	0.05835	7.1274	-0.76617	2.29028	0.00165	-0.00083
388	OC	2301.8368	7.71485	7.70634	33.63206	113.56940	1.69411	0.05814	7.1274	-0.77830	2.27645	0.00165	-0.00083
389	QDC	2302.5988	7.71839	7.70742	34.82357	110.20393	1.69481	0.05753	7.1274	-0.78502	2.14113	0.00020	-0.00078
390	HCN	2329.6473	7.78994	7.78345	111.24628	31.39753	2.13093	0.03632	7.1870	-2.04041	0.77132	0.03267	-0.00079
391	QF	2331.3262	7.79232	7.79213	110.94669	30.90050	2.11718	0.03616	7.1870	2.21501	-0.46898	-0.04897	0.00059
392	OC	2331.5802	7.79269	7.79343	109.82490	31.14129	2.10474	0.03631	7.1870	2.20149	-0.47901	-0.04897	0.00059
393	QFC	2332.3422	7.79381	7.79728	106.56686	31.87479	2.06806	0.03675	7.1870	2.07502	-0.48339	-0.04729	0.00056
394	HCN	2359.3907	7.87215	7.88351	30.74060	86.27335	1.21956	0.05197	7.2375	0.72836	-1.52693	-0.01482	0.00056
395	QD	2361.0696	7.88099	7.88658	30.34811	85.86998	1.23376	0.05125	7.2375	-0.48960	1.76203	0.03183	-0.00142
396	OC	2361.3236	7.88232	7.88706	30.59946	84.97795	1.24185	0.05088	7.2375	-0.49998	1.74989	0.03183	-0.00142
397	QDC	2362.0856	7.88624	7.88851	31.36496	82.39289	1.26570	0.04982	7.2375	-0.50439	1.64331	0.03076	-0.00138
398	HCN	2389.1341	7.97236	7.98713	87.91056	26.31495	2.52841	0.01249	7.2968	-1.58616	0.42917	0.06323	-0.00138
399	QF	2390.8130	7.97537	7.99733	87.59859	26.66662	2.55272	0.01055	7.2968	1.76798	-0.64310	-0.03442	-0.00094
400	OC	2391.0670	7.97584	7.99884	86.70349	26.99673	2.54398	0.01031	7.2968	1.75602	-0.65656	-0.03442	-0.00094
401	QFC	2391.8290	7.97726	8.00325	84.10685	28.01111	2.51853	0.00959	7.2968	1.65233	-0.67437	-0.03238	-0.00095
402	HCN	2418.8775	8.07298	8.08749	27.16880	102.41487	2.07326	-0.01612	7.3686	0.45272	-2.07527	0.00009	-0.00095
403	QD	2420.5564	8.08287	8.09006	27.49208	102.79718	2.14031	-0.01718	7.3686	-0.64938	1.85245	0.08021	-0.00031
404	OC	2420.8104	8.08433	8.09046	27.82530	101.85892	2.16069	-0.01726	7.3686	-0.66251	1.84150	0.08021	-0.00031

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
405	QDC	2421.5724	8.08861	8.09167	28.84650	99.14242	2.22110	-0.01750	7.3686	-0.67735	1.72423	0.07834	-0.00033
406	HCN	2448.6209	8.17148	8.16742	102.48696	35.13207	4.77080	-0.02628	7.4803	-2.04521	0.64141	0.11082	-0.00032
407	QF	2450.2998	8.17405	8.17510	102.76465	35.30447	4.80257	-0.02768	7.4803	1.88337	-0.74629	-0.07318	-0.00135
408	OC	2450.5538	8.17445	8.17623	101.81076	35.68643	4.78398	-0.02802	7.4803	1.87213	-0.75749	-0.07318	-0.00135
409	QFC	2451.3158	8.17565	8.17958	99.04473	36.84406	4.72968	-0.02904	7.4803	1.75857	-0.76139	-0.06935	-0.00133
410	HCN	2478.3643	8.25265	8.24964	34.14257	109.31555	3.28461	-0.06492	7.6073	0.64093	-1.91683	-0.03688	-0.00133
411	QD	2480.0432	8.26055	8.25206	34.25508	108.72978	3.32803	-0.06505	7.6073	-0.70937	2.25823	0.08887	0.00117
412	OC	2480.2972	8.26173	8.25244	34.61828	107.58622	3.35060	-0.06475	7.6073	-0.72052	2.24398	0.08887	0.00117
413	QDC	2481.0592	8.26517	8.25358	35.71888	104.26733	3.41722	-0.06388	7.6073	-0.72353	2.11245	0.08598	0.00112
414	HCN	2508.1077	8.33759	8.33656	106.06433	28.27245	6.17354	-0.03361	7.7613	-1.87721	0.69610	0.11845	0.00112
415	QF	2509.7866	8.34009	8.34620	105.55511	27.83896	6.17321	-0.03279	7.7613	2.17399	-0.43240	-0.11885	-0.00014
416	OC	2510.0406	8.34047	8.34764	104.45423	28.06137	6.14302	-0.03283	7.7613	2.16021	-0.44323	-0.11885	-0.00014
417	QFC	2510.8026	8.34165	8.35191	101.25641	28.74409	6.05434	-0.03293	7.7613	2.03725	-0.45255	-0.11393	-0.00012
418	HCN	2537.8511	8.42602	8.44478	28.26141	83.82752	3.40339	-0.03605	7.9113	0.66145	-1.58309	-0.08146	-0.00011
419	QD	2539.5300	8.43564	8.44793	27.94384	83.76727	3.37498	-0.03509	7.9113	-0.46827	1.61821	0.04743	0.00125
420	OC	2539.7840	8.43708	8.44842	28.18454	82.94800	3.38703	-0.03477	7.9113	-0.47936	1.60724	0.04743	0.00125
421	QDC	2540.5460	8.44132	8.44990	28.92181	80.57645	3.42207	-0.03382	7.9113	-0.48797	1.50571	0.04453	0.00122
422	HCN	2567.5945	8.53218	8.54486	86.63880	28.74623	5.05727	-0.00072	8.0469	-1.64588	0.40979	0.07701	0.00122
423	QF	2569.2734	8.53523	8.55417	86.60657	29.31265	5.02373	0.00133	8.0469	1.66467	-0.75435	-0.11675	0.00124
424	OC	2569.5274	8.53570	8.55554	85.76373	29.69931	4.99407	0.00165	8.0469	1.65361	-0.76794	-0.11675	0.00124
425	QFC	2570.2894	8.53713	8.55955	83.32059	30.88201	4.90664	0.00259	8.0469	1.55326	-0.78383	-0.11276	0.00123
426	HCN	2597.3379	8.62940	8.63580	29.25957	111.44869	2.28739	0.03596	8.1602	0.44543	-2.19356	-0.08029	0.00123
427	QD	2599.0168	8.63856	8.63817	29.73574	111.64474	2.22496	0.03686	8.1602	-0.73509	2.07930	0.00552	-0.00017
428	OC	2599.2708	8.63991	8.63853	30.11251	110.59153	2.22636	0.03682	8.1602	-0.74825	2.06718	0.00552	-0.00017
429	QDC	2600.0328	8.64387	8.63964	31.26288	107.53926	2.22984	0.03670	8.1602	-0.76109	1.93928	0.00362	-0.00014
430	HCN	2627.0813	8.72039	8.71234	109.39278	34.96414	2.75838	0.03303	8.2387	-2.12745	0.74289	0.03609	-0.00014

431 QF	2628.7602	8.72281	8.72008	109.50091	34.78215	2.73027	0.03386	8.2387	2.06443	-0.63218	-0.06940	0.00114
432 OC	2629.0142	8.72318	8.72124	108.45528	35.10589	2.71264	0.03415	8.2387	2.05223	-0.64240	-0.06940	0.00114
433 QFC	2629.7762	8.72431	8.72465	105.42096	36.08631	2.66059	0.03501	8.2387	1.93063	-0.64397	-0.06723	0.00111
434 HCN	2656.8247	8.79917	8.79916	33.78772	99.52568	1.27269	0.06494	8.2995	0.71772	-1.70046	-0.03476	0.00111
435 QD	2658.5036	8.80719	8.80182	33.61806	98.84906	1.25477	0.06470	8.2995	-0.61452	2.09480	0.01330	-0.00139
436 OC	2658.7576	8.80839	8.80224	33.93288	97.78842	1.25814	0.06435	8.2995	-0.62493	2.08096	0.01330	-0.00139
437 QDC	2659.5196	8.81191	8.80350	34.88663	94.71080	1.26787	0.06331	8.2995	-0.62644	1.95878	0.01222	-0.00133
438 HCN	2686.5681	8.88846	8.89509	97.97523	26.06861	2.02910	0.02726	8.3506	-1.70601	0.57804	0.04469	-0.00133
439 QF	2688.2470	8.89117	8.90549	97.41612	25.90039	2.03855	0.02588	8.3506	2.03187	-0.47570	-0.03349	-0.00032
440 OC	2688.5010	8.89159	8.90704	96.38732	26.14510	2.03005	0.02579	8.3506	2.01850	-0.48773	-0.03349	-0.00032
441 QFC	2689.2630	8.89286	8.91162	93.39968	26.89952	2.00515	0.02554	8.3506	1.90310	-0.50212	-0.03186	-0.00034
442 HCN	2716.3115	8.98406	9.00538	26.65164	88.05344	1.57407	0.01622	8.4060	0.56465	-1.75786	0.00061	-0.00035
443 QD	2717.9904	8.99421	9.00838	26.56367	88.30248	1.62590	0.01513	8.4060	-0.51114	1.61271	0.06146	-0.00095
444 OC	2718.2444	8.99573	9.00884	26.82639	87.48586	1.64152	0.01489	8.4060	-0.52320	1.60235	0.06146	-0.00095
445 QDC	2719.0064	9.00018	9.01025	27.63356	85.12329	1.68781	0.01417	8.4060	-0.53584	1.49880	0.06004	-0.00094
446 HCN	2746.0549	9.09102	9.09709	90.69776	31.89911	3.74250	-0.01113	8.4921	-1.79571	0.46822	0.09251	-0.00094
447 QF	2747.7338	9.09393	9.10549	90.90274	32.46065	3.77670	-0.01307	8.4921	1.67624	-0.80981	-0.05200	-0.00140
448 OC	2747.9878	9.09438	9.10673	90.05392	32.87532	3.76349	-0.01343	8.4921	1.66560	-0.82276	-0.05200	-0.00140
449 QFC	2748.7498	9.09575	9.11035	87.59419	34.13812	3.72501	-0.01449	8.4921	1.56305	-0.83411	-0.04898	-0.00138

1

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
450 HCN	2775.7983	9.18139	9.18120	31.79646	115.51483	2.83073	-0.05191	8.5957	0.49985	-2.17321	-0.01651	-0.00138
451 QD	2777.4772	9.18983	9.18349	32.24360	115.38280	2.89405	-0.05255	8.5957	-0.77184	2.25017	0.09235	0.00062
452 OC	2777.7312	9.19108	9.18384	32.63888	114.24311	2.91751	-0.05239	8.5957	-0.78441	2.23682	0.09235	0.00062
453 QDC	2778.4932	9.19472	9.18492	33.84136	110.93740	2.98692	-0.05193	8.5957	-0.79330	2.10231	0.08983	0.00058
454 HCN	2805.5417	9.26713	9.25879	111.97994	32.89762	5.84733	-0.03620	8.7373	-2.09556	0.78181	0.12230	0.00058
455 QF	2807.2206	9.26949	9.26706	111.81643	32.45697	5.86380	-0.03638	8.7373	2.19086	-0.51376	-0.10278	-0.00080
456 OC	2807.4746	9.26985	9.26830	110.70682	32.72047	5.83770	-0.03658	8.7373	2.17769	-0.52365	-0.10278	-0.00080
457 QFC	2808.2366	9.27096	9.27196	107.48482	33.52070	5.76116	-0.03718	8.7373	2.05152	-0.52630	-0.09811	-0.00077
458 HCN	2835.2851	9.34731	9.35400	31.95872	89.79244	3.53820	-0.05792	8.8850	0.74076	-1.55325	-0.06564	-0.00077
459 QD	2836.9640	9.35581	9.35695	31.59883	89.25089	3.54099	-0.05735	8.8850	-0.52184	1.86887	0.06898	0.00145
460 OC	2837.2180	9.35709	9.35741	31.86652	88.30475	3.55851	-0.05698	8.8850	-0.53207	1.85608	0.06898	0.00145
461 QDC	2837.9800	9.36084	9.35880	32.67974	85.56141	3.60991	-0.05589	8.8850	-0.53491	1.74487	0.06592	0.00140
462 HCN	2865.0285	9.44374	9.45660	90.40937	25.71471	5.82369	-0.01796	9.0362	-1.59941	0.46689	0.09840	0.00140
463 QF	2866.7074	9.44667	9.46707	89.98125	25.90169	5.80120	-0.01616	9.0362	1.84892	-0.58063	-0.12503	0.00075
464 OC	2866.9614	9.44712	9.46863	89.04517	26.19998	5.76945	-0.01596	9.0362	1.83645	-0.59374	-0.12503	0.00075
465 QFC	2867.7234	9.44850	9.47318	86.32851	27.11835	5.67594	-0.01538	9.0362	1.72945	-0.61122	-0.12042	0.00077
466 HCN	2894.7719	9.54397	9.56148	26.59396	97.17032	2.84950	0.00537	9.1711	0.47900	-1.97760	-0.08795	0.00077
467 QD	2896.4508	9.55410	9.56420	26.79289	97.56451	2.79221	0.00647	9.1711	-0.60001	1.74786	0.01933	0.00054
468 OC	2896.7048	9.55560	9.56461	27.10097	96.67928	2.79712	0.00661	9.1711	-0.61291	1.73730	0.01933	0.00054
469 QDC	2897.4668	9.56000	9.56589	28.04652	94.11739	2.81094	0.00702	9.1711	-0.62770	1.62549	0.01694	0.00055
470 HCN	2924.5153	9.64609	9.64466	98.36616	34.44497	3.69988	0.02177	9.2744	-1.97209	0.57984	0.04942	0.00054
471 QF	2926.1942	9.64878	9.65246	98.66520	34.78406	3.66384	0.02340	9.2744	1.79780	-0.78611	-0.09211	0.00140
472 OC	2926.4482	9.64919	9.65362	97.75469	35.18640	3.64045	0.02375	9.2744	1.78691	-0.79792	-0.09211	0.00140
473 QFC	2927.2102	9.65045	9.65700	95.11531	36.40733	3.57137	0.02482	9.2744	1.67755	-0.80401	-0.08921	0.00138
474 HCN	2954.2587	9.72971	9.72631	33.70365	112.89986	1.58914	0.06224	9.3550	0.59290	-2.02281	-0.05673	0.00138
475 QD	2955.9376	9.73770	9.72865	33.95212	112.43617	1.54414	0.06255	9.3550	-0.74405	2.29306	0.00285	-0.00102
476 OC	2956.1916	9.73889	9.72902	34.33305	111.27489	1.54487	0.06229	9.3550	-0.75567	2.27892	0.00285	-0.00102
477 QDC	2956.9536	9.74236	9.73012	35.48848	107.90488	1.54653	0.06153	9.3550	-0.76031	2.14463	0.00153	-0.00096
478 HCNS	2983.7227	9.81350	9.80776	108.05779	30.22188	2.00902	0.03572	9.4104	-1.95065	0.75631	0.03400	-0.00097
479 OS2	2984.0021	9.81391	9.80924	109.15128	29.80332	2.01852	0.03545	9.4104	-1.96308	0.74178	0.03400	-0.00097
480 QFS	2984.8167	9.81509	9.81365	110.70565	29.06993	2.03091	0.03493	9.4104	0.06456	0.16306	-0.00361	-0.00031
481 D1	2992.8522	9.82668	9.85850	110.25371	28.72967	2.00193	0.03241	9.4104	-0.00832	-0.12071	-0.00361	-0.00031
482 B	2998.9736	9.83550	9.89110	110.69548	31.52887	2.00470	0.03049	9.4266	-0.06385	-0.33655	0.00451	-0.00031
483 O	2999.2530	9.83590	9.89250	110.73186	31.71969	2.00596	0.03041	9.4266	-0.06638	-0.34642	0.00451	-0.00031
484 B	3005.3744	9.84466	9.92099	111.88442	37.28170	2.05842	0.02848	9.4430	-0.12190	-0.56217	0.01263	-0.00031

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
485	O	3005.6538	9.84506	9.92217	111.95325	37.59859	2.06195	0.02840	9.4430	-0.12444	-0.57203	0.01263	-0.00031
486	B	3011.7752	9.85369	9.94570	113.81660	45.92188	2.16410	0.02647	9.4602	-0.17996	-0.78763	0.02075	-0.00031
487	OOO	3012.3756	9.85453	9.94776	114.03596	46.88035	2.17656	0.02629	9.4602	-0.18541	-0.80881	0.02075	-0.00031
488	Q1	3014.4767	9.85755	9.95443	103.71745	55.54565	2.11093	0.02695	9.4602	4.93073	-3.45265	-0.08269	0.00095
489	D2	3018.2958	9.86471	9.96326	69.61511	85.31047	1.79511	0.03057	9.4602	3.99869	-4.34103	-0.08269	0.00095
490	Q2	3020.8206	9.87110	9.96763	59.64849	94.78634	1.71312	0.03071	9.4602	0.13799	0.77130	0.01696	-0.00083
491	LS1	3047.5700	9.94207	10.02272	64.49015	65.56242	2.16675	0.00839	9.4602	-0.31900	0.32121	0.01696	-0.00083
492	.C0	3047.5700	9.94207	10.02272	64.49015	65.56242	2.16675	0.00839	9.4602	-0.31900	0.32121	0.01696	-0.00083
493	LS2	3074.0146	9.99743	10.09179	93.30879	60.34097	2.61522	-0.01369	9.4602	-0.77078	-0.12376	0.01696	-0.00083
494	-Q2	3076.5394	10.00186	10.09811	84.03641	70.33230	2.46947	-0.01685	9.4602	4.26385	-4.02318	-0.13101	-0.00170
495	D2	3080.3585	10.01083	10.10520	54.79726	104.62616	1.96913	-0.02336	9.4602	3.39218	-4.95639	-0.13101	-0.00170
496	-Q1	3082.4596	10.01758	10.10819	46.30567	114.95838	1.78904	-0.02571	9.4602	0.78385	0.20477	-0.04185	-0.00052
497	D3	3084.0944	10.02335	10.11046	43.83595	114.31310	1.72063	-0.02656	9.4602	0.72686	0.18995	-0.04185	-0.00052
498	B	3090.2158	10.04789	10.11907	36.24367	112.31976	1.48932	-0.02973	9.4732	0.51344	0.13567	-0.03373	-0.00052
499	O	3090.4952	10.04912	10.11946	35.95948	112.24466	1.47989	-0.02988	9.4732	0.50370	0.13314	-0.03373	-0.00052
500	B	3096.6166	10.07842	10.12820	31.09927	110.94705	1.29827	-0.03305	9.4844	0.29028	0.07883	-0.02561	-0.00052
501	O	3096.8960	10.07986	10.12860	30.93978	110.90370	1.29112	-0.03319	9.4844	0.28054	0.07630	-0.02561	-0.00052
502	B	3103.0174	10.11272	10.13741	28.81162	110.30218	1.15919	-0.03636	9.4943	0.06712	0.02197	-0.01749	-0.00052
503	O	3103.2968	10.11426	10.13781	28.77683	110.29061	1.15430	-0.03651	9.4943	0.05738	0.01943	-0.01749	-0.00052
504	B	3109.4182	10.14802	10.14665	29.38073	110.38534	1.07206	-0.03967	9.5033	-0.15604	-0.03491	-0.00938	-0.00052
505	OS1	3109.7392	10.14976	10.14711	29.48450	110.40868	1.06905	-0.03984	9.5033	-0.16723	-0.03782	-0.00938	-0.00052
506	OS2	3110.0186	10.15126	10.14751	29.58066	110.43052	1.06644	-0.03998	9.5033	-0.17697	-0.04035	-0.00938	-0.00052
507	QDS	3110.8332	10.15560	10.14869	30.34440	108.84124	1.06685	-0.04010	9.5033	-0.76531	1.98151	0.01039	0.00023
508	OSB3	3111.4181	10.15863	10.14956	31.25764	106.53852	1.07292	-0.03997	9.5033	-0.79588	1.95503	0.01039	0.00023
509	HCBS	3138.8977	10.23460	10.22596	114.45770	33.21775	1.78897	-0.03372	9.5474	-2.23186	0.71222	0.04286	0.00023
510	QF	3140.5766	10.23690	10.23412	114.58818	33.03153	1.80305	-0.03442	9.5474	2.15581	-0.59894	-0.02618	-0.00107
511	OC	3140.8306	10.23726	10.23534	113.49621	33.33844	1.79640	-0.03469	9.5474	2.14330	-0.60939	-0.02618	-0.00107
512	QFC	3141.5926	10.23834	10.23892	110.32686	34.27017	1.77700	-0.03550	9.5474	2.01681	-0.61310	-0.02474	-0.00104
513	HCN	3168.6411	10.31021	10.31674	34.82881	96.73433	1.53849	-0.06359	9.5986	0.77444	-1.69529	0.00773	-0.00104
514	QD	3170.3200	10.31800	10.31948	34.53188	96.21908	1.60125	-0.06328	9.5986	-0.59381	1.99559	0.06743	0.00140
515	OC	3170.5740	10.31916	10.31990	34.83606	95.20866	1.61838	-0.06292	9.5986	-0.60376	1.98243	0.06743	0.00140
516	QDC	3171.3360	10.32260	10.32120	35.75592	92.27800	1.66924	-0.06188	9.5986	-0.60315	1.86441	0.06603	0.00135
517	HCN	3198.3845	10.39885	10.41258	96.28873	26.86514	3.88599	-0.02539	9.6868	-1.63481	0.55306	0.09851	0.00135
518	QF	3200.0634	10.40160	10.42265	95.60171	26.82923	3.92556	-0.02392	9.6868	2.03522	-0.53122	-0.05163	0.00041
519	OC	3200.3174	10.40203	10.42415	94.57129	27.10218	3.91244	-0.02381	9.6868	2.02156	-0.54336	-0.05163	0.00041
520	QFC	3201.0794	10.40333	10.42855	91.57854	27.94102	3.87430	-0.02349	9.6868	1.90675	-0.55725	-0.04849	0.00043
521	HCN	3228.1279	10.49795	10.51791	25.46399	92.33376	2.99336	-0.01181	9.7954	0.53757	-1.82242	-0.01602	0.00043
522	QD	3229.8068	10.50858	10.52077	25.39627	92.52246	3.06276	-0.01072	9.7954	-0.49638	1.71244	0.09914	0.00087
523	OC	3230.0608	10.51017	10.52121	25.65159	91.65528	3.08794	-0.01050	9.7954	-0.50884	1.70164	0.09914	0.00087
524	QDC	3230.8228	10.51482	10.52255	26.43858	89.14504	3.16248	-0.00984	9.7954	-0.52372	1.59335	0.09648	0.00086
525	HCN	3257.8713	10.60835	10.60713	90.03197	31.94548	6.20265	0.01332	9.9458	-1.82739	0.52059	0.12895	0.00086
526	QF	3259.5502	10.61128	10.61554	90.38514	32.33111	6.21882	0.01521	9.9458	1.62155	-0.75517	-0.10979	0.00140
527	OC	3259.8042	10.61173	10.61678	89.56398	32.71787	6.19093	0.01556	9.9458	1.61135	-0.76750	-0.10979	0.00140
528	QFC	3260.5662	10.61310	10.62043	87.18564	33.89516	6.10916	0.01662	9.9458	1.51048	-0.77718	-0.10483	0.00139
529	MS1	3274.0730	10.64486	10.66743	53.24879	63.52290	4.69325	0.03534	9.9458	1.00210	-1.41636	-0.10483	0.00139
530	B	3280.1944	10.66542	10.68090	42.39074	82.63164	4.07639	0.04383	9.9813	0.77170	-1.70516	-0.09671	0.00139
531	O	3280.4738	10.66648	10.68143	41.96245	83.58818	4.04937	0.04421	9.9813	0.76119	-1.71838	-0.09671	0.00139
532	B	3286.5952	10.69237	10.69177	34.05384	106.39172	3.48221	0.05269	10.0119	0.53079	-2.00672	-0.08859	0.00138
533	MS2	3287.6147	10.69721	10.69327	33.01070	110.53244	3.39189	0.05410	10.0119	0.49242	-2.05489	-0.08859	0.00138
534	QD	3289.2936	10.70532	10.69566	33.55869	110.32658	3.35100	0.05468	10.0119	-0.82576	2.17486	0.03962	-0.00071
535	OC	3289.5476	10.70652	10.69603	33.98141	109.22510	3.36106	0.05450	10.0119	-0.83849	2.16167	0.03962	-0.00071
536	QDC	3290.3096	10.71002	10.69716	35.26575	106.03035	3.39016	0.05398	10.0119	-0.84664	2.03181	0.03675	-0.00066
537	HCN	3317.3581	10.77930	10.77472	116.68206	31.45032	4.81477	0.03611	10.1429	-2.16340	0.72445	0.06922	-0.00066
538	QF	3319.0370	10.78157	10.78336	116.44277	31.11430	4.77603	0.03615	10.1429	2.30287	-0.52005	-0.11511	0.00071
539	OC	3319.2910	10.78192	10.78466	115.27640	31.38112	4.74679	0.03633	10.1429	2.28912	-0.53042	-0.11511	0.00071

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
540 QFC	3320.0530	10.78298	10.78847	111.88863	32.19357	4.66053	0.03687	10.1429	2.15768	-0.53558	-0.11132	0.00068
541 HCN	3347.1015	10.85745	10.87207	32.14604	90.34055	2.08014	0.05532	10.2489	0.79049	-1.61327	-0.07885	0.00068
542 QD	3348.7804	10.86593	10.87500	31.63022	89.96277	2.01346	0.05468	10.2489	-0.47672	1.83344	-0.00101	-0.00143
543 OC	3349.0344	10.86720	10.87546	31.87490	89.03451	2.01320	0.05432	10.2489	-0.48657	1.82113	-0.00101	-0.00143
544 QDC	3349.7964	10.87096	10.87684	32.61795	86.34386	2.01178	0.05324	10.2489	-0.48835	1.71067	-0.00272	-0.00139
545 HCN	3376.8449	10.95582	10.97140	86.81490	27.03082	2.36876	0.01570	10.3175	-1.51536	0.48137	0.02975	-0.00139
546 QF	3378.5238	10.95888	10.98135	86.33850	27.24819	2.34256	0.01385	10.3175	1.79302	-0.61360	-0.06080	-0.00083
547 OC	3378.7778	10.95935	10.98283	85.43079	27.56316	2.32711	0.01364	10.3175	1.78062	-0.62643	-0.06080	-0.00083
548 QFC	3379.5398	10.96079	10.98715	82.79688	28.52985	2.28149	0.01300	10.3175	1.67668	-0.64192	-0.05894	-0.00084
549 HCN	3406.5883	11.06035	11.07193	25.77142	99.39370	1.11780	-0.00966	10.3696	0.43161	-1.97689	-0.02647	-0.00084
550 QD	3408.2672	11.07077	11.07459	26.08186	99.64274	1.10895	-0.01074	10.3696	-0.62046	1.83175	0.01587	-0.00045
551 OC	3408.5212	11.07231	11.07500	26.40048	98.71503	1.11298	-0.01086	10.3696	-0.63395	1.82065	0.01587	-0.00045
552 QDC	3409.2832	11.07682	11.07624	27.37989	96.02863	1.12471	-0.01120	10.3696	-0.65109	1.70557	0.01492	-0.00046
553 HCN	3436.3317	11.16297	11.15535	100.64941	33.49335	1.95881	-0.02350	10.4173	-2.05776	0.60556	0.04739	-0.00045
554 QF	3438.0106	11.16560	11.16340	101.08687	33.68573	1.97499	-0.02503	10.4173	1.80280	-0.72258	-0.02822	-0.00138
555 OC	3438.2646	11.16600	11.16459	100.17376	34.05572	1.96782	-0.02538	10.4173	1.79212	-0.73406	-0.02822	-0.00138
556 QFC	3439.0266	11.16722	11.16809	97.52742	35.17928	1.94692	-0.02642	10.4173	1.68147	-0.74013	-0.02664	-0.00136
557 HCN	3466.0751	11.24350	11.24062	35.27689	107.32370	1.65698	-0.06308	10.4731	0.62000	-1.92601	0.00583	-0.00135
558 QD	3467.7540	11.25113	11.24309	35.53114	106.89567	1.72035	-0.06331	10.4731	-0.77466	2.17547	0.07005	0.00108
559 OC	3468.0080	11.25227	11.24347	35.92757	105.79400	1.73814	-0.06304	10.4731	-0.78610	2.16184	0.07005	0.00108
560 QDC	3468.7700	11.25559	11.24464	37.12790	102.59775	1.79095	-0.06224	10.4731	-0.78879	2.03362	0.06855	0.00102
561 HCN	3495.8185	11.32455	11.32695	111.76386	29.15978	4.07570	-0.03458	10.5664	-1.97058	0.68043	0.10102	0.00102
562 QF	3497.4974	11.32692	11.33627	111.19968	28.83262	4.11338	-0.03396	10.5664	2.29939	-0.48142	-0.05637	-0.00028
563 OC	3497.7514	11.32729	11.33766	110.03524	29.07994	4.09906	-0.03403	10.5664	2.28503	-0.49227	-0.05637	-0.00028
564 QFC	3498.5134	11.32841	11.34178	106.65189	29.83679	4.05736	-0.03423	10.5664	2.15598	-0.50077	-0.05308	-0.00025
565 HCN	3525.5619	11.40961	11.43053	28.76682	87.52989	3.05218	-0.04102	10.6789	0.72352	-1.63131	-0.02061	-0.00025
566 QD	3527.2408	11.41908	11.43355	28.27098	87.39209	3.11569	-0.04013	10.6789	-0.42190	1.71162	0.09667	0.00131
567 OC	3527.4948	11.42051	11.43402	28.48799	86.52549	3.14024	-0.03979	10.6789	-0.43248	1.70020	0.09667	0.00131
568 QDC	3528.2568	11.42471	11.43544	29.15251	84.01555	3.21288	-0.03881	10.6789	-0.43940	1.59440	0.09396	0.00128
569 HCN	3555.3053	11.51746	11.52851	82.86368	28.56679	6.18510	-0.00428	10.8298	-1.54636	0.45483	0.12644	0.00128
570 QF	3556.9842	11.52065	11.53790	82.74337	28.96830	6.19766	-0.00225	10.8298	1.61648	-0.69908	-0.11156	0.00115
571 OC	3557.2382	11.52115	11.53929	81.92501	29.32675	6.16933	-0.00196	10.8298	1.60539	-0.71213	-0.11156	0.00115
572 QFC	3558.0002	11.52265	11.54335	79.55311	30.42340	6.08621	-0.00108	10.8298	1.50799	-0.72676	-0.10662	0.00115
573 HCN	3585.0487	11.61961	11.62218	28.08576	106.40929	3.63307	0.03012	10.9842	0.39481	-2.08134	-0.07414	0.00115
574 QD	3586.7276	11.62913	11.62466	28.66287	106.55546	3.62448	0.03107	10.9842	-0.74587	1.99615	0.06386	-0.00002
575 OC	3586.9816	11.63053	11.62504	29.04527	105.54444	3.64070	0.03107	10.9842	-0.75966	1.98427	0.06386	-0.00002
576 QDC	3587.7436	11.63463	11.62621	30.21516	102.61479	3.68817	0.03106	10.9842	-0.77530	1.86125	0.06074	0.00000
577 HCN	3614.7921	11.71200	11.70226	110.92350	33.70352	5.76166	0.03114	11.1356	-2.20857	0.68552	0.09321	0.00000
578 QF	3616.4710	11.71438	11.71028	111.20316	33.63764	5.73254	0.03214	11.1356	2.04558	-0.64544	-0.12771	0.00121
579 OC	3616.7250	11.71474	11.71148	110.16701	33.96824	5.70010	0.03245	11.1356	2.03374	-0.65614	-0.12771	0.00121
580 QFC	3617.4870	11.71586	11.71500	107.16111	34.97136	5.60453	0.03336	11.1356	1.91183	-0.66003	-0.12315	0.00118
581 HCN	3644.5355	11.78809	11.79033	35.51901	100.63220	2.70422	0.06522	11.2670	0.73685	-1.76650	-0.09068	0.00118
582 QD	3646.2144	11.79571	11.79297	35.39183	100.10353	2.63760	0.06509	11.2670	-0.65949	2.07462	0.01090	-0.00133
583 OC	3646.4684	11.79685	11.79337	35.72946	99.05304	2.64037	0.06476	11.2670	-0.66979	2.06116	0.01090	-0.00133
584 QDC	3647.2304	11.80019	11.79462	36.75013	96.00555	2.64781	0.06376	11.2670	-0.66938	1.93904	0.00865	-0.00127

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
585 HCN	3674.2789	11.87310	11.88312	101.78853	27.33915	3.31231	0.02930	11.3613	-1.73516	0.59867	0.04112	-0.00128
586 QF	3675.9578	11.87571	11.89303	101.08216	27.17765	3.27486	0.02808	11.3613	2.14684	-0.50043	-0.08549	-0.00018
587 OC	3676.2118	11.87611	11.89451	99.99514	27.43484	3.25315	0.02803	11.3613	2.13275	-0.51212	-0.08549	-0.00018
588 QFC	3676.9738	11.87734	11.89887	96.83718	28.22484	3.18900	0.02789	11.3613	2.01241	-0.52442	-0.08289	-0.00021
589 HCN	3704.0223	11.96771	11.98925	26.12428	89.57748	1.37764	0.02228	11.4322	0.60192	-1.74290	-0.05042	-0.00021
590 QD	3705.7012	11.97810	11.99220	25.87882	89.67887	1.33653	0.02123	11.4322	-0.45260	1.68381	0.00119	-0.00104
591 OC	3705.9552	11.97966	11.99265	26.11174	88.82626	1.33683	0.02096	11.4322	-0.46443	1.67295	0.00119	-0.00104
592 QDC	3706.7172	11.98424	11.99404	26.82931	86.35808	1.33731	0.02017	11.4322	-0.47706	1.56683	0.00005	-0.00103

593 HCN	3733.7657	12.07937	12.08185	86.11119	30.82254	1.76940	-0.00759	11.4802	-1.71466	0.48561	0.03253	-0.00103
594 QF	3735.4446	12.08243	12.09055	86.34141	31.25794	1.76694	-0.00958	11.4802	1.58048	-0.75047	-0.03544	-0.00135
595 OC	3735.6986	12.08290	12.09184	85.54114	31.64240	1.75794	-0.00992	11.4802	1.57019	-0.76317	-0.03544	-0.00135
596 QFC	3736.4606	12.08434	12.09560	83.22329	32.81460	1.73147	-0.01095	11.4802	1.47223	-0.77482	-0.03404	-0.00134
597 HCN	3763.5091	12.17304	12.16979	31.42561	110.32746	1.24150	-0.04732	11.5256	0.44278	-2.08971	-0.00156	-0.00134
598 QD	3765.1880	12.18155	12.17219	32.04476	110.25031	1.27891	-0.04804	11.5256	-0.81941	2.13467	0.04636	0.00049
599 OC	3765.4420	12.18281	12.17256	32.46439	109.16915	1.29069	-0.04791	11.5256	-0.83266	2.12187	0.04636	0.00049
600 QDC	3766.2040	12.18647	12.17369	33.74203	106.03417	1.32559	-0.04755	11.5256	-0.84367	1.99317	0.04525	0.00045
601 HCN	3793.2525	12.25746	12.24992	116.49683	32.46889	2.98010	-0.03540	11.5934	-2.21586	0.72559	0.07772	0.00045
602 QF	3794.9314	12.25973	12.25828	116.44353	32.19145	3.01405	-0.03578	11.5934	2.24692	-0.55682	-0.03749	-0.00090
603 OC	3795.1854	12.26008	12.25953	115.30545	32.47694	3.00453	-0.03601	11.5934	2.23373	-0.56715	-0.03749	-0.00090
604 QFC	3795.9474	12.26115	12.26322	112.00088	33.34460	2.97689	-0.03669	11.5934	2.10386	-0.57128	-0.03508	-0.00087
605 HCN	3822.9959	12.33378	12.34379	33.63437	93.27771	2.45880	-0.06030	11.6789	0.79343	-1.64358	-0.00260	-0.00087
606 QD	3824.6748	12.34187	12.34663	33.19982	92.81232	2.53372	-0.05982	11.6789	-0.52909	1.91482	0.09233	0.00144
607 OC	3824.9288	12.34308	12.34707	33.47108	91.84283	2.55717	-0.05946	11.6789	-0.53888	1.90205	0.09233	0.00144
608 -TBC	3825.6908	12.34666	12.34841	34.29264	89.03168	2.62669	-0.05838	11.6789	-0.53905	1.78793	0.09012	0.00139
609 HCN	3852.7393	12.42711	12.44188	90.98636	26.75562	5.49496	-0.02085	11.8090	-1.55698	0.51362	0.12259	0.00139
610 QF	3854.4182	12.43003	12.45196	90.38078	26.84678	5.52316	-0.01917	11.8090	1.90992	-0.56907	-0.08917	0.00063
611 OC	3854.6722	12.43048	12.45346	89.41385	27.13905	5.50051	-0.01901	11.8090	1.89686	-0.58159	-0.08917	0.00063
612 TBB	3855.4342	12.43185	12.45785	86.60667	28.03699	5.43425	-0.01852	11.8090	1.78786	-0.59657	-0.08476	0.00064
613 HCN	3882.4827	12.52982	12.54532	25.33906	95.62049	3.57218	-0.00113	11.9520	0.47727	-1.90102	-0.05229	0.00064
614 QD	3884.1616	12.54046	12.54808	25.46819	95.85948	3.59871	-0.00003	11.9520	-0.55582	1.76173	0.08406	0.00067
615 OC	3884.4156	12.54204	12.54850	25.75386	94.96729	3.62006	0.00014	11.9520	-0.56887	1.75086	0.08406	0.00067
616 -TBA	3885.1776	12.54666	12.54980	26.68673	92.19634	3.68661	0.00065	11.9520	-0.65593	1.88390	0.09062	0.00066
617 HCN	3912.2261	12.63370	12.64225	101.37939	26.34094	6.56848	0.01862	12.1168	-2.10554	0.54993	0.12310	0.00066
618 QF	3913.9050	12.63630	12.65252	101.92902	26.28405	6.56325	0.02035	12.1168	1.78521	-0.51532	-0.12929	0.00141
619 OC	3914.1590	12.63670	12.65405	101.02478	26.54894	6.53041	0.02071	12.1168	1.77477	-0.52755	-0.12929	0.00141
620 TB9	3914.9210	12.63791	12.65856	98.88796	27.23287	6.44967	0.02172	12.1168	1.03458	-0.36836	-0.08270	0.00125
621 HCN	3941.9695	12.69592	12.75864	58.23825	77.61224	4.64343	0.05559	12.2936	0.46829	-1.49344	-0.05023	0.00125
622 QD	3943.6484	12.70047	12.76205	60.47703	77.65360	4.70803	0.05589	12.2936	-1.83015	1.46933	0.12759	-0.00089
623 OC	3943.9024	12.70113	12.76257	61.41139	76.90980	4.74044	0.05567	12.2936	-1.84842	1.45900	0.12759	-0.00089
624 -TB8	3944.6644	12.70306	12.76417	64.27013	74.70991	4.83766	0.05499	12.2936	-1.90322	1.42800	0.12759	-0.00089
625 HCN	3971.7129	12.73960	12.86660	219.84359	27.18390	8.71942	0.03085	12.5123	-3.84850	0.32843	0.16006	-0.00089
626 QF	3973.3918	12.74080	12.87641	218.60603	27.93327	8.70692	0.03033	12.5123	4.56976	-0.78428	-0.17487	0.00027
627 OC	3973.6458	12.74099	12.87785	216.29105	28.33541	8.66251	0.03040	12.5123	4.54433	-0.79896	-0.17487	0.00027
628 TB7	3974.4078	12.74156	12.88203	207.87126	29.80147	8.49760	0.03071	12.5123	6.47817	-1.12971	-0.25769	0.00056
629 OOC	3975.5321	12.74245	12.88778	193.56597	32.43824	8.20789	0.03135	12.5123	6.24578	-1.21558	-0.25769	0.00056

1

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
630 B	3981.6535	12.74872	12.91203	124.84607	50.17984	6.65532	0.03480	12.5726	4.98051	-1.68261	-0.24957	0.00056
631 O	3981.9329	12.74908	12.91290	122.07909	51.12605	6.58559	0.03496	12.5726	4.92276	-1.70395	-0.24957	0.00056
632 BH	3988.0543	12.75966	12.92868	69.55713	74.83891	5.09516	0.03841	12.6437	3.65751	-2.16953	-0.23740	0.00056
633 O	3988.3337	12.76031	12.92927	67.52945	76.05719	5.02883	0.03857	12.6437	3.59976	-2.19084	-0.23740	0.00056
634 BH	3994.4551	12.78160	12.94014	31.20438	105.72331	3.61294	0.04202	12.6962	2.33450	-2.65510	-0.22522	0.00056
635 O	3994.7345	12.78305	12.94056	29.91599	107.21292	3.55001	0.04217	12.6962	2.27675	-2.67637	-0.22522	0.00056
636 BH	4000.8559	12.84128	12.94844	9.78781	142.81389	2.20866	0.04561	12.7312	1.01150	-3.13902	-0.21304	0.00056
637 OOO	4001.4563	12.85167	12.94910	8.64775	146.61050	2.08075	0.04595	12.7312	0.88740	-3.18465	-0.21304	0.00056
638 -QB6	4003.1352	12.88745	12.95089	6.70112	147.85049	1.78637	0.04541	12.7312	0.29674	2.46196	-0.13951	-0.00119
639 OC	4003.3892	12.89355	12.95117	6.56085	146.60289	1.75093	0.04511	12.7312	0.25550	2.44983	-0.13951	-0.00119
640 -TB6	4004.1512	12.91238	12.95201	6.38991	140.10817	1.66136	0.04376	12.7312	-0.02971	6.01801	-0.09597	-0.00233
641 OOC	4005.2755	12.93996	12.95335	6.65471	126.91207	1.55346	0.04114	12.7312	-0.20581	5.71937	-0.09597	-0.00233
642 GP9	4010.4870	13.03439	12.96189	13.05413	74.51312	1.05333	0.02899	12.7312	-1.02212	4.33505	-0.09597	-0.00233
643 B	4016.6084	13.08325	12.98208	31.43683	31.39024	0.49072	0.01471	12.7374	-1.98093	2.70933	-0.08785	-0.00233
644 O	4016.8878	13.08464	12.98354	32.55600	29.89701	0.46618	0.01406	12.7374	-2.02470	2.63509	-0.08785	-0.00233
645 BH	4023.0092	13.10618	13.05014	63.21243	7.59035	-0.03430	-0.00022	12.7400	-2.98350	1.00868	-0.07567	-0.00233
646 O	4023.2886	13.10688	13.05622	64.89183	7.04744	-0.05545	-0.00088	12.7400	-3.02726	0.93442	-0.07567	-0.00233

647	BH	4029.4100	13.11853	13.27224	107.82215	5.56689	-0.48139	-0.01516	12.7366	-3.98606	-0.69257	-0.06350	-0.00233
648	GP10	4030.5993	13.12021	13.30153	117.52469	7.59014	-0.55690	-0.01793	12.7366	-4.17234	-1.00868	-0.06350	-0.00233
649	GAP6	4030.9203	13.12064	13.30798	120.21933	8.26506	-0.57728	-0.01868	12.7366	-4.22262	-1.09399	-0.06350	-0.00233
650	QB5	4032.2937	13.12236	13.33042	136.42554	11.42720	-0.67462	-0.02155	12.7366	-7.70837	-1.18283	-0.07864	-0.00184
651	GAP2	4032.6145	13.12273	13.33474	141.41733	12.20779	-0.69985	-0.02215	12.7366	-7.85046	-1.25019	-0.07864	-0.00184
652	BV	4037.0545	13.12674	13.37374	219.84628	27.44805	-1.04897	-0.01072	12.7365	-9.81303	-2.18234	-0.07862	0.00699
653	O	4037.3339	13.12694	13.37532	225.36435	28.68393	-1.07094	-0.00877	12.7365	-9.93668	-2.24100	-0.07862	0.00699
654	BH	4043.4553	13.13034	13.39814	363.59677	63.98077	-1.51493	0.03401	12.7206	-12.64571	-3.52471	-0.06645	0.00699
655	GP11	4059.2938	13.13481	13.41906	875.19461	228.26455	-2.56733	0.14470	12.7206	-19.65522	-6.84773	-0.06645	0.00699
656	QB4	4060.6672	13.13505	13.41998	930.01744	247.46933	-2.65858	0.15430	12.7206	-20.26302	-7.13587	-0.06645	0.00699
657	GAP2	4060.9880	13.13511	13.42018	943.06509	252.06977	-2.67990	0.15654	12.7206	-20.40501	-7.20319	-0.06645	0.00699
658	GP20	4060.9880	13.13511	13.42018	943.06509	252.06977	-2.67990	0.15654	12.7206	-20.40501	-7.20319	-0.06645	0.00699
659	-BV	4065.4280	13.13579	13.42267	1132.90542	320.16917	-2.97481	0.16796	12.7192	-22.35015	-8.13472	-0.06640	-0.00184
660	O	4065.7074	13.13583	13.42281	1145.42917	324.73123	-2.99336	0.16745	12.7192	-22.47360	-8.19334	-0.06640	-0.00184
661	GP21	4072.6410	13.13668	13.42570	1478.31400	448.43589	-3.45372	0.15466	12.7192	-25.53692	-9.64805	-0.06640	-0.00184
662	QB3	4075.9938	13.13708	13.42667	1010.52526	785.14448	-2.87631	0.18591	12.7192	142.40216	-106.09104	0.39719	0.02121
663	OB3	4076.8701	13.13724	13.42683	776.36160	982.08874	-2.52825	0.20450	12.7192	124.81644	-118.65420	0.39719	0.02121
664	QB2	4082.7629	13.13970	13.42764	294.39919	829.23757	-1.62543	0.17189	12.7192	-7.25218	130.83289	-0.05503	-0.03093
665	OB3	4083.6392	13.14017	13.42783	307.24916	615.79192	-1.67365	0.14479	12.7192	-7.41171	112.74312	-0.05503	-0.03093
666	QB1	4086.9920	13.14206	13.42944	220.96304	208.58841	-1.46458	0.06827	12.7192	28.96812	27.22765	0.17480	-0.01650
667	LB0	4094.6151	13.38926	13.65813	0.26308	0.28366	-0.13205	-0.05754	12.7192	-0.01693	0.09754	0.17480	-0.01650
668	.D0	4094.6151	13.38926	13.65813	0.26308	0.28366	-0.13205	-0.05754	12.7192	-0.01693	0.09754	0.17480	-0.01650
669	LB0	4102.2383	13.63108	13.91772	221.47941	205.61404	1.20048	-0.18334	12.7192	-29.00199	-27.03257	0.17480	-0.01650
670	-QB1	4105.5911	13.63259	13.91975	654.98222	286.47269	2.12812	-0.19286	12.7192	-120.00881	6.83207	0.40013	0.01105
671	OB3	4106.4674	13.63278	13.92024	882.19589	274.62661	2.47875	-0.18318	12.7192	-139.27872	6.68623	0.40013	0.01105
672	-QB2	4112.3602	13.63354	13.92288	1045.70696	726.14307	2.73895	-0.24904	12.7192	126.25070	-116.82385	-0.32262	-0.03601
673	OB3	4113.2365	13.63369	13.92305	836.14551	945.32227	2.45624	-0.28059	12.7192	112.89281	-133.29506	-0.32262	-0.03601
674	-QB3	4116.5893	13.63460	13.92348	478.05395	1383.53713	1.88986	-0.32844	12.7192	10.19637	23.81812	-0.02841	0.00860

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
675	GP21	4123.5229	13.63731	13.92439	347.21487	1072.99454	1.69286	-0.26884	12.7192	8.67397	20.97008	-0.02841	0.00860
676	O	4123.8023	13.63743	13.92443	342.38500	1061.30853	1.68492	-0.26644	12.7192	8.61262	20.85531	-0.02841	0.00860
677	-BV	4128.2423	13.63976	13.92516	270.20967	884.21315	1.55870	-0.24789	12.7214	7.64245	19.03156	-0.02844	-0.00024
678	GP20	4128.2423	13.63976	13.92516	270.20967	884.21315	1.55870	-0.24789	12.7214	7.64245	19.03156	-0.02844	-0.00024
679	GAP2	4128.5631	13.63995	13.92522	265.32841	872.04353	1.54958	-0.24796	12.7214	7.57191	18.89977	-0.02844	-0.00024
680	-QB4	4129.9365	13.64081	13.92547	244.94491	820.90523	1.51052	-0.24829	12.7214	7.26996	18.33564	-0.02844	-0.00024
681	GP11	4145.7750	13.66013	13.93022	69.80675	343.13009	1.06005	-0.25204	12.7214	3.78779	11.82981	-0.02844	-0.00024
682	BH	4151.8964	13.68091	13.93382	31.67262	213.65180	0.92322	-0.25347	12.7334	2.44200	9.32037	-0.01626	-0.00023
683	O	4152.1758	13.68234	13.93403	30.32519	208.47568	0.91868	-0.25354	12.7334	2.38058	9.20546	-0.01626	-0.00023
684	BV	4156.6158	13.71753	13.93825	13.51826	134.83975	0.84643	-0.23495	12.7312	1.40462	7.37943	-0.01628	0.00860
685	GAP2	4156.9366	13.72144	13.93863	12.63960	130.14695	0.84121	-0.23219	12.7312	1.33406	7.24748	-0.01628	0.00860
686	-QB5	4158.3100	13.74182	13.94043	9.04990	114.96326	0.80500	-0.22419	12.7312	1.25062	3.93075	-0.03630	0.00308
687	GAP5	4160.1711	13.78480	13.94318	5.37625	100.82818	0.73744	-0.21846	12.7312	0.72334	3.66444	-0.03630	0.00308
688	BH	4166.2925	14.01033	13.95559	7.13683	61.31561	0.55250	-0.19958	12.7390	-1.01096	2.78991	-0.02412	0.00309
689	O	4166.5719	14.01633	13.95632	7.72387	59.76779	0.54576	-0.19872	12.7390	-1.09012	2.74989	-0.02412	0.00309
690	BH	4172.6933	14.08031	13.97886	31.68565	31.46302	0.43535	-0.17981	12.7449	-2.82441	1.87368	-0.01195	0.00309
691	O	4172.9727	14.08168	13.98030	33.28605	30.42720	0.43202	-0.17895	12.7449	-2.90357	1.83362	-0.01195	0.00309
692	BH	4179.0941	14.10067	14.02942	79.44903	13.34776	0.39615	-0.16001	12.7499	-4.63786	0.95629	0.00023	0.00310
693	O	4179.3735	14.10122	14.03282	82.06279	12.82458	0.39621	-0.15915	12.7499	-4.71702	0.91622	0.00023	0.00310
694	BH	4185.4949	14.10999	14.14480	150.42699	6.98107	0.43489	-0.14019	12.7549	-6.45132	0.03832	0.01241	0.00310
695	OOO	4186.0953	14.11061	14.15849	158.27560	6.98677	0.44234	-0.13833	12.7549	-6.62142	-0.04781	0.01241	0.00310
696	QB6	4187.7742	14.11222	14.19488	170.40740	8.02554	0.44882	-0.13753	12.7549	-0.44917	-0.58408	-0.00472	-0.00215
697	GAP7	4188.0283	14.11246	14.19982	170.63617	8.33323	0.44762	-0.13808	12.7549	-0.45096	-0.62655	-0.00472	-0.00215
698	TB6	4188.7903	14.11317	14.21348	168.23042	9.55004	0.43996	-0.14098	12.7549	3.58892	-0.97999	-0.01534	-0.00548
699	OOC	4189.9146	14.11426	14.23021	160.26480	12.01309	0.42271	-0.14714	12.7549	3.49616	-1.21078	-0.01534	-0.00548
700	BH	4196.0360	14.12127	14.27880	120.55460	34.52556	0.36605	-0.18065	12.7596	2.99111	-2.46661	-0.00317	-0.00547

701 O	4196.3154	14.12164	14.28007	118.88961	35.91992	0.36517	-0.18218	12.7596	2.96806	-2.52394	-0.00317	-0.00547
702 B	4202.4368	14.13131	14.29894	85.64433	74.50530	0.37063	-0.21567	12.7625	2.46300	-3.77921	0.00495	-0.00547
703 O	4202.7162	14.13183	14.29953	84.27444	76.63314	0.37201	-0.21720	12.7625	2.43994	-3.83652	0.00495	-0.00547
704 B	4208.8376	14.14584	14.30925	57.49466	131.28239	0.42716	-0.25068	12.7658	1.93488	-5.09076	0.01307	-0.00547
705 O	4209.1170	14.14662	14.30959	56.41989	134.14312	0.43081	-0.25221	12.7658	1.91183	-5.14804	0.01307	-0.00547
706 B	4215.2384	14.16828	14.31546	36.10562	204.84119	0.53565	-0.28567	12.7696	1.40677	-6.40091	0.02119	-0.00546
707 OOO	4215.8388	14.17099	14.31592	34.44616	212.60099	0.54837	-0.28895	12.7696	1.35724	-6.52392	0.02119	-0.00546
708 QD	4217.5177	14.17910	14.31714	32.18766	220.78960	0.60201	-0.28880	12.7696	0.01662	1.75149	0.04306	0.00564
709 OC	4217.7717	14.18036	14.31733	32.18122	219.90103	0.61295	-0.28737	12.7696	0.00873	1.74681	0.04306	0.00564
710 -TB7	4218.5337	14.18412	14.31788	32.42798	215.61719	0.64811	-0.28200	12.7696	-0.33337	3.86097	0.04926	0.00844
711 HCN	4245.5822	14.27614	14.35589	75.53058	60.61831	2.41127	-0.05349	12.8172	-1.26017	1.86734	0.08174	0.00845
712 QF	4247.2611	14.27966	14.36043	74.93226	58.26455	2.47006	-0.04087	12.8172	1.60888	-0.43554	-0.01208	0.00666
713 OC	4247.5151	14.28020	14.36113	74.11804	58.48712	2.46699	-0.03918	12.8172	1.59672	-0.44072	-0.01208	0.00666
714 TB8	4248.2771	14.28186	14.36319	71.71245	59.17064	2.45779	-0.03411	12.8172	1.56023	-0.45628	-0.01208	0.00666
715 HCN	4275.3256	14.39994	14.42076	22.34636	98.70054	2.56164	0.14593	12.8961	0.26489	-1.00453	0.02039	0.00665
716 QD	4277.0045	14.41185	14.42347	23.02165	95.78593	2.67890	0.15233	12.8961	-0.67568	2.70321	0.12004	0.00092
717 OC	4277.2585	14.41360	14.42390	23.36898	94.41829	2.70939	0.15256	12.8961	-0.69175	2.68118	0.12004	0.00092
718 -TB9	4278.0205	14.41868	14.42521	24.31276	90.94527	2.79248	0.15373	12.8961	-0.54428	1.88589	0.09792	0.00215
719 HCN	4305.0690	14.51512	14.52002	92.76207	25.54033	5.87174	0.21184	13.0351	-1.98636	0.53129	0.13039	0.00214

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
720 QF	4306.7479	14.51796	14.53062	93.46908	25.49845	5.90087	0.22231	13.0351	1.57430	-0.50581	-0.09587	0.01040
721 OC	4307.0019	14.51840	14.53219	92.67174	25.75857	5.87652	0.22496	13.0351	1.56485	-0.51832	-0.09587	0.01040
722 TBA	4307.7639	14.51972	14.53683	90.15352	26.62188	5.79848	0.23307	13.0351	1.73803	-0.61527	-0.10892	0.01091
723 MS1	4321.2707	14.55153	14.59555	51.33955	52.68960	4.32736	0.38045	13.0351	1.13564	-1.31470	-0.10892	0.01091
724 B	4327.3921	14.57334	14.61153	39.10744	70.72157	3.68548	0.44723	13.0676	0.86264	-1.63093	-0.10080	0.01091
725 O	4327.6715	14.57449	14.61216	38.62888	71.63698	3.65732	0.45027	13.0676	0.85018	-1.64539	-0.10080	0.01091
726 B	4333.7929	14.60332	14.62406	29.89161	93.71499	3.06514	0.51702	13.0949	0.57717	-1.96118	-0.09268	0.01090
727 MS2	4334.8124	14.60885	14.62575	28.76113	97.76751	2.97065	0.52814	13.0949	0.53170	-2.01390	-0.09268	0.01090
728 QD	4336.4913	14.61822	14.62845	28.91284	98.24419	2.90923	0.52938	13.0949	-0.62399	1.73609	0.01913	-0.00942
729 OC	4336.7453	14.61961	14.62887	29.23293	97.36489	2.91409	0.52699	13.0949	-0.63620	1.72571	0.01913	-0.00942
730 -TBB	4337.5073	14.62369	14.63013	30.21101	94.82070	2.92771	0.51998	13.0949	-0.64709	1.61384	0.01664	-0.00898
731 HCN	4364.5558	14.70577	14.70757	99.57244	35.27618	3.80836	0.27689	13.2019	-1.91728	0.58676	0.04911	-0.00900
732 QF	4366.2347	14.70843	14.71519	99.61185	35.64355	3.76835	0.27056	13.2019	1.89431	-0.81024	-0.09651	0.00141
733 OC	4366.4887	14.70883	14.71631	98.65252	36.05814	3.74383	0.27092	13.2019	1.88261	-0.82204	-0.09651	0.00141
734 TBC	4367.2507	14.71008	14.71962	95.86962	37.31525	3.67143	0.27192	13.2019	1.77023	-0.82736	-0.09352	0.00120
735 HCN	4394.2992	14.79177	14.78735	31.65201	115.01111	1.57241	0.30411	13.2837	0.60396	-2.04393	-0.06105	0.00118
736 QD	4395.9781	14.80029	14.78965	31.73588	114.48246	1.51955	0.29636	13.2837	-0.65498	2.35204	-0.00226	-0.01036
737 OC	4396.2321	14.80156	14.79000	32.07152	113.29130	1.51897	0.29373	13.2837	-0.66642	2.33754	-0.00226	-0.01036
738 QDC	4396.9941	14.80528	14.79109	33.09203	109.83403	1.51676	0.28593	13.2837	-0.67255	2.20054	-0.00355	-0.01011
739 HCN	4424.0426	14.88253	14.86965	101.58250	29.65893	1.85133	0.01235	13.3358	-1.85962	0.76249	0.02892	-0.01012
740 QF	4425.7215	14.88514	14.87885	101.30170	29.08608	1.84027	-0.00441	13.3358	2.02327	-0.41403	-0.04203	-0.00997
741 OC	4425.9755	14.88554	14.88024	100.27713	29.29901	1.82959	-0.00695	13.3358	2.01050	-0.42426	-0.04203	-0.00997
742 QFC	4426.7375	14.88676	14.88433	97.30270	29.95069	1.79812	-0.01454	13.3358	1.89375	-0.43080	-0.04057	-0.00996
743 HCN	4453.7860	14.97124	14.97610	29.34131	82.15293	1.13144	-0.28380	13.3806	0.61885	-1.49836	-0.00810	-0.00995
744 QD	4455.4649	14.98047	14.97933	29.23306	81.91899	1.15420	-0.29127	13.3806	-0.55300	1.63471	0.03536	0.00110
745 OC	4455.7189	14.98185	14.97982	29.51686	81.09145	1.16319	-0.29099	13.3806	-0.56435	1.62332	0.03536	0.00110
746 QDC	4456.4809	14.98590	14.98134	30.38333	78.69512	1.18975	-0.29024	13.3806	-0.57251	1.52215	0.03436	0.00085
747 HCN	4483.5294	15.07069	15.08081	93.32521	27.14975	2.54982	-0.26696	13.4391	-1.75452	0.38282	0.06683	0.00087
748 QF	4485.2083	15.07353	15.09066	93.22471	27.71059	2.57943	-0.27411	13.4391	1.81309	-0.72398	-0.03175	-0.00942
749 OC	4485.4623	15.07396	15.09211	92.30663	28.08192	2.57137	-0.27650	13.4391	1.80141	-0.73795	-0.03175	-0.00942
750 QFC	4486.2243	15.07530	15.09634	89.64359	29.22078	2.54796	-0.28360	13.4391	1.69411	-0.75630	-0.02969	-0.00920
751 HCN	4513.2728	15.16331	15.17571	29.58259	109.41356	2.17566	-0.53213	13.5130	0.52641	-2.20727	0.00279	-0.00918
752 QD	4514.9517	15.17241	15.17812	29.80261	109.78578	2.25059	-0.53039	13.5130	-0.66025	1.99034	0.08695	0.01124
753 OC	4515.2057	15.17376	15.17849	30.14112	108.77760	2.27268	-0.52753	13.5130	-0.67249	1.97886	0.08695	0.01124
754 QDC	4515.9677	15.17772	15.17962	31.17396	105.85738	2.33819	-0.51913	13.5130	-0.68265	1.85428	0.08499	0.01080

755	HCN	4543.0162	15.25712	15.25161	102.50793	36.16551	5.06760	-0.22685	13.6315	-1.95464	0.72133	0.11746	0.01081
756	QF	4544.6951	15.25970	15.25909	102.48324	36.13107	5.10092	-0.21582	13.6315	1.96903	-0.70038	-0.07798	0.00240
757	OC	4544.9491	15.26010	15.26020	101.48605	36.48952	5.08111	-0.21522	13.6315	1.95694	-0.71086	-0.07798	0.00240
758	QFC	4545.7111	15.26131	15.26348	98.59246	37.57395	5.02325	-0.21332	13.6315	1.84120	-0.71199	-0.07390	0.00257
759	HCN	4572.7596	15.34187	15.33419	31.56624	105.34903	3.45494	-0.14375	13.7660	0.63683	-1.79267	-0.04143	0.00258
760	QD	4574.4385	15.35044	15.33671	31.53341	104.60553	3.49612	-0.13488	13.7660	-0.61686	2.22599	0.09074	0.00793
761	OC	4574.6925	15.35171	15.33710	31.84959	103.47840	3.51916	-0.13287	13.7660	-0.62798	2.21153	0.09074	0.00793
762	QDC	4575.4545	15.35546	15.33829	32.81096	100.20681	3.58716	-0.12687	13.7660	-0.63339	2.08283	0.08772	0.00782
763	HCN	4602.5030	15.43446	15.42628	98.31802	26.46344	6.39039	0.08469	13.9262	-1.78847	0.64251	0.12019	0.00782
764	QF	4604.1819	15.43716	15.43657	98.01027	26.10158	6.38602	0.10070	13.9262	1.96783	-0.42239	-0.12537	0.01135

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
765	OC	4604.4359	15.43757	15.43811	97.01382	26.31907	6.35418	0.10358	13.9262	1.95521	-0.43386	-0.12537	0.01135
766	QFC	4605.1979	15.43884	15.44266	94.12135	26.99004	6.26059	0.11220	13.9262	1.84146	-0.44650	-0.12029	0.01126
767	HCN	4632.2464	15.52606	15.53906	28.63612	83.59354	3.43773	0.41663	14.0801	0.57960	-1.64531	-0.08781	0.01125
768	QD	4633.9253	15.53550	15.54222	28.61775	83.75504	3.39965	0.42201	14.0801	-0.56843	1.55118	0.04220	-0.00487
769	OC	4634.1793	15.53690	15.54271	28.90949	82.96966	3.41036	0.42077	14.0801	-0.58017	1.54085	0.04220	-0.00487
770	QDC	4634.9413	15.54104	15.54419	29.80137	80.69787	3.44141	0.41720	14.0801	-0.59002	1.44115	0.03928	-0.00451
771	HCN	4661.9898	15.62600	15.63579	94.81473	30.58849	4.93457	0.29490	14.2140	-1.81359	0.41075	0.07175	-0.00453
772	QF	4663.6687	15.62879	15.64453	94.81486	31.26538	4.89622	0.29673	14.2140	1.81352	-0.82251	-0.11719	0.00672
773	OC	4663.9227	15.62922	15.64581	93.89652	31.68667	4.86645	0.29844	14.2140	1.80203	-0.83613	-0.11719	0.00672
774	QFC	4664.6847	15.63053	15.64957	91.23308	32.97207	4.77864	0.30347	14.2140	1.69402	-0.85040	-0.11330	0.00648
775	HCN	4691.7332	15.71602	15.72122	30.62425	117.12444	2.14464	0.47850	14.3229	0.54676	-2.25950	-0.08083	0.00646
776	QD	4693.4121	15.72481	15.72348	30.83913	117.17589	2.07667	0.47396	14.3229	-0.67747	2.22951	-0.00056	-0.01184
777	OC	4693.6661	15.72612	15.72383	31.18633	116.04659	2.07653	0.47095	14.3229	-0.68948	2.21657	-0.00056	-0.01184
778	QDC	4694.4281	15.72994	15.72489	32.24388	112.77201	2.07543	0.46208	14.3229	-0.69807	2.08171	-0.00233	-0.01145
779	HCN	4721.4766	15.80739	15.79603	103.75336	34.70346	2.44303	0.15225	14.3937	-1.94571	0.80347	0.03014	-0.01146
780	QF	4723.1555	15.80994	15.80386	103.61922	34.30084	2.41510	0.13772	14.3937	2.02389	-0.55856	-0.06323	-0.00595
781	OC	4723.4095	15.81033	15.80504	102.59426	34.58706	2.39904	0.13621	14.3937	2.01140	-0.56828	-0.06323	-0.00595
782	QFC	4724.1715	15.81153	15.80850	99.61925	35.45372	2.35159	0.13163	14.3937	1.89362	-0.56884	-0.06132	-0.00605
783	HCN	4751.2200	15.89264	15.88634	30.85945	93.46455	1.12374	-0.03217	14.4471	0.64850	-1.57498	-0.02884	-0.00606
784	QD	4752.8989	15.90141	15.88918	30.74370	92.76006	1.11105	-0.04120	14.4471	-0.57809	1.98557	0.01365	-0.00465
785	OC	4753.1529	15.90272	15.88961	31.04017	91.75483	1.11452	-0.04238	14.4471	-0.58911	1.97203	0.01365	-0.00465
786	QDC	4753.9149	15.90657	15.89096	31.94265	88.83866	1.12456	-0.04593	14.4471	-0.59498	1.85579	0.01270	-0.00468
787	HCN	4780.9634	15.98819	15.98822	95.14032	25.00496	1.89863	-0.17257	14.4938	-1.74151	0.50332	0.04517	-0.00468
788	QF	4782.6423	15.99097	15.99902	94.88030	25.02571	1.91304	-0.18608	14.4938	1.89305	-0.51594	-0.02809	-0.01150
789	OC	4782.8963	15.99140	16.00063	93.92175	25.29107	1.90590	-0.18900	14.4938	1.88078	-0.52879	-0.02809	-0.01150
790	QFC	4783.6583	15.99271	16.00535	91.14005	26.11046	1.88508	-0.19771	14.4938	1.77050	-0.54630	-0.02656	-0.01134
791	HCN	4810.7068	16.08166	16.09838	28.55251	91.97940	1.59725	-0.50434	14.5476	0.54343	-1.88793	0.00591	-0.01133
792	QD	4812.3857	16.09111	16.10125	28.65168	92.40884	1.65882	-0.50706	14.5476	-0.60375	1.63764	0.06782	0.00811
793	OC	4812.6397	16.09251	16.10169	28.96145	91.57948	1.67605	-0.50500	14.5476	-0.61585	1.62752	0.06782	0.00811
794	QDC	4813.4017	16.09663	16.10303	29.90846	89.18065	1.72718	-0.49898	14.5476	-0.62667	1.52123	0.06637	0.00768
795	HCN	4840.4502	16.17995	16.18471	97.87669	34.02597	3.95312	-0.29091	14.6379	-1.88619	0.51714	0.09885	0.00770
796	QF	4842.1291	16.18265	16.19259	97.92157	34.55280	3.99111	-0.28723	14.6379	1.86003	-0.83761	-0.05384	-0.00329
797	OC	4842.3831	16.18307	16.19375	96.97961	34.98148	3.97743	-0.28806	14.6379	1.84846	-0.85012	-0.05384	-0.00329
798	QFC	4843.1451	16.18434	16.19715	94.24745	36.28364	3.93762	-0.29049	14.6379	1.73779	-0.85839	-0.05065	-0.00306
799	HCN	4870.1936	16.26709	16.26507	31.44438	117.65083	2.99829	-0.37306	14.7476	0.58411	-2.14858	-0.01818	-0.00305
800	QD	4871.8725	16.27567	16.26732	31.58285	117.30038	3.06419	-0.36621	14.7476	-0.66834	2.35282	0.09710	0.01116
801	OC	4872.1265	16.27694	16.26767	31.92532	116.10874	3.08885	-0.36337	14.7476	-0.67998	2.33867	0.09710	0.01116
802	QDC	4872.8885	16.28068	16.26873	32.96703	112.65079	3.16183	-0.35498	14.7476	-0.68680	2.20029	0.09444	0.01086
803	HCN	4899.9370	16.35759	16.34372	102.78057	31.50611	6.14688	-0.06116	14.8970	-1.89428	0.79858	0.12691	0.01087
804	QF	4901.6159	16.36017	16.35237	102.53804	30.92412	6.16145	-0.04470	14.8970	2.03563	-0.44455	-0.10965	0.00885
805	OC	4901.8699	16.36056	16.35368	101.50718	31.15245	6.13360	-0.04245	14.8970	2.02288	-0.45439	-0.10965	0.00885
806	QFC	4902.6319	16.36178	16.35753	98.51456	31.84800	6.05192	-0.03569	14.8970	1.90525	-0.45822	-0.10474	0.00888
807	HCN	4929.6804	16.44491	16.44488	29.83139	84.36573	3.64954	0.20460	15.0511	0.63404	-1.48259	-0.07227	0.00888
808	QD	4931.3593	16.45399	16.44802	29.70166	83.93766	3.64466	0.21282	15.0511	-0.55513	1.73208	0.06643	0.00086
809	OC	4931.6133	16.45535	16.44851	29.98651	83.06083	3.66154	0.21304	15.0511	-0.56632	1.71998	0.06643	0.00086

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
810	QDC	4932.3753	16.45933	16.44999	30.85531	80.52005	3.71097	0.21376	15.0511	-0.57360	1.61510	0.06329	0.00104
811	HCN	4959.4238	16.54338	16.55086	93.39697	25.89808	5.85355	0.24177	15.2044	-1.73863	0.40357	0.09576	0.00103
812	QF	4961.1027	16.54621	16.56121	93.23914	26.31184	5.82575	0.25131	15.2044	1.83062	-0.65526	-0.12871	0.01041
813	OC	4961.3567	16.54665	16.56274	92.31219	26.64821	5.79305	0.25396	15.2044	1.81877	-0.66905	-0.12871	0.01041
814	QFC	4962.1187	16.54798	16.56721	89.62308	27.68260	5.69675	0.26181	15.2044	1.71097	-0.68813	-0.12408	0.01020
815	HCN	4989.1672	16.63677	16.65138	29.12593	103.77675	2.77133	0.53745	15.3384	0.52568	-2.12397	-0.09161	0.01018
816	QD	4990.8461	16.64602	16.65392	29.32044	104.23371	2.70530	0.53721	15.3384	-0.64400	1.85766	0.01253	-0.01047
817	OC	4991.1001	16.64739	16.65431	29.65071	103.29277	2.70848	0.53454	15.3384	-0.65626	1.84681	0.01253	-0.01047
818	QDC	4991.8621	16.65141	16.65550	30.65918	100.56887	2.71716	0.52674	15.3384	-0.66691	1.72864	0.01022	-0.01002
819	HCN	5018.9106	16.73210	16.72967	101.21258	36.01364	3.42430	0.25542	15.4357	-1.94152	0.65714	0.04269	-0.01004
820	QF	5020.5895	16.73472	16.73716	101.22735	36.18755	3.38590	0.24662	15.4357	1.93291	-0.76293	-0.08820	-0.00049
821	OC	5020.8435	16.73512	16.73827	100.24845	36.57794	3.36350	0.24650	15.4357	1.92102	-0.77404	-0.08820	-0.00049
822	QFC	5021.6055	16.73634	16.74153	97.40839	37.76000	3.29732	0.24605	15.4357	1.80685	-0.77690	-0.08551	-0.00069
823	HCN	5048.6540	16.81726	16.81019	31.69517	110.77091	1.41505	0.22723	15.5089	0.62263	-1.92125	-0.05304	-0.00070
824	QD	5050.3329	16.82578	16.81259	31.71837	110.10677	1.37070	0.21881	15.5089	-0.63675	2.30832	-0.00007	-0.00927
825	OC	5050.5869	16.82705	16.81295	32.04470	108.93786	1.37068	0.21645	15.5089	-0.64800	2.29372	-0.00007	-0.00927
826	QDC	5051.3489	16.83078	16.81409	33.03676	105.54482	1.37019	0.20946	15.5089	-0.65363	2.16005	-0.00124	-0.00909
827	HCNS	5078.1180	16.90831	16.89550	98.98726	28.32104	1.75869	-0.03400	15.5574	-1.81008	0.72373	0.03124	-0.00910
828	OS2	5078.3974	16.90876	16.89708	100.00210	27.92082	1.76742	-0.03655	15.5574	-1.82215	0.70870	0.03124	-0.00910
829	QFS	5079.2120	16.91004	16.90180	101.46590	27.21446	1.77946	-0.04425	15.5574	0.03426	0.16278	-0.00170	-0.00984
830	D1	5087.2475	16.92265	16.94967	101.55244	27.03393	1.76577	-0.12335	15.5574	-0.04503	-0.14031	-0.00170	-0.00984
831	B	5093.3689	16.93221	16.98405	102.47343	30.16328	1.78019	-0.18361	15.5717	-0.10543	-0.37089	0.00641	-0.00984
832	O	5093.6483	16.93264	16.98552	102.53312	30.37348	1.78199	-0.18636	15.5717	-0.10818	-0.38142	0.00641	-0.00984
833	B	5099.7697	16.94207	17.01497	104.22732	36.45419	1.84610	-0.24661	15.5864	-0.16858	-0.61190	0.01453	-0.00984
834	O	5100.0491	16.94250	17.01618	104.32229	36.79906	1.85016	-0.24936	15.5864	-0.17134	-0.62243	0.01453	-0.00984
835	B	5106.1705	16.95173	17.03999	106.78970	45.82945	1.96396	-0.30958	15.6019	-0.23174	-0.85274	0.02265	-0.00984
836	OOO	5106.7709	16.95263	17.04205	107.07152	46.86697	1.97756	-0.31549	15.6019	-0.23767	-0.87536	0.02265	-0.00984
837	Q1	5108.8720	16.95584	17.04870	97.63857	55.84063	1.92578	-0.35250	15.6019	4.57573	-3.53774	-0.07152	-0.02569
838	D2	5112.6911	16.96342	17.05746	65.96528	86.39287	1.65263	-0.45059	15.6019	3.71766	-4.46211	-0.07152	-0.02569
839	Q2	5115.2159	16.97014	17.06176	56.87356	96.33025	1.58906	-0.48158	15.6019	0.05589	0.71853	0.02056	0.00144
840	LS1	5141.9653	17.04176	17.11490	66.50394	69.15261	2.13900	-0.44302	15.6019	-0.41591	0.29748	0.02056	0.00144
841	.E0	5141.9653	17.04176	17.11490	66.50394	69.15261	2.13900	-0.44302	15.6019	-0.41591	0.29748	0.02056	0.00144
842	LS2	5168.4099	17.09409	17.17973	100.83556	64.42668	2.68266	-0.40490	15.6019	-0.88234	-0.11877	0.02056	0.00144
843	-Q2	5170.9347	17.09819	17.18566	91.03613	75.00542	2.54095	-0.43092	15.6019	4.57395	-4.27197	-0.13145	-0.02230
844	D2	5174.7538	17.10644	17.19231	59.61147	111.37887	2.03892	-0.51608	15.6019	3.65433	-5.25212	-0.13145	-0.02230
845	-Q1	5176.8549	17.11264	17.19513	50.50066	122.26823	1.86142	-0.53643	15.6019	0.82622	0.24428	-0.03892	0.00309
846	D3	5178.4897	17.11793	17.19726	47.88829	121.49271	1.79780	-0.53137	15.6019	0.77175	0.23011	-0.03892	0.00309
847	B	5184.6111	17.14035	17.20537	39.68847	118.99239	1.58443	-0.51242	15.6156	0.56779	0.17833	-0.03080	0.00310
848	O	5184.8905	17.14148	17.20574	39.37378	118.89341	1.57582	-0.51156	15.6156	0.55849	0.17591	-0.03080	0.00310
849	B	5191.0119	17.16832	17.21400	33.78493	117.05692	1.41214	-0.49257	15.6277	0.35453	0.12409	-0.02268	0.00310
850	O	5191.2913	17.16964	17.21438	33.58942	116.98826	1.40580	-0.49170	15.6277	0.34522	0.12167	-0.02268	0.00310
851	B	5197.4127	17.20021	17.22276	30.61153	115.81610	1.29181	-0.47269	15.6386	0.14126	0.06981	-0.01456	0.00311
852	O	5197.6921	17.20166	17.22314	30.53520	115.77777	1.28774	-0.47182	15.6386	0.13195	0.06739	-0.01456	0.00311
853	B	5203.8135	17.23398	17.23158	30.16828	115.27027	1.22344	-0.45277	15.6487	-0.07201	0.01552	-0.00645	0.00311
854	OS1	5204.1345	17.23567	17.23202	30.21794	115.26120	1.22137	-0.45177	15.6487	-0.08270	0.01273	-0.00645	0.00311

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
855	OS2	5204.4139	17.23714	17.23241	30.26675	115.25477	1.21957	-0.45090	15.6487	-0.09201	0.01031	-0.00645	0.00311
856	QDS	5205.2285	17.24139	17.23354	30.90007	113.51099	1.22354	-0.44497	15.6487	-0.68936	2.11955	0.01619	0.01143
857	OSB3	5205.8134	17.24437	17.23437	31.72290	111.04784	1.23300	-0.43828	15.6487	-0.71729	2.09125	0.01619	0.01143
858	HCBS	5233.2930	17.32246	17.30984	107.19405	32.60054	2.10844	-0.12389	15.7007	-2.02919	0.76250	0.04866	0.01145
859	QF	5234.9719	17.32493	17.31818	107.11666	32.20673	2.12195	-0.10846	15.7007	2.07430	-0.52294	-0.03265	0.00703
860	OC	5235.2259	17.32531	17.31943	106.06611	32.47493	2.11366	-0.10668	15.7007	2.06172	-0.53298	-0.03265	0.00703
861	QFC	5235.9879	17.32647	17.32312	103.01669	33.28987	2.08943	-0.10129	15.7007	1.94096	-0.53627	-0.03095	0.00711
862	HCN	5263.0364	17.40471	17.40510	31.87444	90.52680	1.68281	0.09109	15.7592	0.68925	-1.57895	0.00152	0.00711

863 QD	5264.7153	17.41321	17.40803	31.68322	90.02337	1.73968	0.09999	15.7592	-0.57292	1.87236	0.06660	0.00344
864 OC	5264.9693	17.41448	17.40848	31.97697	89.07544	1.75660	0.10087	15.7592	-0.58357	1.85964	0.06660	0.00344
865 QDC	5265.7313	17.41822	17.40986	32.86953	86.32701	1.80677	0.10352	15.7592	-0.58752	1.74800	0.06508	0.00353
866 HCN	5292.7798	17.49883	17.50634	94.59312	26.09632	3.99766	0.19882	15.8515	-1.69446	0.47795	0.09755	0.00352
867 QF	5294.4587	17.50163	17.51667	94.21216	26.26873	4.03207	0.21121	15.8515	1.91649	-0.58283	-0.05678	0.01132
868 OC	5294.7127	17.50206	17.51820	93.24178	26.56810	4.01765	0.21408	15.8515	1.90390	-0.59578	-0.05678	0.01132
869 QFC	5295.4747	17.50338	17.52268	90.42516	27.48898	3.97562	0.22264	15.8515	1.79321	-0.61248	-0.05356	0.01114
870 HCN	5322.5232	17.59457	17.61033	27.52623	97.15054	2.95764	0.52379	15.9611	0.53223	-1.96190	-0.02109	0.01112
871 QD	5324.2021	17.60438	17.61305	27.60094	97.49378	3.01729	0.52554	15.9611	-0.57768	1.76186	0.09253	-0.00904
872 OC	5324.4561	17.60584	17.61347	27.89752	96.60147	3.04079	0.52325	15.9611	-0.58995	1.75117	0.09253	-0.00904
873 QDC	5325.2181	17.61011	17.61474	28.80617	94.01870	3.11031	0.51652	15.9611	-0.60224	1.63903	0.08991	-0.00860
874 HCN	5352.2666	17.69610	17.69413	95.99421	33.98790	5.97282	0.28364	16.1068	-1.88177	0.57954	0.12238	-0.00862
875 QF	5353.9455	17.69885	17.70204	96.14520	34.29954	5.98542	0.27816	16.1068	1.79377	-0.76911	-0.10745	0.00206
876 OC	5354.1995	17.69927	17.70322	95.23680	34.69324	5.95813	0.27869	16.1068	1.78263	-0.78090	-0.10745	0.00206
877 QFC	5354.9615	17.70057	17.70665	92.60296	35.88846	5.87807	0.28018	16.1068	1.67455	-0.78732	-0.10268	0.00184
878 MS1	5368.4683	17.73091	17.75162	54.86165	65.39101	4.49117	0.30502	16.1068	1.11970	-1.39696	-0.10268	0.00184
879 B	5374.5897	17.75109	17.76477	42.69289	84.18018	3.88746	0.31627	16.1408	0.86823	-1.67236	-0.09456	0.00184
880 O	5374.8691	17.75214	17.76530	42.21093	85.11821	3.86104	0.31678	16.1408	0.85675	-1.68496	-0.09456	0.00184
881 B	5380.9905	17.77826	17.77549	33.26129	107.43066	3.30703	0.32801	16.1699	0.60529	-1.95991	-0.08645	0.00183
882 MS2	5382.0100	17.78323	17.77697	32.06983	111.47367	3.21890	0.32988	16.1699	0.56341	-2.00585	-0.08645	0.00183
883 QD	5383.6889	17.79162	17.77935	32.31731	111.04494	3.17607	0.32239	16.1699	-0.71395	2.25572	0.03516	-0.01070
884 OC	5383.9429	17.79286	17.77972	32.68301	109.90258	3.18500	0.31968	16.1699	-0.72582	2.24179	0.03516	-0.01070
885 QDC	5384.7049	17.79651	17.78084	33.79460	106.58779	3.21075	0.31162	16.1699	-0.73263	2.10926	0.03243	-0.01044
886 HCN	5411.7534	17.87088	17.86044	106.69601	29.83630	4.51859	0.02925	16.2931	-1.96261	0.72725	0.06490	-0.01044
887 QF	5413.4323	17.87336	17.86956	106.42952	29.39256	4.48214	0.01247	16.2931	2.11792	-0.45732	-0.10809	-0.00965
888 OC	5413.6863	17.87374	17.87093	105.35694	29.62753	4.45469	0.01002	16.2931	2.10483	-0.46777	-0.10809	-0.00965
889 QFC	5414.4483	17.87491	17.87498	102.24255	30.34581	4.37369	0.00266	16.2931	1.98314	-0.47465	-0.10453	-0.00965
890 HCN	5441.4968	17.95574	17.96405	30.25928	85.49842	1.97698	-0.25842	16.3928	0.67816	-1.56354	-0.07206	-0.00965
891 QD	5443.1757	17.96470	17.96715	30.00664	85.26606	1.91849	-0.26619	16.3928	-0.52448	1.69896	0.00201	0.00043
892 OC	5443.4297	17.96605	17.96762	30.27582	84.40593	1.91900	-0.26608	16.3928	-0.53527	1.68738	0.00201	0.00043
893 QDC	5444.1917	17.97000	17.96908	31.09625	81.91452	1.91991	-0.26584	16.3928	-0.54117	1.58290	0.00038	0.00021
894 HCN	5471.2402	18.05500	18.06546	90.78896	27.55431	2.36082	-0.26007	16.4598	-1.66573	0.42610	0.03285	0.00022
895 QF	5472.9191	18.05792	18.07519	90.55641	27.99192	2.34002	-0.26809	16.4598	1.80127	-0.69230	-0.05750	-0.00982
896 OC	5473.1731	18.05837	18.07663	89.64439	28.34702	2.32541	-0.27058	16.4598	1.78936	-0.70572	-0.05750	-0.00982
897 QFC	5473.9351	18.05974	18.08083	86.99860	29.43536	2.28231	-0.27798	16.4598	1.68352	-0.72226	-0.05564	-0.00960
898 HCN	5500.9836	18.15174	18.16116	28.16992	106.25024	1.20798	-0.53751	16.5135	0.49144	-2.11648	-0.02317	-0.00959
899 QD	5502.6625	18.16129	18.16364	28.42241	106.52344	1.20764	-0.53627	16.5135	-0.64503	1.95725	0.02276	0.01105

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
900 OC	5502.9165	18.16270	18.16402	28.75330	105.53208	1.21342	-0.53347	16.5135	-0.65769	1.94573	0.02276	0.01105
901 QDC	5503.6785	18.16685	18.16519	29.76545	102.66035	1.23037	-0.52522	16.5135	-0.67030	1.82376	0.02172	0.01060
902 HCN	5530.7270	18.24866	18.23994	101.64875	34.77714	2.24860	-0.23820	16.5677	-1.98730	0.68501	0.05420	0.01062
903 QF	5532.4059	18.25126	18.24771	101.78767	34.77951	2.26684	-0.22787	16.5677	1.90633	-0.68645	-0.03259	0.00176
904 OC	5532.6599	18.25166	18.24886	100.82219	35.13095	2.25856	-0.22742	16.5677	1.89477	-0.69719	-0.03259	0.00176
905 QFC	5533.4219	18.25288	18.25226	98.02178	36.19601	2.23442	-0.22602	16.5677	1.78106	-0.70024	-0.03078	0.00194
906 HCN	5560.4704	18.33201	18.32487	32.81260	104.11853	1.83254	-0.17346	16.6310	0.62979	-1.80987	0.00169	0.00195
907 QD	5562.1493	18.34023	18.32741	32.88051	103.51061	1.89454	-0.16469	16.6310	-0.67110	2.16417	0.07256	0.00845
908 OC	5562.4033	18.34146	18.32781	33.22427	102.41476	1.91298	-0.16254	16.6310	-0.68230	2.15022	0.07256	0.00845
909 QDC	5563.1653	18.34505	18.32901	34.26770	99.23477	1.96764	-0.15616	16.6310	-0.68673	2.02389	0.07091	0.00831
910 HCN	5590.2138	18.42035	18.41601	102.83532	27.27628	4.31629	0.06868	16.7311	-1.84829	0.63549	0.10338	0.00831
911 QF	5591.8927	18.42292	18.42597	102.43678	26.98681	4.35022	0.08500	16.7311	2.08057	-0.45940	-0.06319	0.01123
912 OC	5592.1467	18.42332	18.42746	101.38320	27.22308	4.33417	0.08785	16.7311	2.06736	-0.47080	-0.06319	0.01123
913 QFC	5592.9087	18.42453	18.43185	98.32378	27.94961	4.28735	0.09639	16.7311	1.94846	-0.48246	-0.05971	0.01116
914 HCN	5619.9572	18.50971	18.52469	28.60879	86.25397	3.10294	0.39814	16.8480	0.62898	-1.67221	-0.02724	0.01115
915 QD	5621.6361	18.51919	18.52775	28.42178	86.33391	3.15684	0.40395	16.8480	-0.51521	1.62562	0.09179	-0.00427
916 OC	5621.8901	18.52060	18.52822	28.68638	85.51082	3.18016	0.40287	16.8480	-0.52652	1.61490	0.09179	-0.00427

917 QDC	5622.6521	18.52477	18.52966	29.49569	83.12865	3.24907	0.39975	16.8480	-0.53533	1.51197	0.08905	-0.00392
918 HCN	5649.7006	18.61253	18.62038	90.36713	30.21286	6.08846	0.29338	16.9979	-1.71515	0.44365	0.12153	-0.00394
919 QF	5651.3795	18.61546	18.62924	90.32565	30.75391	6.09595	0.29617	16.9979	1.73933	-0.77277	-0.11266	0.00727
920 OC	5651.6335	18.61591	18.63055	89.44495	31.14983	6.06733	0.29801	16.9979	1.72801	-0.78596	-0.11266	0.00727
921 QFC	5652.3955	18.61729	18.63437	86.89123	32.35817	5.98335	0.30346	16.9979	1.62401	-0.79945	-0.10780	0.00703
922 HCN	5679.4440	18.70671	18.70831	29.66438	112.58204	3.49826	0.49336	17.1484	0.49173	-2.16527	-0.07533	0.00701
923 QD	5681.1229	18.71577	18.71066	30.00750	112.61144	3.48332	0.48925	17.1484	-0.70045	2.14813	0.05743	-0.01187
924 OC	5681.3769	18.71710	18.71102	30.36654	111.52341	3.49791	0.48624	17.1484	-0.71307	2.13547	0.05743	-0.01187
925 QDC	5682.1389	18.72103	18.71212	31.46191	108.36890	3.54053	0.47734	17.1484	-0.72412	2.00520	0.05443	-0.01146
926 HCN	5709.1874	18.79858	18.78592	106.08122	33.73632	5.44348	0.16705	17.2922	-2.03463	0.75300	0.08690	-0.01148
927 QF	5710.8663	18.80107	18.79397	106.09320	33.44432	5.41405	0.15296	17.2922	2.02765	-0.57538	-0.12177	-0.00539
928 OC	5711.1203	18.80145	18.79517	105.06627	33.73918	5.38312	0.15159	17.2922	2.01541	-0.58549	-0.12177	-0.00539
929 QFC	5711.8823	18.80262	18.79872	102.08607	34.63347	5.29197	0.14744	17.2922	1.89641	-0.58789	-0.11747	-0.00551
930 HCN	5738.9308	18.88050	18.87695	32.43733	94.78697	2.54523	-0.00175	17.4160	0.67858	-1.63511	-0.08500	-0.00552
931 QD	5740.6097	18.88885	18.87975	32.31678	94.19697	2.48312	-0.01085	17.4160	-0.60525	1.97897	0.01062	-0.00527
932 OC	5740.8637	18.89009	18.88018	32.62697	93.19502	2.48582	-0.01219	17.4160	-0.61599	1.96572	0.01062	-0.00527
933 QDC	5741.6257	18.89376	18.88150	33.56870	90.28878	2.49310	-0.01622	17.4160	-0.61961	1.84907	0.00850	-0.00529
934 HCN	5768.6742	18.97224	18.97569	97.24892	26.02745	3.15351	-0.15917	17.5052	-1.73471	0.52584	0.04097	-0.00528
935 QF	5770.3531	18.97497	18.98607	96.83137	26.03324	3.12089	-0.17327	17.5052	1.97807	-0.52936	-0.07963	-0.01160
936 OC	5770.6071	18.97539	18.98762	95.82978	26.30533	3.10066	-0.17621	17.5052	1.96518	-0.54185	-0.07963	-0.01160
937 QFC	5771.3691	18.97667	18.99216	92.92198	27.14316	3.04093	-0.18500	17.5052	1.85162	-0.55744	-0.07715	-0.01146
938 HCN	5798.4176	19.06631	19.08286	27.62300	92.56114	1.38481	-0.49476	17.5739	0.56255	-1.86012	-0.04468	-0.01144
939 QD	5800.0965	19.07609	19.08571	27.60082	92.86062	1.35368	-0.49797	17.5739	-0.54906	1.68558	0.00739	0.00764
940 OC	5800.3505	19.07755	19.08614	27.88279	92.00701	1.35555	-0.49603	17.5739	-0.56104	1.67507	0.00739	0.00764
941 QDC	5801.1125	19.08183	19.08748	28.74672	89.53685	1.36075	-0.49037	17.5739	-0.57248	1.56731	0.00624	0.00722
942 HCN	5828.1610	19.16919	19.17043	93.50703	32.94515	1.96010	-0.29493	17.6254	-1.82177	0.52416	0.03871	0.00723
943 QF	5829.8399	19.17201	19.17858	93.61825	33.38065	1.96182	-0.29218	17.6254	1.75695	-0.78908	-0.03667	-0.00393
944 OC	5830.0939	19.17245	19.17978	92.72854	33.78464	1.95251	-0.29317	17.6254	1.74586	-0.80143	-0.03667	-0.00393

1	POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
	945 QFC	5830.8559	19.17377	19.18331	90.14909	35.01298	1.92516	-0.29608	17.6254	1.63993	-0.81024	-0.03511	-0.00369
	946 HCN	5857.9044	19.25869	19.25392	31.37589	113.37095	1.40624	-0.39578	17.6767	0.53298	-2.08552	-0.00263	-0.00368
	947 QD	5859.5833	19.26726	19.25625	31.68404	113.08509	1.44715	-0.38925	17.6767	-0.72042	2.25212	0.05162	0.01141
	948 OC	5859.8373	19.26853	19.25661	32.05311	111.94448	1.46026	-0.38635	17.6767	-0.73260	2.23849	0.05162	0.01141
	949 QDC	5860.5993	19.27224	19.25771	33.17614	108.63540	1.49912	-0.37778	17.6767	-0.74088	2.10507	0.05036	0.01108
	950 HCN	5887.6478	19.34709	19.33448	107.41147	31.28445	3.29198	-0.07780	17.7524	-2.00368	0.75360	0.08283	0.01109
	951 QF	5889.3267	19.34955	19.34318	107.23548	30.84015	3.32448	-0.06149	17.7524	2.10625	-0.48332	-0.04433	0.00845
	952 OC	5889.5807	19.34993	19.34449	106.16877	31.08826	3.31322	-0.05934	17.7524	2.09338	-0.49348	-0.04433	0.00845
	953 TF8	5890.3427	19.35109	19.34835	103.20962	31.80237	3.28264	-0.05285	17.7524	1.79253	-0.44307	-0.03595	0.00859
	954 HCN	5917.3912	19.42415	19.43643	36.10548	83.22717	2.74093	0.17943	17.8474	0.68838	-1.45735	-0.00348	0.00859
	955 QD	5919.0701	19.43162	19.43962	36.17902	82.78843	2.82348	0.18797	17.8474	-0.73312	1.71306	0.10233	0.00152
	956 OC	5919.3241	19.43273	19.44011	36.55419	81.92126	2.84947	0.18835	17.8474	-0.74391	1.70099	0.10233	0.00152
	957 -TF7	5920.0861	19.43600	19.44161	37.76806	79.23746	2.92958	0.18938	17.8474	-0.84988	1.81932	0.10796	0.00116
	958 HCN	5947.1346	19.50266	19.55839	117.10588	20.58191	6.28045	0.22053	17.9953	-2.08332	0.34842	0.14044	0.00115
	959 QF	5948.8135	19.50492	19.57144	116.57392	20.86785	6.31322	0.22959	17.9953	2.39336	-0.52236	-0.10161	0.00971
	960 OC	5949.0675	19.50527	19.57337	115.36182	21.13714	6.28741	0.23205	17.9953	2.37870	-0.53785	-0.10161	0.00971
	961 TF6	5949.8295	19.50634	19.57899	111.69539	22.00662	6.20790	0.23953	17.9953	2.43183	-0.60345	-0.10704	0.00991
	962 HCN	5976.8780	19.59106	19.67681	25.42744	99.93515	3.74322	0.50742	18.1535	0.75758	-2.27646	-0.07457	0.00989
	963 QD	5978.5569	19.60187	19.67944	24.61901	101.14801	3.73746	0.50765	18.1535	-0.26581	1.56958	0.06767	-0.00961
	964 OC	5978.8109	19.60350	19.67984	24.75685	100.35287	3.75464	0.50521	18.1535	-0.27686	1.56089	0.06767	-0.00961
	965 -TF5	5979.5729	19.60836	19.68107	25.24872	97.81795	3.80958	0.49744	18.1535	-0.36902	1.76381	0.07652	-0.01079
	966 HCN	6006.6214	19.71257	19.75989	78.13338	33.09872	6.31003	0.20542	18.3159	-1.58618	0.62803	0.10899	-0.01080
	967 QF	6008.3003	19.71594	19.76804	78.44957	33.19028	6.28963	0.19371	18.3159	1.40189	-0.68373	-0.13317	-0.00321
	968 OC	6008.5543	19.71646	19.76926	77.73985	33.54047	6.25581	0.19290	18.3159	1.39229	-0.69497	-0.13317	-0.00321
	969 TF4	6009.3163	19.71804	19.77281	75.59989	34.64325	6.15270	0.19050	18.3159	1.41556	-0.75250	-0.13744	-0.00308
	970 HCN	6036.3648	19.81787	19.84558	28.09218	108.34513	2.86583	0.10706	18.4586	0.34085	-1.97119	-0.10497	-0.00309

971	QD	6038.0437	19.82737	19.84802	28.85464	108.00158	2.78018	0.09851	18.4586	-0.80467	2.17142	0.00239	-0.00704
972	OC	6038.2977	19.82876	19.84840	29.26709	106.90191	2.78079	0.09673	18.4586	-0.81917	2.15798	0.00239	-0.00704
973	-TF3	6039.0597	19.83281	19.84955	30.54866	103.64388	2.78261	0.09136	18.4586	-0.86267	2.11765	0.00239	-0.00704
974	OOC	6040.1840	19.83849	19.85132	32.56060	98.94910	2.78530	0.08345	18.4586	-0.92687	2.05816	0.00239	-0.00704
975	B	6046.3054	19.86375	19.86258	46.04735	75.72862	2.82478	0.04036	18.4814	-1.27637	1.73504	0.01051	-0.00704
976	O	6046.5848	19.86471	19.86317	46.76504	74.76321	2.82772	0.03839	18.4814	-1.29232	1.72025	0.01051	-0.00704
977	B	6052.7062	19.88246	19.87829	64.72595	55.68272	2.91690	-0.00470	18.5047	-1.64183	1.39666	0.01863	-0.00704
978	O	6052.9856	19.88314	19.87910	65.64787	54.90641	2.92210	-0.00667	18.5047	-1.65778	1.38186	0.01863	-0.00704
979	B	6059.1070	19.89596	19.89995	88.08294	39.97118	3.06097	-0.04976	18.5289	-2.00728	1.05790	0.02674	-0.00704
980	O	6059.3864	19.89647	19.90107	89.20907	39.38416	3.06844	-0.05173	18.5289	-2.02324	1.04309	0.02674	-0.00704
981	BH	6065.5078	19.90604	19.93027	116.11790	28.59559	3.26942	-0.09481	18.5674	-2.37274	0.71922	0.03892	-0.00704
982	OOO	6066.1082	19.90686	19.93366	118.98757	27.75111	3.29279	-0.09904	18.5674	-2.40701	0.68736	0.03892	-0.00704
983	QF	6067.7871	19.90907	19.94348	119.41009	27.31562	3.25232	-0.11418	18.5674	2.16076	-0.42245	-0.08687	-0.01109
984	OC	6068.0411	19.90941	19.94495	118.31548	27.53301	3.23025	-0.11699	18.5674	2.14870	-0.43341	-0.08687	-0.01109
985	TF2	6068.8031	19.91046	19.94929	114.18065	28.43357	3.15177	-0.12590	18.5674	3.26372	-0.75144	-0.11899	-0.01231
986	OOC	6069.9274	19.91208	19.95540	106.97097	30.19277	3.01800	-0.13975	18.5674	3.14899	-0.81330	-0.11899	-0.01231
987	BH	6076.0488	19.92317	19.98283	72.24315	42.20667	2.32692	-0.21511	18.5999	2.52433	-1.14916	-0.10681	-0.01231
988	O	6076.3282	19.92379	19.98387	70.84052	42.85311	2.29707	-0.21855	18.5999	2.49582	-1.16452	-0.10681	-0.01231
989	BH	6082.4496	19.94125	20.00327	44.10916	59.16289	1.68053	-0.29387	18.6240	1.87116	-1.49967	-0.09463	-0.01230

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
990	O	6082.7290	19.94227	20.00401	43.07152	60.00519	1.65409	-0.29731	18.6240	1.84265	-1.51501	-0.09463	-0.01230
991	BH	6088.8504	19.97255	20.01804	24.33661	80.60074	1.11209	-0.37259	18.6408	1.21799	-1.84925	-0.08246	-0.01229
992	O	6089.1298	19.97440	20.01859	23.66396	81.63838	1.08905	-0.37603	18.6408	1.18948	-1.86457	-0.08246	-0.01229
993	BH	6095.2512	20.03131	20.02905	12.92550	106.50693	0.62159	-0.45126	18.6511	0.56482	-2.19768	-0.07028	-0.01228
994	OOO	6095.8516	20.03889	20.02993	12.28408	109.16555	0.57939	-0.45863	18.6511	0.50355	-2.23055	-0.07028	-0.01228
995	QD	6097.5305	20.06158	20.03235	11.61934	109.63116	0.47883	-0.46439	18.6511	-0.09919	1.95918	-0.05016	0.00546
996	OC	6097.7845	20.06505	20.03272	11.67534	108.63874	0.46609	-0.46301	18.6511	-0.12127	1.94797	-0.05016	0.00546
997	-TF1	6098.5465	20.07534	20.03385	11.91569	105.64985	0.42796	-0.45875	18.6511	-0.19420	1.97388	-0.04991	0.00572
998	OOC	6099.6708	20.09004	20.03558	12.46243	101.27003	0.37186	-0.45232	18.6511	-0.29211	1.92178	-0.04991	0.00572
999	GP15	6103.7929	20.13667	20.04260	16.35040	86.21390	0.16614	-0.42876	18.6511	-0.65109	1.73075	-0.04991	0.00572
1000	BH	6109.9143	20.18320	20.05546	27.58455	66.75008	-0.10207	-0.39374	18.6515	-1.18418	1.44865	-0.03773	0.00573
1001	O	6110.1937	20.18479	20.05613	28.25307	65.94420	-0.11261	-0.39214	18.6515	-1.20851	1.43568	-0.03773	0.00573
1002	BH	6116.3151	20.21186	20.07311	46.31142	50.09841	-0.30629	-0.35706	18.6488	-1.74160	1.15271	-0.02555	0.00574
1003	O	6116.5945	20.21281	20.07401	47.29143	49.45790	-0.31343	-0.35546	18.6488	-1.76593	1.13973	-0.02555	0.00574
1004	BH	6122.7159	20.22951	20.09679	72.17398	37.23996	-0.43256	-0.32032	18.6442	-2.29902	0.85606	-0.01337	0.00574
1005	GP16	6124.9946	20.23420	20.10705	83.10364	33.58017	-0.46304	-0.30724	18.6442	-2.49746	0.75003	-0.01337	0.00574
1006	OS1	6125.3156	20.23480	20.10858	84.71589	33.10347	-0.46733	-0.30539	18.6442	-2.52542	0.73510	-0.01337	0.00574
1007	OS2	6125.5950	20.23533	20.10993	86.13389	32.69633	-0.47107	-0.30379	18.6442	-2.54975	0.72210	-0.01337	0.00574
1008	QFS	6126.4096	20.23680	20.11395	89.00867	32.03561	-0.47838	-0.30140	18.6442	-0.96153	0.09308	-0.00456	0.00014
1009	D1	6134.4451	20.24999	20.15396	105.85754	32.57273	-0.51500	-0.30029	18.6442	-1.13527	-0.15992	-0.00456	0.00014
1010	GP13	6153.3681	20.27347	20.23172	156.56550	49.89956	-0.60123	-0.29770	18.6442	-1.54443	-0.75573	-0.00456	0.00014
1011	OOO	6153.9685	20.27408	20.23362	158.42777	50.81836	-0.60397	-0.29761	18.6442	-1.55741	-0.77463	-0.00456	0.00014
1012	-QF1	6156.0696	20.27608	20.24020	181.98650	49.05415	-0.64432	-0.28249	18.6442	-10.02841	1.58596	-0.03417	0.01413
1013	D2	6159.8887	20.27884	20.25430	266.72584	37.98548	-0.77483	-0.22852	18.6442	-12.15989	1.31228	-0.03417	0.01413
1014	-QF2	6162.4135	20.28025	20.26530	288.86335	36.96439	-0.80347	-0.20876	18.6442	3.82030	-0.88848	0.01176	0.00171
1015	LSF	6189.0105	20.30271	20.33113	123.83622	118.47024	-0.49077	-0.16322	18.6442	2.38442	-2.17600	0.01176	0.00171
1016	.F0	6189.0105	20.30271	20.33113	123.83622	118.47024	-0.49077	-0.16322	18.6442	2.38442	-2.17600	0.01176	0.00171
1017	LSF	6215.6075	20.36871	20.35495	35.18919	268.46450	-0.17807	-0.11768	18.6442	0.94855	-3.46352	0.01176	0.00171
1018	QF2	6218.1323	20.38034	20.35647	35.64362	247.48154	-0.16074	-0.10503	18.6442	-1.13716	11.36817	0.00213	0.00819
1019	D2	6221.9514	20.39550	20.35945	45.26785	168.32470	-0.15260	-0.07374	18.6442	-1.38286	9.35840	0.00213	0.00819
1020	QF1	6224.0525	20.40266	20.36162	46.57145	146.20845	-0.14058	-0.05997	18.6442	0.78336	1.51803	0.00921	0.00502
1021	D3	6225.6873	20.40840	20.36343	44.10278	141.30550	-0.12553	-0.05176	18.6442	0.72672	1.48108	0.00921	0.00502
1022	GP14	6251.0111	20.53223	20.40151	29.51657	80.78597	0.10761	0.07539	18.6442	-0.15073	0.90875	0.00921	0.00502
1023	OS1	6251.3320	20.53396	20.40215	29.61690	80.20492	0.11056	0.07700	18.6442	-0.16185	0.90149	0.00921	0.00502
1024	OS2	6251.6114	20.53546	20.40270	29.71004	79.70293	0.11314	0.07840	18.6442	-0.17153	0.89518	0.00921	0.00502

1025	QDS	6252.4260	20.53978	20.40435	30.46665	77.07572	0.12151	0.08189	18.6442	-0.76195	2.31371	0.01138	0.00353
1026	OSB3	6253.0110	20.54279	20.40558	31.37583	74.39707	0.12817	0.08396	18.6442	-0.79230	2.26549	0.01138	0.00353
1027	OSB4	6254.5664	20.55038	20.40907	33.96598	67.54913	0.14587	0.08945	18.6442	-0.87299	2.13728	0.01138	0.00353
1028	BH	6260.6878	20.57496	20.42689	46.59747	44.46343	0.25279	0.11107	18.6466	-1.19056	1.63375	0.02356	0.00353
1029	O	6260.9672	20.57591	20.42790	47.26681	43.55694	0.25938	0.11205	18.6466	-1.20505	1.61069	0.02356	0.00353
1030	BH	6267.0886	20.59366	20.45650	63.96352	26.92475	0.44084	0.13365	18.6508	-1.52261	1.10617	0.03573	0.00353
1031	O	6267.3680	20.59435	20.45817	64.81841	26.31307	0.45083	0.13464	18.6508	-1.53711	1.08309	0.03573	0.00353
1032	BH	6273.4894	20.60745	20.50617	85.58035	16.14470	0.70683	0.15622	18.6577	-1.85467	0.57790	0.04791	0.00352
1033	O	6273.7688	20.60797	20.50895	86.62079	15.82822	0.72022	0.15720	18.6577	-1.86917	0.55482	0.04791	0.00352
1034	BH	6279.8902	20.61789	20.58177	111.44796	12.12997	1.05076	0.17876	18.6684	-2.18673	0.04929	0.06009	0.00352
1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
1035	OOO	6280.4905	20.61874	20.58966	114.09240	12.10058	1.08683	0.18087	18.6684	-2.21788	-0.00033	0.06009	0.00352
1036	QF	6282.1695	20.62105	20.61115	114.19982	13.13323	1.15194	0.19268	18.6684	2.15527	-0.62784	0.01706	0.01062
1037	OC	6282.4235	20.62141	20.61419	113.10813	13.45902	1.15628	0.19538	18.6684	2.14271	-0.65480	0.01706	0.01062
1038	TF1	6283.1855	20.62250	20.62286	109.52103	14.56333	1.16744	0.20379	18.6684	2.55981	-0.79596	0.01224	0.01145
1039	KKK	6283.1855	20.62250	20.62286	109.52103	14.56333	1.16744	0.20379	18.6684	2.55981	-0.79596	0.01224	0.01145

CIRCUMFERENCE = 6283.1855 M THETX = 6.28318501 RAD NUX = 20.62250 DNUX/(DP/P) = -67.57039
RADIUS = 1000.0000 M THETY = 0.00000000 RAD NUY = 20.62286 DNUY/(DP/P) = -68.27574
(DS/S)/(DP/P)= 0.0029712 TGAM=(18.34577, 0.00000)

MAXIMA --- BETX(661) = 1478.31400 BETY(325) = 1478.50169 XEQ(276) = 9.13516 YEQ(144) = 0.82697
MINIMA --- BETX(668) = 0.26308 BETY(319) = 0.26540 XEQ(645) = -0.03430 YEQ(614) = -0.00003

Main Injector (Half-Ring)

First, in the Clockwise direction ...

*** MR+ CYC 2 // .RNG

1BETATRON FUNCTIONS OF MR+

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
0	0.0000	0.00000	0.00000	56.43046	10.53326	1.91012	0.00000	0.0000	0.02703	-0.02251	0.00344	0.00000
1 QF	1.0668	0.00306	0.01579	53.88343	11.17551	1.87079	0.00000	0.0000	2.32445	-0.58856	-0.07691	0.00000
2 BPM	1.2228	0.00352	0.01800	53.16095	11.36211	1.85878	0.00000	0.0000	2.30591	-0.60736	-0.07691	0.00000
3 CED	2.0704	0.00615	0.02934	49.33734	12.47826	1.79359	0.00000	0.0000	2.20519	-0.70948	-0.07691	0.00000
4 000	3.1786	0.00991	0.04260	44.59570	14.19871	1.70836	0.00000	0.0000	2.07350	-0.84299	-0.07691	0.00000
5 B2	9.2492	0.03974	0.09107	23.80122	28.86606	1.30108	0.00000	0.0294	1.35216	-1.57267	-0.05728	0.00000
6 0	9.5540	0.04182	0.09272	22.98798	29.83594	1.28362	0.00000	0.0294	1.31594	-1.60935	-0.05728	0.00000
7 B2	15.6246	0.10302	0.11693	11.39053	53.79432	0.99553	0.00000	0.0515	0.59461	-2.33652	-0.03764	0.00000
8 0	15.9294	0.10734	0.11782	11.03910	55.22981	0.98405	0.00000	0.0515	0.55839	-2.37311	-0.03764	0.00000
9 QD	16.9962	0.12329	0.12081	10.45454	57.82165	0.96588	0.00000	0.0515	-0.00222	-0.01977	0.00345	0.00000
10 QD	18.0630	0.13924	0.12379	11.04884	55.31165	0.99146	0.00000	0.0515	-0.56322	2.33709	0.04469	0.00000
11 BPM	18.2191	0.14147	0.12424	11.22750	54.58519	0.99843	0.00000	0.0515	-0.58183	2.31886	0.04469	0.00000
12 CED	19.0667	0.15296	0.12680	12.29946	50.73818	1.03631	0.00000	0.0515	-0.68288	2.21984	0.04469	0.00000
13 000	20.1749	0.16643	0.13045	13.95940	45.96161	1.08584	0.00000	0.0515	-0.81499	2.09037	0.04469	0.00000
14 B2	26.2455	0.21588	0.15918	28.24664	24.87459	1.41672	0.00000	0.0759	-1.53867	1.38259	0.06433	0.00000
15 0	26.5503	0.21757	0.16117	29.19569	24.04264	1.43632	0.00000	0.0759	-1.57501	1.34691	0.06433	0.00000
16 B2	32.6209	0.24229	0.21934	52.70985	11.99689	1.88639	0.00000	0.1083	-2.29869	0.63698	0.08396	0.00000
17 0	32.9257	0.24320	0.22345	54.12221	11.61948	1.91198	0.00000	0.1083	-2.33503	0.60126	0.08396	0.00000
18 QF	33.9925	0.24625	0.23863	56.68094	10.96584	1.95786	0.00000	0.1083	-0.02726	0.02064	0.00172	0.00000
19 QF	35.0593	0.24928	0.25387	54.23505	11.52873	1.91562	0.00000	0.1083	2.28536	-0.55620	-0.08060	0.00000
20 BPM	35.2153	0.24975	0.25601	53.52467	11.70506	1.90305	0.00000	0.1083	2.26746	-0.57392	-0.08060	0.00000
21 CED	36.0629	0.25236	0.26705	49.76330	12.75956	1.83473	0.00000	0.1083	2.17021	-0.67018	-0.08060	0.00000
22 000	37.1711	0.25608	0.28009	45.09417	14.38443	1.74541	0.00000	0.1083	2.04305	-0.79605	-0.08060	0.00000
23 B2	43.2417	0.28530	0.32879	24.51848	28.22740	1.31575	0.00000	0.1382	1.34656	-1.48384	-0.06096	0.00000
24 0	43.5465	0.28731	0.33048	23.70827	29.14249	1.29716	0.00000	0.1382	1.31159	-1.51842	-0.06096	0.00000
25 B2	49.6171	0.34587	0.35547	12.01286	51.74320	0.98669	0.00000	0.1604	0.61510	-2.20384	-0.04133	0.00000
26 0	49.9219	0.34997	0.35639	11.64856	53.09718	0.97410	0.00000	0.1604	0.58013	-2.23834	-0.04133	0.00000
27 QD	50.9887	0.36508	0.35950	11.03940	55.49713	0.95174	0.00000	0.1604	-0.00055	0.02262	-0.00075	0.00000
28 QD	52.0555	0.38019	0.36260	11.65098	53.00354	0.97249	0.00000	0.1604	-0.58133	2.27956	0.03980	0.00000
29 BPM	52.2115	0.38230	0.36307	11.83518	52.29503	0.97870	0.00000	0.1604	-0.59925	2.26132	0.03980	0.00000
30 CED	53.0591	0.39322	0.36575	12.93352	48.54563	1.01243	0.00000	0.1604	-0.69658	2.16223	0.03980	0.00000
31 000	54.1673	0.40606	0.36957	14.61845	43.89683	1.05653	0.00000	0.1604	-0.82384	2.03268	0.03980	0.00000
32 B2	60.2379	0.45381	0.39983	28.85160	23.51376	1.35771	0.00000	0.1839	-1.52091	1.32435	0.05943	0.00000
33 0	60.5427	0.45547	0.40193	29.78942	22.71731	1.37583	0.00000	0.1839	-1.55592	1.28865	0.05943	0.00000
34 B2	66.6133	0.47990	0.46354	52.91028	11.38189	1.79619	0.00000	0.2149	-2.25299	0.57826	0.07907	0.00000
35 0	66.9181	0.48080	0.46787	54.29437	11.04028	1.82030	0.00000	0.2149	-2.28799	0.54252	0.07907	0.00000
36 QF	67.9849	0.48384	0.48379	56.74316	10.48929	1.86305	0.00000	0.2149	0.02720	-0.01829	0.00079	0.00000
37 QF	69.0517	0.48688	0.49966	54.18176	11.12068	1.82197	0.00000	0.2149	2.33755	-0.58245	-0.07752	0.00000
38 BPM	69.2078	0.48734	0.50187	53.45521	11.30537	1.80987	0.00000	0.2149	2.31894	-0.60124	-0.07752	0.00000
39 CED	70.0554	0.48996	0.51327	49.60986	12.41111	1.74416	0.00000	0.2149	2.21781	-0.70331	-0.07752	0.00000
40 000	71.1636	0.49370	0.52661	44.84081	14.11783	1.65825	0.00000	0.2149	2.08560	-0.83677	-0.07752	0.00000
41 B2	77.2342	0.52337	0.57536	23.91683	28.70791	1.24726	0.00000	0.2432	1.36139	-1.56616	-0.05789	0.00000
42 0	77.5390	0.52544	0.57702	23.09801	29.67381	1.22961	0.00000	0.2432	1.32503	-1.60282	-0.05789	0.00000
43 B2	83.6096	0.58643	0.60135	11.40766	53.55125	0.93782	0.00000	0.2643	0.60082	-2.32971	-0.03825	0.00000
44 0	83.9144	0.59076	0.60225	11.05249	54.98259	0.92616	0.00000	0.2643	0.56446	-2.36629	-0.03825	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
45 QD	84.9812	0.60669	0.60524	10.45574	57.57124	0.90602	0.00000	0.2643	0.00331	-0.02365	0.00035	0.00000

46 QD	86.0480	0.62265	0.60824	11.03793	55.08050	0.92692	0.00000	0.2643	-0.55723	2.32320	0.03898	0.00000
47 BPM	86.2040	0.62488	0.60869	11.21471	54.35835	0.93300	0.00000	0.2643	-0.57576	2.30508	0.03898	0.00000
48 CED	87.0516	0.63638	0.61126	12.27604	50.53423	0.96603	0.00000	0.2643	-0.67639	2.20663	0.03898	0.00000
49 000	88.1598	0.64989	0.61493	13.92101	45.78608	1.00923	0.00000	0.2643	-0.80797	2.07792	0.03898	0.00000
50 B2	94.2304	0.69954	0.64374	28.10488	24.82497	1.30542	0.00000	0.2868	-1.52867	1.37430	0.05861	0.00000
51 0	94.5352	0.70123	0.64573	29.04779	23.99801	1.32328	0.00000	0.2868	-1.56486	1.33883	0.05861	0.00000
52 B2	100.6058	0.72609	0.70389	52.42064	12.02506	1.73866	0.00000	0.3167	-2.28556	0.63307	0.07825	0.00000
53 0	100.9106	0.72701	0.70799	53.82495	11.64997	1.76251	0.00000	0.3167	-2.32175	0.59756	0.07825	0.00000
54 QF	101.9774	0.73007	0.72312	56.36887	11.00507	1.80570	0.00000	0.3167	-0.02687	0.01603	0.00242	0.00000
55 QF	103.0442	0.73312	0.73830	53.93617	11.57950	1.76763	0.00000	0.3167	2.27280	-0.56257	-0.07353	0.00000
56 BPM	103.2002	0.73359	0.74043	53.22970	11.75783	1.75616	0.00000	0.3167	2.25496	-0.58031	-0.07353	0.00000
57 CED	104.0478	0.73621	0.75142	49.48921	12.82325	1.69384	0.00000	0.3167	2.15807	-0.67668	-0.07353	0.00000
58 000	105.1560	0.73996	0.76439	44.84645	14.46266	1.61236	0.00000	0.3167	2.03139	-0.80267	-0.07353	0.00000
59 B2	111.2266	0.76933	0.81281	24.39667	28.39034	1.22564	0.00000	0.3444	1.33748	-1.49117	-0.05389	0.00000
60 0	111.5314	0.77135	0.81450	23.59196	29.30990	1.20921	0.00000	0.3444	1.30264	-1.52578	-0.05389	0.00000
61 B2	117.6020	0.83012	0.83934	11.98950	52.00425	0.94169	0.00000	0.3653	0.60874	-2.21190	-0.03425	0.00000
62 0	117.9068	0.83423	0.84026	11.62903	53.36315	0.93125	0.00000	0.3653	0.57389	-2.24644	-0.03425	0.00000
63 QD	118.9736	0.84936	0.84335	11.03219	55.76815	0.91552	0.00000	0.3653	-0.00604	0.02604	0.00466	0.00000
64 QD	120.0404	0.86447	0.84645	11.65557	53.25534	0.94127	0.00000	0.3653	-0.58707	2.29389	0.04379	0.00000
65 BPM	120.1964	0.86658	0.84691	11.84158	52.54237	0.94810	0.00000	0.3653	-0.60507	2.27554	0.04379	0.00000
66 CED	121.0440	0.87748	0.84958	12.95018	48.76935	0.98521	0.00000	0.3653	-0.70285	2.17588	0.04379	0.00000
67 000	122.1522	0.89030	0.85338	14.64967	44.09113	1.03373	0.00000	0.3653	-0.83070	2.04557	0.04379	0.00000
68 B2	128.2228	0.93789	0.88353	28.98567	23.57640	1.35912	0.00000	0.3886	-1.53100	1.33313	0.06342	0.00000
69 0	128.5276	0.93954	0.88562	29.92969	22.77467	1.37845	0.00000	0.3886	-1.56616	1.29723	0.06342	0.00000
70 B2	134.5982	0.96385	0.94722	53.19445	11.36011	1.82302	0.00000	0.4198	-2.26645	0.58271	0.08306	0.00000
71 0	134.9030	0.96475	0.95155	54.58680	11.01585	1.84834	0.00000	0.4198	-2.30162	0.54677	0.08306	0.00000
72 QF	135.9698	0.96777	0.96752	57.05138	10.45519	1.89469	0.00000	0.4198	0.02625	-0.01333	0.00351	0.00000
73 QF	137.0366	0.97079	0.98345	54.47811	11.07446	1.85577	0.00000	0.4198	2.34945	-0.57588	-0.07620	0.00000
74 BPM	137.1927	0.97125	0.98567	53.74786	11.25710	1.84388	0.00000	0.4198	2.33078	-0.59464	-0.07620	0.00000
75 CED	138.0403	0.97385	0.99712	49.88271	12.35152	1.77930	0.00000	0.4198	2.22934	-0.69656	-0.07620	0.00000
76 000	139.1485	0.97757	1.01053	45.08859	14.04304	1.69486	0.00000	0.4198	2.09671	-0.82981	-0.07620	0.00000
77 B2	145.2191	1.00708	1.05956	24.04357	28.54182	1.29193	0.00000	0.4489	1.37023	-1.55809	-0.05656	0.00000
78 0	145.5239	1.00914	1.06123	23.21940	29.50279	1.27469	0.00000	0.4489	1.33375	-1.59469	-0.05656	0.00000
79 B2	151.5945	1.06988	1.08570	11.43702	53.27483	0.99096	0.00000	0.4710	0.60727	-2.32048	-0.03692	0.00000
80 0	151.8993	1.07420	1.08660	11.07794	54.70053	0.97971	0.00000	0.4710	0.57079	-2.35701	-0.03692	0.00000
81 QD	152.9661	1.09011	1.08961	10.46888	57.28229	0.96221	0.00000	0.4710	0.00870	-0.02658	0.00399	0.00000
82 QD	154.0329	1.10605	1.09261	11.03970	54.81056	0.98829	0.00000	0.4710	-0.55180	2.30858	0.04509	0.00000
83 BPM	154.1889	1.10828	1.09307	11.21477	54.09296	0.99533	0.00000	0.4710	-0.57024	2.29056	0.04509	0.00000
84 CED	155.0365	1.11979	1.09566	12.26632	50.29297	1.03355	0.00000	0.4710	-0.67039	2.19268	0.04509	0.00000
85 000	156.1447	1.13331	1.09934	13.89729	45.57494	1.08353	0.00000	0.4710	-0.80134	2.06470	0.04509	0.00000
86 B2	162.2153	1.18312	1.12827	27.97988	24.74992	1.41686	0.00000	0.4953	-1.51861	1.36511	0.06473	0.00000
87 0	162.5201	1.18482	1.13026	28.91660	23.92850	1.43659	0.00000	0.4953	-1.55463	1.32984	0.06473	0.00000
88 B2	168.5907	1.20980	1.18847	52.14444	12.04023	1.88911	0.00000	0.5278	-2.27190	0.62811	0.08437	0.00000
89 0	168.8955	1.21072	1.19256	53.54036	11.66810	1.91483	0.00000	0.5278	-2.30792	0.59281	0.08437	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
90 QF	169.9623	1.21380	1.20766	56.06769	11.03371	1.96107	0.00000	0.5278	-0.02537	0.01078	0.00200	0.00000
91 QF	171.0291	1.21687	1.22279	53.64539	11.62070	1.91905	0.00000	0.5278	2.26169	-0.56928	-0.08047	0.00000
92 BPM	171.1851	1.21734	1.22491	52.94238	11.80112	1.90650	0.00000	0.5278	2.24391	-0.58705	-0.08047	0.00000
93 CED	172.0327	1.21998	1.23587	49.22041	12.87816	1.83829	0.00000	0.5278	2.14728	-0.68363	-0.08047	0.00000
94 000	173.1409	1.22374	1.24877	44.60117	14.53329	1.74912	0.00000	0.5278	2.02096	-0.80990	-0.08047	0.00000
95 B2	179.2115	1.25328	1.29693	24.26630	28.55793	1.32028	0.00000	0.5577	1.32899	-1.49991	-0.06083	0.00000
96 0	179.5163	1.25531	1.29860	23.46674	29.48285	1.30174	0.00000	0.5577	1.29424	-1.53460	-0.06083	0.00000
97 B2	185.5869	1.31434	1.32331	11.95446	52.29329	0.99209	0.00000	0.5801	0.60228	-2.22221	-0.04119	0.00000
98 0	185.8917	1.31846	1.32422	11.59790	53.65850	0.97953	0.00000	0.5801	0.56753	-2.25682	-0.04119	0.00000
99 QD	186.9585	1.33362	1.32729	11.01326	56.07214	0.95744	0.00000	0.5801	-0.01127	0.02845	-0.00038	0.00000

100 QD	188.0253	1.34874	1.33037	11.64747	53.54073	0.97872	0.00000	0.5801	-0.59214	2.30865	0.04042	0.00000
101 BPM	188.1814	1.35086	1.33084	11.83508	52.82317	0.98502	0.00000	0.5801	-0.61024	2.29021	0.04042	0.00000
102 CED	189.0290	1.36176	1.33349	12.95286	49.02575	1.01928	0.00000	0.5801	-0.70852	2.19000	0.04042	0.00000
103 000	190.1372	1.37457	1.33727	14.66564	44.31703	1.06407	0.00000	0.5801	-0.83703	2.05898	0.04042	0.00000
104 B2	196.2078	1.42204	1.36728	29.10033	23.66312	1.36902	0.00000	0.6038	-1.54093	1.34265	0.06005	0.00000
105 0	196.5126	1.42368	1.36937	30.05045	22.85565	1.38732	0.00000	0.6038	-1.57627	1.30655	0.06005	0.00000
106 B2	202.5832	1.44788	1.43087	53.45985	11.35170	1.81146	0.00000	0.6350	-2.28017	0.58812	0.07969	0.00000
107 0	202.8880	1.44877	1.43521	54.86061	11.00420	1.83575	0.00000	0.6350	-2.31551	0.55198	0.07969	0.00000
108 QF	203.9548	1.45178	1.45121	57.34244	10.43230	1.87882	0.00000	0.6350	0.02423	-0.00784	0.00075	0.00000
109 QF	205.0216	1.45478	1.46717	54.76032	11.03869	1.83733	0.00000	0.6350	2.35965	-0.56911	-0.07823	0.00000
110 BPM	205.1776	1.45524	1.46941	54.02688	11.21921	1.82513	0.00000	0.6350	2.34094	-0.58782	-0.07823	0.00000
111 CED	206.0252	1.45783	1.48090	50.14469	12.30184	1.75882	0.00000	0.6350	2.23928	-0.68947	-0.07823	0.00000
112 000	207.1334	1.46153	1.49436	45.32885	13.97728	1.67213	0.00000	0.6350	2.10636	-0.82238	-0.07823	0.00000
113 SB	213.2040	1.49088	1.54366	24.17517	28.38170	1.19723	0.00000	0.6350	1.37825	-1.55044	-0.07823	0.00000
114 0	213.5088	1.49293	1.54534	23.34613	29.33799	1.17339	0.00000	0.6350	1.34169	-1.58699	-0.07823	0.00000
115 B2	219.5794	1.55339	1.56994	11.47690	53.01065	0.75812	0.00000	0.6537	0.61363	-2.31182	-0.05859	0.00000
116 0	219.8842	1.55769	1.57084	11.11397	54.43105	0.74027	0.00000	0.6537	0.57707	-2.34830	-0.05859	0.00000
117 QD	220.9510	1.57355	1.57386	10.49305	57.00658	0.69405	0.00000	0.6537	0.01370	-0.02953	-0.02837	0.00000
118 QD	222.0178	1.58946	1.57689	11.05374	54.55332	0.67928	0.00000	0.6537	-0.54716	2.29448	0.00057	0.00000
119 BPM	222.1738	1.59169	1.57735	11.22735	53.84010	0.67937	0.00000	0.6537	-0.56551	2.27656	0.00057	0.00000
120 CED	223.0214	1.60320	1.57994	12.27045	50.06338	0.67985	0.00000	0.6537	-0.66514	2.17923	0.00057	0.00000
121 000	224.1296	1.61672	1.58364	13.88903	45.37437	0.68048	0.00000	0.6537	-0.79541	2.05197	0.00057	0.00000
122 B2	230.2002	1.66664	1.61268	27.87717	24.68026	0.74353	0.00000	0.6675	-1.50898	1.35628	0.02020	0.00000
123 0	230.5050	1.66835	1.61468	28.80796	23.86416	0.74969	0.00000	0.6675	-1.54481	1.32121	0.02020	0.00000
124 B2	236.5756	1.69344	1.67293	51.89406	12.05682	0.93193	0.00000	0.6838	-2.25837	0.62341	0.03984	0.00000
125 0	236.8804	1.69436	1.67701	53.28169	11.68749	0.94407	0.00000	0.6838	-2.29420	0.58831	0.03984	0.00000
126 QF	237.9472	1.69745	1.69208	55.79144	11.06314	0.96501	0.00000	0.6838	-0.02287	0.00573	-0.00073	0.00000
127 QF	239.0140	1.70054	1.70716	53.37636	11.66230	0.94252	0.00000	0.6838	2.25253	-0.57580	-0.04127	0.00000
128 BPM	239.1701	1.70101	1.70928	52.67621	11.84477	0.93608	0.00000	0.6838	2.23478	-0.59362	-0.04127	0.00000
129 CED	240.0177	1.70366	1.72018	48.96957	12.93309	0.90110	0.00000	0.6838	2.13833	-0.69039	-0.04127	0.00000
130 000	241.1259	1.70745	1.73303	44.36993	14.60350	0.85537	0.00000	0.6838	2.01222	-0.81692	-0.04127	0.00000
131 SB	247.1965	1.73715	1.78092	24.13272	28.72950	0.60483	0.00000	0.6838	1.32142	-1.51003	-0.04127	0.00000
132 0	247.5013	1.73919	1.78258	23.33776	29.66063	0.59225	0.00000	0.6838	1.28674	-1.54483	-0.04127	0.00000
133 B2	253.5719	1.79850	1.80714	11.90923	52.60933	0.40132	0.00000	0.6934	0.59599	-2.23474	-0.02164	0.00000
134 0	253.8767	1.80264	1.80805	11.55649	53.98221	0.39472	0.00000	0.6934	0.56130	-2.26947	-0.02164	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
135 QD	254.9435	1.81785	1.81110	10.98341	56.40807	0.38041	0.00000	0.6934	-0.01605	0.02982	-0.00530	0.00000
136 QD	256.0103	1.83301	1.81416	11.62706	53.85877	0.38333	0.00000	0.6934	-0.59634	2.32380	0.01079	0.00000
137 BPM	256.1663	1.83513	1.81462	11.81599	53.13650	0.38501	0.00000	0.6934	-0.61453	2.30526	0.01079	0.00000
138 CED	257.0139	1.84604	1.81726	12.94151	49.31400	0.39416	0.00000	0.6934	-0.71336	2.20454	0.01079	0.00000
139 000	258.1221	1.85886	1.82102	14.66577	44.57380	0.40611	0.00000	0.6934	-0.84256	2.07285	0.01079	0.00000
140 B2	264.1927	1.90625	1.85088	29.19095	23.77375	0.53121	0.00000	0.7024	-1.55030	1.35285	0.03043	0.00000
141 0	264.4975	1.90788	1.85295	30.14684	22.96011	0.54049	0.00000	0.7024	-1.58584	1.31656	0.03043	0.00000
142 B2	270.5681	1.93199	1.91429	53.69569	11.35682	0.78478	0.00000	0.7152	-2.29357	0.59446	0.05006	0.00000
143 0	270.8729	1.93288	1.91863	55.10468	11.00551	0.80004	0.00000	0.7152	-2.32911	0.55813	0.05006	0.00000
144 QF	271.9397	1.93587	1.93463	57.60451	10.42084	0.83504	0.00000	0.7152	0.02121	-0.00185	0.01531	0.00000
145 QF	273.0065	1.93887	1.95063	55.01688	11.01364	0.83246	0.00000	0.7152	2.36776	-0.56217	-0.02012	0.00000
146 BPM	273.1625	1.93932	1.95286	54.28092	11.19198	0.82932	0.00000	0.7152	2.34902	-0.58081	-0.02012	0.00000
147 CED	274.0101	1.94190	1.96439	50.38513	12.26242	0.81226	0.00000	0.7152	2.24724	-0.68210	-0.02012	0.00000
148 000	275.1183	1.94558	1.97791	45.55180	13.92096	0.78996	0.00000	0.7152	2.11417	-0.81452	-0.02012	0.00000
149 SB	281.1889	1.97478	2.02745	24.30830	28.21368	0.66779	0.00000	0.7152	1.38523	-1.53990	-0.02012	0.00000
150 0	281.4937	1.97681	2.02914	23.47502	29.16350	0.66166	0.00000	0.7152	1.34863	-1.57632	-0.02012	0.00000
151 B2	287.5643	2.03696	2.05389	11.52658	52.69051	0.59910	0.00000	0.7274	0.61974	-2.29850	-0.00049	0.00000
152 0	287.8691	2.04124	2.05480	11.15994	54.10276	0.59895	0.00000	0.7274	0.58314	-2.33484	-0.00049	0.00000
153 QD	288.9359	2.05705	2.05784	10.52794	56.66454	0.61199	0.00000	0.7274	0.01817	-0.03030	0.02503	0.00000
154 QD	290.0027	2.07291	2.06088	11.08005	54.22819	0.65275	0.00000	0.7274	-0.54347	2.27964	0.05168	0.00000

155	BPM	290.1587	2.07514	2.06134	11.25249	53.51959	0.66081	0.00000	0.7274	-0.56171	2.26181	0.05168	0.00000
156	CED	291.0063	2.08662	2.06396	12.28870	49.76747	0.70461	0.00000	0.7274	-0.66081	2.16495	0.05168	0.00000
157	000	292.1145	2.10013	2.06768	13.89689	45.10942	0.76188	0.00000	0.7274	-0.79036	2.03831	0.05168	0.00000
158	B2	298.1851	2.15010	2.09687	27.80006	24.56038	1.13517	0.00000	0.7458	-1.50003	1.34604	0.07131	0.00000
159	0	298.4899	2.15182	2.09888	28.72534	23.75047	1.15690	0.00000	0.7458	-1.53566	1.31115	0.07131	0.00000
160	B2	304.5605	2.17700	2.15731	51.67675	12.04456	1.64938	0.00000	0.7732	-2.24533	0.61678	0.09095	0.00000
161	0	304.8653	2.17793	2.16140	53.05636	11.67922	1.67710	0.00000	0.7732	-2.28096	0.58184	0.09095	0.00000
162	QF	305.9321	2.18103	2.17647	55.54802	11.06805	1.73566	0.00000	0.7732	-0.01940	-0.00035	0.01842	0.00000
163	QF	306.9989	2.18413	2.19154	53.13667	11.68074	1.71611	0.00000	0.7732	2.24562	-0.58260	-0.05494	0.00000
164	BPM	307.1550	2.18460	2.19364	52.43868	11.86534	1.70754	0.00000	0.7732	2.22787	-0.60049	-0.05494	0.00000
165	CED	308.0026	2.18727	2.20453	48.74369	12.96567	1.66097	0.00000	0.7732	2.13148	-0.69769	-0.05494	0.00000
166	000	309.1108	2.19107	2.21734	44.15914	14.65285	1.60009	0.00000	0.7732	2.00546	-0.82476	-0.05494	0.00000
167	SB	315.1814	2.22092	2.26501	24.00140	28.89226	1.26659	0.00000	0.7732	1.31510	-1.52087	-0.05494	0.00000
168	0	315.4862	2.22298	2.26666	23.21028	29.83004	1.24984	0.00000	0.7732	1.28043	-1.55582	-0.05494	0.00000
169	B2	321.5568	2.28261	2.29107	11.85562	52.93029	0.97596	0.00000	0.7948	0.59012	-2.24871	-0.03530	0.00000
170	0	321.8616	2.28676	2.29197	11.50645	54.31173	0.96520	0.00000	0.7948	0.55546	-2.28359	-0.03530	0.00000
171	QD	322.9284	2.30203	2.29501	10.94384	56.75273	0.94912	0.00000	0.7948	-0.02017	0.02997	0.00504	0.00000
172	QD	323.9952	2.31724	2.29805	11.59512	54.18768	0.97602	0.00000	0.7948	-0.59949	2.33819	0.04560	0.00000
173	BPM	324.1512	2.31936	2.29851	11.78505	53.46093	0.98314	0.00000	0.7948	-0.61778	2.31957	0.04560	0.00000
174	CED	324.9988	2.33030	2.30113	12.91654	49.61454	1.02179	0.00000	0.7948	-0.71715	2.21841	0.04560	0.00000
175	000	326.1070	2.34314	2.30487	14.65001	44.84423	1.07233	0.00000	0.7948	-0.84707	2.08615	0.04560	0.00000
176	B2	332.1776	2.39050	2.33455	29.25375	23.90166	1.40873	0.00000	0.8190	-1.55873	1.36302	0.06524	0.00000
177	0	332.4824	2.39213	2.33662	30.21485	23.08187	1.42862	0.00000	0.8190	-1.59447	1.32658	0.06524	0.00000
178	B2	338.5530	2.41617	2.39773	53.89224	11.37611	1.88422	0.00000	0.8513	-2.30612	0.60132	0.08487	0.00000
179	0	338.8578	2.41705	2.40206	55.30894	11.02066	1.91008	0.00000	0.8513	-2.34186	0.56484	0.08487	0.00000

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
180	QF	339.9246	2.42003	2.41805	57.82678	10.42255	1.95697	0.00000	0.8513	0.01732	0.00424	0.00269	0.00000
181	QF	340.9914	2.42302	2.43405	55.23723	11.00202	1.91578	0.00000	0.8513	2.37342	-0.55558	-0.07961	0.00000
182	BPM	341.1474	2.42347	2.43629	54.49951	11.17829	1.90336	0.00000	0.8513	2.35468	-0.57414	-0.07961	0.00000
183	CED	341.9950	2.42604	2.44784	50.59412	12.23702	1.83588	0.00000	0.8513	2.25290	-0.67496	-0.07961	0.00000
184	000	343.1032	2.42970	2.46139	45.74828	13.87909	1.74765	0.00000	0.8513	2.11982	-0.80678	-0.07961	0.00000
185	B2	349.1738	2.45876	2.51116	24.43756	28.05061	1.32397	0.00000	0.8813	1.39088	-1.52722	-0.05998	0.00000
186	0	349.4786	2.46078	2.51286	23.60083	28.99264	1.30569	0.00000	0.8813	1.35428	-1.56343	-0.05998	0.00000
187	B2	355.5492	2.52061	2.53777	11.58406	52.33780	1.00120	0.00000	0.9037	0.62535	-2.28143	-0.04034	0.00000
188	0	355.8540	2.52486	2.53868	11.21400	53.73958	0.98891	0.00000	0.9037	0.58875	-2.31757	-0.04034	0.00000
189	QD	356.9208	2.54060	2.54175	10.57216	56.28098	0.96794	0.00000	0.9037	0.02192	-0.02875	0.00089	0.00000
190	QD	357.9876	2.55641	2.54481	11.11760	53.85861	0.99082	0.00000	0.9037	-0.54088	2.26518	0.04216	0.00000
191	BPM	358.1437	2.55862	2.54527	11.28922	53.15451	0.99740	0.00000	0.9037	-0.55902	2.24742	0.04216	0.00000
192	CED	358.9913	2.57007	2.54790	12.32040	49.42646	1.03314	0.00000	0.9037	-0.65756	2.15093	0.04216	0.00000
193	000	360.0995	2.58355	2.55165	13.92060	44.79894	1.07987	0.00000	0.9037	-0.78640	2.02478	0.04216	0.00000
194	B2	366.1701	2.63352	2.58104	27.75182	24.39828	1.39541	0.00000	0.9279	-1.49214	1.33514	0.06180	0.00000
195	0	366.4749	2.63524	2.58306	28.67223	23.59497	1.41425	0.00000	0.9279	-1.52757	1.30038	0.06180	0.00000
196	B2	372.5455	2.66049	2.64180	51.50155	12.00370	1.84899	0.00000	0.9597	-2.23331	0.60866	0.08144	0.00000
197	0	372.8503	2.66142	2.64590	52.87377	11.64327	1.87381	0.00000	0.9597	-2.26874	0.57386	0.08144	0.00000
198	QF	373.9171	2.66454	2.66101	55.34753	11.04749	1.91787	0.00000	0.9597	-0.01510	-0.00701	0.00086	0.00000
199	QF	374.9839	2.66765	2.67609	52.93627	11.67409	1.87562	0.00000	0.9597	2.24123	-0.58917	-0.07976	0.00000
200	BPM	375.1399	2.66812	2.67820	52.23964	11.86075	1.86317	0.00000	0.9597	2.22348	-0.60717	-0.07976	0.00000
201	CED	375.9875	2.67080	2.68909	48.55214	12.97293	1.79557	0.00000	0.9597	2.12704	-0.70498	-0.07976	0.00000
202	000	377.0957	2.67462	2.70188	43.97750	14.67716	1.70717	0.00000	0.9597	2.00095	-0.83286	-0.07976	0.00000
203	B2	383.1663	2.70461	2.74939	23.87768	29.03398	1.28258	0.00000	0.9889	1.31028	-1.53166	-0.06013	0.00000
204	0	383.4711	2.70667	2.75103	23.08950	29.97838	1.26425	0.00000	0.9889	1.27559	-1.56679	-0.06013	0.00000
205	B2	389.5417	2.76662	2.77531	11.79578	53.23280	0.95886	0.00000	1.0105	0.58492	-2.26314	-0.04049	0.00000
206	0	389.8465	2.77080	2.77621	11.44978	54.62309	0.94651	0.00000	1.0105	0.55024	-2.29819	-0.04049	0.00000
207	QD	390.9133	2.78614	2.77923	10.89611	57.08111	0.92443	0.00000	1.0105	-0.02346	0.02885	-0.00107	0.00000
208	QD	391.9801	2.80141	2.78225	11.55291	54.50367	0.94421	0.00000	1.0105	-0.60145	2.35075	0.03831	0.00000
209	BPM	392.1361	2.80354	2.78271	11.74347	53.77301	0.95019	0.00000	1.0105	-0.61984	2.33207	0.03831	0.00000

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
210 CED	392.9837	2.81452	2.78532	12.87891	49.90571	0.98266	0.00000	1.0105	-0.71975	2.23058	0.03831	0.00000
211 000	394.0919	2.82738	2.78903	14.61893	45.10889	1.02511	0.00000	1.0105	-0.85037	2.09789	0.03831	0.00000
212 B2	400.1625	2.87477	2.81854	29.28605	24.03802	1.31722	0.00000	1.0333	-1.56587	1.37241	0.05794	0.00000
213 0	400.4673	2.87640	2.82060	30.25155	23.21254	1.33489	0.00000	1.0333	-1.60180	1.33585	0.05794	0.00000
214 B2	406.5379	2.90039	2.88144	54.04127	11.40858	1.74619	0.00000	1.0633	-2.31730	0.60823	0.07758	0.00000
215 0	406.8427	2.90127	2.88576	55.46485	11.04896	1.76984	0.00000	1.0633	-2.35322	0.57163	0.07758	0.00000
216 QF	407.9095	2.90424	2.90172	57.99999	10.43768	1.81215	0.00000	1.0633	0.01272	0.00998	0.00145	0.00000
217 QF	408.9763	2.90722	2.91770	55.41220	11.00507	1.77291	0.00000	1.0633	2.37639	-0.54983	-0.07474	0.00000
218 BPM	409.1323	2.90767	2.91994	54.67354	11.17953	1.76125	0.00000	1.0633	2.35768	-0.56829	-0.07474	0.00000
219 CED	409.9799	2.91023	2.93149	50.76299	12.22792	1.69790	0.00000	1.0633	2.25600	-0.66860	-0.07474	0.00000
220 000	411.0881	2.91388	2.94506	45.91012	13.85512	1.61508	0.00000	1.0633	2.12306	-0.79974	-0.07474	0.00000
221 B2	417.1587	2.94282	2.99500	24.55552	27.91866	1.22100	0.00000	1.0910	1.39488	-1.51648	-0.05510	0.00000
222 0	417.4635	2.94483	2.99671	23.71634	28.85409	1.20420	0.00000	1.0910	1.35831	-1.55251	-0.05510	0.00000
223 B2	423.5341	3.00433	3.02174	11.64608	52.04418	0.92931	0.00000	1.1117	0.63013	-2.26682	-0.03547	0.00000
224 0	423.8389	3.00857	3.02266	11.27310	53.43700	0.91850	0.00000	1.1117	0.59357	-2.30277	-0.03547	0.00000
225 QD	424.9057	3.02423	3.02574	10.62323	55.96054	0.90119	0.00000	1.1117	0.02475	-0.02706	0.00288	0.00000
226 QD	425.9725	3.03996	3.02882	11.16429	53.54902	0.92469	0.00000	1.1117	-0.53954	2.25347	0.04135	0.00000
227 BPM	426.1286	3.04217	3.02929	11.33548	52.84857	0.93114	0.00000	1.1117	-0.55758	2.23576	0.04135	0.00000
228 CED	426.9762	3.05357	3.03194	12.36377	49.14006	0.96619	0.00000	1.1117	-0.65560	2.13955	0.04135	0.00000
229 000	428.0844	3.06701	3.03571	13.95888	44.53736	1.01201	0.00000	1.1117	-0.78376	2.01376	0.04135	0.00000
230 B2	434.1550	3.11693	3.06527	27.73532	24.25833	1.32261	0.00000	1.1345	-1.48575	1.32612	0.06099	0.00000
231 0	434.4598	3.11865	3.06730	28.65178	23.46049	1.34120	0.00000	1.1345	-1.52100	1.29146	0.06099	0.00000
232 B2	440.5304	3.14393	3.12631	51.37865	11.96532	1.77099	0.00000	1.1648	-2.22300	0.60175	0.08062	0.00000
233 0	440.8352	3.14487	3.13043	52.74453	11.60906	1.79557	0.00000	1.1648	-2.25825	0.56706	0.08062	0.00000
234 QF	441.9020	3.14799	3.14557	55.20163	11.02630	1.84053	0.00000	1.1648	-0.01021	-0.01258	0.00335	0.00000
235 QF	442.9688	3.15111	3.16068	52.78679	11.66439	1.80266	0.00000	1.1648	2.23965	-0.59453	-0.07408	0.00000
236 BPM	443.1248	3.15159	3.16279	52.09066	11.85274	1.79110	0.00000	1.1648	2.22187	-0.61263	-0.07408	0.00000
237 CED	443.9724	3.15427	3.17368	48.40603	12.97464	1.72831	0.00000	1.1648	2.12527	-0.71098	-0.07408	0.00000
238 000	445.0806	3.15810	3.18647	43.83555	14.69296	1.64621	0.00000	1.1648	1.99897	-0.83957	-0.07408	0.00000
239 B2	451.1512	3.18821	3.23384	23.76670	29.15484	1.25614	0.00000	1.1931	1.30715	-1.54225	-0.05444	0.00000
240 0	451.4560	3.19029	3.23548	22.98045	30.10576	1.23955	0.00000	1.1931	1.27242	-1.57757	-0.05444	0.00000
241 B2	457.5266	3.25055	3.25965	11.73222	53.51460	0.96867	0.00000	1.2146	0.58060	-2.27778	-0.03481	0.00000
242 0	457.8314	3.25475	3.26054	11.38887	54.91388	0.95806	0.00000	1.2146	0.54587	-2.31303	-0.03481	0.00000
243 QD	458.8982	3.27017	3.26354	10.84224	57.39042	0.94234	0.00000	1.2146	-0.02578	0.02660	0.00524	0.00000
244 QD	459.9650	3.28551	3.26655	11.50223	54.80377	0.96931	0.00000	1.2146	-0.60216	2.36150	0.04552	0.00000
245 BPM	460.1210	3.28765	3.26700	11.69302	54.06976	0.97642	0.00000	1.2146	-0.62064	2.34277	0.04552	0.00000
246 CED	460.9686	3.29868	3.26959	12.83024	50.18450	1.01500	0.00000	1.2146	-0.72105	2.24106	0.04552	0.00000
247 000	462.0768	3.31159	3.27329	14.57386	45.36480	1.06544	0.00000	1.2146	-0.85233	2.10807	0.04552	0.00000
248 B2	468.1474	3.35905	3.30263	29.28658	24.18015	1.40135	0.00000	1.2386	-1.57143	1.38097	0.06515	0.00000
249 0	468.4522	3.36068	3.30467	30.25553	23.34948	1.42121	0.00000	1.2386	-1.60754	1.34432	0.06515	0.00000
250 B2	474.5228	3.38464	3.36520	54.13676	11.45250	1.87630	0.00000	1.2708	-2.32663	0.61507	0.08479	0.00000
251 0	474.8276	3.38553	3.36951	55.56608	11.08873	1.90215	0.00000	1.2708	-2.36274	0.57839	0.08479	0.00000
252 QF	475.8944	3.38849	3.38541	58.11709	10.46472	1.94912	0.00000	1.2708	0.00759	0.01533	0.00294	0.00000
253 QF	476.9612	3.39146	3.40137	55.53466	11.02132	1.90838	0.00000	1.2708	2.37657	-0.54491	-0.07904	0.00000
254 BPM	477.1173	3.39191	3.40360	54.79594	11.19423	1.89605	0.00000	1.2708	2.35789	-0.56327	-0.07904	0.00000
255 CED	477.9649	3.39447	3.41514	50.88484	12.23363	1.82905	0.00000	1.2708	2.25643	-0.66301	-0.07904	0.00000
256 000	479.0731	3.39811	3.42871	46.03072	13.84765	1.74146	0.00000	1.2708	2.12376	-0.79342	-0.07904	0.00000
257 B2	485.1437	3.42694	3.47876	24.65837	27.81009	1.32129	0.00000	1.3007	1.39709	-1.50615	-0.05940	0.00000
258 0	485.4485	3.42895	3.48048	23.81783	28.73915	1.30318	0.00000	1.3007	1.36061	-1.54197	-0.05940	0.00000
259 B2	491.5191	3.48815	3.50563	11.71053	51.77700	1.00220	0.00000	1.3231	0.63394	-2.25229	-0.03977	0.00000
260 0	491.8239	3.49236	3.50656	11.33520	53.16089	0.99008	0.00000	1.3231	0.59745	-2.28803	-0.03977	0.00000
261 QD	492.8907	3.50793	3.50965	10.67935	55.66545	0.96976	0.00000	1.3231	0.02655	-0.02428	0.00153	0.00000
262 QD	493.9575	3.52359	3.51275	11.21846	53.26140	0.99337	0.00000	1.3231	-0.53948	2.24380	0.04290	0.00000
263 BPM	494.1135	3.52578	3.51322	11.38961	52.56396	1.00006	0.00000	1.3231	-0.55743	2.22612	0.04290	0.00000
264 CED	494.9611	3.53714	3.51588	12.41725	48.87164	1.03642	0.00000	1.3231	-0.65498	2.13008	0.04290	0.00000

	265	000	496.0693	3.55052	3.51967	14.01028	44.28968	1.08396	0.00000	1.3231	-0.78251	2.00452	0.04290	0.00000
	266	B2	502.1399	3.60033	3.54941	27.75075	24.11543	1.40395	0.00000	1.3474	-1.48108	1.31811	0.06253	0.00000
	267	0	502.4447	3.60205	3.55145	28.66431	23.32245	1.42301	0.00000	1.3474	-1.51616	1.28351	0.06253	0.00000
	268	B2	508.5153	3.62735	3.61077	51.31155	11.91630	1.86219	0.00000	1.3794	-2.21473	0.59504	0.08217	0.00000
	269	0	508.8201	3.62828	3.61491	52.67234	11.56412	1.88723	0.00000	1.3794	-2.24980	0.56041	0.08217	0.00000
1	POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
	270	QF	509.8869	3.63141	3.63010	55.11454	10.99368	1.93176	0.00000	1.3794	-0.00490	-0.01765	0.00101	0.00000
	271	QF	510.9537	3.63453	3.64524	52.69261	11.64174	1.88936	0.00000	1.3794	2.24088	-0.59895	-0.08020	0.00000
	272	BPM	511.1097	3.63501	3.64736	51.99611	11.83149	1.87685	0.00000	1.3794	2.22305	-0.61716	-0.08020	0.00000
	273	CED	511.9573	3.63770	3.65826	48.30969	12.96155	1.80887	0.00000	1.3794	2.12619	-0.71609	-0.08020	0.00000
	274	000	513.0655	3.64154	3.67106	43.73755	14.69203	1.71999	0.00000	1.3794	1.99955	-0.84543	-0.08020	0.00000
	275	B2	519.1361	3.67174	3.71836	23.67302	29.25005	1.29276	0.00000	1.4088	1.30586	-1.55223	-0.06056	0.00000
	276	0	519.4409	3.67383	3.71999	22.88759	30.20712	1.27430	0.00000	1.4088	1.27103	-1.58775	-0.06056	0.00000
	277	B2	525.5115	3.73440	3.74406	11.66754	53.76452	0.96625	0.00000	1.4306	0.57735	-2.29207	-0.04093	0.00000
	278	0	525.8163	3.73862	3.74495	11.32621	55.17257	0.95377	0.00000	1.4306	0.54252	-2.32752	-0.04093	0.00000
	279	QD	526.8831	3.75412	3.74793	10.78443	57.66836	0.93138	0.00000	1.4306	-0.02705	0.02331	-0.00121	0.00000
	280	QD	527.9499	3.76954	3.75092	11.44514	55.07606	0.95118	0.00000	1.4306	-0.60157	2.37000	0.03846	0.00000
	281	BPM	528.1060	3.77170	3.75138	11.63576	54.33941	0.95718	0.00000	1.4306	-0.62014	2.35126	0.03846	0.00000
	282	CED	528.9536	3.78277	3.75395	12.77250	50.43987	0.98978	0.00000	1.4306	-0.72100	2.24942	0.03846	0.00000
	283	000	530.0618	3.79574	3.75763	14.51665	45.60179	1.03241	0.00000	1.4306	-0.85286	2.11628	0.03846	0.00000
	284	B2	536.1324	3.84332	3.78681	29.25534	24.32242	1.32548	0.00000	1.4536	-1.57517	1.38836	0.05810	0.00000
	285	0	536.4372	3.84496	3.78884	30.22662	23.48726	1.34318	0.00000	1.4536	-1.61144	1.35167	0.05810	0.00000
	286	B2	542.5078	3.86892	3.84903	54.17478	11.50612	1.75545	0.00000	1.4838	-2.33375	0.62158	0.07773	0.00000
	287	0	542.8126	3.86980	3.85332	55.60849	11.13840	1.77914	0.00000	1.4838	-2.37002	0.58486	0.07773	0.00000
	288	QF	543.8794	3.87277	3.86916	58.17327	10.50260	1.82141	0.00000	1.4838	0.00215	0.02007	0.00121	0.00000
	289	QF	544.9462	3.87573	3.88507	55.59958	11.05014	1.78171	0.00000	1.4838	2.37394	-0.54102	-0.07536	0.00000
	290	BPM	545.1022	3.87618	3.88730	54.86167	11.22182	1.76995	0.00000	1.4838	2.35532	-0.55928	-0.07536	0.00000
	291	CED	545.9498	3.87873	3.89881	50.95467	12.25395	1.70608	0.00000	1.4838	2.25416	-0.65844	-0.07536	0.00000
	292	000	547.0580	3.88237	3.91236	46.10511	13.85698	1.62256	0.00000	1.4838	2.12190	-0.78808	-0.07536	0.00000
	293	B2	553.1286	3.91113	3.96248	24.74191	27.72919	1.22471	0.00000	1.5115	1.39745	-1.49663	-0.05572	0.00000
	294	0	553.4334	3.91313	3.96420	23.90111	28.65239	1.20773	0.00000	1.5115	1.36107	-1.53224	-0.05572	0.00000
	295	B2	559.5040	3.97205	3.98944	11.77476	51.54683	0.92907	0.00000	1.5323	0.63661	-2.23840	-0.03609	0.00000
	296	0	559.8088	3.97624	3.99037	11.39777	52.92219	0.91807	0.00000	1.5323	0.60024	-2.27394	-0.03609	0.00000
	297	QD	560.8756	3.99173	3.99348	10.73824	55.40741	0.90007	0.00000	1.5323	0.02727	-0.02052	0.00222	0.00000
	298	QD	561.9424	4.00730	3.99659	11.27788	53.00713	0.92285	0.00000	1.5323	-0.54070	2.23655	0.04063	0.00000
	299	BPM	562.0984	4.00948	3.99706	11.44940	52.31195	0.92919	0.00000	1.5323	-0.55858	2.21888	0.04063	0.00000
	300	CED	562.9460	4.02078	3.99974	12.47864	48.63186	0.96363	0.00000	1.5323	-0.65571	2.12290	0.04063	0.00000
	301	000	564.0542	4.03410	4.00355	14.07269	44.06572	1.00866	0.00000	1.5323	-0.78270	1.99742	0.04063	0.00000
	302	B2	570.1248	4.08375	4.03345	27.79748	23.97522	1.31492	0.00000	1.5549	-1.47830	1.31142	0.06027	0.00000
	303	0	570.4296	4.08547	4.03551	28.70930	23.18632	1.33329	0.00000	1.5549	-1.51323	1.27684	0.06027	0.00000
	304	B2	576.5002	4.11075	4.09516	51.30301	11.85860	1.75873	0.00000	1.5851	-2.20883	0.58880	0.07991	0.00000
	305	0	576.8050	4.11168	4.09931	52.66016	11.51023	1.78309	0.00000	1.5851	-2.24376	0.55418	0.07991	0.00000
	306	QF	577.8718	4.11481	4.11457	55.08984	10.95091	1.82757	0.00000	1.5851	0.00061	-0.02202	0.00317	0.00000
	307	QF	578.9386	4.11794	4.12977	52.65761	11.60705	1.78980	0.00000	1.5851	2.24488	-0.60226	-0.07371	0.00000
	308	BPM	579.0946	4.11841	4.13189	51.95987	11.79785	1.77830	0.00000	1.5851	2.22698	-0.62058	-0.07371	0.00000
	309	CED	579.9422	4.12111	4.14282	48.26709	12.93421	1.71583	0.00000	1.5851	2.12977	-0.72009	-0.07371	0.00000
	310	000	581.0504	4.12495	4.15564	43.68753	14.67441	1.63415	0.00000	1.5851	2.00267	-0.85020	-0.07371	0.00000
	311	B2	587.1210	4.15522	4.20291	23.60049	29.31584	1.24634	0.00000	1.6132	1.30645	-1.56119	-0.05407	0.00000
	312	0	587.4258	4.15731	4.20454	22.81473	30.27843	1.22986	0.00000	1.6132	1.27149	-1.59693	-0.05407	0.00000
	313	B2	593.4964	4.21815	4.22853	11.60442	53.97265	0.96125	0.00000	1.6345	0.57528	-2.30543	-0.03443	0.00000
	314	0	593.8012	4.22240	4.22942	11.26438	55.38891	0.95075	0.00000	1.6345	0.54032	-2.34109	-0.03443	0.00000
1	POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
	315	QD	594.8680	4.23799	4.23239	10.72507	57.90393	0.93527	0.00000	1.6345	-0.02721	0.01912	0.00531	0.00000
	316	QD	595.9348	4.25349	4.23537	11.38399	55.30977	0.96216	0.00000	1.6345	-0.59972	2.37592	0.04529	0.00000
	317	BPM	596.0909	4.25566	4.23582	11.57405	54.57126	0.96923	0.00000	1.6345	-0.61835	2.35718	0.04529	0.00000
	318	CED	596.9385	4.26679	4.23839	12.70809	50.66169	1.00761	0.00000	1.6345	-0.71959	2.25535	0.04529	0.00000

319	000	598.0467	4.27982	4.24205	14.44967	45.81049	1.05780	0.00000	1.6345	-0.85195	2.12220	0.04529	0.00000
320	B2	604.1173	4.32757	4.27108	29.19361	24.45917	1.39231	0.00000	1.6584	-1.57695	1.39428	0.06492	0.00000
321	0	604.4221	4.32921	4.27309	30.16601	23.62040	1.41210	0.00000	1.6584	-1.61336	1.35760	0.06492	0.00000
322	B2	610.4927	4.35320	4.33295	54.15377	11.56732	1.86581	0.00000	1.6904	-2.33836	0.62750	0.08456	0.00000
323	0	610.7975	4.35408	4.33721	55.59033	11.19599	1.89158	0.00000	1.6904	-2.37476	0.59078	0.08456	0.00000
324	QF	611.8643	4.35705	4.35297	58.16623	10.54982	1.93855	0.00000	1.6904	-0.00337	0.02402	0.00316	0.00000
325	QF	612.9311	4.36001	4.36882	55.60429	11.09036	1.89828	0.00000	1.6904	2.36862	-0.53832	-0.07838	0.00000
326	BPM	613.0871	4.36046	4.37104	54.86804	11.26118	1.88605	0.00000	1.6904	2.35007	-0.55647	-0.07838	0.00000
327	CED	613.9347	4.36301	4.38252	50.96961	12.28806	1.81961	0.00000	1.6904	2.24930	-0.65504	-0.07838	0.00000
328	000	615.0429	4.36665	4.39604	46.13025	13.88272	1.73276	0.00000	1.6904	2.11756	-0.78392	-0.07838	0.00000
329	B2	621.1135	4.39537	4.44615	24.80269	27.67917	1.31658	0.00000	1.7201	1.39592	-1.48830	-0.05874	0.00000
330	0	621.4183	4.39736	4.44787	23.96279	28.59723	1.29868	0.00000	1.7201	1.35969	-1.52371	-0.05874	0.00000
331	B2	627.4889	4.45604	4.47319	11.83614	51.36281	1.00169	0.00000	1.7425	0.63805	-2.22571	-0.03911	0.00000
332	0	627.7937	4.46021	4.47412	11.45823	52.73037	0.98977	0.00000	1.7425	0.60181	-2.26104	-0.03911	0.00000
333	QD	628.8605	4.47561	4.47724	10.79747	55.19665	0.97015	0.00000	1.7425	0.02686	-0.01593	0.00219	0.00000
334	QD	629.9273	4.49109	4.48037	11.34012	52.79632	0.99448	0.00000	1.7425	-0.54316	2.23201	0.04359	0.00000
335	BPM	630.0833	4.49327	4.48084	11.51240	52.10255	1.00128	0.00000	1.7425	-0.56098	2.21433	0.04359	0.00000
336	CED	630.9309	4.50450	4.48352	12.54541	48.43022	1.03823	0.00000	1.7425	-0.65778	2.11830	0.04359	0.00000
337	000	632.0391	4.51776	4.48735	14.14356	43.87437	1.08654	0.00000	1.7425	-0.78433	1.99274	0.04359	0.00000
338	B2	638.1097	4.56721	4.51740	27.87358	23.84327	1.41073	0.00000	1.7668	-1.47754	1.30632	0.06322	0.00000
339	0	638.4145	4.56892	4.51947	28.78490	23.05749	1.43000	0.00000	1.7668	-1.51235	1.27172	0.06322	0.00000
340	B2	644.4851	4.59415	4.57947	51.35336	11.79451	1.87338	0.00000	1.7990	-2.20556	0.58326	0.08286	0.00000
341	0	644.7899	4.59509	4.58364	52.70848	11.44951	1.89864	0.00000	1.7990	-2.24036	0.54862	0.08286	0.00000
342	QF	645.8567	4.59821	4.59898	55.12855	10.89971	1.94365	0.00000	1.7990	0.00610	-0.02551	0.00120	0.00000
343	QF	646.9235	4.60134	4.61424	52.68323	11.56169	1.90119	0.00000	1.7990	2.25148	-0.60433	-0.08051	0.00000
344	BPM	647.0796	4.60181	4.61637	51.98344	11.75315	1.88863	0.00000	1.7990	2.23350	-0.62275	-0.08051	0.00000
345	CED	647.9272	4.60451	4.62734	48.27997	12.89367	1.82039	0.00000	1.7990	2.13586	-0.72284	-0.08051	0.00000
346	000	649.0354	4.60835	4.64019	43.68753	14.64079	1.73117	0.00000	1.7990	2.00819	-0.85370	-0.08051	0.00000
347	B2	655.1060	4.63865	4.68749	23.55208	29.34959	1.30208	0.00000	1.8286	1.30890	-1.56879	-0.06087	0.00000
348	0	655.4108	4.64074	4.68912	22.76488	30.31688	1.28352	0.00000	1.8286	1.27379	-1.60474	-0.06087	0.00000
349	B2	661.4814	4.70182	4.71306	11.54543	54.13073	0.97362	0.00000	1.8506	0.57449	-2.31732	-0.04124	0.00000
350	0	661.7862	4.70609	4.71395	11.20592	55.55430	0.96105	0.00000	1.8506	0.53938	-2.35319	-0.04124	0.00000
351	QD	662.8530	4.72176	4.71691	10.66659	58.08779	0.93849	0.00000	1.8506	-0.02624	0.01418	-0.00121	0.00000
352	QD	663.9198	4.73735	4.71988	11.32131	55.49560	0.95845	0.00000	1.8506	-0.59668	2.37903	0.03876	0.00000
353	BPM	664.0758	4.73953	4.72033	11.51042	54.75612	0.96450	0.00000	1.8506	-0.61537	2.36031	0.03876	0.00000
354	CED	664.9234	4.75072	4.72289	12.63964	50.84115	0.99735	0.00000	1.8506	-0.71689	2.25859	0.03876	0.00000
355	000	666.0316	4.76382	4.72654	14.37565	45.98260	1.04031	0.00000	1.8506	-0.84963	2.12560	0.03876	0.00000
356	B2	672.1022	4.81178	4.75543	29.10392	24.58500	1.33520	0.00000	1.8737	-1.57669	1.39851	0.05840	0.00000
357	0	672.4070	4.81342	4.75744	30.07620	23.74363	1.35300	0.00000	1.8737	-1.61320	1.36187	0.05840	0.00000
358	B2	678.4776	4.83746	4.81695	54.07458	11.63368	1.76708	0.00000	1.9042	-2.34027	0.63260	0.07803	0.00000
359	0	678.7824	4.83835	4.82119	55.51234	11.25923	1.79086	0.00000	1.9042	-2.37678	0.59592	0.07803	0.00000

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
360	QF	679.8492	4.84132	4.83687	58.09625	10.60450	1.83319	0.00000	1.9042	-0.00876	0.02702	0.00101	0.00000
361	QF	680.9160	4.84428	4.85263	55.54861	11.14041	1.79301	0.00000	1.9042	2.36081	-0.53691	-0.07605	0.00000
362	BPM	681.0720	4.84473	4.85484	54.81478	11.31077	1.78115	0.00000	1.9042	2.34235	-0.55495	-0.07605	0.00000
363	CED	681.9196	4.84729	4.86627	50.92904	12.33461	1.71669	0.00000	1.9042	2.24205	-0.65297	-0.07605	0.00000
364	000	683.0278	4.85093	4.87975	46.10510	13.92387	1.63241	0.00000	1.9042	2.11091	-0.78112	-0.07605	0.00000
365	B2	689.0984	4.87963	4.92980	24.83823	27.66202	1.23037	0.00000	1.9321	1.39258	-1.48150	-0.05641	0.00000
366	0	689.4032	4.88162	4.93153	24.00031	28.57588	1.21317	0.00000	1.9321	1.35651	-1.51671	-0.05641	0.00000
367	B2	695.4738	4.94011	4.95688	11.89213	51.23224	0.93032	0.00000	1.9529	0.63818	-2.21472	-0.03678	0.00000
368	0	695.7786	4.94426	4.95782	11.51409	52.59304	0.91911	0.00000	1.9529	0.60211	-2.24985	-0.03678	0.00000
369	QD	696.8454	4.95958	4.96095	10.85460	55.04153	0.90040	0.00000	1.9529	0.02536	-0.01069	0.00156	0.00000
370	QD	697.9122	4.97498	4.96408	11.40261	52.63731	0.92247	0.00000	1.9529	-0.54675	2.23036	0.03997	0.00000
371	BPM	698.0683	4.97714	4.96456	11.57600	51.94406	0.92871	0.00000	1.9529	-0.56453	2.21265	0.03997	0.00000
372	CED	698.9159	4.98832	4.96725	12.61483	48.27471	0.96259	0.00000	1.9529	-0.66108	2.11645	0.03997	0.00000

373	000	700.0241	5.00150	4.97109	14.21996	43.72321	1.00689	0.00000	1.9529	-0.78733	1.99066	0.03997	0.00000
374	B2	706.0947	5.05072	5.00127	27.97594	23.72482	1.30912	0.00000	1.9755	-1.47882	1.30300	0.05961	0.00000
375	0	706.3995	5.05242	5.00335	28.88801	22.94107	1.32729	0.00000	1.9755	-1.51354	1.26834	0.05961	0.00000
376	B2	712.4701	5.07759	5.06369	51.46056	11.72655	1.74872	0.00000	2.0055	-2.20504	0.57865	0.07924	0.00000
377	0	712.7749	5.07852	5.06789	52.81533	11.38438	1.77287	0.00000	2.0055	-2.23976	0.54395	0.07924	0.00000
378	QF	713.8417	5.08164	5.08331	55.22907	10.84210	1.81688	0.00000	2.0055	0.01133	-0.02799	0.00295	0.00000
379	QF	714.9085	5.08476	5.09865	52.76841	11.50746	1.77912	0.00000	2.0055	2.26041	-0.60507	-0.07347	0.00000
380	BPM	715.0645	5.08523	5.10079	52.06584	11.69917	1.76766	0.00000	2.0055	2.24234	-0.62359	-0.07347	0.00000
381	CED	715.9121	5.08792	5.11180	48.34780	12.84157	1.70539	0.00000	2.0055	2.14421	-0.72422	-0.07347	0.00000
382	000	717.0203	5.09176	5.12470	43.73756	14.59252	1.62397	0.00000	2.0055	2.01590	-0.85578	-0.07347	0.00000
383	B2	723.0909	5.12206	5.17208	23.52978	29.34997	1.23760	0.00000	2.0334	1.31310	-1.57472	-0.05383	0.00000
384	0	723.3957	5.12415	5.17371	22.74007	30.32093	1.22119	0.00000	2.0334	1.27782	-1.61086	-0.05383	0.00000
385	B2	729.4663	5.18541	5.19763	11.49300	54.23250	0.95401	0.00000	2.0545	0.57502	-2.32729	-0.03420	0.00000
386	0	729.7711	5.18970	5.19851	11.15323	55.66221	0.94358	0.00000	2.0545	0.53973	-2.36335	-0.03420	0.00000
387	QD	730.8379	5.20545	5.20147	10.61139	58.21264	0.92820	0.00000	2.0545	-0.02421	0.00870	0.00524	0.00000
388	QD	731.9047	5.22113	5.20443	11.25965	55.62621	0.95485	0.00000	2.0545	-0.59257	2.37920	0.04492	0.00000
389	BPM	732.0607	5.22331	5.20488	11.44749	54.88667	0.96186	0.00000	2.0545	-0.61130	2.36051	0.04492	0.00000
390	CED	732.9083	5.23457	5.20743	12.56997	50.97115	0.99994	0.00000	2.0545	-0.71301	2.25902	0.04492	0.00000
391	000	734.0165	5.24774	5.21107	14.29765	46.11130	1.04972	0.00000	2.0545	-0.84599	2.12633	0.04492	0.00000
392	B2	740.0871	5.29593	5.23986	28.98995	24.69490	1.38201	0.00000	2.0782	-1.57441	1.40088	0.06456	0.00000
393	0	740.3919	5.29757	5.24186	29.96086	23.85208	1.40168	0.00000	2.0782	-1.61098	1.36431	0.06456	0.00000
394	B2	746.4625	5.32170	5.30104	53.94048	11.70256	1.85316	0.00000	2.1100	-2.33940	0.63667	0.08419	0.00000
395	0	746.7673	5.32258	5.30526	55.37773	11.32560	1.87882	0.00000	2.1100	-2.37597	0.60007	0.08419	0.00000
396	QF	747.8341	5.32556	5.32085	57.96622	10.66448	1.92569	0.00000	2.1100	-0.01379	0.02896	0.00334	0.00000
397	QF	748.9009	5.32853	5.33653	55.43482	11.19829	1.88589	0.00000	2.1100	2.35085	-0.53685	-0.07766	0.00000
398	BPM	749.0569	5.32898	5.33873	54.70408	11.36861	1.87378	0.00000	2.1100	2.33248	-0.55480	-0.07766	0.00000
399	CED	749.9045	5.33154	5.35010	50.83464	12.39175	1.80795	0.00000	2.1100	2.23269	-0.65230	-0.07766	0.00000
400	000	751.0127	5.33519	5.36352	46.03070	13.97879	1.72188	0.00000	2.1100	2.10222	-0.77978	-0.07766	0.00000
401	B2	757.0833	5.36391	5.41345	24.84706	27.67842	1.31004	0.00000	2.1395	1.38755	-1.47650	-0.05803	0.00000
402	0	757.3881	5.36589	5.41518	24.01215	28.58917	1.29235	0.00000	2.1395	1.35167	-1.51152	-0.05803	0.00000
403	B2	763.4587	5.42425	5.44055	11.94045	51.16029	0.99970	0.00000	2.1618	0.63701	-2.20587	-0.03839	0.00000
404	0	763.7635	5.42838	5.44148	11.56307	52.51564	0.98800	0.00000	2.1618	0.60112	-2.24082	-0.03839	0.00000

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
405	QD	764.8303	5.44363	5.44462	10.90729	54.94820	0.96911	0.00000	2.1618	0.02281	-0.00502	0.00285	0.00000
406	QD	765.8971	5.45896	5.44776	11.46279	52.53641	0.99412	0.00000	2.1618	-0.55133	2.23168	0.04421	0.00000
407	BPM	766.0532	5.46111	5.44823	11.63761	51.84276	1.00102	0.00000	2.1618	-0.56908	2.21391	0.04421	0.00000
408	CED	766.9008	5.47222	5.45093	12.68404	48.17151	1.03849	0.00000	2.1618	-0.66550	2.11743	0.04421	0.00000
409	000	768.0090	5.48533	5.45478	14.29877	43.61824	1.08749	0.00000	2.1618	-0.79157	1.99128	0.04421	0.00000
410	B2	774.0796	5.53430	5.48506	28.10034	23.62455	1.41548	0.00000	2.1862	-1.48209	1.30161	0.06385	0.00000
411	0	774.3844	5.53599	5.48715	29.01439	22.84169	1.43494	0.00000	2.1862	-1.51676	1.26685	0.06385	0.00000
412	B2	780.4550	5.56106	5.54782	51.62018	11.65744	1.88212	0.00000	2.2186	-2.20729	0.57516	0.08349	0.00000
413	0	780.7598	5.56199	5.55204	52.97632	11.31743	1.90756	0.00000	2.2186	-2.24196	0.54036	0.08349	0.00000
414	QF	781.8266	5.56510	5.56755	55.38728	10.78035	1.95303	0.00000	2.2186	0.01610	-0.02936	0.00144	0.00000
415	QF	782.8934	5.56821	5.58298	52.90965	11.44650	1.91061	0.00000	2.2186	2.27130	-0.60446	-0.08067	0.00000
416	BPM	783.0494	5.56869	5.58513	52.20370	11.63803	1.89803	0.00000	2.2186	2.25314	-0.62307	-0.08067	0.00000
417	CED	783.8970	5.57137	5.59620	48.46780	12.77995	1.82965	0.00000	2.2186	2.15448	-0.72417	-0.08067	0.00000
418	000	785.0052	5.57520	5.60915	43.83557	14.53150	1.74025	0.00000	2.2186	2.02548	-0.85636	-0.08067	0.00000
419	B2	791.0758	5.60546	5.65667	23.53451	29.31696	1.31016	0.00000	2.2484	1.31889	-1.57875	-0.06103	0.00000
420	0	791.3806	5.60755	5.65829	22.74132	30.29043	1.29156	0.00000	2.2484	1.28341	-1.61506	-0.06103	0.00000
421	B2	797.4512	5.66894	5.68221	11.44928	54.27391	0.98066	0.00000	2.2705	0.57683	-2.33493	-0.04140	0.00000
422	0	797.7560	5.67324	5.68310	11.10847	55.70833	0.96804	0.00000	2.2705	0.54135	-2.37117	-0.04140	0.00000
423	QD	798.8228	5.68906	5.68605	10.56175	58.27352	0.94546	0.00000	2.2705	-0.02117	0.00288	-0.00108	0.00000
424	QD	799.8896	5.70481	5.68901	11.20156	55.69640	0.96572	0.00000	2.2705	-0.58757	2.37642	0.03919	0.00000
425	BPM	800.0456	5.70701	5.68946	11.38784	54.95772	0.97183	0.00000	2.2705	-0.60631	2.35780	0.03919	0.00000
426	CED	800.8932	5.71832	5.69201	12.50193	51.04653	1.00505	0.00000	2.2705	-0.70810	2.25664	0.03919	0.00000

427	000	802.0014	5.73157	5.69564	14.21885	46.19149	1.04849	0.00000	2.2705	-0.84119	2.12437	0.03919	0.00000
428	B2	808.0720	5.78001	5.72435	28.85639	24.78453	1.34599	0.00000	2.2938	-1.57018	1.40128	0.05883	0.00000
429	0	808.3768	5.78166	5.72634	29.82473	23.94142	1.36392	0.00000	2.2938	-1.60679	1.36483	0.05883	0.00000
430	B2	814.4474	5.80588	5.78523	53.75697	11.77122	1.78061	0.00000	2.3245	-2.33578	0.63956	0.07846	0.00000
431	0	814.7522	5.80677	5.78942	55.19202	11.39247	1.80453	0.00000	2.3245	-2.37239	0.60307	0.07846	0.00000
432	QF	815.8190	5.80976	5.80492	57.78147	10.72737	1.84700	0.00000	2.3245	-0.01825	0.02974	0.00086	0.00000
433	QF	816.8858	5.81274	5.82051	55.26758	11.26170	1.80635	0.00000	2.3245	2.33913	-0.53813	-0.07678	0.00000
434	BPM	817.0419	5.81319	5.82269	54.54048	11.43242	1.79437	0.00000	2.3245	2.32086	-0.55600	-0.07678	0.00000
435	CED	817.8895	5.81576	5.83401	50.69028	12.45722	1.72929	0.00000	2.3245	2.22161	-0.65306	-0.07678	0.00000
436	000	818.9977	5.81941	5.84736	45.91010	14.04530	1.64421	0.00000	2.3245	2.09185	-0.77996	-0.07678	0.00000
437	B2	825.0683	5.84818	5.89712	24.82882	27.72771	1.23773	0.00000	2.3526	1.38106	-1.47348	-0.05714	0.00000
438	0	825.3731	5.85017	5.89885	23.99781	28.63657	1.22031	0.00000	2.3526	1.34537	-1.50834	-0.05714	0.00000
439	B2	831.4437	5.90845	5.92420	11.97911	51.14982	0.93303	0.00000	2.3735	0.63458	-2.19951	-0.03751	0.00000
440	0	831.7485	5.91256	5.92513	11.60315	52.50124	0.92160	0.00000	2.3735	0.59889	-2.23430	-0.03751	0.00000
441	QD	832.8153	5.92776	5.92827	10.95339	54.92036	0.90215	0.00000	2.3735	0.01932	0.00087	0.00092	0.00000
442	QD	833.8821	5.94301	5.93141	11.51820	52.49762	0.92357	0.00000	2.3735	-0.55671	2.23589	0.03939	0.00000
443	BPM	834.0381	5.94515	5.93189	11.69469	51.80267	0.92972	0.00000	2.3735	-0.57445	2.21806	0.03939	0.00000
444	CED	834.8857	5.95621	5.93459	12.75021	48.12471	0.96311	0.00000	2.3735	-0.67085	2.12120	0.03939	0.00000
445	000	835.9939	5.96925	5.93844	14.37674	43.56362	1.00676	0.00000	2.3735	-0.79688	1.99456	0.03939	0.00000
446	B2	842.0645	6.01795	5.96879	28.24169	23.54645	1.30547	0.00000	2.3960	-1.48722	1.30220	0.05903	0.00000
447	0	842.3693	6.01964	5.97089	29.15886	22.76327	1.32346	0.00000	2.3960	-1.52188	1.26730	0.05903	0.00000
448	B2	848.4399	6.04460	6.03185	51.82569	11.58990	1.74136	0.00000	2.4259	-2.21223	0.57291	0.07866	0.00000
449	0	848.7447	6.04552	6.03610	53.18483	11.25130	1.76533	0.00000	2.4259	-2.24689	0.53798	0.07866	0.00000
1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
450	QF	849.8115	6.04862	6.05170	55.59667	10.71693	1.80890	0.00000	2.4259	0.02021	-0.02955	0.00270	0.00000
451	QF	850.8783	6.05172	6.06722	53.10115	11.38125	1.77105	0.00000	2.4259	2.28372	-0.60251	-0.07338	0.00000
452	BPM	851.0343	6.05219	6.06938	52.39135	11.57218	1.75961	0.00000	2.4259	2.26545	-0.62120	-0.07338	0.00000
453	CED	851.8819	6.05486	6.08051	48.63504	12.71128	1.69741	0.00000	2.4259	2.16624	-0.72271	-0.07338	0.00000
454	000	852.9901	6.05868	6.09354	43.97752	14.46016	1.61609	0.00000	2.4259	2.03653	-0.85542	-0.07338	0.00000
455	B2	859.0607	6.08887	6.14122	23.56607	29.25187	1.23026	0.00000	2.4536	1.32603	-1.58072	-0.05374	0.00000
456	0	859.3655	6.09096	6.14285	22.76860	30.22659	1.21388	0.00000	2.4536	1.29035	-1.61718	-0.05374	0.00000
457	B2	865.4361	6.15240	6.16680	11.41608	54.25334	0.94724	0.00000	2.4747	0.57985	-2.33995	-0.03411	0.00000
458	0	865.7409	6.15672	6.16769	11.07348	55.69086	0.93685	0.00000	2.4747	0.54417	-2.37633	-0.03411	0.00000
459	QD	866.8077	6.17259	6.17064	10.51968	58.26804	0.92140	0.00000	2.4747	-0.01727	-0.00303	0.00505	0.00000
460	QD	867.8745	6.18841	6.17360	11.14941	55.70340	0.94770	0.00000	2.4747	-0.58188	2.37081	0.04443	0.00000
461	BPM	868.0306	6.19062	6.17405	11.33391	54.96646	0.95463	0.00000	2.4747	-0.60061	2.35226	0.04443	0.00000
462	CED	868.8782	6.20199	6.17660	12.43832	51.06429	0.99229	0.00000	2.4747	-0.70237	2.25152	0.04443	0.00000
463	000	869.9864	6.21531	6.18023	14.14251	46.21999	1.04153	0.00000	2.4747	-0.83542	2.11980	0.04443	0.00000
464	B2	876.0570	6.26401	6.20889	28.70872	24.85033	1.37084	0.00000	2.4982	-1.56420	1.39971	0.06407	0.00000
465	0	876.3618	6.26567	6.21088	29.67341	24.00813	1.39037	0.00000	2.4982	-1.60080	1.36341	0.06407	0.00000
466	B2	882.4324	6.29001	6.26951	53.53159	11.83696	1.83888	0.00000	2.5297	-2.32958	0.64114	0.08370	0.00000
467	0	882.7372	6.29090	6.27367	54.96285	11.45720	1.86439	0.00000	2.5297	-2.36617	0.60480	0.08370	0.00000
468	QF	883.8040	6.29390	6.28908	57.54958	10.79069	1.91106	0.00000	2.5297	-0.02196	0.02935	0.00347	0.00000
469	QF	884.8708	6.29689	6.30458	55.05378	11.32815	1.87173	0.00000	2.5297	2.32615	-0.54072	-0.07692	0.00000
470	BPM	885.0268	6.29735	6.30676	54.33072	11.49966	1.85973	0.00000	2.5297	2.30798	-0.55852	-0.07692	0.00000
471	CED	885.8744	6.29992	6.31800	50.50189	12.52843	1.79453	0.00000	2.5297	2.20928	-0.65522	-0.07692	0.00000
472	000	886.9826	6.30359	6.33128	45.74826	14.12077	1.70928	0.00000	2.5297	2.08023	-0.78165	-0.07692	0.00000
473	B2	893.0532	6.33244	6.38083	24.78426	27.80795	1.30193	0.00000	2.5590	1.37336	-1.47258	-0.05729	0.00000
474	0	893.3580	6.33443	6.38255	23.95788	28.71622	1.28447	0.00000	2.5590	1.33786	-1.50731	-0.05729	0.00000
475	B2	899.4286	6.39269	6.40785	12.00652	51.20123	0.99631	0.00000	2.5812	0.63099	-2.19589	-0.03765	0.00000
476	0	899.7334	6.39679	6.40879	11.63268	52.55041	0.98483	0.00000	2.5812	0.59550	-2.23055	-0.03765	0.00000
477	QD	900.8002	6.41194	6.41192	10.99098	54.95911	0.96667	0.00000	2.5812	0.01504	0.00675	0.00347	0.00000
478	QD	901.8670	6.42714	6.41506	11.56655	52.52248	0.99229	0.00000	2.5812	-0.56266	2.24285	0.04475	0.00000
479	BPM	902.0230	6.42927	6.41554	11.74490	51.82537	0.99927	0.00000	2.5812	-0.58042	2.22493	0.04475	0.00000
480	CED	902.8706	6.44028	6.41824	12.81061	48.13616	1.03720	0.00000	2.5812	-0.67690	2.12761	0.04475	0.00000

481	OOO	903.9788	6.45325	6.42209	14.45067	43.56152	1.08679	0.00000	2.5812	-0.80304	2.00038	0.04475	0.00000
482	B2	910.0494	6.50169	6.45248	28.39416	23.49362	1.41800	0.00000	2.6056	-1.49399	1.30474	0.06438	0.00000
483	O	910.3542	6.50337	6.45458	29.31548	22.70894	1.43762	0.00000	2.6056	-1.52869	1.26968	0.06438	0.00000
484	B2	916.4248	6.52820	6.51579	52.06863	11.52662	1.88803	0.00000	2.6381	-2.21964	0.57201	0.08402	0.00000
485	O	916.7296	6.52912	6.52006	53.43230	11.18862	1.91364	0.00000	2.6381	-2.25434	0.53691	0.08402	0.00000
486	QF	917.7964	6.53221	6.53576	55.84866	10.65435	1.95953	0.00000	2.6381	0.02349	-0.02858	0.00170	0.00000
487	QF	918.8632	6.53529	6.55136	53.33506	11.31428	1.91725	0.00000	2.6381	2.29714	-0.59931	-0.08069	0.00000
488	BPM	919.0192	6.53576	6.55354	52.62108	11.50422	1.90466	0.00000	2.6381	2.27877	-0.61806	-0.08069	0.00000
489	CED	919.8668	6.53842	6.56474	48.84265	12.63825	1.83627	0.00000	2.6381	2.17902	-0.71988	-0.08069	0.00000
490	OOO	920.9750	6.54222	6.57783	44.15759	14.38132	1.74685	0.00000	2.6381	2.04860	-0.85300	-0.08069	0.00000
491	B2	927.0456	6.57231	6.62574	23.62317	29.15728	1.31667	0.00000	2.6680	1.33422	-1.58055	-0.06105	0.00000
492	O	927.3504	6.57440	6.62737	22.82076	30.13193	1.29806	0.00000	2.6680	1.29835	-1.61712	-0.06105	0.00000
493	B2	933.4210	6.63583	6.65138	11.39475	54.17159	0.98708	0.00000	2.6902	0.58396	-2.34213	-0.04141	0.00000
494	O	933.7258	6.64015	6.65226	11.04970	55.61047	0.97445	0.00000	2.6902	0.54809	-2.37862	-0.04141	0.00000

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
495	QD	934.7926	6.65607	6.65522	10.48694	58.19640	0.95201	0.00000	2.6902	-0.01266	-0.00880	-0.00082	0.00000
496	QD	935.8594	6.67195	6.65819	11.10536	55.64692	0.97269	0.00000	2.6902	-0.57573	2.36258	0.03974	0.00000
497	BPM	936.0155	6.67416	6.65863	11.28794	54.91253	0.97889	0.00000	2.6902	-0.59444	2.34413	0.03974	0.00000
498	CED	936.8631	6.68559	6.66118	12.38176	51.02374	1.01257	0.00000	2.6902	-0.69606	2.24388	0.03974	0.00000
499	OOO	937.9713	6.69896	6.66482	14.07174	46.19567	1.05660	0.00000	2.6902	-0.82892	2.11280	0.03974	0.00000
500	B2	944.0419	6.74793	6.69346	28.55300	24.88968	1.35741	0.00000	2.7137	-1.55670	1.39623	0.05937	0.00000
501	O	944.3467	6.74960	6.69545	29.51311	24.04955	1.37550	0.00000	2.7137	-1.59325	1.36011	0.05937	0.00000
502	B2	950.4173	6.77406	6.75387	53.27358	11.89715	1.79549	0.00000	2.7447	-2.32103	0.64135	0.07901	0.00000
503	O	950.7221	6.77496	6.75801	54.69962	11.51720	1.81958	0.00000	2.7447	-2.35757	0.60519	0.07901	0.00000
504	QF	951.7889	6.77797	6.77334	57.28008	10.85192	1.86228	0.00000	2.7447	-0.02477	0.02780	0.00076	0.00000
505	QF	952.8557	6.78098	6.78875	54.80218	11.39498	1.82118	0.00000	2.7447	2.31243	-0.54450	-0.07752	0.00000
506	BPM	953.0117	6.78143	6.79091	54.08339	11.56767	1.80909	0.00000	2.7447	2.29436	-0.56225	-0.07752	0.00000
507	CED	953.8593	6.78402	6.80209	50.27720	12.60254	1.74338	0.00000	2.7447	2.19619	-0.65869	-0.07752	0.00000
508	OOO	954.9675	6.78771	6.81529	45.55181	14.20219	1.65747	0.00000	2.7447	2.06783	-0.78478	-0.07752	0.00000
509	B2	961.0381	6.81666	6.86460	24.71521	27.91594	1.24650	0.00000	2.7730	1.36477	-1.47383	-0.05789	0.00000
510	O	961.3429	6.81866	6.86631	23.89401	28.82495	1.22885	0.00000	2.7730	1.32946	-1.50847	-0.05789	0.00000
511	B2	967.4135	6.87695	6.89154	12.02155	51.31251	0.93707	0.00000	2.7940	0.62639	-2.19516	-0.03825	0.00000
512	O	967.7183	6.88105	6.89247	11.65046	52.66121	0.92541	0.00000	2.7940	0.59109	-2.22972	-0.03825	0.00000
513	QD	968.7851	6.89618	6.89560	11.01854	55.06292	0.90526	0.00000	2.7940	0.01014	0.01237	0.00032	0.00000
514	QD	969.8519	6.91133	6.89873	11.60586	52.61001	0.92611	0.00000	2.7940	-0.56894	2.25226	0.03891	0.00000
515	BPM	970.0079	6.91345	6.89920	11.78618	51.90998	0.93218	0.00000	2.7940	-0.58674	2.23425	0.03891	0.00000
516	CED	970.8555	6.92441	6.90190	12.86276	48.20541	0.96516	0.00000	2.7940	-0.68341	2.13641	0.03891	0.00000
517	OOO	971.9637	6.93733	6.90575	14.51754	43.61202	1.00829	0.00000	2.7940	-0.80981	2.00850	0.03891	0.00000
518	B2	978.0343	6.98552	6.93613	28.55152	23.46814	1.30410	0.00000	2.8165	-1.50214	1.30913	0.05855	0.00000
519	O	978.3391	6.98719	6.93824	29.47781	22.68084	1.32195	0.00000	2.8165	-1.53690	1.27389	0.05855	0.00000
520	B2	984.4097	7.01189	6.99965	52.33904	11.47011	1.73695	0.00000	2.8464	-2.22923	0.57248	0.07819	0.00000
521	O	984.7145	7.01280	7.00394	53.70858	11.13188	1.76079	0.00000	2.8464	-2.26400	0.53720	0.07819	0.00000
522	QF	985.7813	7.01587	7.01972	56.13290	10.59509	1.80395	0.00000	2.8464	0.02580	-0.02647	0.00243	0.00000
523	QF	986.8481	7.01894	7.03542	53.60175	11.24825	1.76593	0.00000	2.8464	2.31101	-0.59498	-0.07344	0.00000
524	BPM	987.0042	7.01941	7.03761	52.88346	11.43685	1.75447	0.00000	2.8464	2.29255	-0.61377	-0.07344	0.00000
525	CED	987.8518	7.02206	7.04887	49.08210	12.56378	1.69222	0.00000	2.8464	2.19229	-0.71580	-0.07344	0.00000
526	OOO	988.9600	7.02584	7.06204	44.36839	14.29811	1.61083	0.00000	2.8464	2.06119	-0.84920	-0.07344	0.00000
527	B2	995.0306	7.05581	7.11019	23.70346	29.03695	1.22464	0.00000	2.8740	1.34312	-1.57824	-0.05380	0.00000
528	O	995.3354	7.05789	7.11184	22.89568	30.01022	1.20824	0.00000	2.8740	1.30707	-1.61488	-0.05380	0.00000
529	B2	1001.4060	7.11923	7.13592	11.38617	54.03190	0.94123	0.00000	2.8949	0.58900	-2.34141	-0.03417	0.00000
530	O	1001.7108	7.12356	7.13681	11.03810	55.47037	0.93082	0.00000	2.8949	0.55294	-2.37797	-0.03417	0.00000
531	QD	1002.7776	7.13950	7.13978	10.46485	58.06144	0.91517	0.00000	2.8949	-0.00753	-0.01421	0.00473	0.00000
532	QD	1003.8444	7.15542	7.14274	11.07120	55.52921	0.94098	0.00000	2.8949	-0.56937	2.35207	0.04384	0.00000
533	BPM	1004.0004	7.15765	7.14320	11.25179	54.79809	0.94782	0.00000	2.8949	-0.58804	2.33372	0.04384	0.00000
534	CED	1004.8480	7.16911	7.14575	12.33456	50.92649	0.98498	0.00000	2.8949	-0.68942	2.23401	0.04384	0.00000

535 OOO	1005.9562	7.18254	7.14939	14.00947	46.11950	1.03357	0.00000	2.8949	-0.82196	2.10364	0.04384	0.00000
536 B2	1012.0268	7.23176	7.17805	28.39564	24.90103	1.35929	0.00000	2.9182	-1.54800	1.39097	0.06348	0.00000
537 O	1012.3316	7.23344	7.18004	29.35041	24.06405	1.37864	0.00000	2.9182	-1.58446	1.35504	0.06348	0.00000
538 B2	1018.4022	7.25803	7.23830	52.99356	11.94942	1.82355	0.00000	2.9495	-2.31049	0.64019	0.08311	0.00000
539 O	1018.7070	7.25894	7.24243	54.41315	11.57012	1.84888	0.00000	2.9495	-2.34695	0.60423	0.08311	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
540 QF	1019.7738	7.26196	7.25768	56.98404	10.90863	1.89528	0.00000	2.9495	-0.02657	0.02515	0.00354	0.00000
541 QF	1020.8406	7.26499	7.27300	54.52313	11.45956	1.85638	0.00000	2.9495	2.29854	-0.54933	-0.07619	0.00000
542 BPM	1020.9966	7.26545	7.27516	53.80866	11.63374	1.84449	0.00000	2.9495	2.28056	-0.56705	-0.07619	0.00000
543 CED	1021.8442	7.26805	7.28627	50.02544	12.67663	1.77992	0.00000	2.9495	2.18288	-0.66334	-0.07619	0.00000
544 OOO	1022.9524	7.27175	7.29939	45.32883	14.28636	1.69548	0.00000	2.9495	2.05517	-0.78923	-0.07619	0.00000
545 SB	1029.0230	7.30083	7.34843	24.62345	28.05477	1.23297	0.00000	2.9495	1.35559	-1.47882	-0.07619	0.00000
546 O	1029.3278	7.30283	7.35013	23.80779	28.96681	1.20975	0.00000	2.9495	1.32047	-1.51345	-0.07619	0.00000
547 B2	1035.3984	7.36124	7.37524	12.02311	51.51344	0.80686	0.00000	2.9691	0.62093	-2.19991	-0.05655	0.00000
548 O	1035.7032	7.36534	7.37617	11.65530	52.86503	0.78962	0.00000	2.9691	0.58580	-2.23446	-0.05655	0.00000
549 QD	1036.7700	7.38044	7.37929	11.03455	55.26744	0.74672	0.00000	2.9691	0.00480	0.01646	-0.02418	0.00000
550 QD	1037.8368	7.39557	7.38241	11.63418	52.79690	0.73764	0.00000	2.9691	-0.57532	2.26445	0.00710	0.00000
551 BPM	1037.9929	7.39768	7.38288	11.81650	52.09308	0.73875	0.00000	2.9691	-0.59317	2.24634	0.00710	0.00000
552 CED	1038.8405	7.40862	7.38557	12.90423	48.36847	0.74476	0.00000	2.9691	-0.69014	2.14796	0.00710	0.00000
553 OOO	1039.9487	7.42149	7.38941	14.57436	43.75026	0.75263	0.00000	2.9691	-0.81692	2.01934	0.00710	0.00000
554 B2	1046.0193	7.46945	7.41972	28.70759	23.49800	0.85530	0.00000	2.9847	-1.51137	1.31613	0.02673	0.00000
555 O	1046.3241	7.47111	7.42182	29.63956	22.70649	0.86345	0.00000	2.9847	-1.54624	1.28069	0.02673	0.00000
556 B2	1052.3947	7.49567	7.48330	52.62709	11.43653	1.08532	0.00000	3.0036	-2.24070	0.57543	0.04637	0.00000
557 O	1052.6995	7.49658	7.48760	54.00365	11.09656	1.09945	0.00000	3.0036	-2.27557	0.53995	0.04637	0.00000
558 QF	1053.7663	7.49963	7.50344	56.43919	10.55283	1.12380	0.00000	3.0036	0.02702	-0.02262	-0.00088	0.00000
559 QF	1054.8331	7.50269	7.51920	53.89178	11.19601	1.09758	0.00000	3.0036	2.32480	-0.58934	-0.04809	0.00000
560 BPM	1054.9891	7.50315	7.52140	53.16920	11.38284	1.09008	0.00000	3.0036	2.30626	-0.60811	-0.04809	0.00000
561 CED	1055.8367	7.50578	7.53272	49.34501	12.50017	1.04932	0.00000	3.0036	2.20553	-0.71011	-0.04809	0.00000
562 OOO	1056.9449	7.50954	7.54596	44.60263	14.22185	0.99603	0.00000	3.0036	2.07383	-0.84347	-0.04809	0.00000
563 SB	1063.0155	7.53937	7.59436	23.80356	28.89735	0.70409	0.00000	3.0036	1.35237	-1.57400	-0.04809	0.00000
564 O	1063.3203	7.54144	7.59602	22.99019	29.86804	0.68943	0.00000	3.0036	1.31615	-1.61068	-0.04809	0.00000
565 B2	1069.3909	7.60264	7.62020	11.39070	53.84309	0.45712	0.00000	3.0147	0.59474	-2.33793	-0.02845	0.00000
566 O	1069.6957	7.60697	7.62109	11.03919	55.27945	0.44844	0.00000	3.0147	0.55852	-2.37453	-0.02845	0.00000
567 QD	1070.7625	7.62292	7.62407	10.45437	57.87203	0.42802	0.00000	3.0147	-0.00209	-0.01904	-0.00999	0.00000
568 QD	1071.8293	7.63886	7.62705	11.04839	55.35827	0.42698	0.00000	3.0147	-0.56308	2.33984	0.00803	0.00000
569 BPM	1071.9853	7.64109	7.62750	11.22701	54.63095	0.42823	0.00000	3.0147	-0.58168	2.32159	0.00803	0.00000
570 CED	1072.8329	7.65258	7.63006	12.29872	50.77942	0.43504	0.00000	3.0147	-0.68273	2.22245	0.00803	0.00000
571 OOO	1073.9411	7.66606	7.63371	13.95832	45.99721	0.44393	0.00000	3.0147	-0.81483	2.09283	0.00803	0.00000
572 B2	1080.0117	7.71551	7.66242	28.24327	24.88518	0.55227	0.00000	3.0243	-1.53846	1.38424	0.02767	0.00000
573 O	1080.3165	7.71720	7.66441	29.19219	24.05223	0.56071	0.00000	3.0243	-1.57479	1.34853	0.02767	0.00000
574 B2	1086.3871	7.74193	7.72258	52.70334	11.99185	0.78824	0.00000	3.0373	-2.29841	0.63778	0.04730	0.00000
575 O	1086.6919	7.74284	7.72669	54.11553	11.61396	0.80266	0.00000	3.0373	-2.33475	0.60202	0.04730	0.00000
576 QF	1087.7587	7.74588	7.74188	56.67397	10.95856	0.83468	0.00000	3.0373	-0.02727	0.02156	0.01250	0.00000
577 QF	1088.8255	7.74892	7.75713	54.22841	11.51916	0.82914	0.00000	3.0373	2.28507	-0.55495	-0.02285	0.00000
578 BPM	1088.9815	7.74938	7.75927	53.51812	11.69510	0.82557	0.00000	3.0373	2.26717	-0.57266	-0.02285	0.00000
579 CED	1089.8291	7.75199	7.77032	49.75725	12.74745	0.80620	0.00000	3.0373	2.16992	-0.66890	-0.02285	0.00000
580 OOO	1090.9373	7.75572	7.78337	45.08873	14.36946	0.78087	0.00000	3.0373	2.04278	-0.79474	-0.02285	0.00000
581 SB	1097.0079	7.78494	7.83212	24.51492	28.20298	0.64213	0.00000	3.0373	1.34631	-1.48404	-0.02285	0.00000
582 O	1097.3127	7.78695	7.83382	23.70487	29.11820	0.63516	0.00000	3.0373	1.31134	-1.51864	-0.02285	0.00000
583 B2	1103.3834	7.84552	7.85881	12.01207	51.72604	0.55602	0.00000	3.0488	0.61492	-2.20479	-0.00322	0.00000
584 O	1103.6882	7.84962	7.85974	11.64788	53.08060	0.55504	0.00000	3.0488	0.57995	-2.23933	-0.00322	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
585 QD	1104.7550	7.86473	7.86285	11.03907	55.48345	0.56415	0.00000	3.0488	-0.00070	0.02092	0.02036	0.00000
586 QD	1105.8218	7.87984	7.86595	11.65097	52.99399	0.59882	0.00000	3.0488	-0.58148	2.27745	0.04487	0.00000
587 BPM	1105.9778	7.88195	7.86643	11.83522	52.28613	0.60582	0.00000	3.0488	-0.59940	2.25923	0.04487	0.00000
588 CED	1106.8254	7.89286	7.86910	12.93384	48.54016	0.64385	0.00000	3.0488	-0.69675	2.16028	0.04487	0.00000

589 000	1107.9336	7.90570	7.87292	14.61917	43.89549	0.69357	0.00000	3.0488	-0.82403	2.03090	0.04487	0.00000
590 B2	1114.0042	7.95346	7.90317	28.85518	23.52801	1.02553	0.00000	3.0655	-1.52120	1.32355	0.06450	0.00000
591 0	1114.3090	7.95511	7.90527	29.79317	22.73204	1.04519	0.00000	3.0655	-1.55820	1.28790	0.06450	0.00000
592 B2	1120.3796	7.97954	7.96681	52.91809	11.39978	1.49635	0.00000	3.0902	-2.25337	0.57848	0.08414	0.00000
593 0	1120.6844	7.98044	7.97113	54.30242	11.05801	1.52199	0.00000	3.0902	-2.28838	0.54280	0.08414	0.00000
594 QF	1121.7512	7.98348	7.98703	56.75168	10.50704	1.57683	0.00000	3.0902	0.02716	-0.01858	0.01828	0.00000
595 QF	1122.8180	7.98652	8.00287	54.18997	11.13970	1.56071	0.00000	3.0902	2.33787	-0.58337	-0.04840	0.00000
596 BPM	1122.9740	7.98698	8.00508	53.46332	11.32468	1.55316	0.00000	3.0902	2.31925	-0.60214	-0.04840	0.00000
597 CED	1123.8216	7.98960	8.01645	49.61744	12.43187	1.51214	0.00000	3.0902	2.21812	-0.70412	-0.04840	0.00000
598 000	1124.9298	7.99334	8.02977	44.84772	14.14025	1.45851	0.00000	3.0902	2.08590	-0.83746	-0.04840	0.00000
599 SB	1131.0004	8.02301	8.07845	23.91940	28.74205	1.16472	0.00000	3.0902	1.36159	-1.56787	-0.04840	0.00000
600 0	1131.3052	8.02507	8.08011	23.10046	29.70900	1.14997	0.00000	3.0902	1.32522	-1.60454	-0.04840	0.00000
601 B2	1137.3758	8.08607	8.10442	11.40813	53.60887	0.91579	0.00000	3.1103	0.60096	-2.33169	-0.02876	0.00000
602 0	1137.6806	8.09039	8.10531	11.05287	55.04143	0.90703	0.00000	3.1103	0.56459	-2.36828	-0.02876	0.00000
603 QD	1138.7474	8.10633	8.10830	10.45586	57.63163	0.89666	0.00000	3.1103	0.00343	-0.02309	0.00925	0.00000
604 QD	1139.8142	8.12228	8.11129	11.03780	55.13703	0.92690	0.00000	3.1103	-0.55711	2.32620	0.04767	0.00000
605 BPM	1139.9702	8.12451	8.11175	11.21455	54.41395	0.93434	0.00000	3.1103	-0.57563	2.30806	0.04767	0.00000
606 CED	1140.8178	8.13602	8.11432	12.27565	50.58486	0.97475	0.00000	3.1103	-0.67626	2.20950	0.04767	0.00000
607 000	1141.9260	8.14952	8.11798	13.92030	45.83052	1.02758	0.00000	3.1103	-0.80782	2.08064	0.04767	0.00000
608 B2	1147.9966	8.19917	8.14677	28.10198	24.84131	1.37655	0.00000	3.1337	-1.52846	1.37621	0.06731	0.00000
609 0	1148.3014	8.20087	8.14876	29.04476	24.01320	1.39707	0.00000	3.1337	-1.56464	1.34070	0.06731	0.00000
610 B2	1154.3720	8.22573	8.20691	52.41455	12.02256	1.86523	0.00000	3.1656	-2.28528	0.63412	0.08694	0.00000
611 0	1154.6768	8.22664	8.21101	53.81868	11.64684	1.89173	0.00000	3.1656	-2.32146	0.59857	0.08694	0.00000
612 QF	1155.7436	8.22970	8.22614	56.36227	10.99974	1.94122	0.00000	3.1656	-0.02685	0.01711	0.00548	0.00000
613 QF	1156.8104	8.23276	8.24133	53.92983	11.57159	1.90335	0.00000	3.1656	2.27254	-0.56120	-0.07622	0.00000
614 BPM	1156.9665	8.23322	8.24346	53.22344	11.74948	1.89145	0.00000	3.1656	2.25471	-0.57893	-0.07622	0.00000
615 CED	1157.8141	8.23585	8.25446	49.48338	12.81253	1.82685	0.00000	3.1656	2.15782	-0.67525	-0.07622	0.00000
616 000	1158.9223	8.23960	8.26744	44.84116	14.44872	1.74238	0.00000	3.1656	2.03115	-0.80118	-0.07622	0.00000
617 B2	1164.9929	8.26898	8.31592	24.39399	28.35634	1.33931	0.00000	3.1956	1.33729	-1.48935	-0.05658	0.00000
618 0	1165.2977	8.27100	8.31760	23.58940	29.27479	1.32206	0.00000	3.1956	1.30245	-1.52395	-0.05658	0.00000
619 B2	1171.3683	8.32977	8.34248	11.98890	51.94485	1.03817	0.00000	3.2186	0.60860	-2.20974	-0.03695	0.00000
620 0	1171.6731	8.33388	8.34340	11.62852	53.30243	1.02691	0.00000	3.2186	0.57376	-2.24426	-0.03695	0.00000
621 QD	1172.7399	8.34901	8.34649	11.03195	55.70556	1.01046	0.00000	3.2186	-0.00615	0.02559	0.00598	0.00000
622 QD	1173.8067	8.36412	8.34959	11.65557	53.19648	1.03977	0.00000	3.2186	-0.58719	2.29089	0.04918	0.00000
623 BPM	1173.9627	8.36623	8.35006	11.84161	52.48444	1.04744	0.00000	3.2186	-0.60519	2.27256	0.04918	0.00000
624 CED	1174.8103	8.37713	8.35273	12.95042	48.71637	1.08913	0.00000	3.2186	-0.70298	2.17301	0.04918	0.00000
625 000	1175.9185	8.38995	8.35654	14.65021	44.04436	1.14364	0.00000	3.2186	-0.83085	2.04285	0.04918	0.00000
626 B2	1181.9891	8.43754	8.38671	28.98839	23.55802	1.50178	0.00000	3.2444	-1.53121	1.33118	0.06882	0.00000
627 0	1182.2939	8.43918	8.38880	29.93254	22.75746	1.52276	0.00000	3.2444	-1.56638	1.29532	0.06882	0.00000
628 B2	1188.3645	8.46349	8.45042	53.20039	11.36136	2.00009	0.00000	3.2788	-2.26674	0.58158	0.08845	0.00000
629 0	1188.6693	8.46439	8.45475	54.59292	11.01777	2.02705	0.00000	3.2788	-2.30191	0.54568	0.08845	0.00000
1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
630 QF	1189.7361	8.46741	8.47072	57.05785	10.45946	2.07510	0.00000	3.2788	0.02622	-0.01446	0.00127	0.00000
631 QF	1190.8029	8.47043	8.48663	54.48436	11.08137	2.02975	0.00000	3.2788	2.34969	-0.57726	-0.08596	0.00000
632 BPM	1190.9589	8.47089	8.48886	53.75403	11.26444	2.01634	0.00000	3.2788	2.33102	-0.59603	-0.08596	0.00000
633 CED	1191.8065	8.47349	8.50030	49.88847	12.36127	1.94348	0.00000	3.2788	2.22957	-0.69801	-0.08596	0.00000
634 000	1192.9147	8.47721	8.51369	45.09384	14.05609	1.84822	0.00000	3.2788	2.09693	-0.83134	-0.08596	0.00000
635 B2	1198.9853	8.50672	8.56267	24.04634	28.57597	1.38601	0.00000	3.3103	1.37041	-1.56004	-0.06633	0.00000
636 0	1199.2901	8.50877	8.56434	23.22206	29.53813	1.36579	0.00000	3.3103	1.33393	-1.59666	-0.06633	0.00000
637 B2	1205.3607	8.56952	8.58878	11.43774	53.33657	1.02277	0.00000	3.3336	0.60741	-2.32286	-0.04669	0.00000
638 0	1205.6655	8.57383	8.58968	11.07858	54.76372	1.00854	0.00000	3.3336	0.57093	-2.35941	-0.04669	0.00000
639 QD	1206.7323	8.58974	8.59268	10.46925	57.34773	0.98120	0.00000	3.3336	0.00881	-0.02624	-0.00476	0.00000
640 QD	1207.7991	8.60568	8.59569	11.03984	54.87237	0.99830	0.00000	3.3336	-0.55169	2.31159	0.03695	0.00000
641 BPM	1207.9552	8.60791	8.59614	11.21487	54.15383	1.00406	0.00000	3.3336	-0.57012	2.29355	0.03695	0.00000
642 CED	1208.8028	8.61942	8.59873	12.26623	50.34886	1.03538	0.00000	3.3336	-0.67027	2.19557	0.03695	0.00000

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
643	000	1209.9110	8.63294	8.60241	13.89691	45.62458	1.07633	0.00000	3.3336	-0.80120	2.06745	0.03695	0.00000
644	B2	1215.9816	8.68275	8.63131	27.97738	24.77070	1.36020	0.00000	3.3573	-1.51840	1.36711	0.05658	0.00000
645	0	1216.2864	8.68446	8.63330	28.91397	23.94807	1.37744	0.00000	3.3573	-1.55441	1.33181	0.05658	0.00000
646	B2	1222.3570	8.70944	8.69148	52.13871	12.04051	1.78051	0.00000	3.3881	-2.27161	0.62933	0.07622	0.00000
647	0	1222.6618	8.71036	8.69558	53.53446	11.66764	1.80374	0.00000	3.3881	-2.30762	0.59399	0.07622	0.00000
648	QF	1223.7286	8.71343	8.71068	56.06142	11.03080	1.84385	0.00000	3.3881	-0.02533	0.01195	-0.00130	0.00000
649	QF	1224.7954	8.71651	8.72581	53.63932	11.61512	1.80099	0.00000	3.3881	2.26147	-0.56790	-0.07876	0.00000
650	BPM	1224.9514	8.71697	8.72794	52.93639	11.79511	1.78870	0.00000	3.3881	2.24368	-0.58567	-0.07876	0.00000
651	CED	1225.7990	8.71962	8.73889	49.21478	12.86974	1.72194	0.00000	3.3881	2.14707	-0.68218	-0.07876	0.00000
652	000	1226.9072	8.72338	8.75181	44.59601	14.52156	1.63466	0.00000	3.3881	2.02075	-0.80836	-0.07876	0.00000
653	B2	1232.9778	8.75292	8.80001	24.26348	28.52459	1.21616	0.00000	3.4159	1.32881	-1.49789	-0.05913	0.00000
654	0	1233.2826	8.75495	8.80169	23.46402	29.44827	1.19813	0.00000	3.4159	1.29407	-1.53255	-0.05913	0.00000
655	B2	1239.3532	8.81398	8.82642	11.95363	52.23099	0.89883	0.00000	3.4363	0.60214	-2.21969	-0.03949	0.00000
656	0	1239.6580	8.81810	8.82734	11.59715	53.59465	0.88679	0.00000	3.4363	0.56740	-2.25427	-0.03949	0.00000
657	QD	1240.7248	8.83326	8.83042	11.01276	56.00578	0.86443	0.00000	3.4363	-0.01138	0.02823	-0.00259	0.00000
658	QD	1241.7916	8.84839	8.83349	11.64720	53.47779	0.88123	0.00000	3.4363	-0.59224	2.30571	0.03419	0.00000
659	BPM	1241.9476	8.85051	8.83396	11.83483	52.76115	0.88656	0.00000	3.4363	-0.61034	2.28728	0.03419	0.00000
660	CED	1242.7952	8.86141	8.83662	12.95280	48.96860	0.91554	0.00000	3.4363	-0.70864	2.18717	0.03419	0.00000
661	000	1243.9034	8.87422	8.84040	14.66585	44.26601	0.95344	0.00000	3.4363	-0.83716	2.05628	0.03419	0.00000
662	B2	1249.9740	8.92169	8.87045	29.10259	23.64069	1.22060	0.00000	3.4575	-1.54114	1.34064	0.05383	0.00000
663	0	1250.2788	8.92333	8.87254	30.05284	22.83443	1.23701	0.00000	3.4575	-1.57648	1.30457	0.05383	0.00000
664	B2	1256.3494	8.94752	8.93407	53.46530	11.35016	1.62337	0.00000	3.4853	-2.28046	0.58685	0.07347	0.00000
665	0	1256.6542	8.94842	8.93842	54.86624	11.00342	1.64576	0.00000	3.4853	-2.31581	0.55074	0.07347	0.00000
666	QF	1257.7210	8.95142	8.95441	57.34845	10.43407	1.68651	0.00000	3.4853	0.02417	-0.00903	0.00265	0.00000
667	QF	1258.7878	8.95443	8.97037	54.76616	11.04314	1.65137	0.00000	3.4853	2.35986	-0.57047	-0.06829	0.00000
668	BPM	1258.9439	8.95488	8.97260	54.03267	11.22408	1.64071	0.00000	3.4853	2.34114	-0.58919	-0.06829	0.00000
669	CED	1259.7915	8.95748	8.98409	50.15014	12.30911	1.58283	0.00000	3.4853	2.23948	-0.69092	-0.06829	0.00000
670	000	1260.8997	8.96118	8.99755	45.33387	13.98787	1.50716	0.00000	3.4853	2.10655	-0.82393	-0.06829	0.00000
671	B2	1266.9703	8.99052	9.04680	24.17909	28.40721	1.15222	0.00000	3.5113	1.37846	-1.55088	-0.04865	0.00000
672	0	1267.2751	8.99256	9.04848	23.34993	29.36376	1.13739	0.00000	3.5113	1.34190	-1.58742	-0.04865	0.00000
673	B2	1273.3457	9.05302	9.07306	11.47832	53.03944	0.90166	0.00000	3.5311	0.61381	-2.31189	-0.02902	0.00000
674	0	1273.6505	9.05731	9.07396	11.11529	54.45988	0.89281	0.00000	3.5311	0.57725	-2.34835	-0.02902	0.00000
675	QD	1274.7173	9.07318	9.07698	10.49403	57.03417	0.88184	0.00000	3.5311	0.01383	-0.02834	0.00838	0.00000
676	QD	1275.7841	9.08909	9.08000	11.05446	54.57720	0.91082	0.00000	3.5311	-0.54705	2.29671	0.04615	0.00000
677	BPM	1275.9401	9.09132	9.08046	11.22803	53.86328	0.91802	0.00000	3.5311	-0.56539	2.27877	0.04615	0.00000
678	CED	1276.7877	9.10282	9.08306	12.27092	50.08291	0.95714	0.00000	3.5311	-0.66501	2.18132	0.04615	0.00000
679	000	1277.8959	9.11635	9.08676	13.88919	45.38942	1.00828	0.00000	3.5311	-0.79526	2.05391	0.04615	0.00000
680	B2	1283.9665	9.16626	9.11579	27.87476	24.67680	1.34803	0.00000	3.5540	-1.50871	1.35739	0.06579	0.00000
681	0	1284.2713	9.16797	9.11779	28.80539	23.86003	1.36808	0.00000	3.5540	-1.54453	1.32228	0.06579	0.00000
682	B2	1290.3419	9.19307	9.17607	51.88746	12.04485	1.82701	0.00000	3.5852	-2.25798	0.62364	0.08542	0.00000
683	0	1290.6467	9.19399	9.18016	53.27485	11.67539	1.85305	0.00000	3.5852	-2.29381	0.58849	0.08542	0.00000
684	QF	1291.7135	9.19708	9.19525	55.78407	11.05025	1.90180	0.00000	3.5852	-0.02277	0.00631	0.00562	0.00000
685	QF	1292.7803	9.20017	9.21035	53.36912	11.64767	1.86496	0.00000	3.5852	2.25232	-0.57472	-0.07443	0.00000
686	BPM	1292.9363	9.20064	9.21246	52.66903	11.82980	1.85335	0.00000	3.5852	2.23456	-0.59255	-0.07443	0.00000
687	CED	1293.7839	9.20329	9.22339	48.96275	12.91633	1.79026	0.00000	3.5852	2.13811	-0.68935	-0.07443	0.00000
688	000	1294.8921	9.20708	9.23625	44.36358	14.58448	1.70778	0.00000	3.5852	2.01201	-0.81592	-0.07443	0.00000
689	B2	1300.9627	9.23678	9.28420	24.12986	28.69219	1.31559	0.00000	3.6147	1.32127	-1.50757	-0.05479	0.00000
690	0	1301.2675	9.23882	9.28587	23.33498	29.62181	1.29889	0.00000	3.6147	1.28659	-1.54234	-0.05479	0.00000
691	B2	1307.3381	9.29814	9.31046	11.90815	52.53615	1.02589	0.00000	3.6373	0.59585	-2.23158	-0.03516	0.00000
692	0	1307.6429	9.30228	9.31137	11.55549	53.90710	1.01517	0.00000	3.6373	0.56117	-2.26627	-0.03516	0.00000
693	QD	1308.7097	9.31749	9.31443	10.98265	56.32956	1.00038	0.00000	3.6373	-0.01614	0.02976	0.00731	0.00000
694	QD	1309.7765	9.33265	9.31749	11.62647	53.78390	1.03089	0.00000	3.6373	-0.59642	2.32050	0.05012	0.00000
695	BPM	1309.9325	9.33477	9.31795	11.81543	53.06265	1.03871	0.00000	3.6373	-0.61461	2.30197	0.05012	0.00000
696	CED	1310.7801	9.34569	9.32059	12.94109	49.24563	1.08119	0.00000	3.6373	-0.71345	2.20136	0.05012	0.00000

697 OOO	1311.8883	9.35850	9.32436	14.66558	44.51233	1.13673	0.00000	3.6373	-0.84267	2.06980	0.05012	0.00000
698 B2	1317.9589	9.40589	9.35425	29.19257	23.74489	1.50055	0.00000	3.6630	-1.55049	1.35053	0.06975	0.00000
699 O	1318.2637	9.40753	9.35633	30.14858	22.93265	1.52181	0.00000	3.6630	-1.58603	1.31428	0.06975	0.00000
700 B2	1324.3343	9.43163	9.41772	53.70031	11.35272	2.00481	0.00000	3.6974	-2.29385	0.59290	0.08939	0.00000
701 O	1324.6391	9.43252	9.42206	55.10948	11.00235	2.03206	0.00000	3.6974	-2.32940	0.55661	0.08939	0.00000
702 QF	1325.7059	9.43551	9.43807	57.60970	10.42075	2.08098	0.00000	3.6974	0.02113	-0.00324	0.00198	0.00000
703 QF	1326.7727	9.43850	9.45406	55.02199	11.01660	2.03624	0.00000	3.6974	2.36790	-0.56369	-0.08552	0.00000
704 BPM	1326.9288	9.43896	9.45630	54.28599	11.19542	2.02290	0.00000	3.6974	2.34917	-0.58235	-0.08552	0.00000
705 CED	1327.7764	9.44154	9.46782	50.38995	12.26856	1.95041	0.00000	3.6974	2.24739	-0.68374	-0.08552	0.00000
706 OOO	1328.8846	9.44522	9.48132	45.55631	13.93089	1.85564	0.00000	3.6974	2.11432	-0.81629	-0.08552	0.00000
707 B2	1334.9552	9.47441	9.53083	24.31221	28.24244	1.39609	0.00000	3.7292	1.38541	-1.54077	-0.06589	0.00000
708 O	1335.2600	9.47644	9.53252	23.47882	29.19279	1.37601	0.00000	3.7292	1.34881	-1.57718	-0.06589	0.00000
709 B2	1341.3306	9.53659	9.55724	11.52823	52.72928	1.03566	0.00000	3.7527	0.61991	-2.29920	-0.04625	0.00000
710 O	1341.6354	9.54086	9.55815	11.16148	54.14195	1.02157	0.00000	3.7527	0.58331	-2.33553	-0.04625	0.00000
711 QD	1342.7022	9.55667	9.56119	10.52918	56.70339	0.99499	0.00000	3.7527	0.01829	-0.02929	-0.00376	0.00000
712 QD	1343.7690	9.57253	9.56423	11.08107	54.26321	1.01348	0.00000	3.7527	-0.54338	2.28216	0.03856	0.00000
713 BPM	1343.9250	9.57476	9.56469	11.25349	53.55382	1.01950	0.00000	3.7527	-0.56162	2.26431	0.03856	0.00000
714 CED	1344.7726	9.58624	9.56730	12.28953	49.79756	1.05219	0.00000	3.7527	-0.66070	2.16734	0.03856	0.00000
715 OOO	1345.8808	9.59975	9.57102	13.89745	45.13438	1.09492	0.00000	3.7527	-0.79024	2.04055	0.03856	0.00000
716 B2	1351.9514	9.64972	9.60020	27.79835	24.56334	1.38860	0.00000	3.7768	-1.49978	1.34743	0.05820	0.00000
717 O	1352.2562	9.65144	9.60221	28.72348	23.75259	1.40634	0.00000	3.7768	-1.53541	1.31250	0.05820	0.00000
718 B2	1358.3268	9.67662	9.66066	51.67111	12.03541	1.81921	0.00000	3.8083	-2.24496	0.61728	0.07783	0.00000
719 O	1358.6316	9.67754	9.66475	53.05050	11.66978	1.84293	0.00000	3.8083	-2.28059	0.58231	0.07783	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
720 QF	1359.6984	9.68065	9.67984	55.54161	11.05732	1.88387	0.00000	3.8083	-0.01928	0.00042	-0.00137	0.00000
721 QF	1360.7652	9.68375	9.69492	53.13030	11.66793	1.84003	0.00000	3.8083	2.24546	-0.58139	-0.08051	0.00000
722 BPM	1360.9212	9.68422	9.69703	52.43235	11.85215	1.82747	0.00000	3.8083	2.22772	-0.59929	-0.08051	0.00000
723 CED	1361.7688	9.68689	9.70793	48.73763	12.95045	1.75923	0.00000	3.8083	2.13133	-0.69648	-0.08051	0.00000
724 OOL	1365.6630	9.70217	9.74671	33.86258	20.11396	1.44571	0.00000	3.8083	1.68847	-1.14305	-0.08051	0.00000
725 B2	1371.7336	9.74222	9.78185	17.55423	38.20754	1.01660	0.00000	3.8323	0.99815	-1.83690	-0.06087	0.00000
726 OOL	1375.6278	9.78639	9.79548	11.50480	54.25021	0.77954	0.00000	3.8323	0.55529	-2.28273	-0.06087	0.00000
727 QD	1376.6946	9.80166	9.79852	10.94248	56.69223	0.73177	0.00000	3.8323	-0.02027	0.02816	-0.02903	0.00000
728 QD	1377.7614	9.81687	9.80156	11.59394	54.13363	0.71714	0.00000	3.8323	-0.59956	2.33404	0.00150	0.00000
729 BPM	1377.9175	9.81900	9.80202	11.78389	53.40817	0.71738	0.00000	3.8323	-0.61785	2.31546	0.00150	0.00000
730 CED	1378.7651	9.82994	9.80464	12.91552	49.56857	0.71865	0.00000	3.8323	-0.71724	2.21450	0.00150	0.00000
731 OOL	1382.6593	9.86862	9.81974	20.27985	34.12738	0.72450	0.00000	3.8323	-1.17386	1.75067	0.00150	0.00000
732 B2	1388.7299	9.90331	9.85998	38.85164	17.25246	0.79322	0.00000	3.8470	-1.88564	1.02857	0.02114	0.00000
733 OOL	1392.6241	9.91670	9.90549	55.31590	11.05048	0.87554	0.00000	3.8470	-2.34226	0.56405	0.02114	0.00000
734 QF	1393.6909	9.91967	9.92143	57.83428	10.45500	0.87822	0.00000	3.8470	0.01722	0.00252	-0.01613	0.00000
735 QF	1394.7577	9.92266	9.93738	55.24460	11.03939	0.84138	0.00000	3.8470	2.37364	-0.55855	-0.05268	0.00000
736 BPM	1394.9137	9.92311	9.93961	54.50680	11.21658	0.83316	0.00000	3.8470	2.35490	-0.57709	-0.05268	0.00000
737 CED	1395.7613	9.92568	9.95111	50.60105	12.28024	0.78851	0.00000	3.8470	2.25311	-0.67782	-0.05268	0.00000
738 OOL	1399.6555	9.94045	9.99175	34.87399	19.36164	0.58337	0.00000	3.8470	1.78547	-1.14063	-0.05268	0.00000
739 B2	1405.7261	9.97982	10.02788	17.62250	37.57976	0.32320	0.00000	3.8557	1.05652	-1.85984	-0.03304	0.00000
740 OOL	1409.6203	10.02449	10.04167	11.21500	53.86428	0.19453	0.00000	3.8557	0.58888	-2.32190	-0.03304	0.00000
741 QD	1410.6871	10.04023	10.04473	10.57293	56.40921	0.16342	0.00000	3.8557	0.02202	-0.02768	-0.02550	0.00000
742 QD	1411.7539	10.05603	10.04778	11.11819	53.97887	0.13971	0.00000	3.8557	-0.54080	2.27146	-0.01911	0.00000
743 BPM	1411.9099	10.05825	10.04824	11.28978	53.27282	0.13673	0.00000	3.8557	-0.55894	2.25366	-0.01911	0.00000
744 CED	1412.7575	10.06970	10.05087	12.32081	49.53439	0.12053	0.00000	3.8557	-0.65747	2.15694	-0.01911	0.00000
745 OOL	1416.6517	10.11043	10.06589	19.20434	34.46576	0.04611	0.00000	3.8557	-1.11016	1.71257	-0.01911	0.00000
746 B2	1422.7223	10.14701	10.10522	36.96564	17.86904	-0.01031	0.00000	3.8559	-1.81581	1.02085	0.00052	0.00000
747 OOL	1426.6165	10.16105	10.14871	52.87080	11.65131	-0.00827	0.00000	3.8559	-2.26851	0.57581	0.00052	0.00000
748 Q1	1427.9361	10.16482	10.16788	58.82206	10.37555	-0.00756	0.00000	3.8559	-2.23533	0.39236	0.00055	0.00000
749 X1	1442.3821	10.18984	10.36774	144.68049	22.24922	0.00037	0.00000	3.8559	-3.70806	-1.21430	0.00055	0.00000
750 QF	1443.4489	10.19100	10.37484	146.03241	26.06755	0.00094	0.00000	3.8559	2.45994	-2.41867	0.00052	0.00000

751 QF	1444.5157	10.19220	10.38069	134.49673	32.88380	0.00147	0.00000	3.8559	8.19010	-4.06669	0.00047	0.00000
752 X2	1450.5320	10.20342	10.39732	54.26939	101.12147	0.00430	0.00000	3.8559	5.14483	-7.27539	0.00047	0.00000
753 QD	1451.5988	10.20684	10.39891	46.02998	112.28423	0.00490	0.00000	3.8559	2.69447	-3.03052	0.00066	0.00000
754 QD	1452.6656	10.21071	10.40040	42.42248	113.66776	0.00572	0.00000	3.8559	0.73785	1.75319	0.00089	0.00000
755 LS	1487.1788	10.38803	10.49205	34.85647	35.34056	0.03635	0.00000	3.8559	-0.51863	0.51629	0.00089	0.00000
756 LS	1521.6921	10.48023	10.66728	114.02097	42.39250	0.06698	0.00000	3.8559	-1.77511	-0.72062	0.00089	0.00000
757 QF	1522.7589	10.48172	10.67115	112.66260	45.96212	0.06641	0.00000	3.8559	3.02919	-2.67572	-0.00195	0.00000
758 QF	1523.8257	10.48330	10.67458	101.48057	54.15728	0.06286	0.00000	3.8559	7.29435	-5.12162	-0.00469	0.00000
759 X2	1529.8420	10.49986	10.68583	33.04498	133.98389	0.03461	0.00000	3.8559	4.08063	-8.14670	-0.00469	0.00000
760 QD	1530.9088	10.50568	10.68704	26.20515	145.45525	0.03035	0.00000	3.8559	2.42706	-2.44411	-0.00333	0.00000
761 QD	1531.9756	10.51274	10.68820	22.37381	144.10245	0.02746	0.00000	3.8559	1.21824	3.69307	-0.00211	0.00000
762 X1	1546.4216	10.71194	10.71333	10.34647	58.60181	-0.00299	0.00000	3.8559	-0.38567	2.22556	-0.00211	0.00000
763 Q1-	1547.7412	10.73116	10.71711	11.60404	52.67658	-0.00577	0.00000	3.8559	-0.56871	2.25859	-0.00212	0.00000
764 BPM	1547.8972	10.73329	10.71758	11.78429	51.97458	-0.00611	0.00000	3.8559	-0.58650	2.24052	-0.00212	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
765 CED	1548.7448	10.74425	10.72027	12.86046	48.25967	-0.00790	0.00000	3.8559	-0.68317	2.14235	-0.00212	0.00000
766 000	1549.8530	10.75718	10.72412	14.51471	43.65362	-0.01025	0.00000	3.8559	-0.80956	2.01399	-0.00212	0.00000
767 SB	1555.9236	10.80537	10.75449	28.54671	23.46975	-0.02313	0.00000	3.8559	-1.50191	1.31087	-0.00212	0.00000
768 O	1556.2284	10.80705	10.75659	29.47287	22.68141	-0.02378	0.00000	3.8559	-1.53667	1.27556	-0.00212	0.00000
769 SB	1562.2990	10.83175	10.81802	52.33284	11.46293	-0.03666	0.00000	3.8559	-2.22902	0.57244	-0.00212	0.00000
770 O	1562.6038	10.83266	10.82232	53.70225	11.12473	-0.03731	0.00000	3.8559	-2.26378	0.53714	-0.00212	0.00000
771 QF	1563.6706	10.83573	10.83811	56.12639	10.58783	-0.03871	0.00000	3.8559	0.02575	-0.02630	-0.00051	0.00000
772 QF	1564.7374	10.83880	10.85381	53.59565	11.24036	-0.03838	0.00000	3.8559	2.31069	-0.59456	0.00113	0.00000
773 BPM	1564.8934	10.83927	10.85600	52.87746	11.42883	-0.03820	0.00000	3.8559	2.29224	-0.61334	0.00113	0.00000
774 CED	1565.7410	10.84192	10.86728	49.07663	12.55507	-0.03724	0.00000	3.8559	2.19198	-0.71541	0.00113	0.00000
775 OOL	1569.6352	10.85716	10.90684	33.79829	19.95300	-0.03283	0.00000	3.8559	1.73138	-1.18432	0.00113	0.00000
776 B2	1575.7058	10.89774	10.94186	17.13697	38.75916	0.03364	0.00000	3.8557	1.01339	-1.91299	0.02077	0.00000
777 OOL	1579.6000	10.94343	10.95525	11.03796	55.48134	0.11451	0.00000	3.8557	0.55279	-2.38114	0.02077	0.00000
778 QD	1580.6668	10.95937	10.95821	10.46503	58.07876	0.13943	0.00000	3.8557	-0.00768	-0.01690	0.02612	0.00000
779 QD	1581.7336	10.97529	10.96118	11.07171	55.55132	0.17066	0.00000	3.8557	-0.56954	2.35033	0.03265	0.00000
780 BPM	1581.8897	10.97752	10.96163	11.25235	54.82074	0.17575	0.00000	3.8557	-0.58821	2.33201	0.03265	0.00000
781 CED	1582.7373	10.98898	10.96418	12.33542	50.95189	0.20343	0.00000	3.8557	-0.68960	2.23247	0.03265	0.00000
782 OOL	1586.6315	11.02935	10.97881	19.52025	35.34553	0.33059	0.00000	3.8557	-1.15541	1.77512	0.03265	0.00000
783 B2	1592.7021	11.06514	11.01737	37.95508	18.11195	0.58839	0.00000	3.8645	-1.88152	1.06319	0.05229	0.00000
784 OOL	1596.5963	11.07880	11.06063	54.42311	11.61512	0.79202	0.00000	3.8645	-2.34734	0.60514	0.05229	0.00000
785 QF	1597.6631	11.08182	11.07582	56.99438	10.95327	0.82956	0.00000	3.8645	-0.02653	0.02458	0.01783	0.00000
786 QF	1598.7299	11.08485	11.09108	54.53293	11.50707	0.82976	0.00000	3.8645	2.29901	-0.55149	-0.01744	0.00000
787 BPM	1598.8859	11.08530	11.09323	53.81830	11.68192	0.82704	0.00000	3.8645	2.28102	-0.56917	-0.01744	0.00000
788 CED	1599.7335	11.08790	11.10430	50.03432	12.72820	0.81226	0.00000	3.8645	2.18333	-0.66523	-0.01744	0.00000
789 OOL	1603.6277	11.10278	11.14392	34.77756	19.62796	0.74436	0.00000	3.8645	1.73449	-1.10657	-0.01744	0.00000
790 B2	1609.6983	11.14182	11.17997	17.96719	37.22954	0.69811	0.00000	3.8785	1.03484	-1.79235	0.00220	0.00000
791 OOL	1613.5925	11.18518	11.19395	11.65535	52.90493	0.70667	0.00000	3.8785	0.58599	-2.23297	0.00220	0.00000
792 QD	1614.6593	11.20029	11.19706	11.03421	55.30225	0.72504	0.00000	3.8785	0.00499	0.01967	0.03237	0.00000
793 QD	1615.7261	11.21541	11.20018	11.63342	52.82351	0.77625	0.00000	3.8785	-0.57511	2.26881	0.06400	0.00000
794 BPM	1615.8821	11.21753	11.20066	11.81568	52.11834	0.78623	0.00000	3.8785	-0.59295	2.25065	0.06400	0.00000
795 CED	1616.7297	11.22847	11.20334	12.90303	48.38664	0.84048	0.00000	3.8785	-0.68991	2.15201	0.06400	0.00000
796 OOL	1620.6239	11.26742	11.21879	20.01104	33.39078	1.08971	0.00000	3.8785	-1.13537	1.69881	0.06400	0.00000
797 B2	1626.6945	11.30274	11.25973	38.00988	17.04508	1.53781	0.00000	3.9041	-1.82974	0.99327	0.08364	0.00000
798 OOL	1630.5887	11.31644	11.30547	53.99533	11.07652	1.86350	0.00000	3.9041	-2.27520	0.53941	0.08364	0.00000
799 QF	1631.6555	11.31949	11.32133	56.43046	10.53326	1.91012	0.00000	3.9041	0.02703	-0.02251	0.00344	0.00000

CIRCUMFERENCE = 3263.3111 M
RADIUS = 519.3721 M
(DS/S)/(DP/P)= 0.0023927

THETX = 6.28318445 RAD
THETY = 0.00000000 RAD
TGAM=(20.44351, 0.00000)

NUX = 22.63899
NUY = 22.64266

DNUX/(DP/P) = -28.92284
DNUY/(DP/P) = -28.96209

MAXIMA --- BETX(750) = 146.03241 BETY(760) = 145.45525 XEQ(702) = 2.08098 YEQ(799) = 0.00000
MINIMA --- BETX(762) = 10.34647 BETY(748) = 10.37555 XEQ(749) = 0.00037 YEQ(799) = 0.00000

1

Next, in the Counterclockwise direction ...

***	GF	=	//	-198.6		
***	GD	=	//	198.4		
***	G1	=	//	-12.02368		
***	QF	MAG	//	QL	GF	BRHO
***	QD	MAG	//	QL	GD	BRHO
***	Q1	MAG	//	QL4	G1	BRHO
***	Q1-	MAG	//	QL4	-G1	BRHO
***	MR-	CYC	2 //	.RMG		

1BETATRON FUNCTIONS OF MR-

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
0		0.0000	0.00000	0.00000	10.59780	56.57173	0.94530	0.00000	0.0000	0.02131	-0.02883	-0.00699	0.00000
1	QF	1.0668	0.01577	0.00305	11.14600	54.13399	0.95921	0.00000	0.0000	-0.54290	2.27941	0.03318	0.00000
2	OOL	4.9610	0.06123	0.01671	17.13587	38.11666	1.08842	0.00000	0.0000	-0.99525	1.83371	0.03318	0.00000
3	B2	11.0316	0.10200	0.05193	33.49891	20.06056	1.34943	0.00000	0.0237	-1.70038	1.14006	0.05282	0.00000
4	OOL	14.9258	0.11739	0.09082	48.50370	12.91978	1.55511	0.00000	0.0237	-2.15273	0.69363	0.05282	0.00000
5	CED	15.7734	0.12008	0.10174	52.23646	11.82629	1.59988	0.00000	0.0237	-2.25119	0.59646	0.05282	0.00000
6	BPM	15.9294	0.12055	0.10386	52.94180	11.64295	1.60812	0.00000	0.0237	-2.26932	0.57858	0.05282	0.00000
7	QD	16.9962	0.12366	0.11897	55.41610	11.03683	1.62789	0.00000	0.0237	-0.01505	-0.00189	-0.01589	0.00000
8	QD	18.0630	0.12677	0.13408	53.00411	11.65125	1.57448	0.00000	0.0237	2.24189	-0.58270	-0.08387	0.00000
9	OOL	21.9572	0.14073	0.17749	37.26746	17.93305	1.24785	0.00000	0.0237	1.79916	-1.03042	-0.08387	0.00000
10	B2	28.0278	0.17677	0.21663	19.61415	34.67109	0.79831	0.00000	0.0436	1.10903	-1.72628	-0.06424	0.00000
11	OOL	31.9220	0.21645	0.23156	12.70067	49.85690	0.54816	0.00000	0.0436	0.66630	-2.17332	-0.06424	0.00000
12	CED	32.7696	0.22755	0.23417	11.65285	53.62358	0.49371	0.00000	0.0436	0.56993	-2.27062	-0.06424	0.00000
13	BPM	32.9257	0.22969	0.23463	11.47776	54.33494	0.48368	0.00000	0.0436	0.55219	-2.28853	-0.06424	0.00000
14	QF	33.9925	0.24500	0.23766	10.92149	56.78299	0.42560	0.00000	0.0436	-0.02292	0.02842	-0.04506	0.00000
15	QF	35.0593	0.26023	0.24070	11.57853	54.21728	0.38682	0.00000	0.0436	-0.60223	2.34031	-0.02792	0.00000
16	OOL	38.9535	0.30364	0.25441	18.05373	37.80165	0.27808	0.00000	0.0436	-1.06054	1.87509	-0.02792	0.00000
17	B2	45.0241	0.34230	0.29036	35.26578	19.42814	0.16818	0.00000	0.0478	-1.77495	1.15096	-0.00829	0.00000
18	OOL	48.9183	0.35696	0.33093	50.87457	12.27856	0.13590	0.00000	0.0478	-2.23326	0.68499	-0.00829	0.00000
19	CED	49.7659	0.35951	0.34244	54.74495	11.20332	0.12888	0.00000	0.0478	-2.33302	0.58357	-0.00829	0.00000
20	BPM	49.9219	0.35996	0.34468	55.47586	11.02412	0.12758	0.00000	0.0478	-2.35138	0.56490	-0.00829	0.00000
21	QD	50.9887	0.36293	0.36066	58.00909	10.42551	0.11594	0.00000	0.0478	0.01260	0.00464	-0.01346	0.00000
22	QD	52.0555	0.36591	0.37666	55.42370	11.00372	0.09909	0.00000	0.0478	2.37434	-0.55477	-0.01802	0.00000
23	OOL	55.9497	0.37930	0.42243	38.74755	17.12678	0.02890	0.00000	0.0478	1.90797	-1.01759	-0.01802	0.00000
24	B2	62.0203	0.41428	0.46300	19.99678	33.85233	-0.02091	0.00000	0.0477	1.18101	-1.73705	0.00161	0.00000
25	OOL	65.9145	0.45371	0.47821	12.61471	49.18085	-0.01463	0.00000	0.0477	0.71465	-2.19919	0.00161	0.00000
26	CED	66.7621	0.46492	0.48085	11.48928	52.99417	-0.01326	0.00000	0.0477	0.61314	-2.29978	0.00161	0.00000
27	BPM	66.9181	0.46710	0.48132	11.30086	53.71473	-0.01301	0.00000	0.0477	0.59445	-2.31829	0.00161	0.00000
28	QF	67.9849	0.48272	0.48438	10.65057	56.25634	-0.01157	0.00000	0.0477	0.02427	-0.02819	0.00109	0.00000
29	QF	69.0517	0.49841	0.48745	11.19416	53.83143	-0.01066	0.00000	0.0477	-0.54147	2.26693	0.00063	0.00000
30	O	69.3565	0.50268	0.48836	11.53497	52.46010	-0.01047	0.00000	0.0477	-0.57668	2.23217	0.00063	0.00000
31	SB	75.4271	0.56376	0.51299	22.79383	29.56148	-0.00667	0.00000	0.0477	-1.27798	1.53988	0.00063	0.00000
32	O	75.7319	0.56585	0.51466	23.58362	28.63337	-0.00648	0.00000	0.0477	-1.31319	1.50512	0.00063	0.00000
33	SB	81.8025	0.59610	0.56270	43.78458	14.56209	-0.00269	0.00000	0.0477	-2.01448	0.81282	0.00063	0.00000
34	OOO	82.9107	0.59993	0.57558	48.39135	12.90062	-0.00199	0.00000	0.0477	-2.14251	0.68644	0.00063	0.00000
35	CED	83.7583	0.60262	0.58652	52.10632	11.81889	-0.00146	0.00000	0.0477	-2.24042	0.58978	0.00063	0.00000
36	BPM	83.9144	0.60309	0.58863	52.80828	11.63762	-0.00137	0.00000	0.0477	-2.25845	0.57198	0.00063	0.00000

37	Q1-	85.2339	0.60686	0.60781	58.73207	10.37151	-0.00054	0.00000	0.0477	-2.22460	0.38887	0.00063	0.00000
38	X1	99.6799	0.63195	0.80721	144.14309	22.30023	0.00854	0.00000	0.0477	-3.68782	-1.21462	0.00063	0.00000
39	QD	100.7467	0.63311	0.81430	145.48288	26.12022	0.00901	0.00000	0.0477	2.45087	-2.41987	0.00026	0.00000
40	QD	101.8135	0.63432	0.82014	133.99654	32.93979	0.00908	0.00000	0.0477	8.15377	-4.06855	-0.00013	0.00000
41	X2	107.8298	0.64557	0.83675	54.11431	101.18365	0.00831	0.00000	0.0477	5.12380	-7.27456	-0.00013	0.00000
42	QF	108.8966	0.64901	0.83833	45.91331	112.33650	0.00836	0.00000	0.0477	2.67908	-3.02204	0.00022	0.00000
43	QF	109.9634	0.65289	0.83982	42.33474	113.69442	0.00879	0.00000	0.0477	0.72578	1.76837	0.00058	0.00000
44	LS	144.4767	0.82899	0.93215	35.19480	34.86972	0.02897	0.00000	0.0477	-0.51890	0.51553	0.00058	0.00000
1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
45	LS	178.9899	0.92071	1.10903	113.97068	42.52366	0.04915	0.00000	0.0477	-1.76358	-0.73730	0.00058	0.00000
46	QD	180.0567	0.92220	1.11289	112.59544	46.13447	0.04866	0.00000	0.0477	3.03326	-2.69817	-0.00149	0.00000
47	QD	181.1235	0.92378	1.11630	101.41306	54.38681	0.04599	0.00000	0.0477	7.29076	-5.15345	-0.00350	0.00000
48	X2	187.1398	0.94035	1.12750	33.01485	134.73726	0.02492	0.00000	0.0477	4.07800	-8.20195	-0.00350	0.00000
49	QF	188.2066	0.94617	1.12870	26.18051	146.28737	0.02172	0.00000	0.0477	2.42456	-2.46141	-0.00252	0.00000
50	QF	189.2734	0.95325	1.12986	22.35436	144.92712	0.01951	0.00000	0.0477	1.21585	3.71723	-0.00165	0.00000
51	X1	203.7195	1.15229	1.15485	10.36190	58.86560	-0.00429	0.00000	0.0477	-0.38569	2.24022	-0.00165	0.00000
52	Q1	205.0390	1.17149	1.15861	11.61932	52.90181	-0.00647	0.00000	0.0477	-0.56857	2.27310	-0.00166	0.00000
53	OOL	208.9332	1.21516	1.17265	17.77463	36.96581	-0.01296	0.00000	0.0477	-1.01206	1.81914	-0.00166	0.00000
54	B2	215.0038	1.25472	1.20927	34.25790	19.16531	0.03654	0.00000	0.0477	-1.70337	1.11254	0.01797	0.00000
55	OOL	218.8980	1.26983	1.25013	49.25149	12.27103	0.10652	0.00000	0.0477	-2.14687	0.65785	0.01797	0.00000
56	CED	219.7456	1.27247	1.26163	52.97268	11.23972	0.12175	0.00000	0.0477	-2.24339	0.55889	0.01797	0.00000
57	BPM	219.9016	1.27294	1.26385	53.67552	11.06815	0.12456	0.00000	0.0477	-2.26116	0.54067	0.01797	0.00000
58	QD	220.9684	1.27601	1.27973	56.09778	10.52148	0.14078	0.00000	0.0477	0.02484	-0.02055	0.01234	0.00000
59	QD	222.0352	1.27908	1.29555	53.57267	11.15849	0.15068	0.00000	0.0477	2.30644	-0.58553	0.00615	0.00000
60	OOL	225.9294	1.29295	1.34044	37.39812	17.54379	0.17463	0.00000	0.0477	1.84706	-1.05417	0.00615	0.00000
61	B2	232.0000	1.32920	1.37996	19.32070	34.76830	0.27156	0.00000	0.0519	1.13099	-1.78265	0.02579	0.00000
62	OOL	235.8942	1.36984	1.39478	12.30096	50.47454	0.37197	0.00000	0.0519	0.67162	-2.25059	0.02579	0.00000
63	CED	236.7418	1.38132	1.39735	11.24718	54.37607	0.39383	0.00000	0.0519	0.57163	-2.35244	0.02579	0.00000
64	BPM	236.8979	1.38355	1.39781	11.07167	55.11309	0.39785	0.00000	0.0519	0.55323	-2.37119	0.02579	0.00000
65	QF	237.9647	1.39944	1.40079	10.49943	57.70364	0.43458	0.00000	0.0519	-0.00877	-0.02047	0.04334	0.00000
66	QF	239.0315	1.41531	1.40378	11.11023	55.19784	0.49102	0.00000	0.0519	-0.57237	2.33389	0.06287	0.00000
67	OOL	242.9257	1.46051	1.41719	17.38020	38.79181	0.73584	0.00000	0.0519	-1.03771	1.87905	0.06287	0.00000
68	B2	248.9963	1.50045	1.45192	34.38147	20.27161	1.17705	0.00000	0.0705	-1.76306	1.17116	0.08250	0.00000
69	OOL	252.8905	1.51543	1.49059	49.92503	12.92428	1.49834	0.00000	0.0705	-2.22840	0.71557	0.08250	0.00000
70	CED	253.7381	1.51804	1.50152	53.78846	11.79529	1.56827	0.00000	0.0705	-2.32968	0.61641	0.08250	0.00000
71	BPM	253.8941	1.51850	1.50364	54.51837	11.60579	1.58114	0.00000	0.0705	-2.34833	0.59815	0.08250	0.00000
72	QD	254.9609	1.52152	1.51884	57.08987	10.95764	1.63295	0.00000	0.0705	-0.02578	0.01852	0.01427	0.00000
73	QD	256.0277	1.52453	1.53408	54.62511	11.52437	1.61135	0.00000	0.0705	2.30134	-0.55773	-0.05461	0.00000
74	OOL	259.9219	1.53807	1.57817	38.44924	17.59338	1.39867	0.00000	0.0705	1.85249	-1.00075	-0.05461	0.00000
75	B2	265.9925	1.57301	1.61814	20.20631	33.92699	1.12676	0.00000	0.0951	1.15283	-1.68934	-0.03498	0.00000
76	OOL	269.8867	1.61167	1.63339	12.97553	48.80687	0.99055	0.00000	0.0951	0.70398	-2.13170	-0.03498	0.00000
77	CED	270.7343	1.62255	1.63606	11.86496	52.50213	0.96091	0.00000	0.0951	0.60628	-2.22798	-0.03498	0.00000
78	BPM	270.8903	1.62466	1.63653	11.67857	53.20016	0.95545	0.00000	0.0951	0.58830	-2.24570	-0.03498	0.00000
79	QF	271.9571	1.63974	1.63962	11.05394	55.60872	0.93952	0.00000	0.0951	0.00601	0.02206	0.00499	0.00000
80	QF	273.0239	1.65483	1.64273	11.65215	53.10883	0.96618	0.00000	0.0951	-0.57518	2.28590	0.04519	0.00000
81	O	273.3287	1.65894	1.64365	12.01339	51.72624	0.97996	0.00000	0.0951	-0.60999	2.25017	0.04519	0.00000
82	B2	279.3993	1.71760	1.66883	23.62737	28.71154	1.31386	0.00000	0.1174	-1.30329	1.54027	0.06482	0.00000
83	O	279.7041	1.71962	1.67054	24.43247	27.78350	1.33362	0.00000	0.1174	-1.33810	1.50447	0.06482	0.00000
84	B2	285.7747	1.74896	1.72064	44.88601	13.83888	1.78672	0.00000	0.1479	-2.03140	0.79216	0.08446	0.00000
85	OOO	286.8829	1.75270	1.73422	49.52867	12.22756	1.88032	0.00000	0.1479	-2.15797	0.66183	0.08446	0.00000
86	CED	287.7305	1.75532	1.74576	53.26891	11.19011	1.95190	0.00000	0.1479	-2.25477	0.56215	0.08446	0.00000
87	BPM	287.8866	1.75579	1.74799	53.97531	11.01755	1.96508	0.00000	0.1479	-2.27260	0.54380	0.08446	0.00000
88	QD	288.9534	1.75884	1.76395	56.40827	10.46265	2.01034	0.00000	0.1479	0.02639	-0.01585	0.00006	0.00000
89	QD	290.0202	1.76190	1.77986	53.86604	11.08724	1.96521	0.00000	0.1479	2.32069	-0.57841	-0.08434	0.00000
1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ

90	0	290.3250	1.76281	1.78417	52.46236	11.45102	1.93950	0.00000	0.1479	2.28456	-0.61510	-0.08434	0.00000
91	B2	296.3956	1.78764	1.84471	29.09498	23.34902	1.48712	0.00000	0.1813	1.56496	-1.34446	-0.06471	0.00000
92	0	296.7004	1.78933	1.84675	28.15199	24.17977	1.46739	0.00000	0.1813	1.52883	-1.38111	-0.06471	0.00000
93	B2	302.7710	1.83886	1.87609	13.95953	45.36686	1.13420	0.00000	0.2067	0.80923	-2.10833	-0.04507	0.00000
94	000	303.8792	1.85233	1.87978	12.31154	50.18715	1.08425	0.00000	0.2067	0.67785	-2.24134	-0.04507	0.00000
95	CED	304.7268	1.86381	1.88237	11.24761	54.07289	1.04605	0.00000	0.2067	0.57737	-2.34307	-0.04507	0.00000
96	BPM	304.8828	1.86603	1.88283	11.07032	54.80699	1.03902	0.00000	0.2067	0.55888	-2.36179	-0.04507	0.00000
97	QF	305.9496	1.88194	1.88583	10.48627	57.39156	1.01413	0.00000	0.2067	-0.00318	-0.02434	-0.00177	0.00000
98	QF	307.0164	1.89783	1.88883	11.08431	54.90777	1.03522	0.00000	0.2067	-0.56582	2.31744	0.04146	0.00000
99	0	307.3212	1.90214	1.88973	11.44030	53.50584	1.04786	0.00000	0.2067	-0.60212	2.28208	0.04146	0.00000
100	B2	313.3918	1.96299	1.91391	23.13891	30.05909	1.35913	0.00000	0.2301	-1.32509	1.57952	0.06110	0.00000
101	0	313.6966	1.96505	1.91555	23.95776	29.10701	1.37775	0.00000	0.2301	-1.36140	1.54409	0.06110	0.00000
102	B2	319.7672	1.99469	1.96307	44.87425	14.63706	1.80821	0.00000	0.2612	-2.08436	0.83907	0.08073	0.00000
103	000	320.8754	1.99842	1.97590	49.64030	12.92033	1.89768	0.00000	0.2612	-2.21635	0.71005	0.08073	0.00000
104	CED	321.7230	2.00104	1.98684	53.48303	11.80029	1.96611	0.00000	0.2612	-2.31730	0.61137	0.08073	0.00000
105	BPM	321.8790	2.00150	1.98896	54.20906	11.61234	1.97871	0.00000	0.2612	-2.33589	0.59321	0.08073	0.00000
106	QD	322.9458	2.00454	2.00414	56.76812	10.97471	2.01971	0.00000	0.2612	-0.02674	0.01346	-0.00416	0.00000
107	QD	324.0126	2.00758	2.01935	54.31975	11.55315	1.96990	0.00000	0.2612	2.28717	-0.56382	-0.08886	0.00000
108	0	324.3174	2.00848	2.02349	52.93615	11.90745	1.94282	0.00000	0.2612	2.25220	-0.59859	-0.08886	0.00000
109	B2	330.3880	2.03289	2.08276	29.82029	23.37280	1.46303	0.00000	0.2944	1.55588	-1.28972	-0.06922	0.00000
110	0	330.6928	2.03454	2.08480	28.88248	24.16960	1.44193	0.00000	0.2944	1.52091	-1.32445	-0.06922	0.00000
111	B2	336.7634	2.08223	2.11446	14.64482	44.43699	1.08132	0.00000	0.3190	0.82459	-2.01352	-0.04959	0.00000
112	000	337.8716	2.09505	2.11824	12.95809	49.03944	1.02637	0.00000	0.3190	0.69746	-2.13957	-0.04959	0.00000
113	CED	338.7192	2.10594	2.12089	11.85816	52.74815	0.98434	0.00000	0.3190	0.60023	-2.23597	-0.04959	0.00000
114	BPM	338.8752	2.10805	2.12136	11.67365	53.44867	0.97660	0.00000	0.3190	0.58233	-2.25372	-0.04959	0.00000
115	QF	339.9420	2.12313	2.12444	11.06127	55.86293	0.94545	0.00000	0.3190	0.00032	0.02482	-0.00905	0.00000
116	QF	341.0088	2.13820	2.12753	11.67226	53.34594	0.95716	0.00000	0.3190	-0.58164	2.29893	0.03108	0.00000
117	0	341.3136	2.14230	2.12845	12.03748	51.95545	0.96663	0.00000	0.3190	-0.61659	2.26302	0.03108	0.00000
118	B2	347.3842	2.20074	2.15353	23.74795	28.80675	1.21492	0.00000	0.3402	-1.31258	1.54949	0.05072	0.00000
119	0	347.6890	2.20275	2.15524	24.55875	27.87315	1.23038	0.00000	0.3402	-1.34753	1.51351	0.05072	0.00000
120	B2	353.7596	2.23193	2.20525	45.14314	13.84093	1.59786	0.00000	0.3678	-2.04352	0.79755	0.07036	0.00000
121	000	354.8678	2.23565	2.21883	49.81322	12.21840	1.67583	0.00000	0.3678	-2.17058	0.66656	0.07036	0.00000
122	CED	355.7154	2.23826	2.23038	53.57517	11.17338	1.73546	0.00000	0.3678	-2.26777	0.56636	0.07036	0.00000
123	BPM	355.8715	2.23872	2.23262	54.28564	10.99952	1.74644	0.00000	0.3678	-2.28566	0.54792	0.07036	0.00000
124	QD	356.9383	2.24176	2.24862	56.73234	10.43544	1.78167	0.00000	0.3678	0.02677	-0.01123	-0.00455	0.00000
125	QD	358.0051	2.24480	2.26457	54.17481	11.04889	1.73681	0.00000	0.3678	2.33444	-0.57244	-0.07925	0.00000
126	0	358.3099	2.24570	2.26889	52.76280	11.40902	1.71265	0.00000	0.3678	2.29815	-0.60906	-0.07925	0.00000
127	B2	364.3805	2.27040	2.32972	29.24904	23.22629	1.29120	0.00000	0.3971	1.57548	-1.33720	-0.05961	0.00000
128	0	364.6853	2.27208	2.33177	28.29968	24.05260	1.27303	0.00000	0.3971	1.53920	-1.37379	-0.05961	0.00000
129	B2	370.7559	2.32140	2.36126	13.99996	45.14333	0.97077	0.00000	0.4189	0.81653	-2.09978	-0.03998	0.00000
130	000	371.8641	2.33484	2.36497	12.33641	49.94444	0.92647	0.00000	0.4189	0.68459	-2.23257	-0.03998	0.00000
131	CED	372.7117	2.34630	2.36757	11.26142	53.81517	0.89259	0.00000	0.4189	0.58369	-2.33413	-0.03998	0.00000
132	BPM	372.8677	2.34852	2.36803	11.08217	54.54647	0.88635	0.00000	0.4189	0.56511	-2.35282	-0.03998	0.00000
133	QF	373.9345	2.36441	2.37105	10.48555	57.12384	0.86348	0.00000	0.4189	0.00255	-0.02666	-0.00307	0.00000
134	QF	375.0013	2.38032	2.37407	11.07095	54.65686	0.87976	0.00000	0.4189	-0.55954	2.30424	0.03370	0.00000

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
135	0	375.3061	2.38463	2.37497	11.42306	53.26292	0.89003	0.00000	0.4189	-0.59569	2.26906	0.03370	0.00000
136	B2	381.3767	2.44569	2.39925	23.02533	29.95281	1.15420	0.00000	0.4388	-1.31565	1.57004	0.05334	0.00000
137	0	381.6815	2.44776	2.40090	23.83837	29.00646	1.17046	0.00000	0.4388	-1.35181	1.53478	0.05334	0.00000
138	B2	387.7521	2.47756	2.44851	44.62020	14.62797	1.55382	0.00000	0.4654	-2.07177	0.83331	0.07297	0.00000
139	000	388.8603	2.48132	2.46135	49.35773	12.92328	1.63469	0.00000	0.4654	-2.20321	0.70494	0.07297	0.00000
140	CED	389.7079	2.48395	2.47228	53.17783	11.81148	1.69654	0.00000	0.4654	-2.30374	0.60676	0.07297	0.00000
141	BPM	389.8639	2.48441	2.47440	53.89962	11.62495	1.70793	0.00000	0.4654	-2.32225	0.58869	0.07297	0.00000
142	QD	390.9307	2.48747	2.48955	56.44364	10.99716	1.74680	0.00000	0.4654	-0.02650	0.00862	-0.00037	0.00000
143	QD	391.9975	2.49052	2.50473	54.00931	11.58704	1.70714	0.00000	0.4654	2.27397	-0.56986	-0.07370	0.00000
144	0	392.3023	2.49143	2.50885	52.63372	11.94505	1.68468	0.00000	0.4654	2.23914	-0.60471	-0.07370	0.00000

145 B2	398.3729	2.51598	2.56787	29.65967	23.49423	1.29688	0.00000	0.4944	1.54558	-1.29740	-0.05407	0.00000
146 0	398.6777	2.51764	2.56990	28.72810	24.29574	1.28041	0.00000	0.4944	1.51075	-1.33221	-0.05407	0.00000
147 B2	404.7483	2.56554	2.59939	14.59699	44.66676	1.01181	0.00000	0.5167	0.81719	-2.02283	-0.03443	0.00000
148 000	405.8565	2.57839	2.60315	12.92608	49.29015	0.97365	0.00000	0.5167	0.69057	-2.14916	-0.03443	0.00000
149 CED	406.7041	2.58931	2.60579	11.83751	53.01530	0.94447	0.00000	0.5167	0.59373	-2.24578	-0.03443	0.00000
150 BPM	406.8602	2.59142	2.60626	11.65501	53.71889	0.93909	0.00000	0.5167	0.57590	-2.26357	-0.03443	0.00000
151 QF	407.9270	2.60651	2.60933	11.05539	56.14179	0.92338	0.00000	0.5167	-0.00539	0.02668	0.00485	0.00000
152 QF	408.9938	2.62159	2.61240	11.67871	53.60844	0.94953	0.00000	0.5167	-0.58767	2.31218	0.04436	0.00000
153 0	409.2986	2.62568	2.61332	12.04766	52.20993	0.96305	0.00000	0.5167	-0.62278	2.27610	0.04436	0.00000
154 B2	415.3692	2.68397	2.63828	23.85324	28.92315	1.29191	0.00000	0.5387	-1.32206	1.55916	0.06399	0.00000
155 0	415.6740	2.68597	2.63999	24.66987	27.98371	1.31141	0.00000	0.5387	-1.35717	1.52300	0.06399	0.00000
156 B2	421.7446	2.71500	2.68986	45.39119	13.85697	1.75946	0.00000	0.5686	-2.05644	0.80362	0.08363	0.00000
157 000	422.8528	2.71870	2.70343	50.09056	12.22168	1.85214	0.00000	0.5686	-2.18410	0.67200	0.08363	0.00000
158 CED	423.7004	2.72129	2.71499	53.87581	11.16783	1.92302	0.00000	0.5686	-2.28174	0.57133	0.08363	0.00000
159 BPM	423.8564	2.72175	2.71723	54.59065	10.99243	1.93607	0.00000	0.5686	-2.29972	0.55280	0.08363	0.00000
160 QD	424.9232	2.72477	2.73324	57.05350	10.41795	1.98110	0.00000	0.5686	0.02592	-0.00622	0.00047	0.00000
161 QD	425.9900	2.72779	2.74924	54.48335	11.01976	1.93706	0.00000	0.5686	2.34695	-0.56637	-0.08272	0.00000
162 0	426.2948	2.72870	2.75357	53.06375	11.37616	1.91184	0.00000	0.5686	2.31054	-0.60290	-0.08272	0.00000
163 B2	432.3654	2.75325	2.81465	29.41437	23.10723	1.46932	0.00000	0.6016	1.58544	-1.32917	-0.06308	0.00000
164 0	432.6702	2.75492	2.81671	28.45898	23.92861	1.45009	0.00000	0.6016	1.54903	-1.36566	-0.06308	0.00000
165 B2	438.7408	2.80400	2.84636	14.05464	44.90935	1.12675	0.00000	0.6267	0.82393	-2.08980	-0.04345	0.00000
166 000	439.8490	2.81739	2.85009	12.37519	49.68795	1.07860	0.00000	0.6267	0.69155	-2.22224	-0.04345	0.00000
167 CED	440.6966	2.82882	2.85270	11.28869	53.54095	1.04178	0.00000	0.6267	0.59030	-2.32354	-0.04345	0.00000
168 BPM	440.8526	2.83103	2.85317	11.10738	54.26894	1.03500	0.00000	0.6267	0.57167	-2.34219	-0.04345	0.00000
169 QF	441.9194	2.84690	2.85620	10.49797	56.83629	1.01176	0.00000	0.6267	0.00817	-0.02806	-0.00028	0.00000
170 QF	442.9862	2.86280	2.85923	11.07147	54.38509	1.03440	0.00000	0.6267	-0.55383	2.29107	0.04288	0.00000
171 0	443.2910	2.86711	2.86013	11.42005	52.99913	1.04748	0.00000	0.6267	-0.58981	2.25604	0.04288	0.00000
172 B2	449.3616	2.92831	2.88453	22.92954	29.82731	1.36738	0.00000	0.6503	-1.30625	1.56028	0.06252	0.00000
173 0	449.6664	2.93039	2.88618	23.73680	28.88686	1.38643	0.00000	0.6503	-1.34223	1.52518	0.06252	0.00000
174 B2	455.7370	2.96033	2.93393	44.38101	14.60512	1.82553	0.00000	0.6816	-2.05868	0.82697	0.08215	0.00000
175 000	456.8452	2.96411	2.94679	49.08881	12.91380	1.91657	0.00000	0.6816	-2.18947	0.69921	0.08215	0.00000
176 CED	457.6928	2.96676	2.95772	52.88520	11.81134	1.98620	0.00000	0.6816	-2.28951	0.60148	0.08215	0.00000
177 BPM	457.8489	2.96723	2.95984	53.60254	11.62645	1.99902	0.00000	0.6816	-2.30793	0.58349	0.08215	0.00000
178 QD	458.9157	2.97030	2.97498	56.12948	11.00952	2.04107	0.00000	0.6816	-0.02504	0.00348	-0.00362	0.00000
179 QD	459.9825	2.97337	2.99014	53.70621	11.61116	1.99136	0.00000	0.6816	2.26229	-0.57590	-0.08923	0.00000

1

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
180 0	460.2873	2.97428	2.99425	52.33770	11.97288	1.96416	0.00000	0.6816	2.22757	-0.61086	-0.08923	0.00000
181 B2	466.3579	2.99897	3.05305	29.49153	23.60988	1.48211	0.00000	0.7152	1.53608	-1.30572	-0.06959	0.00000
182 0	466.6627	3.00064	3.05507	28.56571	24.41648	1.46090	0.00000	0.7152	1.50136	-1.34064	-0.06959	0.00000
183 B2	472.7333	3.04878	3.08441	14.53607	44.90289	1.09804	0.00000	0.7402	0.80987	-2.03340	-0.04996	0.00000
184 000	473.8415	3.06169	3.08815	12.88098	49.55016	1.04267	0.00000	0.7402	0.68363	-2.16013	-0.04996	0.00000
185 CED	474.6891	3.07264	3.09078	11.80394	53.29417	1.00033	0.00000	0.7402	0.58707	-2.25705	-0.04996	0.00000
186 BPM	474.8451	3.07476	3.09124	11.62351	54.00129	0.99253	0.00000	0.7402	0.56930	-2.27490	-0.04996	0.00000
187 QF	475.9119	3.08988	3.09429	11.03657	56.43548	0.96133	0.00000	0.7402	-0.01085	0.02759	-0.00875	0.00000
188 QF	476.9787	3.10498	3.09735	11.67122	53.88707	0.97373	0.00000	0.7402	-0.59299	2.32517	0.03207	0.00000
189 0	477.2835	3.10907	3.09826	12.04346	52.48069	0.98350	0.00000	0.7402	-0.62829	2.28893	0.03207	0.00000
190 B2	483.3541	3.16726	3.12310	23.93842	29.05665	1.23776	0.00000	0.7618	-1.33127	1.56893	0.05170	0.00000
191 0	483.6589	3.16925	3.12480	24.76073	28.11129	1.25352	0.00000	0.7618	-1.36657	1.53262	0.05170	0.00000
192 B2	489.7295	3.19815	3.17450	45.61878	13.88644	1.62697	0.00000	0.7899	-2.06956	0.81017	0.07134	0.00000
193 000	490.8377	3.20183	3.18805	50.34798	12.23728	1.70603	0.00000	0.7899	-2.19790	0.67798	0.07134	0.00000
194 CED	491.6853	3.20442	3.19960	54.15707	11.17366	1.76650	0.00000	0.7899	-2.29606	0.57688	0.07134	0.00000
195 BPM	491.8413	3.20487	3.20184	54.87639	10.99654	1.77763	0.00000	0.7899	-2.31413	0.55827	0.07134	0.00000
196 QD	492.9081	3.20788	3.21785	57.35706	10.41082	1.81320	0.00000	0.7899	0.02388	-0.00098	-0.00490	0.00000
197 QD	493.9749	3.21088	3.23386	54.77753	11.00087	1.76726	0.00000	0.7899	2.35765	-0.56042	-0.08091	0.00000
198 0	494.2797	3.21178	3.23821	53.35143	11.35360	1.74260	0.00000	0.7899	2.32115	-0.59682	-0.08091	0.00000
199 B2	500.3503	3.23619	3.29950	29.58340	22.99603	1.31105	0.00000	0.8197	1.59437	-1.32064	-0.06128	0.00000

200 O	500.6551	3.23786	3.30158	28.62260	23.81218	1.29237	0.00000	0.8197	1.55787	-1.35702	-0.06128	0.00000
201 SB	506.7257	3.28668	3.33137	14.12043	44.68552	0.92039	0.00000	0.8197	0.83104	-2.08142	-0.06128	0.00000
202 OOO	507.8339	3.30001	3.33512	12.42555	49.44532	0.85249	0.00000	0.8197	0.69836	-2.21366	-0.06128	0.00000
203 CED	508.6815	3.31139	3.33775	11.32770	53.28364	0.80055	0.00000	0.8197	0.59688	-2.31480	-0.06128	0.00000
204 BPM	508.8375	3.31360	3.33821	11.14436	54.00890	0.79099	0.00000	0.8197	0.57820	-2.33342	-0.06128	0.00000
205 QF	509.9043	3.32943	3.34126	10.52260	56.56947	0.74306	0.00000	0.8197	0.01338	-0.03056	-0.02892	0.00000
206 QF	510.9711	3.34529	3.34431	11.08554	54.13543	0.72882	0.00000	0.8197	-0.54899	2.27773	0.00213	0.00000
207 O	511.2759	3.34960	3.34522	11.43110	52.75754	0.72947	0.00000	0.8197	-0.58477	2.24289	0.00213	0.00000
208 B2	517.3465	3.41087	3.36971	22.85613	29.72351	0.80198	0.00000	0.8345	-1.29738	1.55073	0.02176	0.00000
209 O	517.6513	3.41296	3.37137	23.65791	28.78882	0.80862	0.00000	0.8345	-1.33316	1.51582	0.02176	0.00000
210 B2	523.7219	3.44303	3.41921	44.16875	14.59876	1.00032	0.00000	0.8521	-2.04577	0.82124	0.04140	0.00000
211 OOO	524.8301	3.44682	3.43207	48.84717	12.91943	1.04620	0.00000	0.8521	-2.17587	0.69413	0.04140	0.00000
212 CED	525.6777	3.44948	3.44299	52.62004	11.82514	1.08129	0.00000	0.8521	-2.27537	0.59691	0.04140	0.00000
213 BPM	525.8338	3.44995	3.44511	53.33295	11.64166	1.08775	0.00000	0.8521	-2.29369	0.57902	0.04140	0.00000
214 QD	526.9006	3.45304	3.46023	55.84170	11.03458	1.10713	0.00000	0.8521	-0.02248	-0.00141	-0.00520	0.00000
215 QD	527.9674	3.45613	3.47534	53.42602	11.64788	1.07674	0.00000	0.8521	2.25273	-0.58211	-0.05156	0.00000
216 O	528.2722	3.45705	3.47944	52.06332	12.01341	1.06102	0.00000	0.8521	2.21807	-0.61714	-0.05156	0.00000
217 B2	534.3428	3.48187	3.53797	29.32475	23.73607	0.80761	0.00000	0.8702	1.52786	-1.31354	-0.03193	0.00000
218 O	534.6476	3.48355	3.53997	28.40393	24.54748	0.79788	0.00000	0.8702	1.49320	-1.34854	-0.03193	0.00000
219 SB	540.7182	3.53196	3.56916	14.46492	45.15176	0.60405	0.00000	0.8702	0.80295	-2.04557	-0.03193	0.00000
220 OOO	541.8264	3.54492	3.57288	12.82490	49.82657	0.56867	0.00000	0.8702	0.67694	-2.17281	-0.03193	0.00000
221 CED	542.6740	3.55592	3.57549	11.75904	53.59242	0.54160	0.00000	0.8702	0.58056	-2.27014	-0.03193	0.00000
222 BPM	542.8300	3.55805	3.57595	11.58064	54.30363	0.53662	0.00000	0.8702	0.56282	-2.28805	-0.03193	0.00000
223 QF	543.8968	3.57322	3.57898	11.00572	56.75212	0.51447	0.00000	0.8702	-0.01582	0.02754	-0.00976	0.00000
224 QF	544.9636	3.58835	3.58202	11.65018	54.18961	0.51564	0.00000	0.8702	-0.59736	2.33823	0.01197	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
225 O	545.2684	3.59245	3.58293	12.02515	52.77531	0.51929	0.00000	0.8702	-0.63285	2.30186	0.01197	0.00000
226 B2	551.3390	3.65061	3.60764	23.99969	29.21124	0.65155	0.00000	0.8815	-1.33982	1.57907	0.03160	0.00000
227 O	551.6438	3.65259	3.60933	24.82727	28.25975	0.66118	0.00000	0.8815	-1.37532	1.54262	0.03160	0.00000
228 B2	557.7144	3.68140	3.65881	45.81564	13.93052	0.91262	0.00000	0.8968	-2.08228	0.81736	0.05124	0.00000
229 OOO	558.8226	3.68506	3.67232	50.57384	12.26598	0.96941	0.00000	0.8968	-2.21135	0.68466	0.05124	0.00000
230 CED	559.6702	3.68763	3.68385	54.40619	11.19136	1.01284	0.00000	0.8968	-2.31006	0.58317	0.05124	0.00000
231 BPM	559.8262	3.68809	3.68608	55.12990	11.01230	1.02083	0.00000	0.8968	-2.32824	0.56448	0.05124	0.00000
232 QD	560.8930	3.69108	3.70208	57.62924	10.41416	1.05214	0.00000	0.8968	0.02075	0.00461	0.00723	0.00000
233 QD	561.9598	3.69407	3.71810	55.04398	10.99204	1.03614	0.00000	0.8968	2.36605	-0.55443	-0.03711	0.00000
234 O	562.2646	3.69496	3.72245	53.61277	11.34107	1.02484	0.00000	0.8968	2.32952	-0.59068	-0.03711	0.00000
235 B2	568.3352	3.71925	3.78393	29.74841	22.89008	0.85919	0.00000	0.9151	1.60187	-1.31140	-0.01747	0.00000
236 O	568.6400	3.72090	3.78601	28.78305	23.70054	0.85387	0.00000	0.9151	1.56533	-1.34762	-0.01747	0.00000
237 SB	574.7106	3.76945	3.81596	14.19554	44.44097	0.74782	0.00000	0.9151	0.83764	-2.06892	-0.01747	0.00000
238 OOO	575.8188	3.78271	3.81973	12.48621	49.17244	0.72846	0.00000	0.9151	0.70480	-2.20059	-0.01747	0.00000
239 CED	576.6664	3.79404	3.82237	11.37755	52.98825	0.71365	0.00000	0.9151	0.60320	-2.30130	-0.01747	0.00000
240 BPM	576.8225	3.79624	3.82284	11.19223	53.70929	0.71092	0.00000	0.9151	0.58449	-2.31984	-0.01747	0.00000
241 QF	577.8893	3.81200	3.82591	10.55899	56.25452	0.70826	0.00000	0.9151	0.01801	-0.02998	0.01246	0.00000
242 QF	578.9561	3.82782	3.82897	11.11305	53.83338	0.73772	0.00000	0.9151	-0.54517	2.26523	0.04296	0.00000
243 O	579.2609	3.83212	3.82988	11.45623	52.46308	0.75081	0.00000	0.9151	-0.58075	2.23051	0.04296	0.00000
244 B2	585.3315	3.89339	3.85451	22.80797	29.56417	1.07121	0.00000	0.9328	-1.28932	1.54086	0.06260	0.00000
245 O	585.6363	3.89548	3.85618	23.60478	28.63547	1.09029	0.00000	0.9328	-1.32490	1.50607	0.06260	0.00000
246 B2	591.7069	3.92564	3.90424	43.99078	14.54850	1.52988	0.00000	0.9583	-2.03347	0.81401	0.08224	0.00000
247 OOO	592.8151	3.92946	3.91714	48.64112	12.88469	1.62101	0.00000	0.9583	-2.16283	0.68736	0.08224	0.00000
248 CED	593.6627	3.93213	3.92809	52.39140	11.80157	1.69072	0.00000	0.9583	-2.26177	0.59050	0.08224	0.00000
249 BPM	593.8187	3.93260	3.93021	53.10005	11.62009	1.70355	0.00000	0.9583	-2.27998	0.57267	0.08224	0.00000
250 QD	594.8855	3.93570	3.94534	55.59002	11.02550	1.75232	0.00000	0.9583	-0.01886	-0.00695	0.00887	0.00000
251 QD	595.9523	3.93880	3.96046	53.17812	11.65064	1.72232	0.00000	0.9583	2.24562	-0.58784	-0.06490	0.00000
252 O	596.2571	3.93972	3.96456	51.81975	12.01972	1.70254	0.00000	0.9583	2.21098	-0.62304	-0.06490	0.00000
253 B2	602.3277	3.96468	4.02294	29.16460	23.83420	1.36816	0.00000	0.9882	1.52120	-1.32277	-0.04527	0.00000
254 O	602.6325	3.96637	4.02494	28.24783	24.65127	1.35436	0.00000	0.9882	1.48657	-1.35793	-0.04527	0.00000

255 SB	608.7031	4.01505	4.05399	14.38672	45.38973	1.07955	0.00000	0.9882	0.79675	-2.05828	-0.04527	0.00000
256 000	609.8113	4.02808	4.05769	12.76036	50.09340	1.02939	0.00000	0.9882	0.67082	-2.18613	-0.04527	0.00000
257 CED	610.6589	4.03913	4.06028	11.70482	53.88221	0.99102	0.00000	0.9882	0.57450	-2.28392	-0.04527	0.00000
258 BPM	610.8149	4.04127	4.06074	11.52831	54.59774	0.98396	0.00000	0.9882	0.55677	-2.30192	-0.04527	0.00000
259 QF	611.8817	4.05651	4.06376	10.96421	57.06247	0.95761	0.00000	0.9882	-0.02006	0.02642	-0.00432	0.00000
260 QF	612.9485	4.07169	4.06678	11.61650	54.48836	0.97468	0.00000	0.9882	-0.60057	2.35006	0.03644	0.00000
261 0	613.2533	4.07580	4.06769	11.99349	53.06689	0.98579	0.00000	0.9882	-0.63627	2.31357	0.03644	0.00000
262 B2	619.3239	4.13399	4.09226	24.03418	29.37384	1.26659	0.00000	1.0102	-1.34730	1.58859	0.05608	0.00000
263 0	619.6287	4.13597	4.09393	24.86638	28.41658	1.28369	0.00000	1.0102	-1.38300	1.55203	0.05608	0.00000
264 B2	625.6993	4.16470	4.14318	45.97267	13.98649	1.68368	0.00000	1.0391	-2.09403	0.82456	0.07571	0.00000
265 000	626.8075	4.16835	4.15664	50.75772	12.30644	1.76759	0.00000	1.0391	-2.22383	0.69146	0.07571	0.00000
266 CED	627.6551	4.17092	4.16813	54.61172	11.22058	1.83176	0.00000	1.0391	-2.32312	0.58965	0.07571	0.00000
267 BPM	627.8112	4.17137	4.17036	55.33952	11.03950	1.84358	0.00000	1.0391	-2.34139	0.57091	0.07571	0.00000
268 QD	628.8780	4.17435	4.18633	57.85752	10.42890	1.88230	0.00000	1.0391	0.01668	0.01003	-0.00339	0.00000
269 QD	629.9448	4.17733	4.20233	55.27048	10.99538	1.83640	0.00000	1.0391	2.37178	-0.54900	-0.08234	0.00000

1

POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
270 0	630.2496	4.17822	4.20668	53.83578	11.34105	1.81130	0.00000	1.0391	2.33525	-0.58508	-0.08234	0.00000
271 B2	636.3202	4.20239	4.26829	29.90187	22.80069	1.37108	0.00000	1.0701	1.60760	-1.30228	-0.06270	0.00000
272 0	636.6250	4.20404	4.27038	28.93301	23.60555	1.35197	0.00000	1.0701	1.57106	-1.33832	-0.06270	0.00000
273 B2	642.6956	4.25231	4.30047	14.27659	44.19954	1.03094	0.00000	1.0933	0.84342	-2.05344	-0.04307	0.00000
274 000	643.8038	4.26550	4.30426	12.55445	48.89573	0.98321	0.00000	1.0933	0.71058	-2.18423	-0.04307	0.00000
275 CED	644.6514	4.27677	4.30692	11.43600	52.68323	0.94670	0.00000	1.0933	0.60897	-2.28427	-0.04307	0.00000
276 BPM	644.8074	4.27896	4.30739	11.24888	53.39893	0.93998	0.00000	1.0933	0.59027	-2.30268	-0.04307	0.00000
277 QF	645.8742	4.29464	4.31047	10.60553	55.92156	0.91500	0.00000	1.0933	0.02184	-0.02627	-0.00394	0.00000
278 QF	646.9410	4.31040	4.31355	11.15283	53.50769	0.93151	0.00000	1.0933	-0.54257	2.25482	0.03501	0.00000
279 0	647.2458	4.31468	4.31447	11.49436	52.14371	0.94218	0.00000	1.0933	-0.57795	2.22016	0.03501	0.00000
280 B2	653.3164	4.37587	4.33926	22.78739	29.36373	1.21427	0.00000	1.1143	-1.28245	1.53162	0.05464	0.00000
281 0	653.6212	4.37797	4.34094	23.57995	28.44064	1.23092	0.00000	1.1143	-1.31783	1.49689	0.05464	0.00000
282 B2	659.6918	4.40819	4.38933	43.85540	14.45826	1.62221	0.00000	1.1421	-2.02233	0.80596	0.07428	0.00000
283 000	660.8000	4.41202	4.40230	48.48022	12.81205	1.70452	0.00000	1.1421	-2.15095	0.67952	0.07428	0.00000
284 CED	661.6476	4.41470	4.41331	52.20988	11.74209	1.76748	0.00000	1.1421	-2.24932	0.58282	0.07428	0.00000
285 BPM	661.8036	4.41517	4.41544	52.91463	11.56299	1.77907	0.00000	1.1421	-2.26743	0.56502	0.07428	0.00000
286 QD	662.8704	4.41828	4.43064	55.38610	10.98238	1.81772	0.00000	1.1421	-0.01434	-0.01260	-0.00208	0.00000
287 QD	663.9372	4.42139	4.44581	52.97398	11.61841	1.77465	0.00000	1.1421	2.24130	-0.59253	-0.07835	0.00000
288 0	664.2420	4.42232	4.44992	51.61825	11.99042	1.75077	0.00000	1.1421	2.20664	-0.62798	-0.07835	0.00000
289 B2	670.3126	4.44739	4.50830	29.01842	23.89425	1.33475	0.00000	1.1722	1.51643	-1.33254	-0.05872	0.00000
290 0	670.6174	4.44909	4.51030	28.10457	24.71736	1.31685	0.00000	1.1722	1.48177	-1.36795	-0.05872	0.00000
291 B2	676.6880	4.49804	4.53924	14.30501	45.59411	1.02002	0.00000	1.1950	0.79155	-2.07038	-0.03908	0.00000
292 000	677.7962	4.51114	4.54292	12.69025	50.32529	0.97671	0.00000	1.1950	0.66555	-2.19887	-0.03908	0.00000
293 CED	678.6438	4.52225	4.54551	11.64371	54.13612	0.94359	0.00000	1.1950	0.56917	-2.29715	-0.03908	0.00000
294 BPM	678.7998	4.52440	4.54596	11.46886	54.85579	0.93749	0.00000	1.1950	0.55143	-2.31524	-0.03908	0.00000
295 QF	679.8666	4.53971	4.54897	10.91387	57.33725	0.91674	0.00000	1.1950	-0.02338	0.02429	0.00003	0.00000
296 QF	680.9334	4.55496	4.55197	11.57166	54.75522	0.93755	0.00000	1.1950	-0.60248	2.35950	0.03914	0.00000
297 0	681.2382	4.55908	4.55287	11.94988	53.32802	0.94948	0.00000	1.1950	-0.63838	2.32294	0.03914	0.00000
298 B2	687.3088	4.61738	4.57731	24.04019	29.52957	1.24667	0.00000	1.2164	-1.35337	1.59658	0.05878	0.00000
299 0	687.6136	4.61936	4.57899	24.87614	28.56746	1.26458	0.00000	1.2164	-1.38927	1.55995	0.05878	0.00000
300 B2	693.6842	4.64805	4.62798	46.08254	14.04962	1.68096	0.00000	1.2451	-2.10425	0.83109	0.07841	0.00000
301 000	694.7924	4.65169	4.64138	50.89106	12.35537	1.76786	0.00000	1.2451	-2.23478	0.69773	0.07841	0.00000
302 CED	695.6400	4.65425	4.65283	54.76408	11.25903	1.83432	0.00000	1.2451	-2.33462	0.59573	0.07841	0.00000
303 BPM	695.7961	4.65470	4.65506	55.49549	11.07605	1.84656	0.00000	1.2451	-2.35300	0.57696	0.07841	0.00000
304 QD	696.8629	4.65767	4.67098	58.03130	10.45411	1.88807	0.00000	1.2451	0.01183	0.01479	-0.00088	0.00000
305 QD	697.9297	4.66064	4.68695	55.44651	11.01103	1.84470	0.00000	1.2451	2.37456	-0.54467	-0.08013	0.00000
306 0	698.2345	4.66153	4.69129	54.01010	11.35401	1.82028	0.00000	1.2451	2.33806	-0.58057	-0.08013	0.00000
307 B2	704.3051	4.68560	4.75295	30.03671	22.73677	1.39350	0.00000	1.2764	1.61129	-1.29414	-0.06049	0.00000
308 0	704.6099	4.68725	4.75505	29.06560	23.53660	1.37506	0.00000	1.2764	1.57479	-1.32999	-0.06049	0.00000
309 B2	710.6805	4.73526	4.78525	14.35862	44.00749	1.06747	0.00000	1.3002	0.84802	-2.04149	-0.04085	0.00000

310 000	711.7887	4.74838	4.78906	12.62612	48.67647	1.02220	0.00000	1.3002	0.71533	-2.17162	-0.04085	0.00000
311 CED	712.6363	4.75958	4.79173	11.49950	52.44217	0.98757	0.00000	1.3002	0.61385	-2.27116	-0.04085	0.00000
312 BPM	712.7923	4.76176	4.79220	11.31085	53.15376	0.98119	0.00000	1.3002	0.59517	-2.28948	-0.04085	0.00000
313 QF	713.8591	4.77736	4.79530	10.65941	55.65930	0.95953	0.00000	1.3002	0.02465	-0.02369	0.00008	0.00000
314 QF	714.9259	4.79304	4.79840	11.20247	53.25185	0.98137	0.00000	1.3002	-0.54135	2.24631	0.04102	0.00000
1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
315 0	715.2307	4.79731	4.79932	11.54321	51.89305	0.99387	0.00000	1.3002	-0.57654	2.21170	0.04102	0.00000
316 B2	721.3013	4.85835	4.82424	22.79576	29.20946	1.30246	0.00000	1.3226	-1.27720	1.52421	0.06066	0.00000
317 0	721.6061	4.86044	4.82593	23.58506	28.29087	1.32095	0.00000	1.3226	-1.31238	1.48953	0.06066	0.00000
318 B2	727.6767	4.89069	4.87456	43.77109	14.39152	1.74874	0.00000	1.3525	-2.01304	0.79965	0.08029	0.00000
319 000	728.7849	4.89453	4.88759	48.37456	12.75908	1.83771	0.00000	1.3525	-2.14096	0.67341	0.08029	0.00000
320 CED	729.6325	4.89722	4.89864	52.08684	11.69937	1.90577	0.00000	1.3525	-2.23880	0.57685	0.08029	0.00000
321 BPM	729.7885	4.89769	4.90078	52.78829	11.52213	1.91830	0.00000	1.3525	-2.25681	0.55908	0.08029	0.00000
322 QD	730.8553	4.90081	4.91603	55.24269	10.95251	1.96019	0.00000	1.3525	-0.00919	-0.01712	-0.00205	0.00000
323 QD	731.9221	4.90393	4.93123	52.82634	11.59738	1.91395	0.00000	1.3525	2.24006	-0.59644	-0.08430	0.00000
324 0	732.2269	4.90486	4.93535	51.47139	11.97184	1.88826	0.00000	1.3525	2.20534	-0.63208	-0.08430	0.00000
325 B2	738.2975	4.93002	4.99371	28.89526	23.94795	1.43612	0.00000	1.3850	1.51383	-1.34035	-0.06467	0.00000
326 0	738.6023	4.93172	4.99570	27.98301	24.77587	1.41641	0.00000	1.3850	1.47911	-1.37594	-0.06467	0.00000
327 B2	744.6729	4.98093	5.02455	14.22359	45.77214	1.08347	0.00000	1.4093	0.78760	-2.08207	-0.04503	0.00000
328 000	745.7811	4.99411	5.02822	12.61785	50.52998	1.03357	0.00000	1.4093	0.66136	-2.21124	-0.04503	0.00000
329 CED	746.6287	5.00528	5.03079	11.57855	54.36221	0.99540	0.00000	1.4093	0.56480	-2.31003	-0.04503	0.00000
330 BPM	746.7848	5.00744	5.03125	11.40507	55.08591	0.98837	0.00000	1.4093	0.54703	-2.32822	-0.04503	0.00000
331 QF	747.8516	5.02284	5.03424	10.85707	57.58468	0.96238	0.00000	1.4093	-0.02563	0.02129	-0.00388	0.00000
332 QF	748.9184	5.03816	5.03723	11.51778	54.99777	0.98002	0.00000	1.4093	-0.60300	2.36701	0.03709	0.00000
333 0	749.2232	5.04230	5.03813	11.89637	53.56600	0.99133	0.00000	1.4093	-0.63908	2.33042	0.03709	0.00000
334 B2	755.2938	5.10076	5.06245	24.01753	29.68101	1.27604	0.00000	1.4314	-1.35774	1.60336	0.05672	0.00000
335 0	755.5986	5.10275	5.06411	24.85621	28.71478	1.29333	0.00000	1.4314	-1.39383	1.56669	0.05672	0.00000
336 B2	761.6692	5.13143	5.11286	46.14031	14.11937	1.69724	0.00000	1.4605	-2.11249	0.83713	0.07636	0.00000
337 000	762.7774	5.13507	5.12620	50.96783	12.41190	1.78186	0.00000	1.4605	-2.24369	0.70363	0.07636	0.00000
338 CED	763.6250	5.13762	5.13759	54.85639	11.30564	1.84658	0.00000	1.4605	-2.34404	0.60154	0.07636	0.00000
339 BPM	763.7810	5.13807	5.13981	55.59075	11.12086	1.85849	0.00000	1.4605	-2.36251	0.58274	0.07636	0.00000
340 QD	764.8478	5.14103	5.15567	58.14271	10.48839	1.89756	0.00000	1.4605	0.00644	0.01902	-0.00339	0.00000
341 QD	765.9146	5.14400	5.17160	55.56407	11.03724	1.85132	0.00000	1.4605	2.37426	-0.54122	-0.08298	0.00000
342 0	766.2194	5.14488	5.17593	54.12782	11.37805	1.82603	0.00000	1.4605	2.33785	-0.57692	-0.08298	0.00000
343 B2	772.2900	5.16889	5.23759	30.14677	22.69378	1.38194	0.00000	1.4918	1.61277	-1.28674	-0.06334	0.00000
344 0	772.5948	5.17053	5.23969	29.17473	23.48905	1.36263	0.00000	1.4918	1.57636	-1.32241	-0.06334	0.00000
345 B2	778.6654	5.21831	5.26998	14.43849	43.84506	1.03773	0.00000	1.5152	0.85127	-2.03016	-0.04371	0.00000
346 000	779.7736	5.23135	5.27380	12.69842	48.48816	0.98930	0.00000	1.5152	0.71890	-2.15961	-0.04371	0.00000
347 CED	780.6212	5.24249	5.27648	11.56556	52.23305	0.95225	0.00000	1.5152	0.61766	-2.25862	-0.04371	0.00000
348 BPM	780.7772	5.24466	5.27695	11.37572	52.94072	0.94544	0.00000	1.5152	0.59902	-2.27684	-0.04371	0.00000
349 QF	781.8440	5.26017	5.28007	10.71847	55.42888	0.91989	0.00000	1.5152	0.02632	-0.02029	-0.00436	0.00000
350 QF	782.9108	5.27577	5.28317	11.25998	53.02473	0.93606	0.00000	1.5152	-0.54154	2.23987	0.03479	0.00000
351 0	783.2156	5.28002	5.28410	11.60077	51.66985	0.94666	0.00000	1.5152	-0.57655	2.20528	0.03479	0.00000
352 B2	789.2862	5.34085	5.30914	22.83245	29.06219	1.21742	0.00000	1.5363	-1.27374	1.51813	0.05442	0.00000
353 0	789.5910	5.34294	5.31083	23.61959	28.14730	1.23400	0.00000	1.5363	-1.30875	1.48347	0.05442	0.00000
354 B2	795.6616	5.37318	5.35972	43.74052	14.31936	1.62395	0.00000	1.5641	-2.00595	0.79395	0.07406	0.00000
355 000	796.7698	5.37701	5.37282	48.32756	12.69948	1.70602	0.00000	1.5641	-2.13323	0.66777	0.07406	0.00000
356 CED	797.6174	5.37970	5.38392	52.02633	11.64928	1.76879	0.00000	1.5641	-2.23058	0.57127	0.07406	0.00000
357 BPM	797.7735	5.38018	5.38606	52.72520	11.47378	1.78035	0.00000	1.5641	-2.24850	0.55350	0.07406	0.00000
358 QD	798.8403	5.38330	5.40138	55.16457	10.91413	1.81874	0.00000	1.5641	-0.00362	-0.02103	-0.00235	0.00000
359 QD	799.9071	5.38643	5.41662	52.74020	11.56623	1.77536	0.00000	1.5641	2.24190	-0.59941	-0.07866	0.00000
1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
360 0	800.2119	5.38736	5.42075	51.38416	11.94255	1.75139	0.00000	1.5641	2.20707	-0.63523	-0.07866	0.00000
361 B2	806.2825	5.41258	5.47915	28.79957	23.97985	1.33351	0.00000	1.5942	1.51349	-1.34727	-0.05902	0.00000
362 0	806.5873	5.41429	5.48113	27.88756	24.81205	1.31552	0.00000	1.5942	1.47866	-1.38306	-0.05902	0.00000
363 B2	812.6579	5.46372	5.50992	14.14619	45.91753	1.01684	0.00000	1.6169	0.78508	-2.09294	-0.03939	0.00000

364	000	813.7661	5.47697	5.51357	12.54647	50.70024	0.97319	0.00000	1.6169	0.65845	-2.22280	-0.03939	0.00000
365	CED	814.6137	5.48821	5.51614	11.51234	54.55251	0.93980	0.00000	1.6169	0.56161	-2.32212	-0.03939	0.00000
366	BPM	814.7697	5.49038	5.51659	11.33987	55.28000	0.93366	0.00000	1.6169	0.54378	-2.34040	-0.03939	0.00000
367	QF	815.8365	5.50587	5.51957	10.79642	57.79604	0.91249	0.00000	1.6169	-0.02671	0.01752	-0.00045	0.00000
368	QF	816.9033	5.52127	5.52255	11.45732	55.20745	0.93270	0.00000	1.6169	-0.60210	2.37233	0.03847	0.00000
369	0	817.2081	5.52544	5.52344	11.83541	53.77243	0.94442	0.00000	1.6169	-0.63835	2.33574	0.03847	0.00000
370	B2	823.2787	5.58412	5.54766	23.96724	29.82282	1.23756	0.00000	1.6381	-1.36023	1.60868	0.05811	0.00000
371	0	823.5835	5.58611	5.54932	24.80748	28.85334	1.25527	0.00000	1.6381	-1.39648	1.57201	0.05811	0.00000
372	B2	829.6541	5.61482	5.59781	46.14333	14.19330	1.66759	0.00000	1.6666	-2.11836	0.84245	0.07774	0.00000
373	000	830.7623	5.61846	5.61108	50.98452	12.47404	1.75375	0.00000	1.6666	-2.25015	0.70895	0.07774	0.00000
374	CED	831.6099	5.62101	5.62242	54.88442	11.35877	1.81965	0.00000	1.6666	-2.35095	0.60685	0.07774	0.00000
375	BPM	831.7659	5.62146	5.62463	55.62095	11.17233	1.83178	0.00000	1.6666	-2.36951	0.58806	0.07774	0.00000
376	QD	832.8327	5.62442	5.64042	58.18664	10.53053	1.87291	0.00000	1.6666	0.00076	0.02258	-0.00091	0.00000
377	QD	833.8995	5.62738	5.65629	55.61780	11.07307	1.82985	0.00000	1.6666	2.37090	-0.53877	-0.07952	0.00000
378	0	834.2043	5.62827	5.66061	54.18356	11.41233	1.80561	0.00000	1.6666	2.33461	-0.57429	-0.07952	0.00000
379	B2	840.2749	5.65223	5.72220	30.22700	22.67324	1.38250	0.00000	1.6977	1.61197	-1.28035	-0.05989	0.00000
380	0	840.5797	5.65386	5.72430	29.25540	23.46456	1.36425	0.00000	1.6977	1.57568	-1.31583	-0.05989	0.00000
381	B2	846.6503	5.70145	5.75465	14.51254	43.71798	1.06033	0.00000	1.7214	0.85304	-2.01984	-0.04025	0.00000
382	000	847.7585	5.71442	5.75849	12.76806	48.33746	1.01573	0.00000	1.7214	0.72111	-2.14861	-0.04025	0.00000
383	CED	848.6061	5.72550	5.76117	11.63116	52.06325	0.98161	0.00000	1.7214	0.62021	-2.24709	-0.04025	0.00000
384	BPM	848.7621	5.72766	5.76165	11.44051	52.76731	0.97533	0.00000	1.7214	0.60163	-2.26522	-0.04025	0.00000
385	QF	849.8289	5.74308	5.76477	10.78002	55.23845	0.95418	0.00000	1.7214	0.02679	-0.01619	0.00045	0.00000
386	QF	850.8957	5.75859	5.76789	11.32271	52.83435	0.97630	0.00000	1.7214	-0.54313	2.23572	0.04117	0.00000
387	0	851.2005	5.76281	5.76882	11.66442	51.48201	0.98884	0.00000	1.7214	-0.57799	2.20111	0.04117	0.00000
388	B2	857.2711	5.82338	5.79396	22.89576	28.92711	1.29834	0.00000	1.7436	-1.27225	1.51360	0.06080	0.00000
389	0	857.5759	5.82547	5.79566	23.68195	28.01498	1.31687	0.00000	1.7436	-1.30711	1.47893	0.06080	0.00000
390	B2	863.6465	5.85566	5.84481	43.76508	14.24431	1.74556	0.00000	1.7735	-2.00137	0.78906	0.08044	0.00000
391	000	864.7547	5.85949	5.85797	48.34136	12.63535	1.83470	0.00000	1.7735	-2.12811	0.66282	0.08044	0.00000
392	CED	865.6023	5.86218	5.86912	52.03110	11.59358	1.90288	0.00000	1.7735	-2.22505	0.56626	0.08044	0.00000
393	BPM	865.7584	5.86265	5.87128	52.72824	11.41964	1.91543	0.00000	1.7735	-2.24290	0.54849	0.08044	0.00000
394	QD	866.8252	5.86578	5.88666	55.15533	10.86859	1.95754	0.00000	1.7735	0.00211	-0.02420	-0.00179	0.00000
395	QD	867.8920	5.86890	5.90197	52.71951	11.52604	1.91165	0.00000	1.7735	2.24674	-0.60132	-0.08393	0.00000
396	0	868.1968	5.86984	5.90611	51.36055	11.90358	1.88607	0.00000	1.7735	2.21177	-0.63733	-0.08393	0.00000
397	B2	874.2674	5.89509	5.96459	28.73573	23.98884	1.43618	0.00000	1.8059	1.51542	-1.35307	-0.06430	0.00000
398	0	874.5722	5.89681	5.96658	27.82259	24.82463	1.41658	0.00000	1.8059	1.48045	-1.38904	-0.06430	0.00000
399	B2	880.6428	5.94642	5.99532	14.07635	46.02517	1.08589	0.00000	1.8303	0.78409	-2.10262	-0.04466	0.00000
400	000	881.7510	5.95975	5.99897	12.47937	50.83006	1.03640	0.00000	1.8303	0.65696	-2.23314	-0.04466	0.00000
401	CED	882.5986	5.97104	6.00153	11.44810	54.70030	0.99854	0.00000	1.8303	0.55973	-2.33298	-0.04466	0.00000
402	BPM	882.7546	5.97323	6.00198	11.27623	55.43120	0.99157	0.00000	1.8303	0.54183	-2.35135	-0.04466	0.00000
403	QF	883.8214	5.98880	6.00495	10.73468	57.96387	0.96605	0.00000	1.8303	-0.02657	0.01313	-0.00337	0.00000
404	QF	884.8882	6.00429	6.00792	11.39304	55.37686	0.98433	0.00000	1.8303	-0.59984	2.37527	0.03777	0.00000

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
405	0	885.1930	6.00848	6.00881	11.76979	53.94003	0.99584	0.00000	1.8303	-0.63622	2.33871	0.03777	0.00000
406	B2	891.2636	6.06744	6.03294	23.89162	29.94998	1.28471	0.00000	1.8525	-1.36072	1.61237	0.05741	0.00000
407	0	891.5684	6.06943	6.03459	24.73221	28.97825	1.30221	0.00000	1.8525	-1.39710	1.57573	0.05741	0.00000
408	B2	897.6390	6.09820	6.08284	46.09148	14.26880	1.71027	0.00000	1.8819	-2.12160	0.84686	0.07704	0.00000
409	000	898.7472	6.10184	6.09604	50.94038	12.53960	1.79565	0.00000	1.8819	-2.25387	0.71350	0.07704	0.00000
410	CED	899.5948	6.10439	6.10732	54.84689	11.41654	1.86095	0.00000	1.8819	-2.35504	0.61149	0.07704	0.00000
411	BPM	899.7508	6.10484	6.10952	55.58471	11.22865	1.87297	0.00000	1.8819	-2.37366	0.59272	0.07704	0.00000
412	QD	900.8176	6.10781	6.12524	58.16108	10.57905	1.91243	0.00000	1.8819	-0.00495	0.02533	-0.00333	0.00000
413	QD	901.8844	6.11077	6.14104	55.60522	11.11726	1.86593	0.00000	1.8819	2.36463	-0.53741	-0.08354	0.00000
414	0	902.1892	6.11166	6.14534	54.17475	11.45564	1.84046	0.00000	1.8819	2.32850	-0.57274	-0.08354	0.00000
415	B2	908.2598	6.13560	6.20680	30.27372	22.67588	1.39294	0.00000	1.9134	1.60893	-1.27519	-0.06391	0.00000
416	0	908.5646	6.13723	6.20890	29.30393	23.46400	1.37346	0.00000	1.9134	1.57280	-1.31049	-0.06391	0.00000
417	B2	914.6352	6.18467	6.23928	14.57737	43.63074	1.04513	0.00000	1.9370	0.85324	-2.01090	-0.04427	0.00000

418 000	915.7434	6.19758	6.24313	12.83184	48.22967	0.99607	0.00000	1.9370	0.72187	-2.13901	-0.04427	0.00000
419 CED	916.5910	6.20860	6.24582	11.69329	51.93876	0.95855	0.00000	1.9370	0.62139	-2.23699	-0.04427	0.00000
420 BPM	916.7471	6.21075	6.24630	11.50227	52.63965	0.95164	0.00000	1.9370	0.60290	-2.25503	-0.04427	0.00000
421 QF	917.8139	6.22609	6.24943	10.84124	55.09470	0.92563	0.00000	1.9370	0.02604	-0.01154	-0.00467	0.00000
422 QF	918.8807	6.24151	6.25256	11.38779	52.68741	0.94159	0.00000	1.9370	-0.54605	2.23401	0.03471	0.00000
423 O	919.1855	6.24571	6.25349	11.73125	51.33613	0.95217	0.00000	1.9370	-0.58079	2.19935	0.03471	0.00000
424 B2	925.2561	6.30597	6.27872	22.98281	28.80898	1.22247	0.00000	1.9581	-1.27278	1.51079	0.05435	0.00000
425 O	925.5609	6.30805	6.28043	23.76928	27.89859	1.23903	0.00000	1.9581	-1.30752	1.47606	0.05435	0.00000
426 B2	931.6315	6.33816	6.32981	43.84364	14.16904	1.62852	0.00000	1.9861	-1.99951	0.78515	0.07398	0.00000
427 000	932.7397	6.34198	6.34304	48.41534	12.56894	1.71051	0.00000	1.9861	-2.12584	0.65872	0.07398	0.00000
428 CED	933.5873	6.34467	6.35426	52.10096	11.53424	1.77322	0.00000	1.9861	-2.22246	0.56202	0.07398	0.00000
429 BPM	933.7433	6.34514	6.35643	52.79728	11.36164	1.78476	0.00000	1.9861	-2.24025	0.54422	0.07398	0.00000
430 QD	934.8101	6.34826	6.37188	55.21539	10.81751	1.82297	0.00000	1.9861	0.00774	-0.02652	-0.00261	0.00000
431 QD	935.8769	6.35139	6.38726	52.76521	11.47823	1.77923	0.00000	1.9861	2.25436	-0.60212	-0.07909	0.00000
432 O	936.1817	6.35232	6.39142	51.40166	11.85631	1.75512	0.00000	1.9861	2.21923	-0.63830	-0.07909	0.00000
433 B2	942.2523	6.37757	6.45004	28.70666	23.97459	1.33463	0.00000	2.0162	1.51953	-1.35754	-0.05945	0.00000
434 O	942.5571	6.37929	6.45203	27.79107	24.81316	1.31651	0.00000	2.0162	1.48439	-1.39368	-0.05945	0.00000
435 B2	948.6277	6.42905	6.48075	14.01726	46.09125	1.01521	0.00000	2.0389	0.78469	-2.11075	-0.03982	0.00000
436 000	949.7359	6.44243	6.48439	12.41964	50.91486	0.97108	0.00000	2.0389	0.65695	-2.24191	-0.03982	0.00000
437 CED	950.5835	6.45378	6.48695	11.38878	54.80038	0.93733	0.00000	2.0389	0.55925	-2.34223	-0.03982	0.00000
438 BPM	950.7395	6.45598	6.48740	11.21707	55.53418	0.93112	0.00000	2.0389	0.54127	-2.36070	-0.03982	0.00000
439 QF	951.8063	6.47164	6.49036	10.67468	58.08225	0.90943	0.00000	2.0389	-0.02521	0.00825	-0.00100	0.00000
440 QF	952.8731	6.48722	6.49333	11.32790	55.50002	0.92898	0.00000	2.0389	-0.59630	2.37573	0.03778	0.00000
441 O	953.1779	6.49143	6.49422	11.70253	54.06290	0.94049	0.00000	2.0389	-0.63278	2.33924	0.03778	0.00000
442 B2	959.2485	6.55069	6.51828	23.79414	30.05802	1.22943	0.00000	2.0600	-1.35918	1.61428	0.05742	0.00000
443 O	959.5533	6.55269	6.51992	24.63382	29.08510	1.24693	0.00000	2.0600	-1.39566	1.57771	0.05742	0.00000
444 B2	965.6239	6.58156	6.56795	45.98711	14.34319	1.65505	0.00000	2.0883	-2.12206	0.85023	0.07705	0.00000
445 000	966.7321	6.58520	6.58108	50.83741	12.60627	1.74044	0.00000	2.0883	-2.25468	0.71711	0.07705	0.00000
446 CED	967.5797	6.58776	6.59230	54.74551	11.47692	1.80575	0.00000	2.0883	-2.35611	0.61530	0.07705	0.00000
447 BPM	967.7358	6.58821	6.59449	55.48367	11.28783	1.81778	0.00000	2.0883	-2.37478	0.59656	0.07705	0.00000
448 QD	968.8026	6.59118	6.61013	58.06721	10.63224	1.85850	0.00000	2.0883	-0.01045	0.02720	-0.00100	0.00000
449 QD	969.8694	6.59415	6.62585	55.52691	11.16826	1.81566	0.00000	2.0883	2.35574	-0.53718	-0.07900	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
450 O	970.1742	6.59503	6.63013	54.10181	11.50645	1.79158	0.00000	2.0883	2.31979	-0.57235	-0.07900	0.00000
451 B2	976.2448	6.61899	6.69141	30.28480	22.70161	1.37162	0.00000	2.1192	1.60380	-1.27145	-0.05937	0.00000
452 O	976.5496	6.62062	6.69351	29.31808	23.48740	1.35353	0.00000	2.1192	1.56785	-1.30659	-0.05937	0.00000
453 B2	982.6202	6.66796	6.72389	14.63003	43.58640	1.05276	0.00000	2.1426	0.85185	-2.00365	-0.03973	0.00000
454 000	983.7284	6.68082	6.72774	12.88685	48.16859	1.00873	0.00000	2.1426	0.72113	-2.13115	-0.03973	0.00000
455 CED	984.5760	6.69179	6.73044	11.74912	51.86398	0.97505	0.00000	2.1426	0.62116	-2.22867	-0.03973	0.00000
456 BPM	984.7320	6.69392	6.73092	11.55815	52.56226	0.96885	0.00000	2.1426	0.60275	-2.24662	-0.03973	0.00000
457 QF	985.7988	6.70919	6.73405	10.89933	55.00273	0.94811	0.00000	2.1426	0.02409	-0.00649	0.00070	0.00000
458 QF	986.8656	6.72452	6.73719	11.45224	52.58911	0.97037	0.00000	2.1426	-0.55016	2.23480	0.04117	0.00000
459 O	987.1704	6.72870	6.73812	11.79818	51.23736	0.98291	0.00000	2.1426	-0.58483	2.20006	0.04117	0.00000
460 B2	993.2410	6.78864	6.76342	23.08960	28.71199	1.29242	0.00000	2.1647	-1.27531	1.50980	0.06080	0.00000
461 O	993.5458	6.79070	6.76513	23.87760	27.80223	1.31095	0.00000	2.1647	-1.30998	1.47498	0.06080	0.00000
462 B2	999.6164	6.82070	6.81474	43.97261	14.09618	1.73964	0.00000	2.1945	-2.00045	0.78236	0.08044	0.00000
463 000	1000.7246	6.82452	6.82804	48.54611	12.50261	1.82879	0.00000	2.1945	-2.12651	0.65562	0.08044	0.00000
464 CED	1001.5722	6.82719	6.83931	52.23269	11.47336	1.89697	0.00000	2.1945	-2.22292	0.55869	0.08044	0.00000
465 BPM	1001.7282	6.82767	6.84149	52.92915	11.30180	1.90952	0.00000	2.1945	-2.24067	0.54084	0.08044	0.00000
466 QD	1002.7950	6.83078	6.85703	55.34200	10.76268	1.95177	0.00000	2.1945	0.01303	-0.02791	-0.00154	0.00000
467 QD	1003.8618	6.83390	6.87248	52.87522	11.42450	1.90627	0.00000	2.1945	2.26441	-0.60177	-0.08345	0.00000
468 O	1004.1666	6.83483	6.87666	51.50560	11.80241	1.88083	0.00000	2.1945	2.22909	-0.63811	-0.08345	0.00000
469 B2	1010.2372	6.86005	6.93547	28.71370	23.93761	1.43390	0.00000	2.2269	1.52563	-1.36052	-0.06381	0.00000
470 O	1010.5420	6.86177	6.93746	27.79445	24.77805	1.41445	0.00000	2.2269	1.49031	-1.39682	-0.06381	0.00000
471 B2	1016.6126	6.91161	6.96620	13.97164	46.11344	1.08671	0.00000	2.2512	0.78685	-2.11705	-0.04417	0.00000

472 OOO	1017.7208	6.92504	6.96984	12.36999	50.95166	1.03775	0.00000	2.2512	0.65842	-2.24879	-0.04417	0.00000
473 CED	1018.5684	6.93644	6.97239	11.33709	54.84922	1.00031	0.00000	2.2512	0.56020	-2.34955	-0.04417	0.00000
474 BPM	1018.7244	6.93865	6.97284	11.16510	55.58531	0.99342	0.00000	2.2512	0.54211	-2.36810	-0.04417	0.00000
475 QF	1019.7912	6.95438	6.97580	10.61918	58.14701	0.96846	0.00000	2.2512	-0.02269	0.00307	-0.00279	0.00000
476 QF	1020.8580	6.97005	6.97877	11.26488	55.57260	0.98742	0.00000	2.2512	-0.59166	2.37369	0.03846	0.00000
477 O	1021.1628	6.97429	6.97965	11.63669	54.13669	0.99914	0.00000	2.2512	-0.62819	2.33731	0.03846	0.00000
478 B2	1027.2334	7.03387	7.00366	23.67926	30.14312	1.29221	0.00000	2.2735	-1.35569	1.61435	0.05810	0.00000
479 O	1027.5382	7.03588	7.00530	24.51683	29.17012	1.30991	0.00000	2.2735	-1.39222	1.57789	0.05810	0.00000
480 B2	1033.6088	7.06486	7.05313	45.83501	14.41387	1.72217	0.00000	2.3031	-2.11972	0.85242	0.07773	0.00000
481 OOO	1034.7170	7.06852	7.06620	50.68034	12.67169	1.80832	0.00000	2.3031	-2.25253	0.71967	0.07773	0.00000
482 CED	1035.5646	7.07109	7.07736	54.58493	11.53777	1.87420	0.00000	2.3031	-2.35411	0.61813	0.07773	0.00000
483 BPM	1035.7207	7.07154	7.07953	55.32248	11.34779	1.88633	0.00000	2.3031	-2.37281	0.59944	0.07773	0.00000
484 QD	1036.7875	7.07452	7.09509	57.90931	10.68822	1.92623	0.00000	2.3031	-0.01546	0.02810	-0.00321	0.00000
485 QD	1037.8543	7.07749	7.11073	55.38647	11.22426	1.87954	0.00000	2.3031	2.34465	-0.53810	-0.08401	0.00000
486 O	1038.1591	7.07838	7.11499	53.96807	11.56296	1.85393	0.00000	2.3031	2.30889	-0.57312	-0.08401	0.00000
487 B2	1044.2297	7.10238	7.17605	30.25972	22.74951	1.40358	0.00000	2.3349	1.59680	-1.26926	-0.06437	0.00000
488 O	1044.5345	7.10401	7.17815	29.29721	23.53392	1.38396	0.00000	2.3349	1.56104	-1.30425	-0.06437	0.00000
489 B2	1050.6051	7.15130	7.20850	14.66809	43.58655	1.05279	0.00000	2.3586	0.84895	-1.99835	-0.04474	0.00000
490 OOO	1051.7133	7.16412	7.21235	12.93055	48.15639	1.00322	0.00000	2.3586	0.71894	-2.12531	-0.04474	0.00000
491 CED	1052.5609	7.17505	7.21505	11.79608	51.84153	0.96530	0.00000	2.3586	0.61951	-2.22242	-0.04474	0.00000
492 BPM	1052.7169	7.17718	7.21552	11.60561	52.53785	0.95832	0.00000	2.3586	0.60121	-2.24029	-0.04474	0.00000
493 QF	1053.7837	7.19237	7.21866	10.95162	54.96576	0.93196	0.00000	2.3586	0.02104	-0.00122	-0.00487	0.00000
494 QF	1054.8505	7.20763	7.22180	11.51312	52.54290	0.94785	0.00000	2.3586	-0.55528	2.23807	0.03478	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
495 O	1055.1553	7.21178	7.22273	11.86217	51.18920	0.95846	0.00000	2.3586	-0.58991	2.20321	0.03478	0.00000
496 B2	1061.2259	7.27139	7.24807	23.21125	28.63954	1.22920	0.00000	2.3799	-1.27972	1.51064	0.05442	0.00000
497 O	1061.5307	7.27345	7.24979	24.00193	27.72929	1.24578	0.00000	2.3799	-1.31436	1.47571	0.05442	0.00000
498 B2	1067.6013	7.30330	7.29959	44.14608	14.02831	1.63571	0.00000	2.4080	-2.00417	0.78079	0.07405	0.00000
499 OOO	1068.7095	7.30710	7.31296	48.72768	12.43868	1.71778	0.00000	2.4080	-2.13010	0.65363	0.07405	0.00000
500 CED	1069.5571	7.30977	7.32429	52.42027	11.41308	1.78055	0.00000	2.4080	-2.22642	0.55638	0.07405	0.00000
501 BPM	1069.7131	7.31024	7.32648	53.11782	11.24225	1.79210	0.00000	2.4080	-2.24415	0.53848	0.07405	0.00000
502 QD	1070.7799	7.31335	7.34210	55.52937	10.70605	1.83023	0.00000	2.4080	0.01771	-0.02831	-0.00285	0.00000
503 QD	1071.8467	7.31645	7.35763	53.04449	11.36672	1.78607	0.00000	2.4080	2.27643	-0.60029	-0.07963	0.00000
504 O	1072.1515	7.31738	7.36183	51.66761	11.74378	1.76180	0.00000	2.4080	2.24090	-0.63676	-0.07963	0.00000
505 B2	1078.2221	7.34255	7.42087	28.75652	23.87921	1.33805	0.00000	2.4382	1.53345	-1.36190	-0.05999	0.00000
506 O	1078.5269	7.34426	7.42286	27.83256	24.72053	1.31977	0.00000	2.4382	1.49792	-1.39834	-0.05999	0.00000
507 B2	1084.5975	7.39412	7.45164	13.94158	46.09097	1.01521	0.00000	2.4609	0.79046	-2.12130	-0.04035	0.00000
508 OOO	1085.7057	7.40758	7.45528	12.33272	50.93916	0.97049	0.00000	2.4609	0.66131	-2.25354	-0.04035	0.00000
509 CED	1086.5533	7.41902	7.45784	11.29540	54.84508	0.93629	0.00000	2.4609	0.56252	-2.35468	-0.04035	0.00000
510 BPM	1086.7094	7.42124	7.45829	11.12270	55.58278	0.92999	0.00000	2.4609	0.54434	-2.37330	-0.04035	0.00000
511 QF	1087.7762	7.43704	7.46125	10.57070	58.15586	0.90770	0.00000	2.4609	-0.01914	-0.00223	-0.00159	0.00000
512 QF	1088.8430	7.45278	7.46421	11.20685	55.59203	0.92657	0.00000	2.4609	-0.58613	2.36923	0.03710	0.00000
513 O	1089.1478	7.45704	7.46510	11.57529	54.15880	0.93787	0.00000	2.4609	-0.62267	2.33297	0.03710	0.00000
514 B2	1095.2184	7.51696	7.48908	23.55224	30.20228	1.22265	0.00000	2.4820	-1.35040	1.61259	0.05673	0.00000
515 O	1095.5232	7.51898	7.49071	24.38659	29.23032	1.23995	0.00000	2.4820	-1.38694	1.57625	0.05673	0.00000
516 B2	1101.5938	7.54810	7.53839	45.64215	14.47833	1.64392	0.00000	2.5101	-2.11468	0.85335	0.07637	0.00000
517 OOO	1102.7020	7.55178	7.55139	50.47636	12.73355	1.72855	0.00000	2.5101	-2.24753	0.72107	0.07637	0.00000
518 CED	1103.5496	7.55435	7.56250	54.37251	11.59695	1.79328	0.00000	2.5101	-2.34915	0.61990	0.07637	0.00000
519 BPM	1103.7056	7.55481	7.56466	55.10850	11.40641	1.80520	0.00000	2.5101	-2.36786	0.60127	0.07637	0.00000
520 QD	1104.7724	7.55780	7.58014	57.69463	10.74502	1.84547	0.00000	2.5101	-0.01976	0.02800	-0.00114	0.00000
521 QD	1105.8392	7.56078	7.59570	55.19031	11.28329	1.80279	0.00000	2.5101	2.33185	-0.54014	-0.07859	0.00000
522 O	1106.1440	7.56167	7.59993	53.77966	11.62320	1.77883	0.00000	2.5101	2.29629	-0.57503	-0.07859	0.00000
523 B2	1112.2146	7.58574	7.66073	30.19965	22.81790	1.36135	0.00000	2.5407	1.58825	-1.26870	-0.05896	0.00000
524 O	1112.5194	7.58737	7.66282	29.24229	23.60192	1.34338	0.00000	2.5407	1.55270	-1.30356	-0.05896	0.00000
525 B2	1118.5900	7.63468	7.69311	14.68982	43.63116	1.04510	0.00000	2.5640	0.84466	-1.99519	-0.03932	0.00000

526 000	1119.6982	7.64747	7.69696	12.96096	48.19350	1.00152	0.00000	2.5640	0.71540	-2.12170	-0.03932	0.00000
527 CED	1120.5458	7.65838	7.69965	11.83202	51.87221	0.96819	0.00000	2.5640	0.61653	-2.21846	-0.03932	0.00000
528 BPM	1120.7018	7.66049	7.70013	11.64247	52.56728	0.96206	0.00000	2.5640	0.59833	-2.23627	-0.03932	0.00000
529 QF	1121.7686	7.67563	7.70326	10.99572	54.98511	0.94160	0.00000	2.5640	0.01702	0.00407	0.00083	0.00000
530 QF	1122.8354	7.69082	7.70640	11.56763	52.55042	0.96385	0.00000	2.5640	-0.56117	2.24369	0.04102	0.00000
531 0	1123.1402	7.69496	7.70733	11.92027	51.19334	0.97635	0.00000	2.5640	-0.59581	2.20869	0.04102	0.00000
532 B2	1129.2108	7.75423	7.73269	23.34219	28.59419	1.28496	0.00000	2.5860	-1.28582	1.51331	0.06066	0.00000
533 0	1129.5156	7.75628	7.73442	24.13658	27.68236	1.30345	0.00000	2.5860	-1.32047	1.47824	0.06066	0.00000
534 B2	1135.5862	7.78598	7.78437	44.35612	13.96783	1.73126	0.00000	2.6156	-2.01048	0.78050	0.08029	0.00000
535 000	1136.6944	7.78976	7.79780	48.95174	12.37942	1.82024	0.00000	2.6156	-2.13645	0.65283	0.08029	0.00000
536 CED	1137.5420	7.79242	7.80918	52.65511	11.35552	1.88830	0.00000	2.6156	-2.23280	0.55518	0.08029	0.00000
537 BPM	1137.6981	7.79289	7.81139	53.35464	11.18508	1.90083	0.00000	2.6156	-2.25053	0.53720	0.08029	0.00000
538 QD	1138.7649	7.79598	7.82709	55.76891	10.64959	1.94311	0.00000	2.6156	0.02159	-0.02772	-0.00131	0.00000
539 QD	1139.8317	7.79907	7.84270	53.26528	11.30696	1.89804	0.00000	2.6156	2.28986	-0.59772	-0.08286	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
540 0	1140.1365	7.79999	7.84692	51.88027	11.68248	1.87278	0.00000	2.6156	2.25414	-0.63431	-0.08286	0.00000
541 B2	1146.2071	7.82508	7.90623	28.83316	23.80144	1.42937	0.00000	2.6478	1.54262	-1.36164	-0.06323	0.00000
542 0	1146.5119	7.82679	7.90823	27.90367	24.64264	1.41010	0.00000	2.6478	1.50689	-1.39819	-0.06323	0.00000
543 B2	1152.5825	7.87660	7.93708	13.92844	46.02461	1.08588	0.00000	2.6721	0.79537	-2.12335	-0.04359	0.00000
544 000	1153.6907	7.89009	7.94072	12.30952	50.87779	1.03757	0.00000	2.6721	0.66548	-2.25598	-0.04359	0.00000
545 CED	1154.5383	7.90155	7.94328	11.26562	54.78812	1.00062	0.00000	2.6721	0.56612	-2.35743	-0.04359	0.00000
546 BPM	1154.6943	7.90377	7.94373	11.09181	55.52669	0.99382	0.00000	2.6721	0.54784	-2.37611	-0.04359	0.00000
547 QF	1155.7611	7.91963	7.94669	10.53148	58.10849	0.96949	0.00000	2.6721	-0.01471	-0.00747	-0.00218	0.00000
548 QF	1156.8279	7.93543	7.94966	11.15648	55.55762	0.98913	0.00000	2.6721	-0.57995	2.36249	0.03913	0.00000
549 0	1157.1327	7.93971	7.95054	11.52115	54.12845	1.00106	0.00000	2.6721	-0.61646	2.32639	0.03913	0.00000
550 B2	1163.2033	7.99996	7.97452	23.41890	30.23342	1.29818	0.00000	2.6945	-1.34356	1.60904	0.05877	0.00000
551 0	1163.5081	8.00199	7.97615	24.24906	29.26357	1.31609	0.00000	2.6945	-1.38007	1.57286	0.05877	0.00000
552 B2	1169.5787	8.03127	8.02370	45.41736	14.53430	1.73241	0.00000	2.7242	-2.10717	0.85300	0.07840	0.00000
553 000	1170.6869	8.03496	8.03665	50.23480	12.78968	1.81930	0.00000	2.7242	-2.23991	0.72128	0.07840	0.00000
554 CED	1171.5345	8.03755	8.04771	54.11795	11.65237	1.88575	0.00000	2.7242	-2.34144	0.62053	0.07840	0.00000
555 BPM	1171.6905	8.03801	8.04986	54.85154	11.46162	1.89798	0.00000	2.7242	-2.36013	0.60198	0.07840	0.00000
556 QD	1172.7573	8.04101	8.06526	57.43298	10.80063	1.93833	0.00000	2.7242	-0.02316	0.02692	-0.00305	0.00000
557 QD	1173.8241	8.04401	8.08074	54.94743	11.34327	1.89153	0.00000	2.7242	2.31793	-0.54321	-0.08436	0.00000
558 0	1174.1289	8.04490	8.08495	53.54519	11.68502	1.86582	0.00000	2.7242	2.28258	-0.57801	-0.08436	0.00000
559 B2	1180.1995	8.06906	8.14546	30.10732	22.90436	1.41336	0.00000	2.7562	1.57855	-1.26978	-0.06472	0.00000
560 0	1180.5043	8.07069	8.14754	29.15581	23.68901	1.39363	0.00000	2.7562	1.54320	-1.30454	-0.06472	0.00000
561 B2	1186.5749	8.11807	8.17774	14.69421	43.71867	1.06037	0.00000	2.7801	0.83918	-1.99427	-0.04508	0.00000
562 000	1187.6831	8.13085	8.18158	12.97668	48.27859	1.01040	0.00000	2.7801	0.71066	-2.12044	-0.04508	0.00000
563 CED	1188.5307	8.14174	8.18428	11.85530	51.95495	0.97219	0.00000	2.7801	0.61235	-2.21693	-0.04508	0.00000
564 BPM	1188.6867	8.14385	8.18475	11.66704	52.64953	0.96515	0.00000	2.7801	0.59425	-2.23470	-0.04508	0.00000
565 QF	1189.7535	8.15895	8.18788	11.02961	55.06009	0.93858	0.00000	2.7801	0.01223	0.00921	-0.00493	0.00000
566 QF	1190.8203	8.17409	8.19101	11.61328	52.61141	0.95456	0.00000	2.7801	-0.56756	2.25147	0.03500	0.00000
567 0	1191.1251	8.17820	8.19195	11.96983	51.24963	0.96523	0.00000	2.7801	-0.60226	2.21631	0.03500	0.00000
568 B2	1197.1957	8.23718	8.21730	23.47641	28.57754	1.23729	0.00000	2.8016	-1.29332	1.51770	0.05464	0.00000
569 0	1197.5005	8.23921	8.21903	24.27540	27.66309	1.25394	0.00000	2.8016	-1.32802	1.48247	0.05464	0.00000
570 B2	1203.5711	8.26874	8.26909	44.59310	13.91687	1.64519	0.00000	2.8298	-2.01909	0.78149	0.07427	0.00000
571 000	1204.6793	8.27251	8.28257	49.20803	12.32692	1.72750	0.00000	2.8298	-2.14526	0.65323	0.07427	0.00000
572 CED	1205.5269	8.27515	8.29401	52.92645	11.30272	1.79046	0.00000	2.8298	-2.24175	0.55512	0.07427	0.00000
573 BPM	1205.6830	8.27562	8.29622	53.62879	11.13231	1.80205	0.00000	2.8298	-2.25951	0.53707	0.07427	0.00000
574 QD	1206.7498	8.27869	8.31200	56.04966	10.59532	1.84018	0.00000	2.8298	0.02447	-0.02615	-0.00305	0.00000
575 QD	1207.8166	8.28177	8.32770	53.52748	11.24730	1.79558	0.00000	2.8298	2.30411	-0.59417	-0.08024	0.00000
576 0	1208.1214	8.28269	8.33194	52.13384	11.62068	1.77112	0.00000	2.8298	2.26818	-0.63083	-0.08024	0.00000
577 B2	1214.1920	8.30766	8.39153	28.94011	23.70705	1.34362	0.00000	2.8602	1.55273	-1.35975	-0.06061	0.00000
578 0	1214.4968	8.30936	8.39354	28.00452	24.54712	1.32515	0.00000	2.8602	1.51680	-1.39638	-0.06061	0.00000
579 B2	1220.5674	8.35908	8.42248	13.93283	45.91672	1.01685	0.00000	2.8830	0.80135	-2.12312	-0.04097	0.00000

	580 OOO	1221.6756	8.37257	8.42613	12.30146	50.76972	0.97144	0.00000	2.8830	0.67074	-2.25605	-0.04097	0.00000
	581 CED	1222.5232	8.38404	8.42869	11.24911	54.68034	0.93671	0.00000	2.8830	0.57084	-2.35772	-0.04097	0.00000
	582 BPM	1222.6792	8.38627	8.42915	11.07384	55.41901	0.93032	0.00000	2.8830	0.55244	-2.37643	-0.04097	0.00000
	583 QF	1223.7460	8.40216	8.43212	10.50331	58.00656	0.90737	0.00000	2.8830	-0.00961	-0.01246	-0.00221	0.00000
	584 QF	1224.8128	8.41802	8.43509	11.11608	55.47059	0.92557	0.00000	2.8830	-0.57342	2.35373	0.03645	0.00000
1	POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
	585 O	1225.1176	8.42231	8.43597	11.47674	54.04671	0.93668	0.00000	2.8830	-0.60985	2.31779	0.03645	0.00000
	586 B2	1231.1882	8.48286	8.45997	23.28533	30.23543	1.21755	0.00000	2.9040	-1.33548	1.60385	0.05609	0.00000
	587 O	1231.4930	8.48491	8.46160	24.11054	29.26870	1.23464	0.00000	2.9040	-1.37192	1.56783	0.05609	0.00000
	588 B2	1237.5636	8.51435	8.50907	45.17091	14.57980	1.63470	0.00000	2.9319	-2.09755	0.85138	0.07572	0.00000
	589 OOO	1238.6718	8.51806	8.52197	49.96672	12.83809	1.71861	0.00000	2.9319	-2.23002	0.72027	0.07572	0.00000
	590 CED	1239.5194	8.52066	8.53299	53.83293	11.70208	1.78280	0.00000	2.9319	-2.33134	0.62000	0.07572	0.00000
	591 BPM	1239.6754	8.52112	8.53513	54.56336	11.51148	1.79461	0.00000	2.9319	-2.34999	0.60154	0.07572	0.00000
	592 QD	1240.7422	8.52414	8.55046	57.13636	10.85309	1.83445	0.00000	2.9319	-0.02550	0.02488	-0.00132	0.00000
	593 QD	1241.8090	8.52715	8.56586	54.66893	11.40208	1.79181	0.00000	2.9319	2.30353	-0.54722	-0.07831	0.00000
	594 O	1242.1138	8.52805	8.57005	53.27542	11.74625	1.76794	0.00000	2.9319	2.26837	-0.58195	-0.07831	0.00000
	595 B2	1248.1844	8.55232	8.63025	29.98697	23.00585	1.35217	0.00000	2.9624	1.56815	-1.27246	-0.05868	0.00000
	596 O	1248.4892	8.55396	8.63232	29.04174	23.79212	1.33428	0.00000	2.9624	1.53299	-1.30717	-0.05868	0.00000
	597 B2	1254.5598	8.60145	8.66242	14.68108	43.84599	1.03770	0.00000	2.9855	0.83277	-1.99564	-0.03904	0.00000
	598 OOO	1255.6680	8.61424	8.66624	12.97699	48.40868	0.99444	0.00000	2.9855	0.70494	-2.12157	-0.03904	0.00000
	599 CED	1256.5156	8.62512	8.66893	11.86486	52.08681	0.96135	0.00000	2.9855	0.60716	-2.21789	-0.03904	0.00000
	600 BPM	1256.6717	8.62723	8.66941	11.67819	52.78169	0.95525	0.00000	2.9855	0.58917	-2.23562	-0.03904	0.00000
	601 QF	1257.7385	8.64231	8.67253	11.05174	55.18806	0.93495	0.00000	2.9855	0.00687	0.01401	0.00083	0.00000
	602 QF	1258.8053	8.65741	8.67565	11.64797	52.72371	0.95704	0.00000	2.9855	-0.57416	2.26114	0.04074	0.00000
	603 O	1259.1101	8.66152	8.67658	12.00859	51.35609	0.96945	0.00000	2.9855	-0.60895	2.22581	0.04074	0.00000
	604 B2	1265.1807	8.72022	8.70190	23.60779	28.59018	1.27632	0.00000	3.0073	-1.30189	1.52366	0.06037	0.00000
	605 O	1265.4855	8.72224	8.70363	24.41202	27.67215	1.29473	0.00000	3.0073	-1.33668	1.48825	0.06037	0.00000
	606 B2	1271.5561	8.75160	8.75376	44.84617	13.87722	1.72079	0.00000	3.0367	-2.02962	0.78373	0.08001	0.00000
	607 OOO	1272.6643	8.75535	8.76728	49.48481	12.28303	1.80945	0.00000	3.0367	-2.15612	0.65482	0.08001	0.00000
	608 CED	1273.5119	8.75797	8.77877	53.22188	11.25655	1.87727	0.00000	3.0367	-2.25288	0.55622	0.08001	0.00000
	609 BPM	1273.6679	8.75844	8.78099	53.92769	11.08580	1.88975	0.00000	3.0367	-2.27069	0.53807	0.08001	0.00000
	610 QD	1274.7347	8.76150	8.79684	56.35876	10.54514	1.93198	0.00000	3.0367	0.02624	-0.02367	-0.00113	0.00000
	611 QD	1275.8015	8.76456	8.81261	53.81907	11.18986	1.88736	0.00000	3.0367	2.31850	-0.58975	-0.08222	0.00000
	612 O	1276.1063	8.76547	8.81688	52.41672	11.56056	1.86230	0.00000	3.0367	2.28239	-0.62646	-0.08222	0.00000
	613 B2	1282.1769	8.79032	8.87677	29.07248	23.59937	1.42282	0.00000	3.0688	1.56331	-1.35629	-0.06258	0.00000
	614 O	1282.4817	8.79201	8.87879	28.13049	24.43734	1.40374	0.00000	3.0688	1.52721	-1.39297	-0.06258	0.00000
	615 B2	1288.5523	8.84157	8.90784	13.95455	45.77110	1.08345	0.00000	3.0930	0.80812	-2.12063	-0.04295	0.00000
	616 OOO	1289.6605	8.85505	8.91151	12.30891	50.61876	1.03586	0.00000	3.0930	0.67685	-2.25372	-0.04295	0.00000
	617 CED	1290.5081	8.86652	8.91408	11.24662	54.52555	0.99946	0.00000	3.0930	0.57644	-2.35552	-0.04295	0.00000
	618 BPM	1290.6641	8.86875	8.91453	11.06962	55.26354	0.99276	0.00000	3.0930	0.55796	-2.37426	-0.04295	0.00000
	619 QF	1291.7309	8.88465	8.91751	10.48747	57.85368	0.96911	0.00000	3.0930	-0.00406	-0.01702	-0.00157	0.00000
	620 QF	1292.7977	8.90054	8.92049	11.08748	55.33402	0.98939	0.00000	3.0930	-0.56683	2.34324	0.03974	0.00000
	621 O	1293.1025	8.90485	8.92138	11.44409	53.91647	1.00151	0.00000	3.0930	-0.60315	2.30749	0.03974	0.00000
	622 B2	1299.1731	8.96566	8.94541	23.15766	30.20824	1.30236	0.00000	3.1154	-1.32653	1.59718	0.05938	0.00000
	623 O	1299.4779	8.96772	8.94704	23.97738	29.24552	1.32046	0.00000	3.1154	-1.36286	1.56135	0.05938	0.00000
	624 B2	1305.5485	8.99733	8.99447	44.91411	14.61324	1.74051	0.00000	3.1453	-2.08624	0.84854	0.07902	0.00000
	625 OOO	1306.6567	9.00107	9.00735	49.68441	12.87708	1.82808	0.00000	3.1453	-2.21830	0.71810	0.07902	0.00000
	626 CED	1307.5043	9.00368	9.01832	53.53049	11.74432	1.89505	0.00000	3.1453	-2.31931	0.61834	0.07902	0.00000
	627 BPM	1307.6604	9.00414	9.02046	54.25716	11.55422	1.90738	0.00000	3.1453	-2.33791	0.59997	0.07902	0.00000
	628 QD	1308.7272	9.00718	9.03572	56.81833	10.90054	1.94816	0.00000	3.1453	-0.02667	0.02197	-0.00284	0.00000
	629 QD	1309.7940	9.01021	9.05105	54.36758	11.45764	1.90137	0.00000	3.1453	2.28930	-0.55201	-0.08457	0.00000
1	POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
	630 O	1310.0988	9.01111	9.05523	52.98268	11.80473	1.87559	0.00000	3.1453	2.25432	-0.58672	-0.08457	0.00000
	631 B2	1316.1694	9.03550	9.11511	29.84411	23.11877	1.42185	0.00000	3.1775	1.55751	-1.27666	-0.06493	0.00000
	632 O	1316.4742	9.03716	9.11718	28.90531	23.90760	1.40205	0.00000	3.1775	1.52252	-1.31134	-0.06493	0.00000
	633 SB	1322.5448	9.08482	9.14714	14.65038	44.02091	1.00788	0.00000	3.1775	0.82567	-2.00190	-0.06493	0.00000

634	000	1323.6530	9.09763	9.15095	12.96134	48.59762	0.93592	0.00000	3.1775	0.69846	-2.12796	-0.06493	0.00000
635	CED	1324.5006	9.10852	9.15363	11.85978	52.28666	0.88089	0.00000	3.1775	0.60116	-2.22438	-0.06493	0.00000
636	BPM	1324.6566	9.11063	9.15410	11.67497	52.98357	0.87076	0.00000	3.1775	0.58325	-2.24213	-0.06493	0.00000
637	QF	1325.7234	9.12570	9.15721	11.06073	55.39454	0.82071	0.00000	3.1775	0.00118	0.01625	-0.02925	0.00000
638	QF	1326.7902	9.14078	9.16032	11.66980	52.91628	0.80787	0.00000	3.1775	-0.58069	2.27174	0.00510	0.00000
639	0	1327.0950	9.14488	9.16125	12.03444	51.54224	0.80942	0.00000	3.1775	-0.61561	2.23626	0.00510	0.00000
640	B2	1333.1656	9.20335	9.18649	23.73041	28.66732	0.89996	0.00000	3.1941	-1.31117	1.53117	0.02473	0.00000
641	0	1333.4704	9.20536	9.18821	24.54034	27.74476	0.90749	0.00000	3.1941	-1.34610	1.49561	0.02473	0.00000
642	B2	1339.5410	9.23457	9.23827	45.10473	13.87846	1.11722	0.00000	3.2137	-2.04166	0.78813	0.04437	0.00000
643	000	1340.6492	9.23829	9.25180	49.77058	12.27511	1.16639	0.00000	3.2137	-2.16864	0.65868	0.04437	0.00000
644	CED	1341.4968	9.24090	9.26329	53.52918	11.24244	1.20399	0.00000	3.2137	-2.26576	0.55967	0.04437	0.00000
645	BPM	1341.6528	9.24136	9.26552	54.23903	11.07064	1.21092	0.00000	3.2137	-2.28364	0.54144	0.04437	0.00000
646	QD	1342.7196	9.24440	9.28139	56.68355	10.52244	1.23067	0.00000	3.2137	0.02677	-0.01987	-0.00747	0.00000
647	QD	1343.7864	9.24745	9.29721	54.12822	11.15798	1.19510	0.00000	3.2137	2.33242	-0.58481	-0.05897	0.00000
648	0	1344.0912	9.24835	9.30148	52.71743	11.52566	1.17713	0.00000	3.2137	2.29615	-0.62147	-0.05897	0.00000
649	B2	1350.1618	9.27307	9.36161	29.22530	23.49751	0.87877	0.00000	3.2337	1.57392	-1.35025	-0.03933	0.00000
650	0	1350.4666	9.27475	9.36364	28.27689	24.33179	0.86678	0.00000	3.2337	1.53765	-1.38687	-0.03933	0.00000
651	SB	1356.5372	9.32411	9.39281	13.99260	45.59780	0.62800	0.00000	3.2337	0.81537	-2.11624	-0.03933	0.00000
652	000	1357.6454	9.33756	9.39649	12.33152	50.43580	0.58441	0.00000	3.2337	0.68352	-2.24939	-0.03933	0.00000
653	CED	1358.4930	9.34901	9.39907	11.25829	54.33529	0.55107	0.00000	3.2337	0.58267	-2.35123	-0.03933	0.00000
654	BPM	1358.6490	9.35124	9.39952	11.07936	55.07194	0.54494	0.00000	3.2337	0.56411	-2.36998	-0.03933	0.00000
655	QF	1359.7158	9.36714	9.40251	10.48472	57.66179	0.51501	0.00000	3.2337	0.00166	-0.02104	-0.01698	0.00000
656	QF	1360.7826	9.38304	9.40550	11.07206	55.15905	0.50844	0.00000	3.2337	-0.56048	2.33163	0.00461	0.00000
657	0	1361.0874	9.38735	9.40639	11.42475	53.74853	0.50985	0.00000	3.2337	-0.59666	2.29607	0.00461	0.00000
658	B2	1367.1580	9.44838	9.43048	23.04188	30.15645	0.59743	0.00000	3.2444	-1.31713	1.58947	0.02425	0.00000
659	0	1367.4628	9.45045	9.43212	23.85583	29.19838	0.60482	0.00000	3.2444	-1.35331	1.55382	0.02425	0.00000
660	B2	1373.5334	9.48022	9.47955	44.65900	14.63485	0.81160	0.00000	3.2581	-2.07378	0.84474	0.04388	0.00000
661	000	1374.6416	9.48398	9.49240	49.40110	12.90637	0.86023	0.00000	3.2581	-2.20531	0.71498	0.04388	0.00000
662	CED	1375.4892	9.48661	9.50335	53.22482	11.77845	0.89743	0.00000	3.2581	-2.30592	0.61574	0.04388	0.00000
663	BPM	1375.6453	9.48707	9.50548	53.94729	11.58915	0.90427	0.00000	3.2581	-2.32444	0.59747	0.04388	0.00000
664	QD	1376.7121	9.49013	9.52069	56.49382	10.94187	0.93041	0.00000	3.2581	-0.02662	0.01838	0.00493	0.00000
665	QD	1377.7789	9.49318	9.53596	54.05750	11.50832	0.91471	0.00000	3.2581	2.27593	-0.55733	-0.03424	0.00000
666	0	1378.0837	9.49409	9.54011	52.68071	11.85865	0.90428	0.00000	3.2581	2.24108	-0.59204	-0.03424	0.00000
667	B2	1384.1543	9.51861	9.59970	29.68541	23.23766	0.75602	0.00000	3.2742	1.54714	-1.28204	-0.01461	0.00000
668	0	1384.4591	9.52027	9.60175	28.75290	24.02976	0.75156	0.00000	3.2742	1.51229	-1.31672	-0.01461	0.00000
669	SB	1390.5297	9.56814	9.63157	14.60479	44.20880	0.66289	0.00000	3.2742	0.81830	-2.00734	-0.01461	0.00000
670	000	1391.6379	9.58099	9.63536	12.93150	48.79759	0.64671	0.00000	3.2742	0.69161	-2.13342	-0.01461	0.00000
671	CED	1392.4855	9.59190	9.63803	11.84121	52.49589	0.63433	0.00000	3.2742	0.59472	-2.22984	-0.01461	0.00000
672	BPM	1392.6415	9.59401	9.63850	11.65840	53.19450	0.63205	0.00000	3.2742	0.57688	-2.24759	-0.01461	0.00000
673	QF	1393.7083	9.60910	9.64160	11.05687	55.60742	0.63068	0.00000	3.2742	-0.00454	0.01993	0.01203	0.00000
674	QF	1394.7751	9.62418	9.64470	11.67837	53.11200	0.65790	0.00000	3.2742	-0.58679	2.28390	0.03921	0.00000

1

POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
675	0	1395.0799	9.62827	9.64562	12.04678	51.73061	0.66985	0.00000	3.2742	-0.62188	2.24823	0.03921	0.00000
676	B2	1401.1505	9.68657	9.67079	23.83828	28.73289	0.96744	0.00000	3.2901	-1.32064	1.53942	0.05884	0.00000
677	0	1401.4553	9.68857	9.67251	24.65404	27.80536	0.98538	0.00000	3.2901	-1.35573	1.50367	0.05884	0.00000
678	B2	1407.5259	9.71763	9.72253	45.35472	13.86385	1.40216	0.00000	3.3133	-2.05448	0.79245	0.07848	0.00000
679	000	1408.6341	9.72133	9.73608	50.04965	12.25167	1.48913	0.00000	3.3133	-2.18205	0.66232	0.07848	0.00000
680	CED	1409.4817	9.72393	9.74760	53.83136	11.21327	1.55565	0.00000	3.3133	-2.27962	0.56279	0.07848	0.00000
681	BPM	1409.6377	9.72439	9.74984	54.54554	11.04051	1.56789	0.00000	3.3133	-2.29758	0.54447	0.07848	0.00000
682	QD	1410.7045	9.72741	9.76576	57.00588	10.48499	1.61574	0.00000	3.3133	0.02610	-0.01593	0.01089	0.00000
683	QD	1411.7713	9.73043	9.78164	54.43748	11.11054	1.59095	0.00000	3.3133	2.34514	-0.57924	-0.05719	0.00000
684	0	1412.0761	9.73134	9.78593	53.01898	11.47481	1.57352	0.00000	3.3133	2.30875	-0.61588	-0.05719	0.00000
685	B2	1418.1467	9.75591	9.84637	29.38927	23.37622	1.28595	0.00000	3.3412	1.58398	-1.34424	-0.03756	0.00000
686	0	1418.4515	9.75759	9.84841	28.43476	24.20683	1.27450	0.00000	3.3412	1.54759	-1.38084	-0.03756	0.00000
687	SB	1424.5221	9.80671	9.87772	14.04521	45.39706	1.04651	0.00000	3.3412	0.82278	-2.10979	-0.03756	0.00000

688 OOO	1425.6303	9.82011	9.88141	12.36824	50.22067	1.00489	0.00000	3.3412	0.69046	-2.24286	-0.03756	0.00000
689 CED	1426.4779	9.83154	9.88400	11.28355	54.10904	0.97305	0.00000	3.3412	0.58926	-2.34464	-0.03756	0.00000
690 BPM	1426.6340	9.83375	9.88446	11.10257	54.84363	0.96719	0.00000	3.3412	0.57063	-2.36338	-0.03756	0.00000
691 QF	1427.7008	9.84963	9.88746	10.49515	57.42990	0.94875	0.00000	3.3412	0.00731	-0.02434	0.00286	0.00000
692 QF	1428.7676	9.86553	9.89046	11.07044	54.94438	0.97333	0.00000	3.3412	-0.55468	2.31903	0.04340	0.00000
693 O	1429.0724	9.86984	9.89135	11.41955	53.54149	0.98656	0.00000	3.3412	-0.59068	2.28365	0.04340	0.00000
694 B2	1435.1430	9.93102	9.91552	22.94314	30.07771	1.30959	0.00000	3.3636	-1.30771	1.58075	0.06303	0.00000
695 O	1435.4478	9.93310	9.91716	23.75129	29.12489	1.32880	0.00000	3.3636	-1.34371	1.54530	0.06303	0.00000
696 B2	1441.5184	9.96302	9.96465	44.41699	14.64232	1.77103	0.00000	3.3938	-2.06074	0.83993	0.08267	0.00000
697 OOO	1442.6266	9.96680	9.97748	49.12947	12.92375	1.86264	0.00000	3.3938	-2.19164	0.71085	0.08267	0.00000
698 CED	1443.4742	9.96944	9.98842	52.92959	11.80239	1.93271	0.00000	3.3938	-2.29176	0.61213	0.08267	0.00000
699 BPM	1443.6302	9.96991	9.99054	53.64764	11.61421	1.94561	0.00000	3.3938	-2.31019	0.59395	0.08267	0.00000
700 QD	1444.6970	9.97298	10.00571	56.17736	10.97509	1.98940	0.00000	3.3938	-0.02535	0.01413	-0.00087	0.00000
701 QD	1445.7638	9.97604	10.02093	53.75259	11.55208	1.94376	0.00000	3.3938	2.26400	-0.56310	-0.08438	0.00000
702 O	1446.0686	9.97696	10.02506	52.38304	11.90594	1.91804	0.00000	3.3938	2.22926	-0.59785	-0.08438	0.00000
703 B2	1452.1392	10.00163	10.08436	29.51805	23.36023	1.46545	0.00000	3.4268	1.53750	-1.28863	-0.06474	0.00000
704 O	1452.4440	10.00330	10.08640	28.59138	24.15636	1.44572	0.00000	3.4268	1.50276	-1.32334	-0.06474	0.00000
705 B2	1458.5146	10.05140	10.11607	14.54639	44.40813	1.11232	0.00000	3.4518	0.81100	-2.01205	-0.04511	0.00000
706 OOO	1459.6228	10.06429	10.11985	12.88886	49.00726	1.06234	0.00000	3.4518	0.68470	-2.13804	-0.04511	0.00000
707 CED	1460.4704	10.07524	10.12251	11.81002	52.71333	1.02410	0.00000	3.4518	0.58811	-2.23439	-0.04511	0.00000
708 BPM	1460.6264	10.07736	10.12298	11.62926	53.41337	1.01707	0.00000	3.4518	0.57033	-2.25213	-0.04511	0.00000
709 QF	1461.6932	10.09248	10.12606	11.04037	55.82584	0.99164	0.00000	3.4518	-0.01002	0.02487	-0.00274	0.00000
710 QF	1462.7600	10.10757	10.12915	11.67333	53.31039	1.01118	0.00000	3.4518	-0.59222	2.29745	0.03951	0.00000
711 O	1463.0648	10.11166	10.13007	12.04510	51.92081	1.02322	0.00000	3.4518	-0.62748	2.26155	0.03951	0.00000
712 B2	1469.1354	10.16985	10.15517	23.92663	28.78812	1.32264	0.00000	3.4746	-1.32987	1.54832	0.05914	0.00000
713 O	1469.4402	10.17185	10.15688	24.74806	27.85523	1.34067	0.00000	3.4746	-1.36514	1.51235	0.05914	0.00000
714 B2	1475.5108	10.20077	10.20692	45.58499	13.83522	1.75928	0.00000	3.5048	-2.06752	0.79670	0.07878	0.00000
715 OOO	1476.6190	10.20445	10.22050	50.30954	12.21453	1.84658	0.00000	3.5048	-2.19675	0.66576	0.07878	0.00000
716 CED	1477.4666	10.20704	10.23206	54.11490	11.17082	1.91336	0.00000	3.5048	-2.29382	0.56561	0.07878	0.00000
717 BPM	1477.6227	10.20750	10.23430	54.83353	10.99720	1.92565	0.00000	3.5048	-2.31188	0.54717	0.07878	0.00000
718 QD	1478.6895	10.21050	10.25030	57.31132	10.43460	1.96577	0.00000	3.5048	0.02428	-0.01189	-0.00384	0.00000
719 QD	1479.7563	10.21351	10.26625	54.73302	11.04948	1.91752	0.00000	3.5048	2.35612	-0.57313	-0.08628	0.00000

1 POS	S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
720 O	1480.0611	10.21441	10.27058	53.30785	11.41004	1.89122	0.00000	3.5048	2.31963	-0.60978	-0.08628	0.00000
721 B2	1486.1317	10.23884	10.33138	29.55701	23.23844	1.42707	0.00000	3.5372	1.59306	-1.33832	-0.06665	0.00000
722 O	1486.4365	10.24051	10.33343	28.59700	24.06543	1.40675	0.00000	3.5372	1.55657	-1.37492	-0.06665	0.00000
723 B2	1492.5071	10.28937	10.36290	14.11000	45.17236	1.06179	0.00000	3.5613	0.83000	-2.10132	-0.04701	0.00000
724 OOO	1493.6153	10.30271	10.36661	12.41739	49.97695	1.00969	0.00000	3.5613	0.69735	-2.23417	-0.04701	0.00000
725 CED	1494.4629	10.31410	10.36921	11.32123	53.85045	0.96984	0.00000	3.5613	0.59590	-2.33579	-0.04701	0.00000
726 BPM	1494.6189	10.31631	10.36967	11.13818	54.58227	0.96251	0.00000	3.5613	0.57722	-2.35449	-0.04701	0.00000
727 QF	1495.6857	10.33214	10.37269	10.51824	57.16158	0.93380	0.00000	3.5613	0.01262	-0.02678	-0.00701	0.00000
728 QF	1496.7525	10.34801	10.37570	11.08268	54.69315	0.94743	0.00000	3.5613	-0.54966	2.30569	0.03267	0.00000
729 O	1497.0573	10.35232	10.37660	11.42867	53.29833	0.95739	0.00000	3.5613	-0.58547	2.27049	0.03267	0.00000
730 B2	1503.1279	10.41359	10.40087	22.86581	29.97243	1.21528	0.00000	3.5824	-1.29867	1.57120	0.05230	0.00000
731 O	1503.4327	10.41567	10.40251	23.66839	29.02538	1.23122	0.00000	3.5824	-1.33448	1.53593	0.05230	0.00000
732 B2	1509.5033	10.44572	10.45010	44.19886	14.63464	1.60831	0.00000	3.6101	-2.04768	0.83418	0.07194	0.00000
733 OOO	1510.6115	10.44952	10.46293	48.88164	12.92808	1.68803	0.00000	3.6101	-2.17789	0.70576	0.07194	0.00000
734 CED	1511.4591	10.45217	10.47386	52.65800	11.81493	1.74900	0.00000	3.6101	-2.27747	0.60754	0.07194	0.00000
735 BPM	1511.6151	10.45264	10.47598	53.37157	11.62816	1.76023	0.00000	3.6101	-2.29581	0.58946	0.07194	0.00000
736 QD	1512.6819	10.45573	10.49113	55.88309	10.99887	1.79683	0.00000	3.6101	-0.02292	0.00927	-0.00358	0.00000
737 QD	1513.7487	10.45881	10.50630	53.46648	11.58738	1.75265	0.00000	3.6101	2.25403	-0.56921	-0.07894	0.00000
738 O	1514.0535	10.45973	10.51042	52.10299	11.94499	1.72859	0.00000	3.6101	2.21937	-0.60404	-0.07894	0.00000
739 B2	1520.1241	10.48454	10.56946	29.34952	23.48355	1.30901	0.00000	3.6397	1.52901	-1.29632	-0.05930	0.00000
740 O	1520.4289	10.48622	10.57149	28.42800	24.28439	1.29094	0.00000	3.6397	1.49435	-1.33111	-0.05930	0.00000
741 B2	1526.4995	10.53458	10.60100	14.47659	44.63958	0.99056	0.00000	3.6619	0.80399	-2.02132	-0.03967	0.00000

742	OOO	1527.6077	10.54753	10.60476	12.83429	49.25955	0.94660	0.00000	3.6619	0.67796	-2.14758	-0.03967	0.00000
743	CED	1528.4553	10.55852	10.60740	11.76673	52.98197	0.91298	0.00000	3.6619	0.58156	-2.24414	-0.03967	0.00000
744	BPM	1528.6113	10.56065	10.60787	11.58801	53.68505	0.90679	0.00000	3.6619	0.56382	-2.26192	-0.03967	0.00000
745	QF	1529.6781	10.57581	10.61094	11.01128	56.10597	0.88471	0.00000	3.6619	-0.01508	0.02686	-0.00188	0.00000
746	QF	1530.7449	10.59094	10.61401	11.65432	53.57385	0.90275	0.00000	3.6619	-0.59674	2.31086	0.03582	0.00000
747	O	1531.0497	10.59504	10.61493	12.02890	52.17614	0.91367	0.00000	3.6619	-0.63221	2.27479	0.03582	0.00000
748	B2	1537.1203	10.65319	10.63991	23.99178	28.90387	1.19073	0.00000	3.6824	-1.33854	1.55808	0.05546	0.00000
749	O	1537.4251	10.65518	10.64162	24.81857	27.96508	1.20763	0.00000	3.6824	-1.37401	1.52193	0.05546	0.00000
750	B2	1543.4957	10.68399	10.69153	45.78721	13.84996	1.60388	0.00000	3.7098	-2.08034	0.80278	0.07509	0.00000
751	OOO	1544.6039	10.68766	10.70510	50.54098	12.21649	1.68710	0.00000	3.7098	-2.20929	0.67120	0.07509	0.00000
752	CED	1545.4515	10.69024	10.71666	54.36977	11.16398	1.75075	0.00000	3.7098	-2.30792	0.57056	0.07509	0.00000
753	BPM	1545.6076	10.69069	10.71890	55.09281	10.98882	1.76246	0.00000	3.7098	-2.32608	0.55204	0.07509	0.00000
754	QD	1546.6744	10.69368	10.73492	57.58920	10.41580	1.80236	0.00000	3.7098	0.02131	-0.00685	-0.00059	0.00000
755	QD	1547.7412	10.69667	10.75092	55.00459	11.01893	1.76122	0.00000	3.7098	2.36490	-0.56699	-0.07624	0.00000
756	O	1548.0460	10.69757	10.75525	53.57408	11.37571	1.73798	0.00000	3.7098	2.32837	-0.60354	-0.07624	0.00000
757	B2	1554.1166	10.72187	10.81632	29.72316	23.11728	1.33475	0.00000	3.7397	1.60080	-1.33025	-0.05661	0.00000
758	O	1554.4214	10.72353	10.81838	28.75844	23.93934	1.31750	0.00000	3.7397	1.56427	-1.36677	-0.05661	0.00000
759	B2	1560.4920	10.77212	10.84801	14.18401	44.93620	1.03346	0.00000	3.7626	0.83670	-2.09134	-0.03697	0.00000
760	OOO	1561.6002	10.78539	10.85174	12.47674	49.71832	0.99249	0.00000	3.7626	0.70388	-2.22387	-0.03697	0.00000
761	CED	1562.4478	10.79673	10.85435	11.36963	53.57414	0.96115	0.00000	3.7626	0.60229	-2.32523	-0.03697	0.00000
762	BPM	1562.6038	10.79893	10.85481	11.18460	54.30266	0.95538	0.00000	3.7626	0.58358	-2.34389	-0.03697	0.00000
763	QF	1563.6706	10.81470	10.85785	10.55299	56.87211	0.93730	0.00000	3.7626	0.01736	-0.02830	0.00295	0.00000
764	QF	1564.7374	10.83053	10.86087	11.10826	54.41981	0.96172	0.00000	3.7626	-0.54567	2.29233	0.04300	0.00000

1 POS		S(M)	NUX	NUY	BETAX(M)	BETAY(M)	XEQ(M)	YEQ(M)	ZEQ (M)	ALPHAX	ALPHAY	DXEQ	DYEQ
765	O	1565.0422	10.83483	10.86178	11.45175	53.03308	0.97482	0.00000	3.7626	-0.58128	2.25730	0.04300	0.00000
766	B2	1571.1128	10.89610	10.88616	22.81358	29.84725	1.29546	0.00000	3.7847	-1.29045	1.56133	0.06264	0.00000
767	O	1571.4176	10.89819	10.88781	23.61109	28.90616	1.31455	0.00000	3.7847	-1.32606	1.52622	0.06264	0.00000
768	B2	1577.4882	10.92834	10.93553	44.01487	14.61296	1.75438	0.00000	3.8147	-2.03523	0.82782	0.08227	0.00000
769	OOO	1578.5964	10.93215	10.94838	48.66925	12.91983	1.84555	0.00000	3.8147	-2.16470	0.70001	0.08227	0.00000
770	CED	1579.4440	10.93482	10.95931	52.42278	11.81602	1.91529	0.00000	3.8147	-2.26373	0.60226	0.08227	0.00000
771	BPM	1579.6000	10.93529	10.96143	53.13205	11.63089	1.92813	0.00000	3.8147	-2.28196	0.58426	0.08227	0.00000
772	QD	1580.6668	10.93839	10.97656	55.62480	11.01251	1.97189	0.00000	3.8147	-0.01945	0.00409	-0.00053	0.00000
773	QD	1581.7336	10.94149	10.99171	53.21256	11.61291	1.92701	0.00000	3.8147	2.24652	-0.57534	-0.08330	0.00000
774	O	1582.0384	10.94242	10.99583	51.85364	11.97428	1.90162	0.00000	3.8147	2.21188	-0.61027	-0.08330	0.00000
775	B2	1588.1090	10.96735	11.05463	29.18766	23.60146	1.45556	0.00000	3.8474	1.52209	-1.30469	-0.06367	0.00000
776	O	1588.4138	10.96904	11.05665	28.27035	24.40743	1.43616	0.00000	3.8474	1.48745	-1.33958	-0.06367	0.00000
777	B2	1594.4844	11.01768	11.08601	14.39922	44.87837	1.10929	0.00000	3.8722	0.79766	-2.03191	-0.04403	0.00000
778	OOO	1595.5926	11.03070	11.08975	12.77084	49.52224	1.06049	0.00000	3.8722	0.67173	-2.15855	-0.04403	0.00000
779	CED	1596.4402	11.04174	11.09238	11.71376	53.26352	1.02317	0.00000	3.8722	0.57541	-2.25542	-0.04403	0.00000
780	BPM	1596.5963	11.04387	11.09284	11.53697	53.97013	1.01630	0.00000	3.8722	0.55768	-2.27325	-0.04403	0.00000
781	QF	1597.6631	11.05910	11.09589	10.97127	56.40221	0.99202	0.00000	3.8722	-0.01945	0.02789	-0.00167	0.00000
782	QF	1598.7299	11.07427	11.09895	11.62247	53.85467	1.01271	0.00000	3.8722	-0.60014	2.32406	0.04062	0.00000
783	O	1599.0347	11.07838	11.09987	11.99919	52.44897	1.02509	0.00000	3.8722	-0.63581	2.28783	0.04062	0.00000
784	B2	1605.1053	11.13656	11.12472	24.03049	29.03739	1.33123	0.00000	3.8952	-1.34621	1.56797	0.06025	0.00000
785	O	1605.4101	11.13855	11.12642	24.86201	28.09262	1.34960	0.00000	3.8952	-1.38188	1.53167	0.06025	0.00000
786	B2	1611.4807	11.16729	11.17616	45.95084	13.87839	1.77493	0.00000	3.9256	-2.09227	0.80936	0.07989	0.00000
787	OOO	1612.5889	11.17094	11.18971	50.73188	12.23097	1.86346	0.00000	3.9256	-2.22197	0.67721	0.07989	0.00000
788	CED	1613.4365	11.17350	11.20126	54.58264	11.16865	1.93117	0.00000	3.9256	-2.32116	0.57613	0.07989	0.00000
789	BPM	1613.5925	11.17395	11.20351	55.30983	10.99176	1.94364	0.00000	3.9256	-2.33942	0.55752	0.07989	0.00000
790	QD	1614.6593	11.17693	11.21953	57.82494	10.40744	1.98453	0.00000	3.9256	0.01736	-0.00157	-0.00351	0.00000
791	QD	1615.7261	11.17992	11.23554	55.23794	10.99866	1.93620	0.00000	3.9256	2.37106	-0.56094	-0.08675	0.00000
792	O	1616.0309	11.18081	11.23989	53.80367	11.35171	1.90976	0.00000	3.9256	2.33452	-0.59737	-0.08675	0.00000
793	B2	1622.1015	11.20499	11.30118	29.87887	23.00365	1.44277	0.00000	3.9584	1.60682	-1.32166	-0.06711	0.00000
794	O	1622.4063	11.20665	11.30325	28.91049	23.82043	1.42231	0.00000	3.9584	1.57029	-1.35806	-0.06711	0.00000
795	B2	1628.4769	11.25496	11.33303	14.26385	44.69691	1.07451	0.00000	3.9827	0.84259	-2.08023	-0.04748	0.00000

796	OOO	1629.5851	11.26816	11.33679	12.54356	49.45390	1.02189	0.00000	3.9827	0.70974	-2.21231	-0.04748	0.00000
797	CED	1630.4327	11.27944	11.33941	11.42654	53.28984	0.98165	0.00000	3.9827	0.60813	-2.31334	-0.04748	0.00000
798	BPM	1630.5887	11.28163	11.33988	11.23969	54.01465	0.97424	0.00000	3.9827	0.58942	-2.33193	-0.04748	0.00000
799	QF	1631.6555	11.29733	11.34293	10.59780	56.57173	0.94530	0.00000	3.9827	0.02131	-0.02883	-0.00699	0.00000

CIRCUMFERENCE = 3263.3111 M THETX = 6.28318445 RAD NUX = 22.59466 DNUX/(DP/P) = -28.87446
RADIUS = 519.3721 M THETY = 0.00000000 RAD NUY = 22.68585 DNUY/(DP/P) = -29.00215
(DS/S)/(DP/P)= 0.0024409 TGAM=(20.24075, 0.00000)

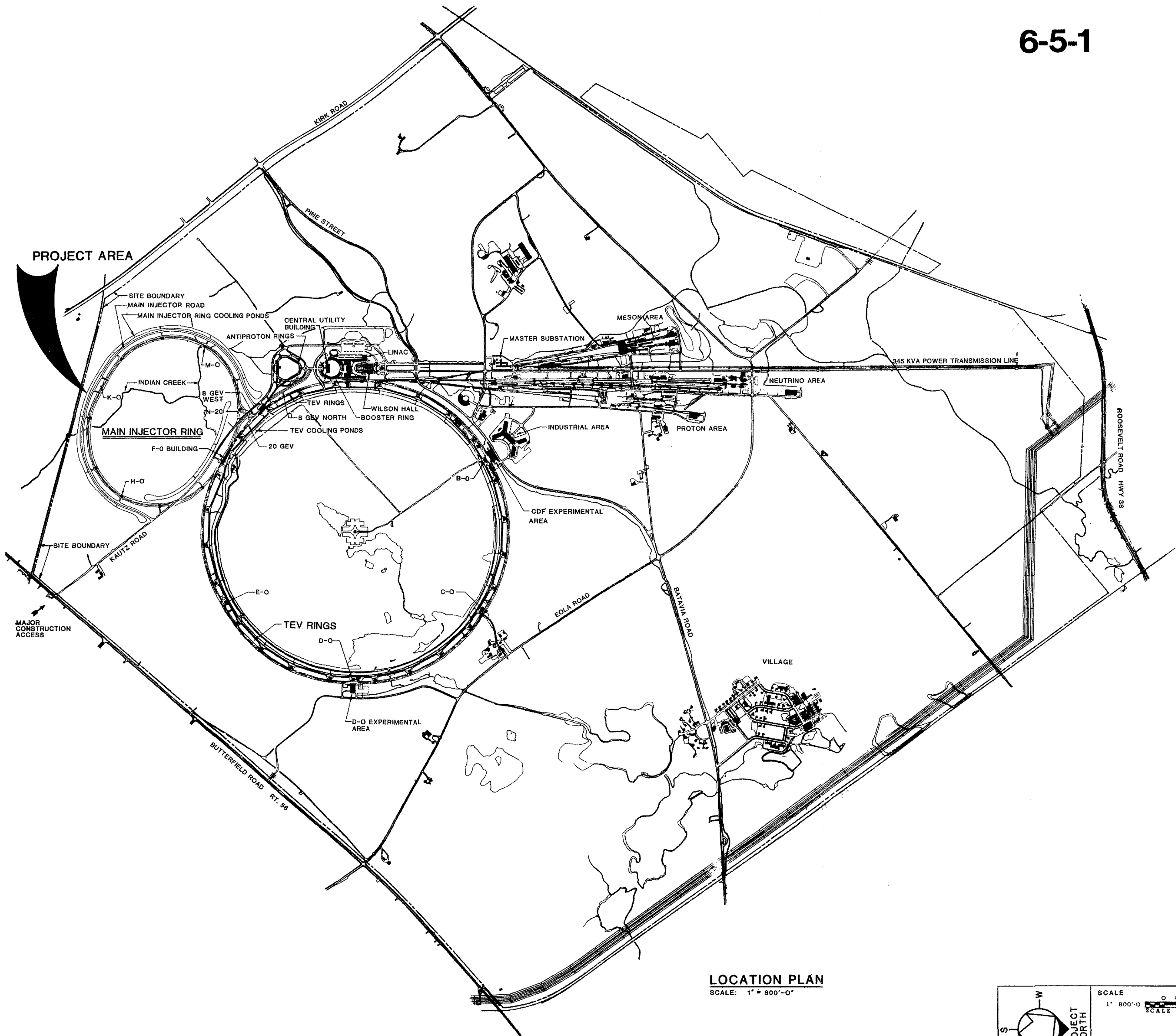
MAXIMA --- BETX(39) = 145.48288 BETY(49) = 146.28737 XEQ(178) = 2.04107 YEQ(799) = 0.00000
MINIMA --- BETX(51) = 10.36190 BETY(37) = 10.37151 XEQ(37) = -0.00054 YEQ(799) = 0.00000

APPENDIX D

Conventional Construction Drawings

COLLIDER UPGRADE: MAIN INJECTOR

6-5-1



LOCATION PLAN
SCALE: 1" = 800'-0"

LIST OF DRAWINGS

CDR-1	Location Plan And List of Drawings
CDR-2	Aerial Photograph
CDR-3	Existing Site Conditions
CDR-4	Site Plan
CDR-5	Criteria Site Plan
CDR-6	Enlarged Site Plan
CDR-7	Beam Line Plan
CDR-8	F-0 Beam Enclosure Plan
CDR-9	8 GeV West Beam Enclosure Plan
CDR-10	8 GeV North Beam Enclosure Long. Section
CDR-11	120 GeV Beam Enclosure Long. Section
CDR-12	8 GeV West Beam Enclosure Long. Section
CDR-13	Typical Service Building Plan
CDR-14	Typical Service Building Sections
CDR-15	N-20 Hatch Building Plan
CDR-16	N-20 Hatch Building Sections
CDR-17	F-0 Service Building Plan
CDR-18	F-0 Service Building Sections
CDR-19	Enclosure Sections Sheet 1
CDR-20	Enclosure Sections Sheet 2
CDR-21	Mechanical Criteria-HVAC
CDR-22	Mechanical Criteria-Process System
CDR-23	Single Line Power Diagram
CDR-24	Site Plan - Electrical Criteria
CDR-25	Enclosure Plan - Electrical Criteria

REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	C. FEDEROWICZ
DRAWN	C. FEDEROWICZ D. WAGNER
CHECKED	
APPROVED	
SUBMITTED	

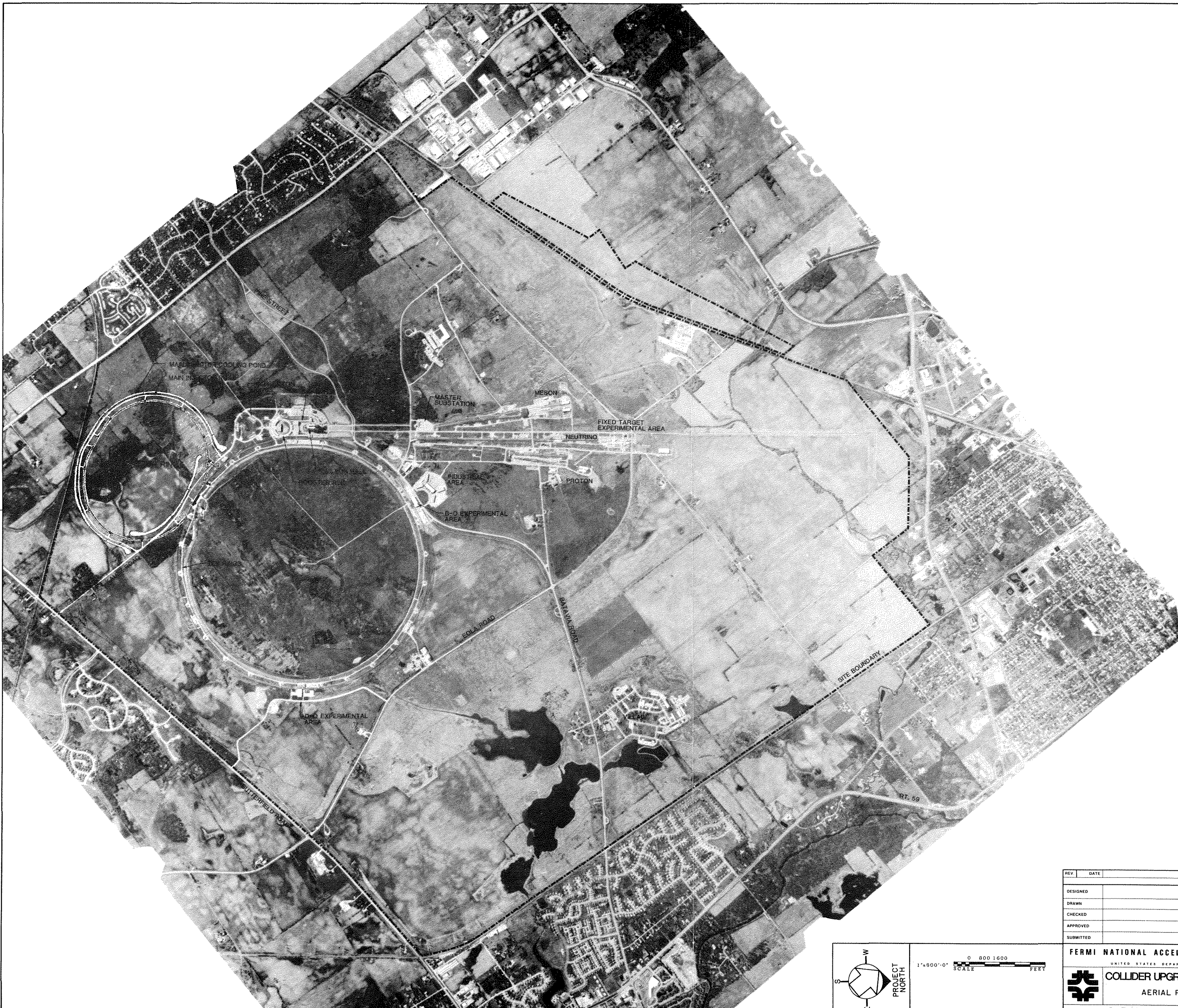
S W E PROJECT NORTH

SCALE
1" 800'-0 — 0 800 1600 SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR
LOCATION PLAN AND LIST OF DRAWINGS

DRAWING NO. 6-5-1 CDR-1 REV.



REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

W
S
E
PROJECT NORTH

1"=800'-0"
0 800 1600
SCALE FEET

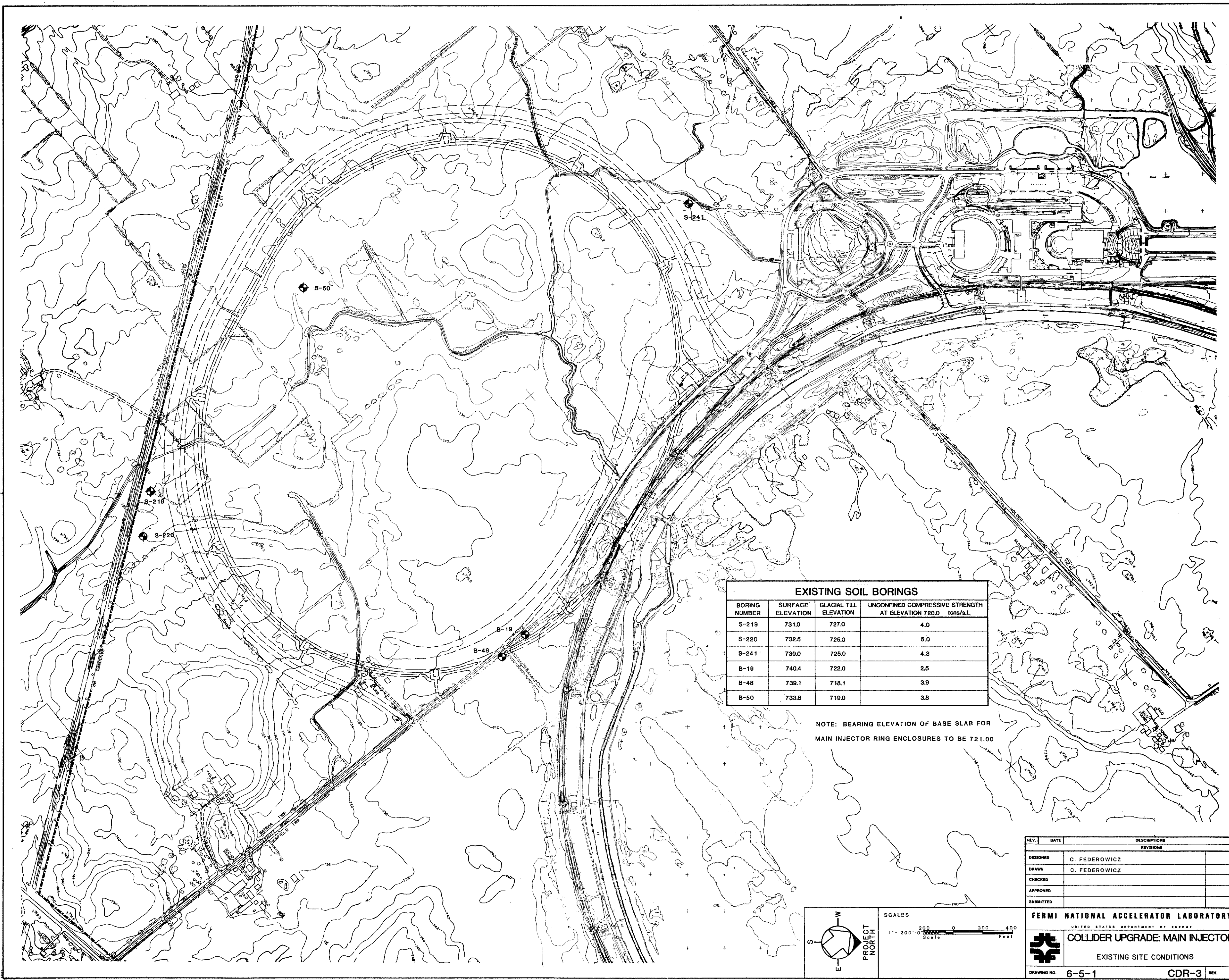
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR

AERIAL PHOTOGRAPH

DRAWING NO. 6-5-1 CDR-2 REV.



EXISTING SOIL BORINGS

BORING NUMBER	SURFACE ELEVATION	GLACIAL TILL ELEVATION	UNCONFINED COMPRESSIVE STRENGTH AT ELEVATION 720.0 tons/s.f.
S-219	731.0	727.0	4.0
S-220	732.5	725.0	5.0
S-241	739.0	725.0	4.3
B-19	740.4	722.0	2.5
B-48	739.1	718.1	3.9
B-50	733.8	719.0	3.8

NOTE: BEARING ELEVATION OF BASE SLAB FOR MAIN INJECTOR RING ENCLOSURES TO BE 721.00

REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	C. FEDEROWICZ	
DRAWN	C. FEDEROWICZ	
CHECKED		
APPROVED		
SUBMITTED		

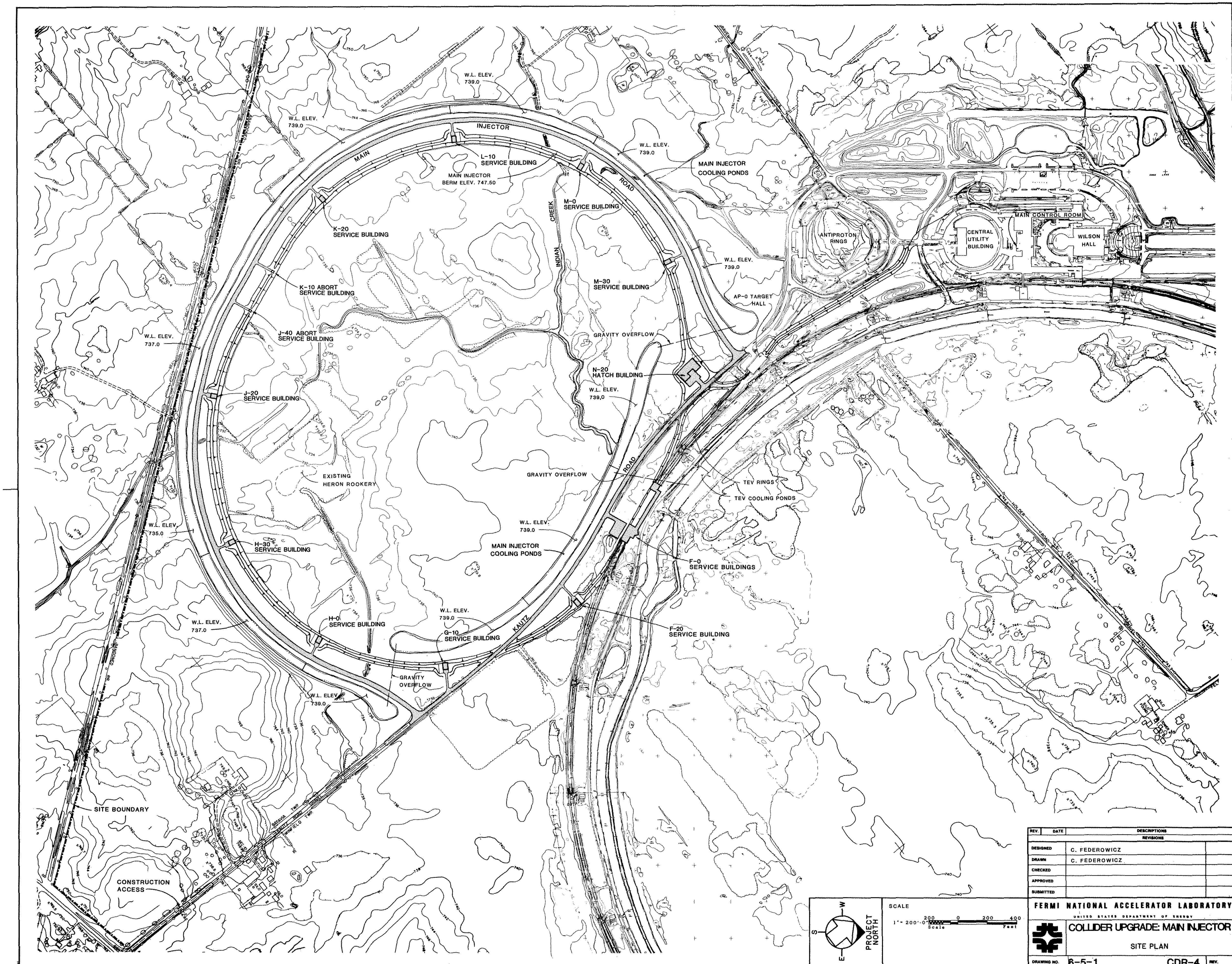
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

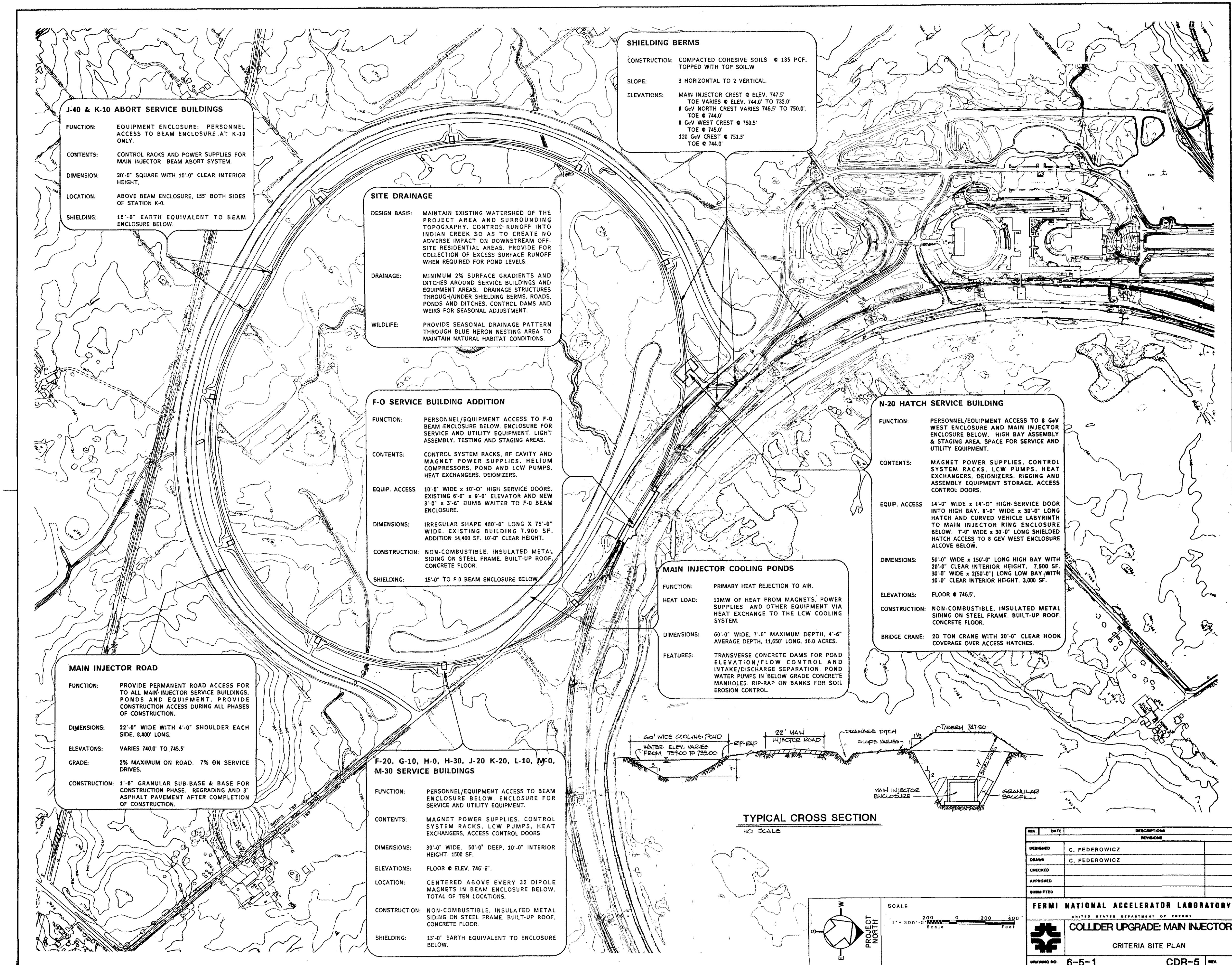
COLLIDER UPGRADE: MAIN INJECTOR

EXISTING SITE CONDITIONS

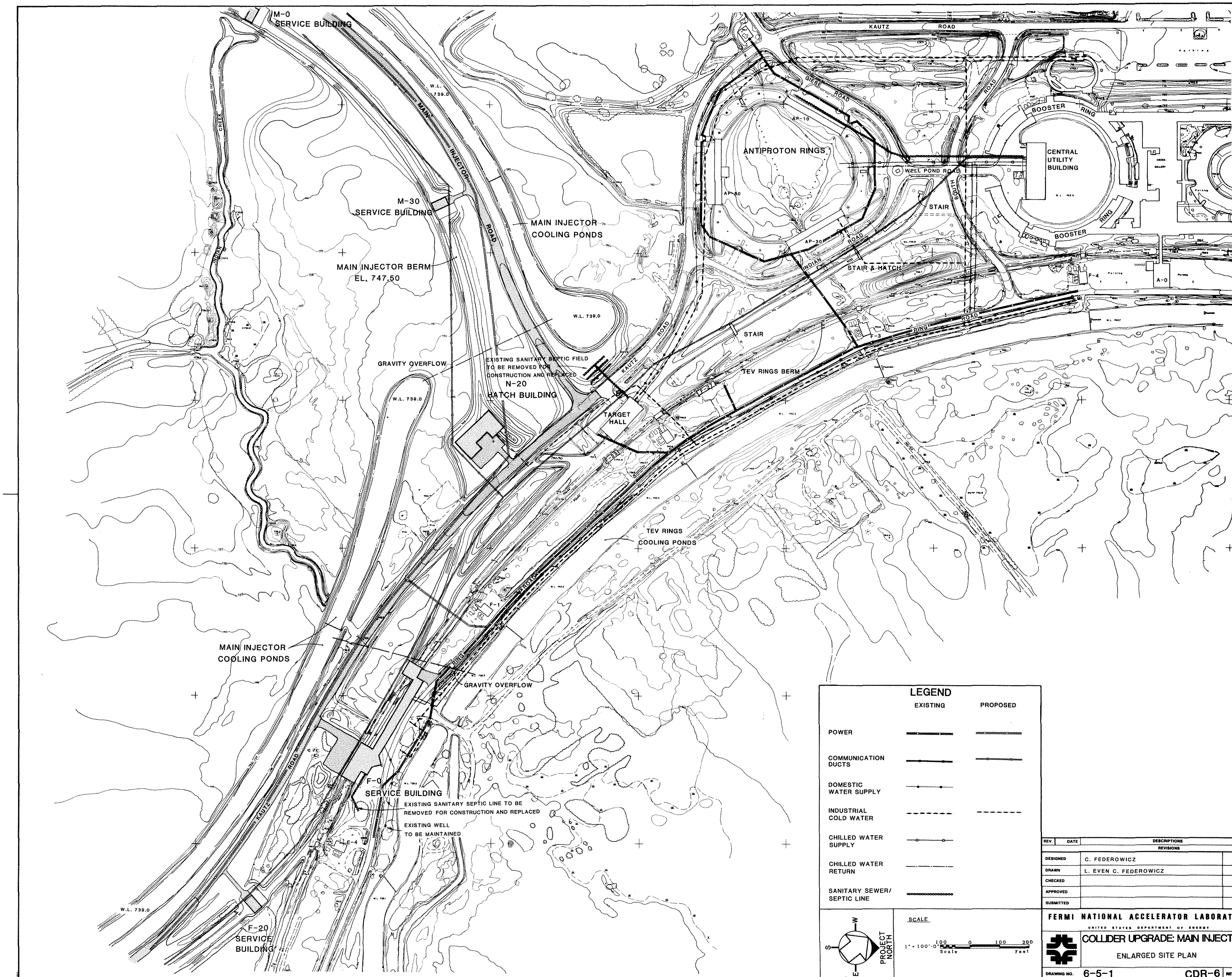
DRAWING NO. 6-5-1 CDR-3 REV.


W.L. ELEV. 739.0
W.L. ELEV. 739.0
MAIN
INJECTOR
ROAD
L-10 SERVICE BUILDING
MAIN INJECTOR BERM ELEV. 747.50
W.L. ELEV. 739.0
MAIN INJECTOR COOLING PONDS
M-0 SERVICE BUILDING
INDIAN CREEK
K-20 SERVICE BUILDING
MAIN CONTROL ROOM
ANTIPROTON RINGS
CENTRAL UTILITY BUILDING
WILSON HALL
W.L. ELEV. 739.0
M-30 SERVICE BUILDING
AP-0 TARGET HALL
K-10 ABORT SERVICE BUILDING
J-40 ABORT SERVICE BUILDING
GRAVITY OVERFLOW
W.L. ELEV. 737.0
N-20 HATCH BUILDING
W.L. ELEV. 739.0
J-20 SERVICE BUILDING
EXISTING HERON ROOKERY
GRAVITY OVERFLOW
TEV RINGS
TEV COOLING PONDS
W.L. ELEV. 735.0
W.L. ELEV. 739.0
H-30 SERVICE BUILDING
MAIN INJECTOR COOLING PONDS
F-0 SERVICE BUILDINGS
W.L. ELEV. 737.0
H-0 SERVICE BUILDING
W.L. ELEV. 739.0
G-10 SERVICE BUILDING
KAUTZ
F-20 SERVICE BUILDING
GRAVITY OVERFLOW
W.L. ELEV 739.0
HOLDER ROAD
SITE BOUNDARY
CONSTRUCTION ACCESS
BATAVIA TWP
WINFIELD TWP
W
S
E
PROJECT NORTH
SCALE
1" = 200'-0"
200 0 200 400
Scale Feet
REV.
DATE
DESCRIPTIONS
REVISIONS
DESIGNED C. FEDEROWICZ
DRAWN C. FEDEROWICZ
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
SITE PLAN
DRAWING NO. 6-5-1
CDR-4
REV.

CDR-4



SHIELDING BERMS
CONSTRUCTION: COMPACTED COHESIVE SOILS @ 135 PCF. TOPPED WITH TOP SOIL.W
SLOPE: 3 HORIZONTAL TO 2 VERTICAL.
ELEVATIONS: MAIN INJECTOR CREST @ ELEV. 747.5' TOE VARIES @ ELEV. 744.0' TO 732.0' 8 GeV NORTH CREST VARIES 746.5' TO 750.0'. TOE @ 744.0' 8 GeV WEST CREST @ 750.5' TOE @ 745.0' 120 GeV CREST @ 751.5' TOE @ 744.0'
J-40 & K-10 ABORT SERVICE BUILDINGS
FUNCTION: EQUIPMENT ENCLOSURE: PERSONNEL ACCESS TO BEAM ENCLOSURE AT K-10 ONLY.
CONTENTS: CONTROL RACKS AND POWER SUPPLIES FOR MAIN INJECTOR BEAM ABORT SYSTEM.
DIMENSION: 20'-0" SQUARE WITH 10'-0" CLEAR INTERIOR HEIGHT.
LOCATION: ABOVE BEAM ENCLOSURE, 155' BOTH SIDES OF STATION K-0.
SHIELDING: 15'-0" EARTH EQUIVALENT TO BEAM ENCLOSURE BELOW.
SITE DRAINAGE
DESIGN BASIS: MAINTAIN EXISTING WATERSHED OF THE PROJECT AREA AND SURROUNDING TOPOGRAPHY. CONTROL RUNOFF INTO INDIAN CREEK SO AS TO CREATE NO ADVERSE IMPACT ON DOWNSTREAM OFF-SITE RESIDENTIAL AREAS. PROVIDE FOR COLLECTION OF EXCESS SURFACE RUNOFF WHEN REQUIRED FOR POND LEVELS.
DRAINAGE: MINIMUM 2% SURFACE GRADIENTS AND DITCHES AROUND SERVICE BUILDINGS AND EQUIPMENT AREAS. DRAINAGE STRUCTURES THROUGH/UNDER SHIELDING BERMS, ROADS, PONDS AND DITCHES. CONTROL DAMS AND WEIRS FOR SEASONAL ADJUSTMENT.
WILDLIFE: PROVIDE SEASONAL DRAINAGE PATTERN THROUGH BLUE HERON NESTING AREA TO MAINTAIN NATURAL HABITAT CONDITIONS.
F-0 SERVICE BUILDING ADDITION
FUNCTION: PERSONNEL/EQUIPMENT ACCESS TO F-0 BEAM ENCLOSURE BELOW. ENCLOSURE FOR SERVICE AND UTILITY EQUIPMENT. LIGHT ASSEMBLY, TESTING AND STAGING AREAS.
CONTENTS: CONTROL SYSTEM RACKS, RF CAVITY AND MAGNET POWER SUPPLIES, HELIUM COMPRESSORS, POND AND LCW PUMPS, HEAT EXCHANGERS, DEIONIZERS.
EQUIP. ACCESS 10'-0" WIDE x 10'-0" HIGH SERVICE DOORS. EXISTING 6'-0" x 9'-0" ELEVATOR AND NEW 3'-0" x 3'-6" DUMB WAITER TO F-0 BEAM ENCLOSURE.
DIMENSIONS: IRREGULAR SHAPE 480'-0" LONG X 75'-0" WIDE. EXISTING BUILDING 7,900 SF. ADDITION 14,400 SF. 10'-0" CLEAR HEIGHT.
CONSTRUCTION: NON-COMBUSTIBLE, INSULATED METAL SIDING ON STEEL FRAME, BUILT-UP ROOF, CONCRETE FLOOR.
SHIELDING: 15'-0" TO F-0 BEAM ENCLOSURE BELOW.
N-20 HATCH SERVICE BUILDING
FUNCTION: PERSONNEL/EQUIPMENT ACCESS TO 8 GeV WEST ENCLOSURE AND MAIN INJECTOR ENCLOSURE BELOW. HIGH BAY ASSEMBLY & STAGING AREA. SPACE FOR SERVICE AND UTILITY EQUIPMENT.
CONTENTS: MAGNET POWER SUPPLIES, CONTROL SYSTEM RACKS, LCW PUMPS, HEAT EXCHANGERS, DEIONIZERS, RIGGING AND ASSEMBLY EQUIPMENT STORAGE. ACCESS CONTROL DOORS.
EQUIP. ACCESS 14'-0" WIDE x 14'-0" HIGH SERVICE DOOR INTO HIGH BAY. 8'-0" WIDE x 30'-0" LONG HATCH AND CURVED VEHICLE LABYRINTH TO MAIN INJECTOR RING ENCLOSURE BELOW. 7'-0" WIDE x 30'-0" LONG SHIELDED HATCH ACCESS TO 8 GEV WEST ENCLOSURE ALCOVE BELOW.
DIMENSIONS: 50'-0" WIDE x 150'-0" LONG HIGH BAY WITH 20'-0" CLEAR INTERIOR HEIGHT. 7,500 SF. 30'-0" WIDE x 2(50'-0") LONG LOW BAY WITH 10'-0" CLEAR INTERIOR HEIGHT. 3,000 SF.
ELEVATIONS: FLOOR @ 746.5'.
CONSTRUCTION: NON-COMBUSTIBLE, INSULATED METAL SIDING ON STEEL FRAME. BUILT-UP ROOF. CONCRETE FLOOR.
BRIDGE CRANE: 20 TON CRANE WITH 20'-0" CLEAR HOOK COVERAGE OVER ACCESS HATCHES.
MAIN INJECTOR COOLING PONDS
FUNCTION: PRIMARY HEAT REJECTION TO AIR.
HEAT LOAD: 12MW OF HEAT FROM MAGNETS, POWER SUPPLIES AND OTHER EQUIPMENT VIA HEAT EXCHANGE TO THE LCW COOLING SYSTEM.
DIMENSIONS: 60'-0" WIDE, 7'-0" MAXIMUM DEPTH, 4'-6" AVERAGE DEPTH, 11,650' LONG. 16.0 ACRES.
FEATURES: TRANSVERSE CONCRETE DAMS FOR POND ELEVATION/FLOW CONTROL AND INTAKE/DISCHARGE SEPARATION. POND WATER PUMPS IN BELOW GRADE CONCRETE MANHOLES. RIP-RAP ON BANKS FOR SOIL EROSION CONTROL.
MAIN INJECTOR ROAD
FUNCTION: PROVIDE PERMANENT ROAD ACCESS FOR TO ALL MAIN INJECTOR SERVICE BUILDINGS, PONDS AND EQUIPMENT. PROVIDE CONSTRUCTION ACCESS DURING ALL PHASES OF CONSTRUCTION.
DIMENSIONS: 22'-0" WIDE WITH 4'-0" SHOULDER EACH SIDE. 8,400' LONG.
ELEVATONS: VARIES 740.0' TO 745.5'
GRADE: 2% MAXIMUM ON ROAD. 7% ON SERVICE DRIVES.
CONSTRUCTION: 1'-6" GRANULAR SUB-BASE & BASE FOR CONSTRUCTION PHASE. REGRADING AND 3" ASPHALT PAVEMENT AFTER COMPLETION OF CONSTRUCTION.
F-20, G-10, H-0, H-30, J-20 K-20, L-10, M-0, M-30 SERVICE BUILDINGS
FUNCTION: PERSONNEL/EQUIPMENT ACCESS TO BEAM ENCLOSURE BELOW. ENCLOSURE FOR SERVICE AND UTILITY EQUIPMENT.
CONTENTS: MAGNET POWER SUPPLIES, CONTROL SYSTEM RACKS, LCW PUMPS, HEAT EXCHANGERS, ACCESS CONTROL DOORS
DIMENSIONS: 30'-0" WIDE, 50'-0" DEEP, 10'-0" INTERIOR HEIGHT. 1500 SF.
ELEVATIONS: FLOOR @ ELEV. 746'-6".
LOCATION: CENTERED ABOVE EVERY 32 DIPOLE MAGNETS IN BEAM ENCLOSURE BELOW. TOTAL OF TEN LOCATIONS.
CONSTRUCTION: NON-COMBUSTIBLE, INSULATED METAL SIDING ON STEEL FRAME, BUILT-UP ROOF, CONCRETE FLOOR.
SHIELDING: 15'-0" EARTH EQUIVALENT TO ENCLOSURE BELOW.
60' WIDE COOLING POND
WATER ELEV. VARIES FROM 739.00 TO 735.00
RIP-RAP
22' MAIN INJECTOR ROAD
DRAINAGE DITCH
SLOPE VARIES
T/BERM 747.50
17' SHIELDING
MAIN INJECTOR ENCLOSURE
GRANULAR BACKFILL
TYPICAL CROSS SECTION
NO SCALE
PROJECT NORTH
SCALE
1" = 200'-0"
Scale Feet
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED C. FEDEROWICZ
DRAWN C. FEDEROWICZ
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
CRITERIA SITE PLAN
DRAWING NO. 6-5-1
CDR-5
REV.



LEGEND

	EXISTING	PROPOSED
POWER		
COMMUNICATION DUCTS		
DOMESTIC WATER SUPPLY		
INDUSTRIAL COLD WATER		
CHILLED WATER SUPPLY		
CHILLED WATER RETURN		
SANITARY SEWER/ SEPTIC LINE		

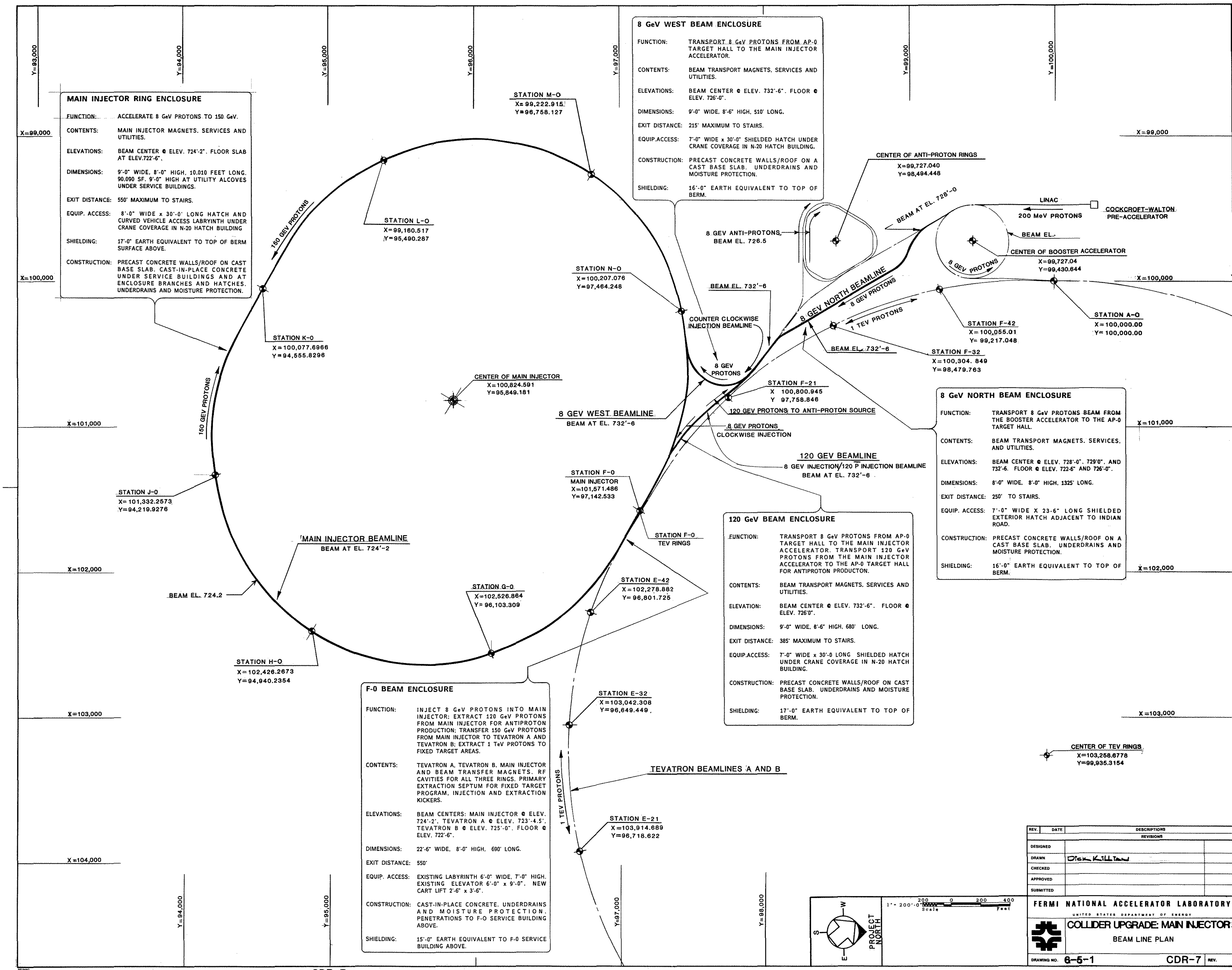
DESIGNED	C. FEDEROWICZ
DRAWN	L. EVEN C. FEDEROWICZ
CHECKED	
APPROVED	
SUBMITTED	

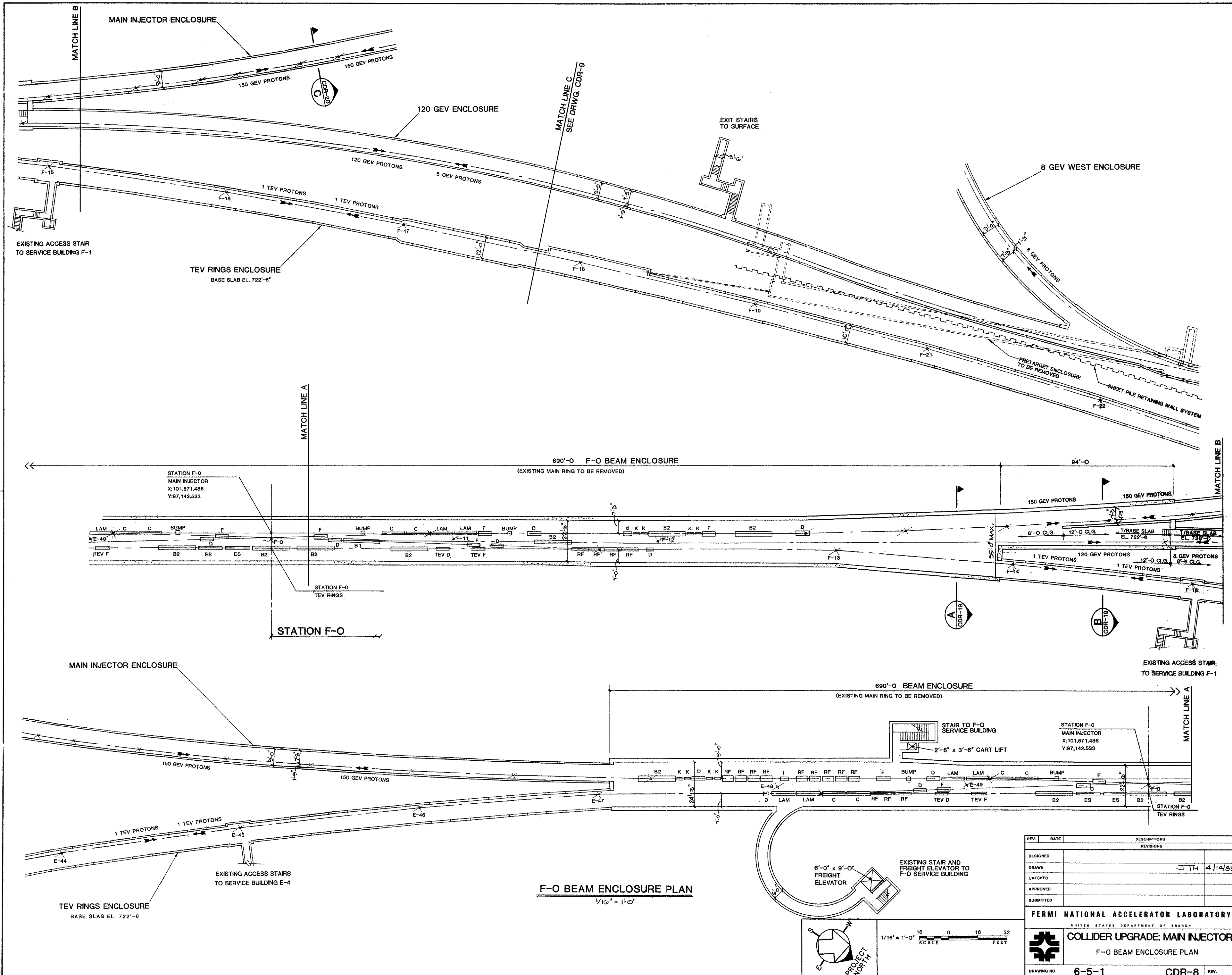
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR

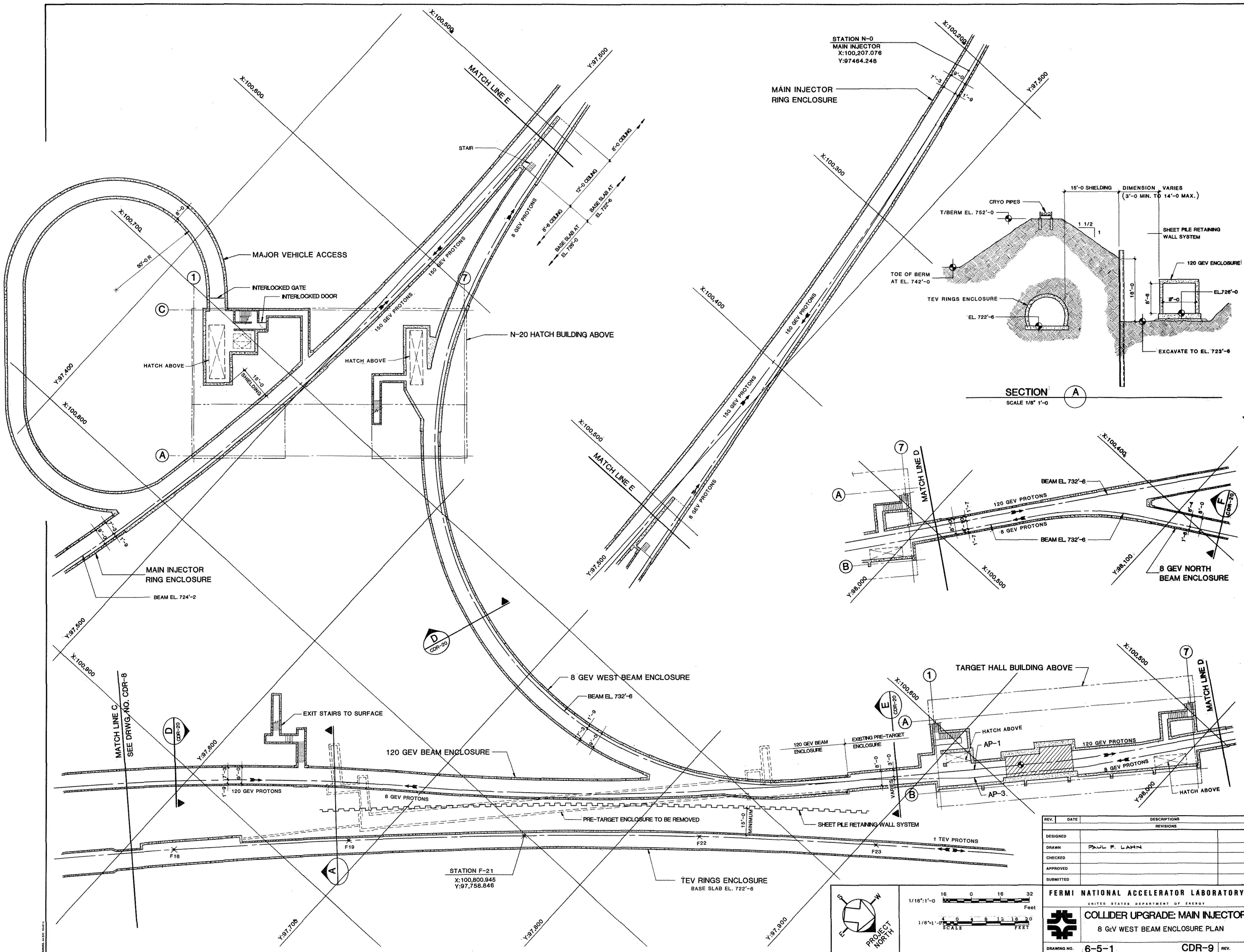
ENLARGED SITE PLAN

DRAWING NO. 6-5-1 CDR-6 REV.

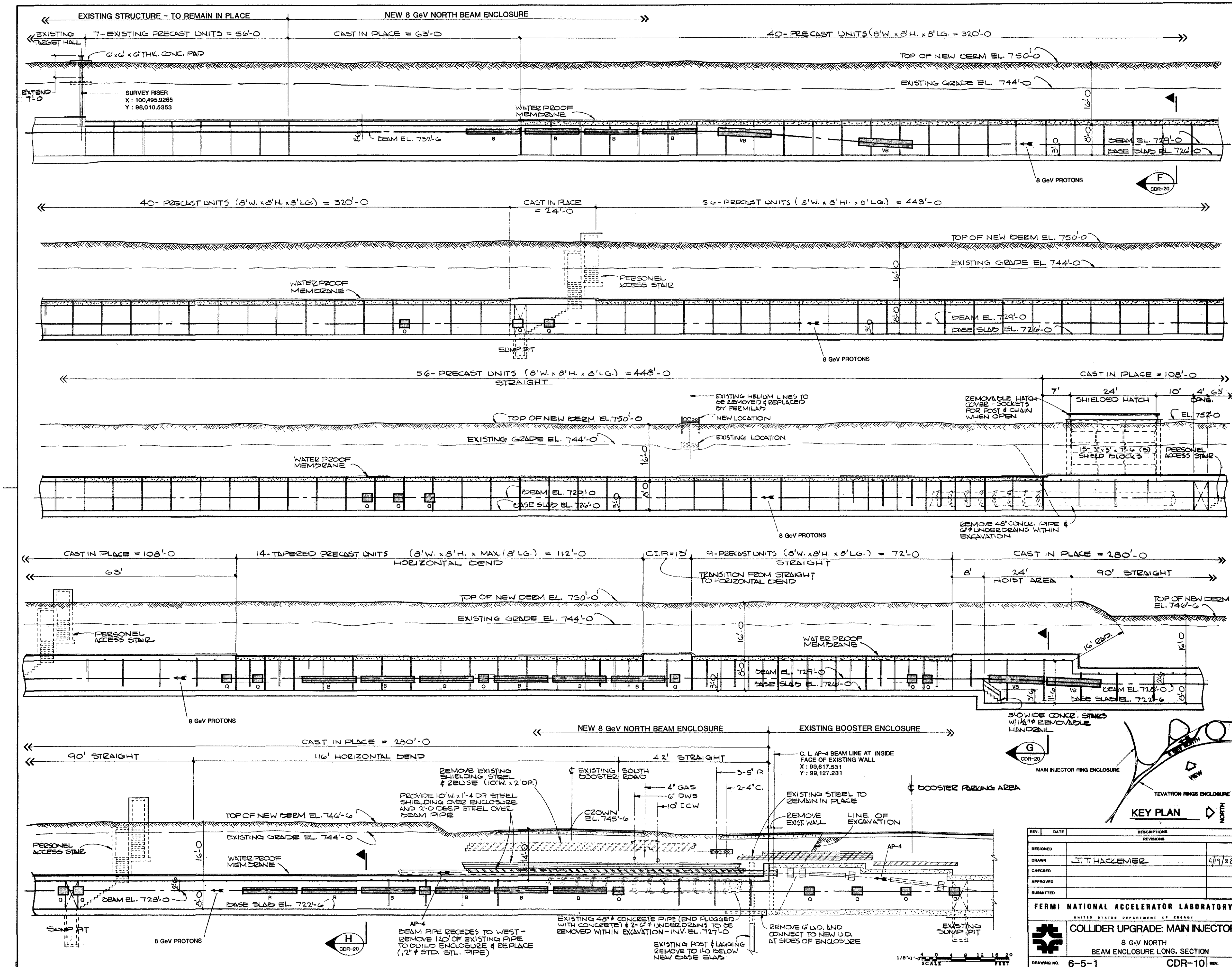

MAIN INJECTOR RING ENCLOSURE
FUNCTION: ACCELERATE 8 GeV PROTONS TO 150 GeV.
CONTENTS: MAIN INJECTOR MAGNETS, SERVICES AND UTILITIES.
ELEVATIONS: BEAM CENTER @ ELEV. 724'-2". FLOOR SLAB AT ELEV.722'-6".
DIMENSIONS: 9'-0" WIDE, 8'-0" HIGH, 10,010 FEET LONG. 90,090 SF. 9'-0" HIGH AT UTILITY ALCOVES UNDER SERVICE BUILDINGS.
EXIT DISTANCE: 550' MAXIMUM TO STAIRS.
EQUIP. ACCESS: 8'-0" WIDE x 30'-0' LONG HATCH AND CURVED VEHICLE ACCESS LABYRINTH UNDER CRANE COVERAGE IN N-20 HATCH BUILDING
SHIELDING: 17'-0" EARTH EQUIVALENT TO TOP OF BERM SURFACE ABOVE.
CONSTRUCTION: PRECAST CONCRETE WALLS/ROOF ON CAST BASE SLAB. CAST-IN-PLACE CONCRETE UNDER SERVICE BUILDINGS AND AT ENCLOSURE BRANCHES AND HATCHES. UNDERDRAINS AND MOISTURE PROTECTION.
8 GeV WEST BEAM ENCLOSURE
FUNCTION: TRANSPORT 8 GeV PROTONS FROM AP-0 TARGET HALL TO THE MAIN INJECTOR ACCELERATOR.
CONTENTS: BEAM TRANSPORT MAGNETS, SERVICES AND UTILITIES.
ELEVATIONS: BEAM CENTER @ ELEV. 732'-6". FLOOR @ ELEV. 726'-0".
DIMENSIONS: 9'-0" WIDE, 8'-6" HIGH, 510' LONG.
EXIT DISTANCE: 215' MAXIMUM TO STAIRS.
EQUIP.ACCESS: 7'-0" WIDE x 30'-0" SHIELDED HATCH UNDER CRANE COVERAGE IN N-20 HATCH BUILDING.
CONSTRUCTION: PRECAST CONCRETE WALLS/ROOF ON A CAST BASE SLAB. UNDERDRAINS AND MOISTURE PROTECTION.
SHIELDING: 16'-0" EARTH EQUIVALENT TO TOP OF BERM.
Y=93,000
Y=94,000
Y=95,000
Y=96,000
Y=97,000
Y=99,000
Y=100,000
X=99,000
X=100,000
X=101,000
X=102,000
X=103,000
X=104,000
STATION M-O
X=99,222.915
Y=96,758.127
STATION L-O
X=99,160.517
Y=95,490.287
150 GEV PROTONS
STATION N-O
X=100,207.076
Y=97,464.246
CENTER OF ANTI-PROTON RINGS
X=99,727.040
Y=98,494.448
BEAM AT EL. 728'-0
LINAC
200 MeV PROTONS
COCKCROFT-WALTON PRE-ACCELERATOR
BEAM EL.
CENTER OF BOOSTER ACCELERATOR
X=99,727.04
Y=99,430.644
8 GEV PROTONS
8 GEV ANTI-PROTONS
BEAM EL. 726.5
BEAM EL. 732'-6
COUNTER CLOCKWISE INJECTION BEAMLINE
8 GEV NORTH BEAMLINE
8 GEV PROTONS
1 TEV PROTONS
STATION F-42
X=100,055.01
Y=99,217.048
STATION A-O
X=100,000.00
Y=100,000.00
BEAM EL. 732'-6
STATION F-32
X=100,304.849
Y=98,479.763
STATION K-O
X=100,077.6966
Y=94,555.8296
8 GEV PROTONS
CENTER OF MAIN INJECTOR
X=100,824.591
Y=95,849.181
STATION F-21
X 100,800.945
Y 97,758.846
120 GEV PROTONS TO ANTI-PROTON SOURCE
8 GEV WEST BEAMLINE
BEAM AT EL. 732'-6
8 GEV PROTONS
CLOCKWISE INJECTION
150 GEV PROTONS
120 GEV BEAMLINE
8 GEV INJECTION/120 P INJECTION BEAMLINE
BEAM AT EL. 732'-6
8 GeV NORTH BEAM ENCLOSURE
FUNCTION: TRANSPORT 8 GeV PROTONS BEAM FROM THE BOOSTER ACCELERATOR TO THE AP-0 TARGET HALL.
CONTENTS: BEAM TRANSPORT MAGNETS, SERVICES, AND UTILITIES.
ELEVATIONS: BEAM CENTER @ ELEV. 728'-0", 729'0", AND 732'-6. FLOOR @ ELEV. 722-6" AND 726'-0".
DIMENSIONS: 8'-0" WIDE, 8'-0" HIGH, 1325' LONG.
EXIT DISTANCE: 250' TO STAIRS.
EQUIP. ACCESS: 7'-0" WIDE X 23-6" LONG SHIELDED EXTERIOR HATCH ADJACENT TO INDIAN ROAD.
CONSTRUCTION: PRECAST CONCRETE WALLS/ROOF ON A CAST BASE SLAB. UNDERDRAINS AND MOISTURE PROTECTION.
SHIELDING: 16'-0" EARTH EQUIVALENT TO TOP OF BERM.
STATION J-O
X=101,332.2573
Y=94,219.9276
STATION F-O
MAIN INJECTOR
X=101,571.486
Y=97,142.533
STATION F-O
TEV RINGS
MAIN INJECTOR BEAMLINE
BEAM AT EL. 724'-2
120 GeV BEAM ENCLOSURE
FUNCTION: TRANSPORT 8 GeV PROTONS FROM AP-0 TARGET HALL TO THE MAIN INJECTOR ACCELERATOR. TRANSPORT 120 GeV PROTONS FROM THE MAIN INJECTOR ACCELERATOR TO THE AP-0 TARGET HALL FOR ANTIPROTON PRODUCTON.
CONTENTS: BEAM TRANSPORT MAGNETS, SERVICES AND UTILITIES.
ELEVATION: BEAM CENTER @ ELEV. 732'-6". FLOOR @ ELEV. 726'0".
DIMENSIONS: 9'-0" WIDE, 8'-6" HIGH, 680' LONG.
EXIT DISTANCE: 385' MAXIMUM TO STAIRS.
EQUIP.ACCESS: 7'-0" WIDE x 30'-0 LONG SHIELDED HATCH UNDER CRANE COVERAGE IN N-20 HATCH BUILDING.
CONSTRUCTION: PRECAST CONCRETE WALLS/ROOF ON CAST BASE SLAB. UNDERDRAINS AND MOISTURE PROTECTION.
SHIELDING: 17'-0" EARTH EQUIVALENT TO TOP OF BERM.
BEAM EL. 724.2
STATION G-O
X=102,526.864
Y=96,103.309
STATION E-42
X=102,278.882
Y=96,801.725
STATION H-O
X=102,426.2673
Y=94,940.2354
F-0 BEAM ENCLOSURE
FUNCTION: INJECT 8 GeV PROTONS INTO MAIN INJECTOR; EXTRACT 120 GeV PROTONS FROM MAIN INJECTOR FOR ANTIPROTON PRODUCTION; TRANSFER 150 GeV PROTONS FROM MAIN INJECTOR TO TEVATRON A AND TEVATRON B; EXTRACT 1 TeV PROTONS TO FIXED TARGET AREAS.
CONTENTS: TEVATRON A, TEVATRON B, MAIN INJECTOR AND BEAM TRANSFER MAGNETS. RF CAVITIES FOR ALL THREE RINGS. PRIMARY EXTRACTION SEPTUM FOR FIXED TARGET PROGRAM, INJECTION AND EXTRACTION KICKERS.
ELEVATIONS: BEAM CENTERS: MAIN INJECTOR @ ELEV. 724'-2', TEVATRON A @ ELEV. 723'-4.5', TEVATRON B @ ELEV. 725'-0". FLOOR @ ELEV. 722'-6".
DIMENSIONS: 22'-6" WIDE, 8'-0" HIGH, 690' LONG.
EXIT DISTANCE: 550'
EQUIP. ACCESS: EXISTING LABYRINTH 6'-0" WIDE, 7'-0" HIGH. EXISTING ELEVATOR 6'-0" x 9'-0". NEW CART LIFT 2'-6" x 3'-6".
CONSTRUCTION: CAST-IN-PLACE CONCRETE. UNDERDRAINS AND MOISTURE PROTECTION. PENETRATIONS TO F-0 SERVICE BUILDING ABOVE.
SHIELDING: 15'-0" EARTH EQUIVALENT TO F-0 SERVICE BUILDING ABOVE.
STATION E-32
X=103,042.308
Y=96,649.449
CENTER OF TEV RINGS
X=103,258.6778
Y=99,935.3154
TEVATRON BEAMLINES A AND B
1 TEV PROTONS
STATION E-21
X=103,914.689
Y=96,718.622
Y=94,000
Y=95,000
Y=97,000
Y=98,000
PROJECT NORTH
1" = 200'-0" Scale Feet
200 0 200 400
REV. DATE DESCRIPTIONS REVISIONS
DESIGNED
DRAWN Dick Killian
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
BEAM LINE PLAN
DRAWING NO. 6-5-1 CDR-7 REV.



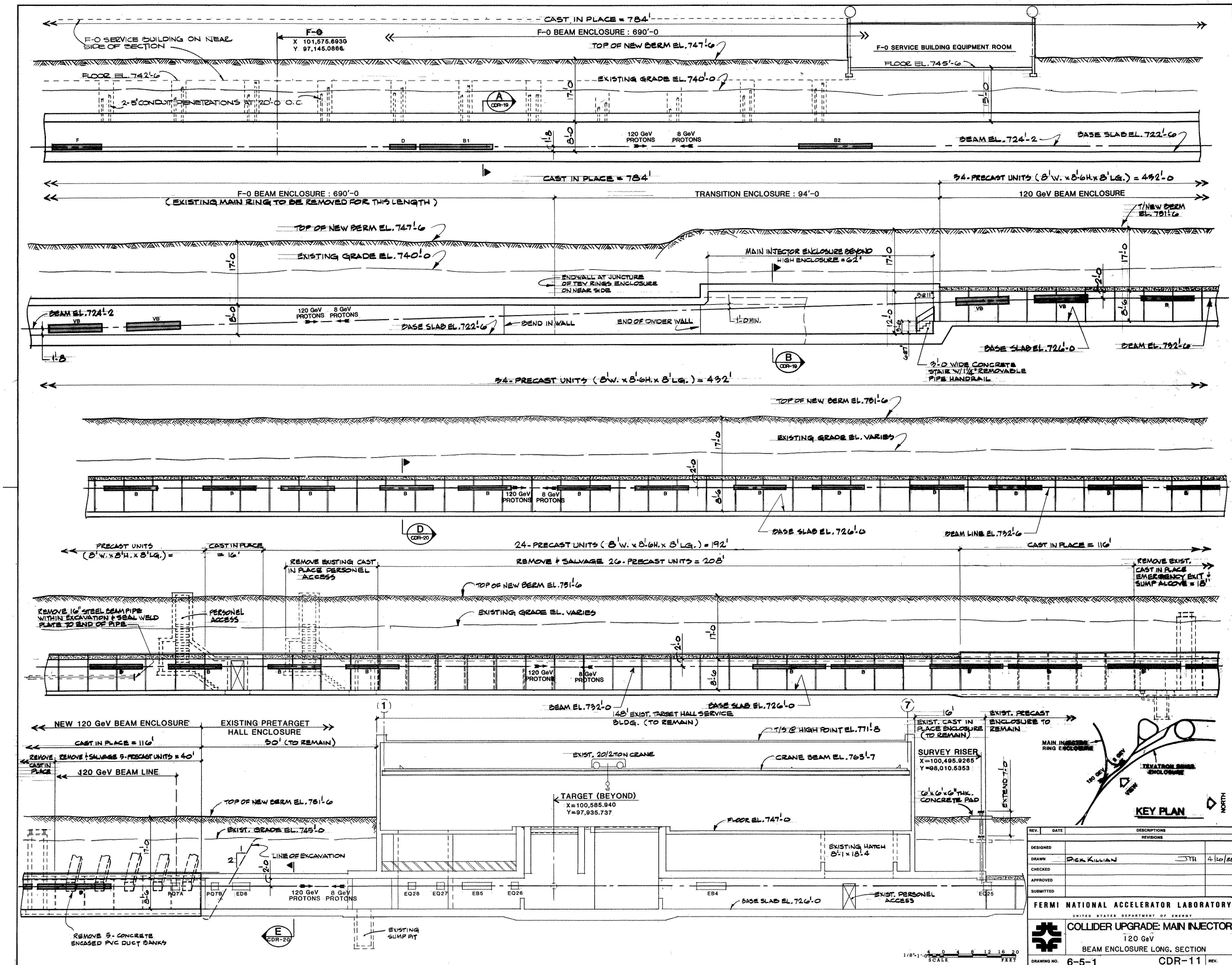
MAIN INJECTOR ENCLOSURE
MATCH LINE B
150 GEV PROTONS
CDR-20 C
120 GEV ENCLOSURE
MATCH LINE C SEE DRWG. CDR-9
EXIT STAIRS TO SURFACE
120 GEV PROTONS
8 GEV PROTONS
8 GEV WEST ENCLOSURE
1 TEV PROTONS
F-15
F-16
F-17
F-18
F-19
F-21
F-22
EXISTING ACCESS STAIR TO SERVICE BUILDING F-1
TEV RINGS ENCLOSURE
BASE SLAB EL. 722'-6"
PRETARGET ENCLOSURE TO BE REMOVED
SHEET PILE RETAINING WALL SYSTEM
MATCH LINE A
690'-0 F-0 BEAM ENCLOSURE
(EXISTING MAIN RING TO BE REMOVED)
94'-0
STATION F-0
MAIN INJECTOR
X:101,571,486
Y:97,142,533
STATION F-0
TEV RINGS
STATION F-0
8'-0 CLG.
12'-0 CLG.
T/BASE SLAB EL. 722'-6
120 GEV PROTONS
8 GEV PROTONS
F-13
F-14
CDR-19 A
CDR-18 B
EXISTING ACCESS STAIR TO SERVICE BUILDING F-1
690'-0 BEAM ENCLOSURE
(EXISTING MAIN RING TO BE REMOVED)
STAIR TO F-0 SERVICE BUILDING
2'-6" x 3'-6" CART LIFT
E-44
E-45
E-46
E-47
E-48
E-49
EXISTING ACCESS STAIRS TO SERVICE BUILDING E-4
6'-0" x 9'-0" FREIGHT ELEVATOR
EXISTING STAIR AND FREIGHT ELEVATOR TO F-0 SERVICE BUILDING
F-0 BEAM ENCLOSURE PLAN
1/16" = 1'-0"
PROJECT NORTH
1/16" = 1'-0" SCALE FEET
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED
DRAWN JTH 4/19/88
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
F-0 BEAM ENCLOSURE PLAN
DRAWING NO. 6-5-1 CDR-8 REV.

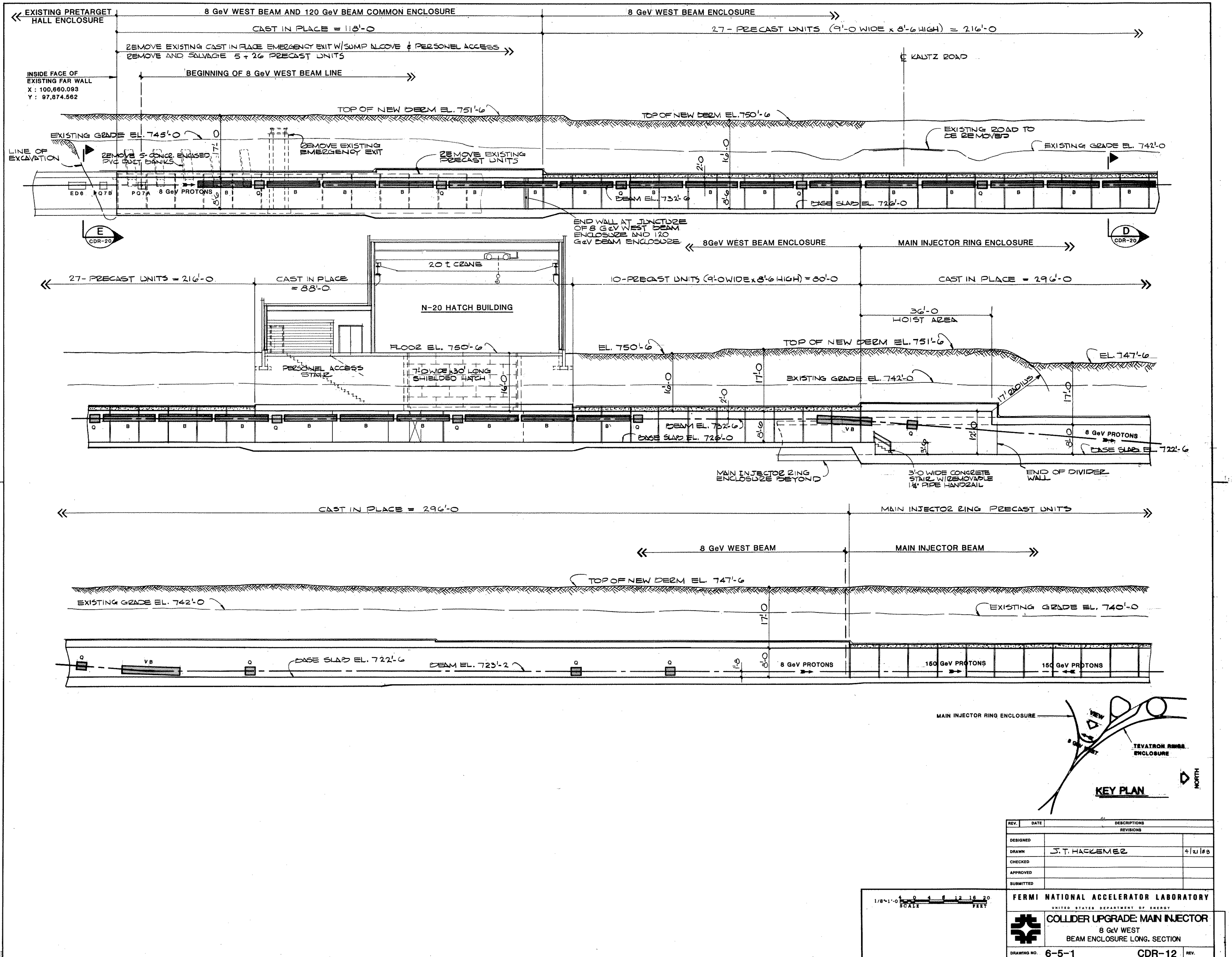


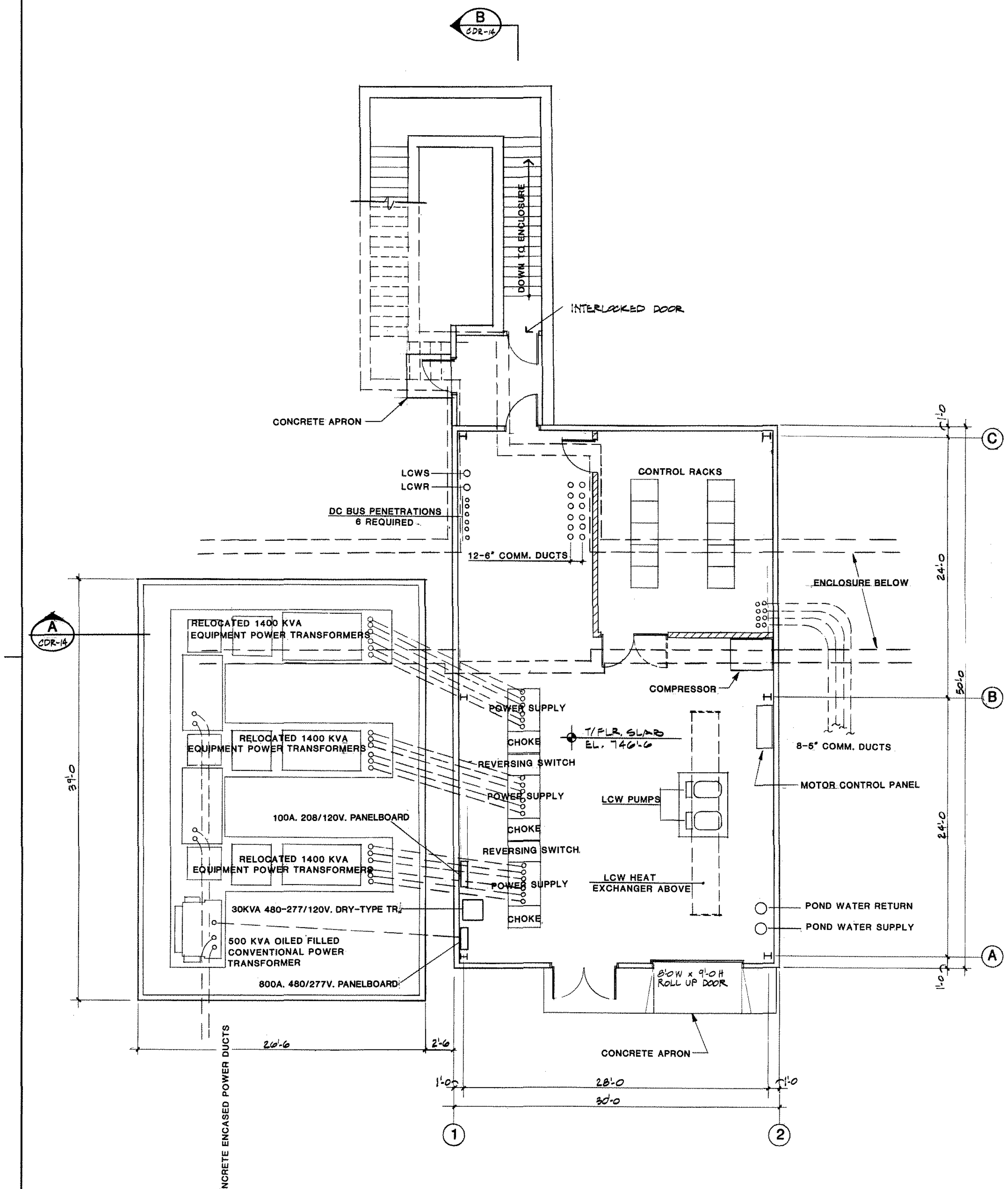
MAJOR VEHICLE ACCESS
INTERLOCKED GATE
INTERLOCKED DOOR
HATCH ABOVE
STAIR
N-20 HATCH BUILDING ABOVE
MATCH LINE E
150 GEV PROTONS
8 GEV PROTONS
MAIN INJECTOR RING ENCLOSURE
BEAM EL. 724'-2
STATION N-0
MAIN INJECTOR
X:100,207.076
Y:97464.248
MAIN INJECTOR RING ENCLOSURE
15'-0 SHIELDING
DIMENSION VARIES (3'-0 MIN. TO 14'-0 MAX.)
CRYO PIPES
T/BERM EL. 752'-0
SHEET PILE RETAINING WALL SYSTEM
TOE OF BERM AT EL. 742'-0
120 GEV ENCLOSURE
TEV RINGS ENCLOSURE
EL. 722'-6
EL.726'-0
EXCAVATE TO EL. 723'-6
SECTION A
SCALE 1/8" 1'-0
MATCH LINE D
BEAM EL. 732'-6
120 GEV PROTONS
8 GEV PROTONS
8 GEV NORTH BEAM ENCLOSURE
8 GEV WEST BEAM ENCLOSURE
BEAM EL. 732'-6
TARGET HALL BUILDING ABOVE
EXIT STAIRS TO SURFACE
120 GEV BEAM ENCLOSURE
MATCH LINE C, SEE DRWG. NO. CDR-8
120 GEV BEAM ENCLOSURE
EXISTING PRE-TARGET ENCLOSURE
HATCH ABOVE
AP-1
AP-3
PRE-TARGET ENCLOSURE TO BE REMOVED
SHEET PILE RETAINING WALL SYSTEM
15'-0 MINIMUM
1 TEV PROTONS
STATION F-21
X:100,800.945
Y:97,758.846
TEV RINGS ENCLOSURE
BASE SLAB EL. 722'-6
PROJECT NORTH
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
8 GeV WEST BEAM ENCLOSURE PLAN
DRAWN PAUL F. LAHN
DRAWING NO. 6-5-1
CDR-9



EXISTING STRUCTURE - TO REMAIN IN PLACE
NEW 8 GeV NORTH BEAM ENCLOSURE
EXISTING TARGET HALL
7-EXISTING PRECAST UNITS = 56'-0
CAST IN PLACE = 63'-0
40- PRECAST UNITS (8'W. x 8'H. x 8' LG. = 320'-0
6'x6' x 6" THK. CONC. PAD
TOP OF NEW BERM EL. 750'-0
EXISTING GRADE EL. 744'-0
EXTEND 7'-0
SURVEY RISER
X : 100,495.9265
Y : 98,010.5353
WATER PROOF MEMBRANE
BEAM EL. 732'-6
BEAM EL. 729'-0
BASE SLAB EL. 726'-0
8 GeV PROTONS
CDR-20
40- PRECAST UNITS (8'W. x 8'H. x 8'LG.) = 320'-0
CAST IN PLACE = 24'-0
56- PRECAST UNITS (8'W. x 8'H. x 8'LG.) = 448'-0
PERSONEL ACCESS STAIR
SUMP PIT
56- PRECAST UNITS (8'W. x 8'H. x 8'LG.) = 448'-0
STRAIGHT
CAST IN PLACE = 108'-0
SHIELDED HATCH
EXISTING HELIUM LINES TO BE REMOVED & REPLACED BY FERMILAB
NEW LOCATION
EXISTING LOCATION
REMOVABLE HATCH COVER - SOCKETS FOR POST & CHAIN WHEN OPEN
EL. 752'-0
15 - 3' x 3' x 7'-6 (B) SHIELD BLOCKS
REMOVE 48" CONC. PIPE & 6" UNDERDRAINS WITHIN EXCAVATION
CAST IN PLACE = 108'-0
14-TAPERED PRECAST UNITS (8'W. x 8'H. x MAX. 8' LG.) = 112'-0
HORIZONTAL BEND
C.I.P.=13'
9-PRECAST UNITS (8'W. x 8'H. x 8'LG.) = 72'-0
STRAIGHT
TRANSITION FROM STRAIGHT TO HORIZONTAL BEND
CAST IN PLACE = 280'-0
HOIST AREA
90' STRAIGHT
TOP OF NEW BERM EL. 746'-6
16' RAD.
BEAM EL. 725'-0
BASE SLAB EL. 722'-6
3'-0 WIDE CONC. STAIRS W/1 1/4" Ø REMOVABLE HANDRAIL
NEW 8 GeV NORTH BEAM ENCLOSURE
EXISTING BOOSTER ENCLOSURE
CAST IN PLACE = 280'-0
90' STRAIGHT
116' HORIZONTAL BEND
42' STRAIGHT
C. L. AP-4 BEAM LINE AT INSIDE FACE OF EXISTING WALL
X : 99,617.531
Y : 99,127.231
REMOVE EXISTING SHIELDING STEEL & REUSE (10'W. x 2'DP.)
PROVIDE 10'W. x 1'-4 DP. STEEL SHIELDING OVER ENCLOSURE AND 2'-0 DEEP STEEL OVER BEAM PIPE
℄ EXISTING SOUTH BOOSTER ROAD
CROWN EL. 745'-6
3-5' P.
2-4" C.
4" GAS
6" DWS
10" ICW
EXISTING STEEL TO REMAIN IN PLACE
REMOVE EXIST. WALL
LINE OF EXCAVATION
℄ BOOSTER PARKING AREA
TOP OF NEW BERM EL. 746'-6
EXISTING GRADE EL. 744'-0
BEAM EL. 728'-0
BASE SLAB EL. 722'-6
AP-4
BEAM PIPE RECEDES TO WEST - REMOVE 120' OF EXISTING PIPE TO BUILD ENCLOSURE & REPLACE (12" Ø STD. STL. PIPE)
EXISTING 48" Ø CONCRETE PIPE (END PLUGGED WITH CONCRETE) & 2-6" Ø UNDERDRAINS TO BE REMOVED WITHIN EXCAVATION - INV. EL. 727'-0
EXISTING POST & LAGGING REMOVE TO 1'-0 BELOW NEW BASE SLAB
REMOVE 6" U.D. AND CONNECT TO NEW U.D. AT SIDES OF ENCLOSURE
EXISTING SUMP PIT
MAIN INJECTOR RING ENCLOSURE
TEVATRON RINGS ENCLOSURE
8 GeV NORTH
VIEW
KEY PLAN
NORTH
REV.
DATE
DESCRIPTIONS
REVISIONS
DESIGNED
DRAWN J. T. HACKEMER 4/19/88
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
8 GeV NORTH
BEAM ENCLOSURE LONG. SECTION
DRAWING NO. 6-5-1 CDR-10 REV.
SCALE FEET

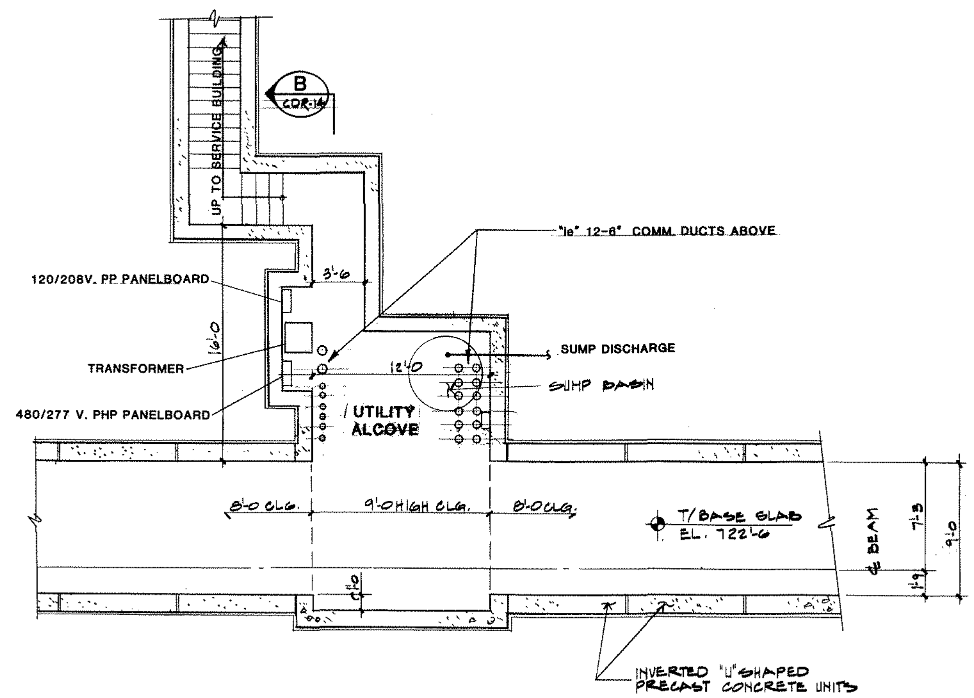

CAST IN PLACE = 784'
F-0 BEAM ENCLOSURE : 690'-0
F-0 SERVICE BUILDING ON NEAR SIDE OF SECTION
F-0
X 101,575.6930
Y 97,145.0866
TOP OF NEW BERM EL. 747'-6
F-0 SERVICE BUILDING EQUIPMENT ROOM
FLOOR EL. 745'-6
FLOOR EL. 742'-6
EXISTING GRADE EL. 740'-0
2-5" CONDUIT PENETRATIONS AT 20'-0 O.C.
120 GeV PROTONS
8 GeV PROTONS
BEAM EL. 724'-2
BASE SLAB EL. 722'-6
34-PRECAST UNITS (8'W. x 8'-6H. x 8' LG.) = 432'-0
TRANSITION ENCLOSURE : 94'-0
120 GeV BEAM ENCLOSURE
(EXISTING MAIN RING TO BE REMOVED FOR THIS LENGTH)
T/NEW BERM EL. 751'-6
MAIN INJECTOR ENCLOSURE BEYOND
HIGH ENCLOSURE = 62'
ENDWALL AT JUNCTURE OF TEV RINGS ENCLOSURE ON NEAR SIDE
BEND IN WALL
END OF DIVIDER WALL
1'-0 MIN.
BASE SLAB EL. 726'-0
BEAM EL. 732'-6
3'-0 WIDE CONCRETE STAIR W/ 1 1/4" REMOVABLE PIPE HANDRAIL
34-PRECAST UNITS (8'W. x 8'-6H. x 8' LG.) = 432'
TOP OF NEW BERM EL. 751'-6
EXISTING GRADE EL. VARIES
BASE SLAB EL. 726'-0
BEAM LINE EL. 732'-6
PRECAST UNITS (8'W. x 8'H. x 8' LG.) =
CAST IN PLACE = 16'
24-PRECAST UNITS (8'W. x 8'-6H. x 8' LG.) = 192'
REMOVE & SALVAGE 26-PRECAST UNITS = 208'
CAST IN PLACE = 116'
REMOVE EXISTING CAST IN PLACE PERSONEL ACCESS
REMOVE EXIST. CAST IN PLACE EMERGENCY EXIT & SUMP ALCOVE = 18'
REMOVE 16" STEEL BEAMPIPE WITHIN EXCAVATION & SEAL WELD PLATE TO END OF PIPE
PERSONEL ACCESS
BEAM EL. 732'-0
148' EXIST. TARGET HALL SERVICE BLDG. (TO REMAIN)
NEW 120 GeV BEAM ENCLOSURE
EXISTING PRETARGET HALL ENCLOSURE
50' (TO REMAIN)
CAST IN PLACE = 116'
REMOVE & SALVAGE 5-PRECAST UNITS = 40'
120 GeV BEAM LINE
T/S @ HIGH POINT EL. 771'-8
EXIST. 20/2 TON CRANE
CRANE BEAM EL. 765'-7
TARGET (BEYOND)
X=100,585.940
Y=97,935.737
FLOOR EL. 747'-0
EXIST. GRADE EL. 745'-0
LINE OF EXCAVATION
EXISTING HATCH 8'-1 x 18'-4
16' EXIST. CAST IN PLACE ENCLOSURE (TO REMAIN)
EXIST. PRECAST ENCLOSURE TO REMAIN
SURVEY RISER
X=100,495.9265
Y=98,010.5353
6'x6'x6" THK. CONCRETE PAD
EXTEND 7'-0
EXIST. PERSONEL ACCESS
REMOVE 5-CONCRETE ENCASED PVC DUCT BANKS
EXISTING SUMP PIT
KEY PLAN
MAIN INJECTOR RING ENCLOSURE
TEVATRON RINGS ENCLOSURE
NORTH
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
120 GeV
BEAM ENCLOSURE LONG. SECTION
DRAWN Dick Killian 4/20/88
DRAWING NO. 6-5-1
CDR-11


EXISTING PRETARGET HALL ENCLOSURE
8 GeV WEST BEAM AND 120 GeV BEAM COMMON ENCLOSURE
8 GeV WEST BEAM ENCLOSURE
CAST IN PLACE = 118'-0
27 - PRECAST UNITS (9'-0 WIDE x 8'-6 HIGH) = 216'-0
REMOVE EXISTING CAST IN PLACE EMERGENCY EXIT W/SUMP ALCOVE & PERSONEL ACCESS
REMOVE AND SALVAGE 5 + 26 PRECAST UNITS
℄ KAUTZ ROAD
INSIDE FACE OF EXISTING FAR WALL
X : 100,660.093
Y : 97,874.562
BEGINNING OF 8 GeV WEST BEAM LINE
TOP OF NEW BERM EL. 751'-6
TOP OF NEW BERM EL. 750'-6
EXISTING GRADE EL. 745'-0
EXISTING ROAD TO BE REMOVED
EXISTING GRADE EL. 742'-0
LINE OF EXCAVATION
REMOVE 5-CONC. ENCASED PVC DUCT BANKS
REMOVE EXISTING EMERGENCY EXIT
REMOVE EXISTING PRECAST UNITS
8 GeV PROTONS
BEAM EL. 732'-6
BASE SLAB EL. 726'-0
END WALL AT JUNCTURE OF 8 GeV WEST BEAM ENCLOSURE AND 120 GeV BEAM ENCLOSURE
E CDR-20
D CDR-20
8GeV WEST BEAM ENCLOSURE
MAIN INJECTOR RING ENCLOSURE
20 t CRANE
27 - PRECAST UNITS = 216'-0
CAST IN PLACE = 88'-0
10 - PRECAST UNITS (9'-0 WIDE x 8'-6 HIGH) = 80'-0
CAST IN PLACE = 296'-0
N-20 HATCH BUILDING
36'-0 HOIST AREA
FLOOR EL. 750'-6
EL. 750'-6
TOP OF NEW BERM EL. 751'-6
EL. 747'-6
PERSONEL ACCESS STAIR
7'-0 WIDE x 30' LONG SHIELDED HATCH
EXISTING GRADE EL. 742'-0
17' RADIUS
BEAM EL. 732'-6
BASE SLAB EL. 726'-0
8 GeV PROTONS
BASE SLAB EL. 722'-6
MAIN INJECTOR RING ENCLOSURE BEYOND
3'-0 WIDE CONCRETE STAIR W/REMOVABLE 1¼" PIPE HANDRAIL
END OF DIVIDER WALL
CAST IN PLACE = 296'-0
MAIN INJECTOR RING PRECAST UNITS
8 GeV WEST BEAM
MAIN INJECTOR BEAM
TOP OF NEW BERM EL. 747'-6
EXISTING GRADE EL. 742'-0
EXISTING GRADE EL. 740'-0
BASE SLAB EL. 722'-6
BEAM EL. 723'-2
8 GeV PROTONS
150 GeV PROTONS
150 GeV PROTONS
MAIN INJECTOR RING ENCLOSURE
VIEW
8 GeV WEST
TEVATRON RINGS ENCLOSURE
NORTH
KEY PLAN
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED
DRAWN J. T. HACKEMER 4/21/88
CHECKED
APPROVED
SUBMITTED
1/8"=1'-0 SCALE FEET
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
8 GeV WEST
BEAM ENCLOSURE LONG. SECTION
DRAWING NO. 6-5-1 CDR-12 REV.



TYPICAL SERVICE BUILDING PLAN

1/4"=1'-0



ENCLOSURE PLAN

BELOW TYPICAL SERVICE BUILDING 1/4"=1'-0

1/4"=1'-0 SCALE 4 0 4 8 FEET

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

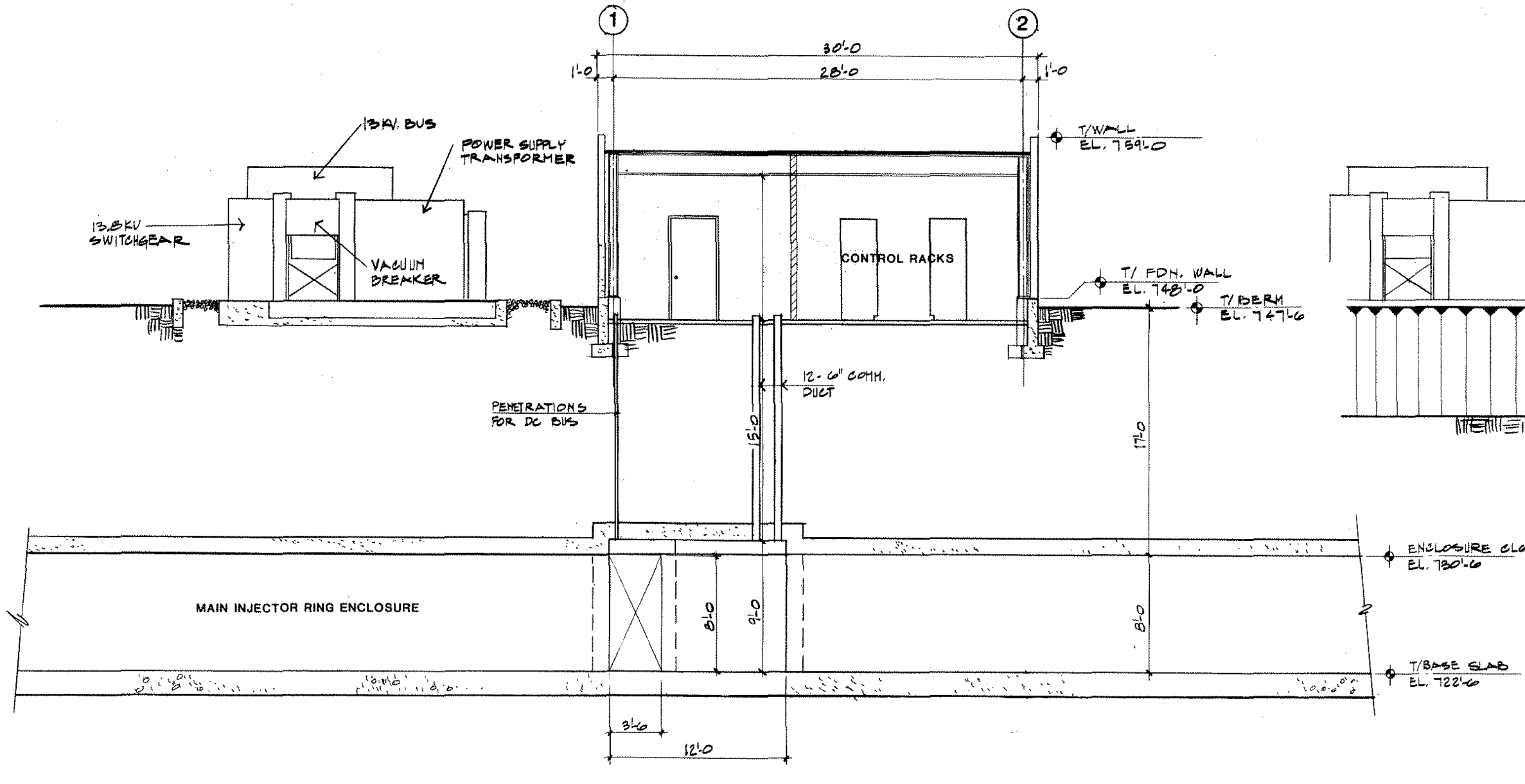
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

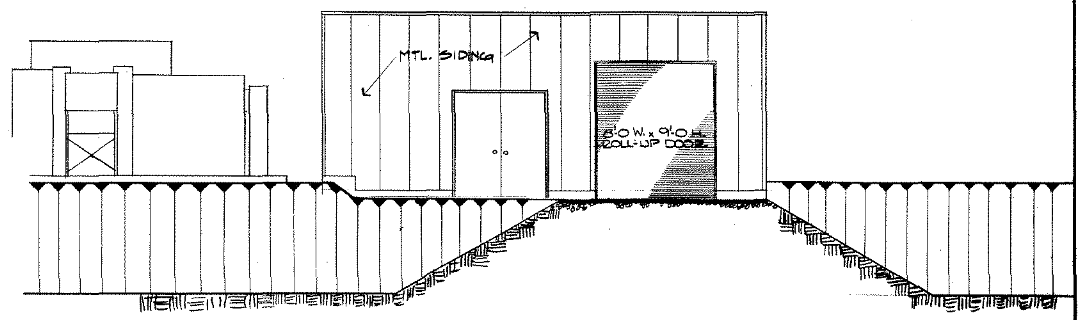
COLLIDER UPGRADE: MAIN INJECTOR

TYPICAL SERVICE BUILDING PLAN

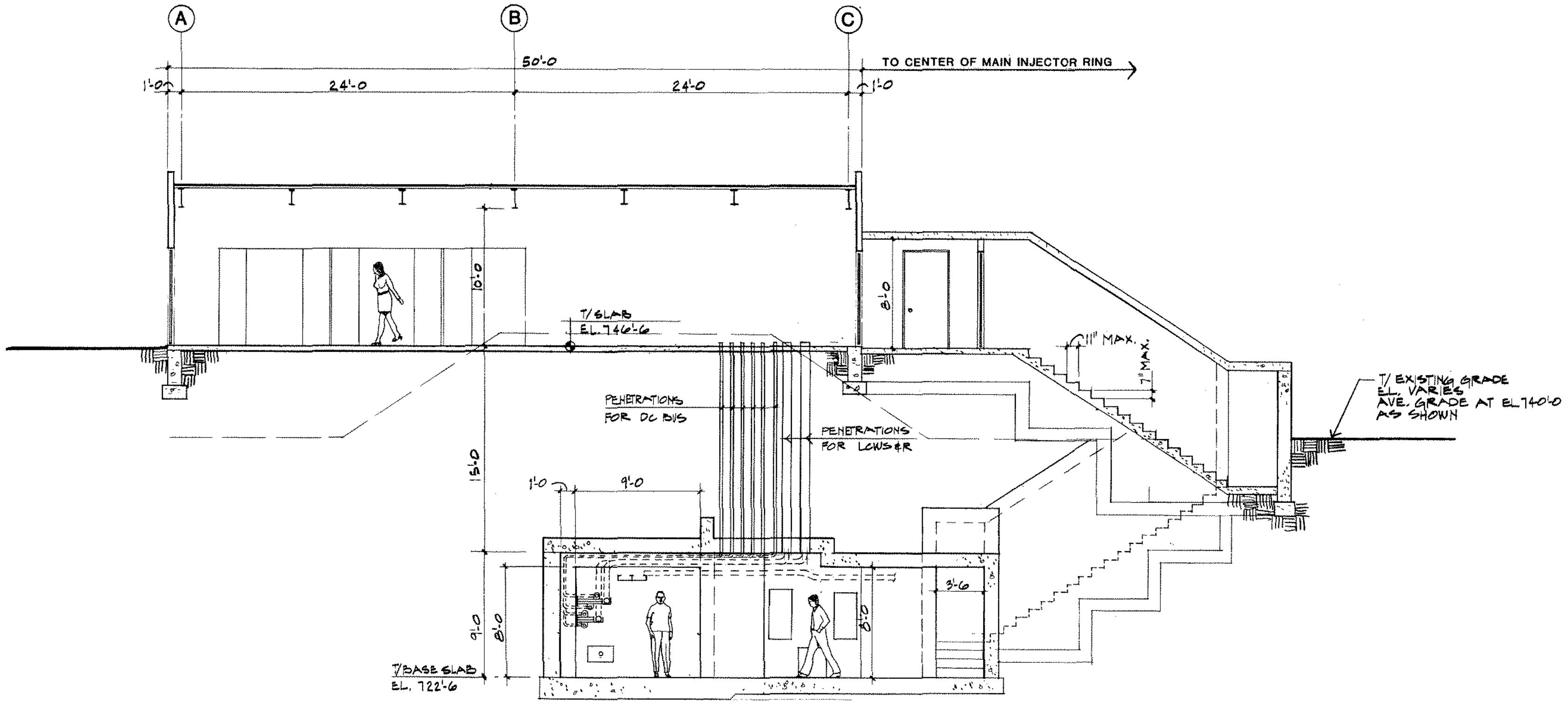
DRAWING NO. 6-5-1 CDR-13 REV.



SECTION (A)
1/4"=1'-0



FRONT ELEVATION
1/4"=1'-0



SECTION (B)
1/4"=1'-0

REV.	DATE	DESCRIPTIONS
		REVISIONS

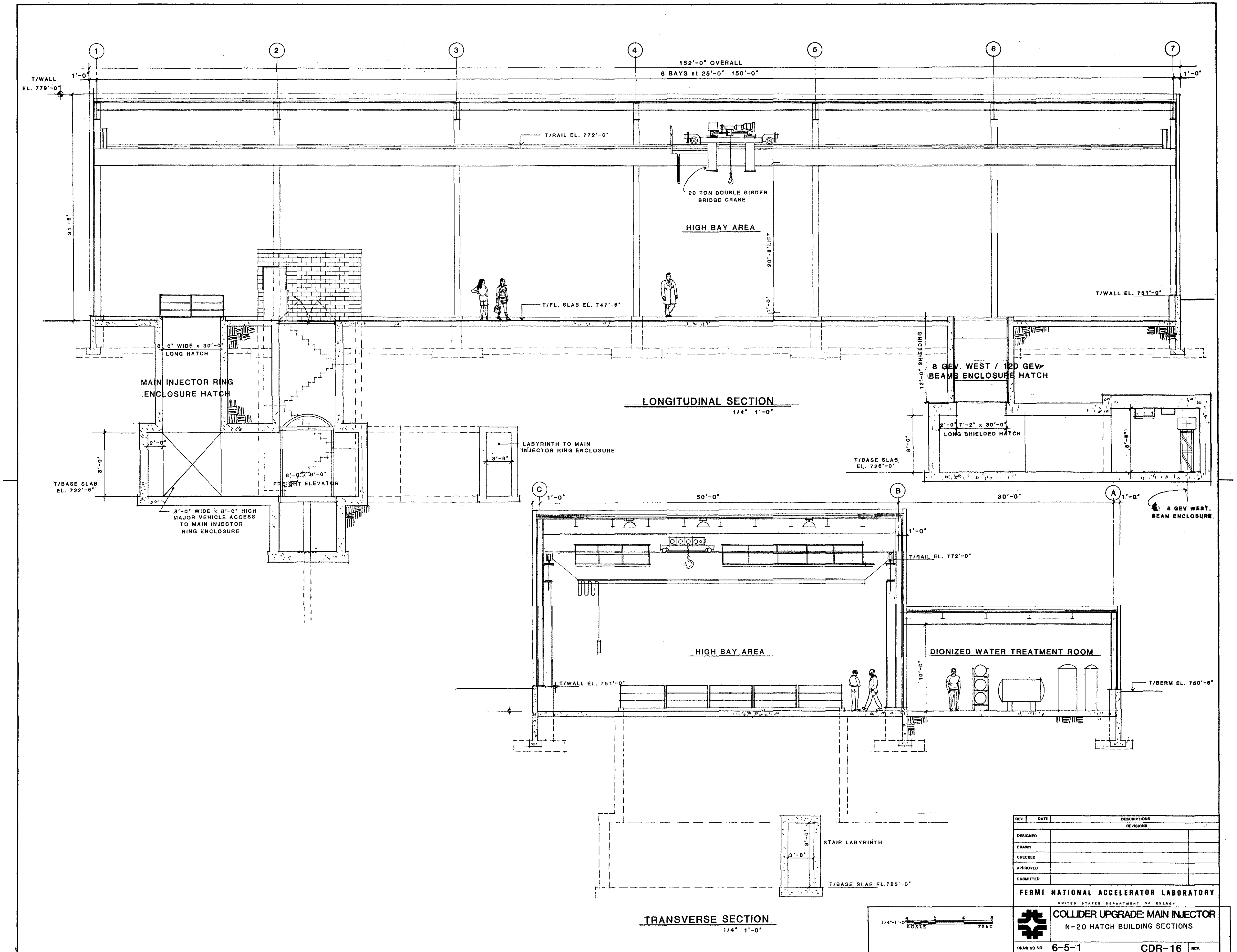
DESIGNED	
DRAWN	
CHECKED	
APPROVED	
SUBMITTED	

1/4"=1'-0" SCALE FEET (4 0 4 8)

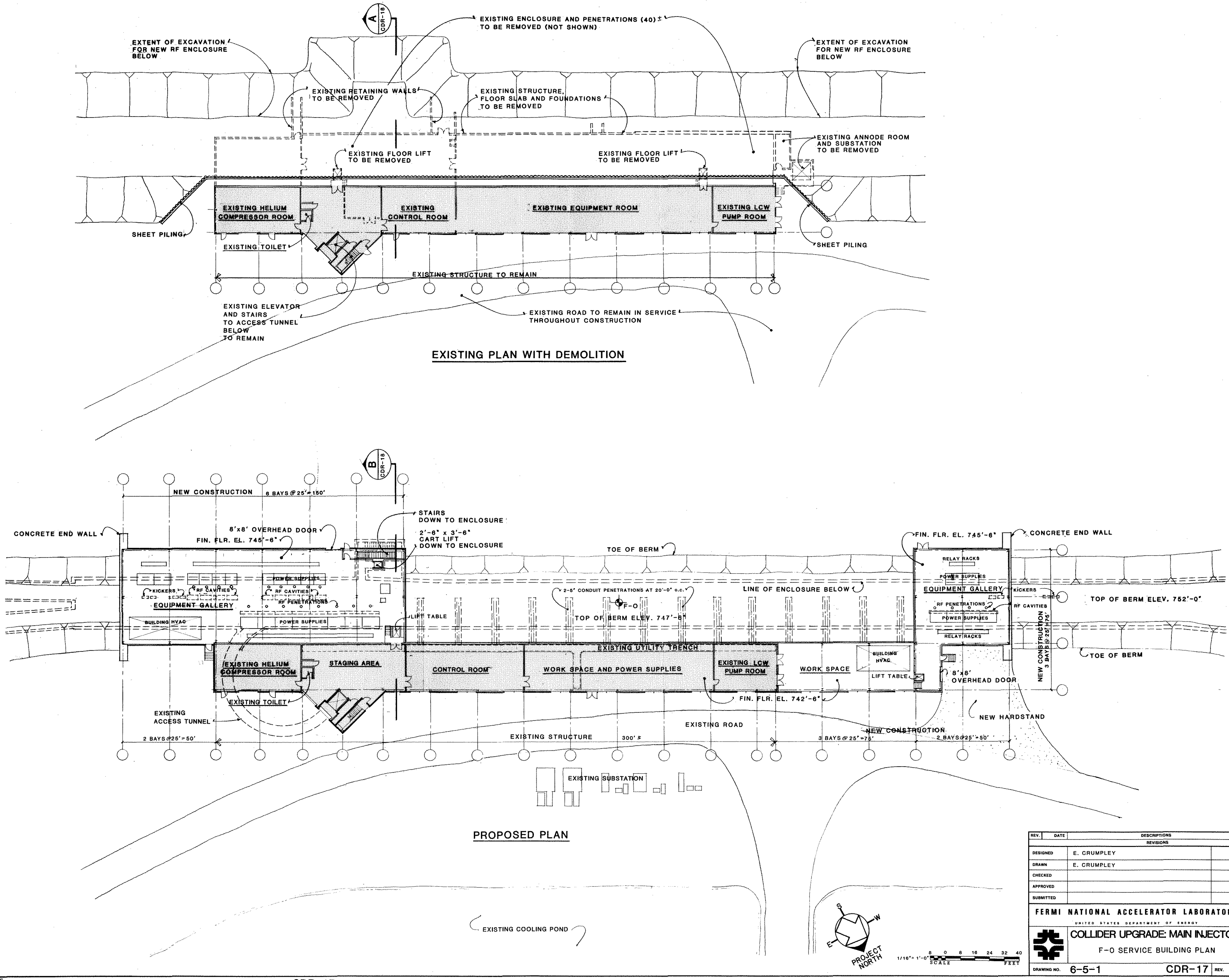
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR
TYPICAL SERVICE BUILDING SECTIONS

DRAWING NO. 6-5-1 CDR-14 REV.



152'-0" OVERALL
6 BAYS at 25'-0" 150'-0"
1'-0"
T/WALL EL. 779'-0"
31'-6"
T/RAIL EL. 772'-0"
20 TON DOUBLE GIRDER BRIDGE CRANE
HIGH BAY AREA
20'-8" LIFT
T/FL. SLAB EL. 747'-6"
T/WALL EL. 751'-0"
8'-0" WIDE x 30'-0" LONG HATCH
MAIN INJECTOR RING ENCLOSURE HATCH
12'-0" SHIELDING
8 GEV. WEST / 120 GEV BEAMS ENCLOSURE HATCH
LONGITUDINAL SECTION
1/4" 1'-0"
2'-0"
7'-2" x 30'-0" LONG SHIELDED HATCH
T/BASE SLAB EL. 726'-0"
LABYRINTH TO MAIN INJECTOR RING ENCLOSURE
3'-6"
8'-0"
T/BASE SLAB EL. 722'-6"
8'-0" x 9'-0" FREIGHT ELEVATOR
8'-0" WIDE x 8'-0" HIGH MAJOR VEHICLE ACCESS TO MAIN INJECTOR RING ENCLOSURE
50'-0"
30'-0"
8 GEV WEST BEAM ENCLOSURE
T/RAIL EL. 772'-0"
HIGH BAY AREA
DIONIZED WATER TREATMENT ROOM
10'-0"
T/WALL EL. 751'-0"
T/BERM EL. 750'-6"
STAIR LABYRINTH
T/BASE SLAB EL. 726'-0"
TRANSVERSE SECTION
1/4" 1'-0"
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED
DRAWN
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
1/4"=1'-0" SCALE FEET
COLLIDER UPGRADE: MAIN INJECTOR
N-20 HATCH BUILDING SECTIONS
DRAWING NO. 6-5-1
CDR-16



REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	E. CRUMPLEY
DRAWN	E. CRUMPLEY
CHECKED	
APPROVED	
SUBMITTED	

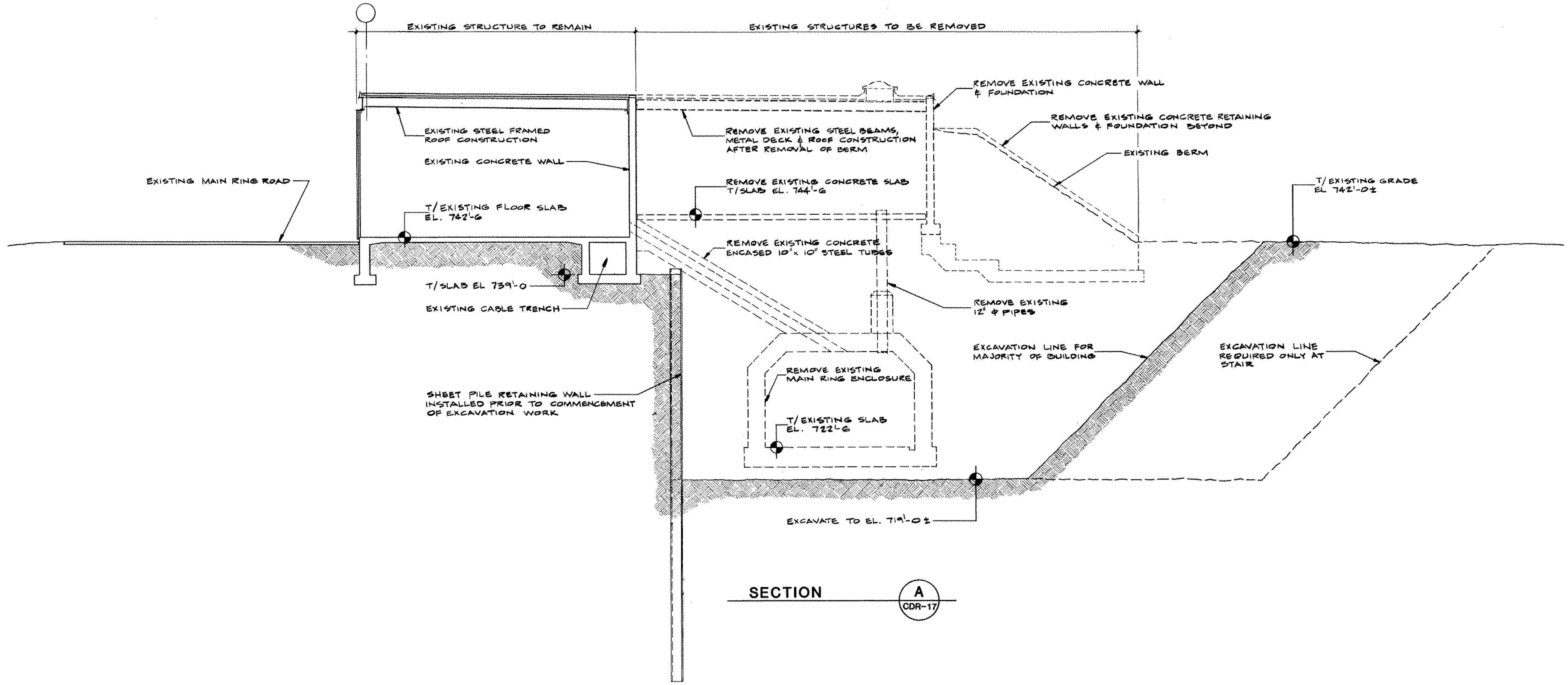
FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

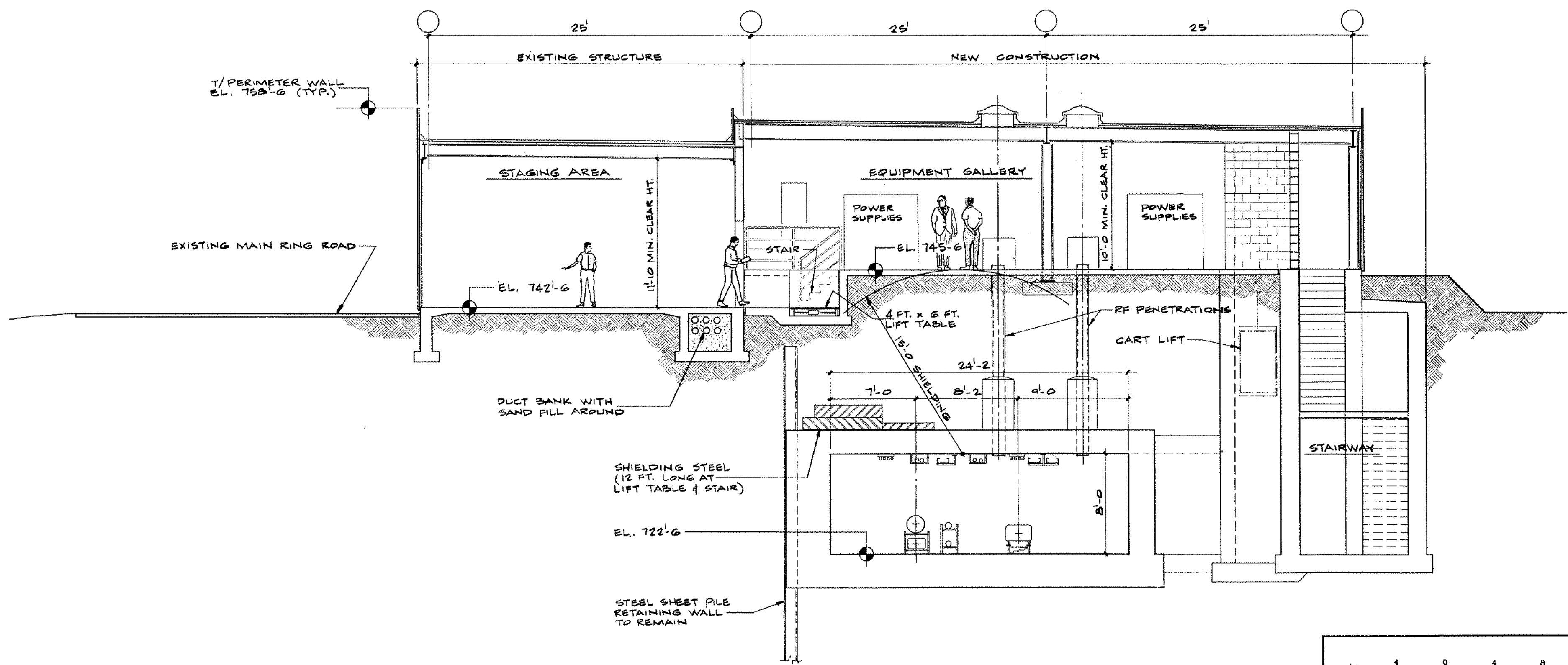
COLLIDER UPGRADE: MAIN INJECTOR

F-O SERVICE BUILDING PLAN

DRAWING NO. 6-5-1 CDR-17 REV.



SECTION A (CDR-17)



SECTION B (CDR-17)

1/4":1'-0" 4 0 4 8 Scale Feet

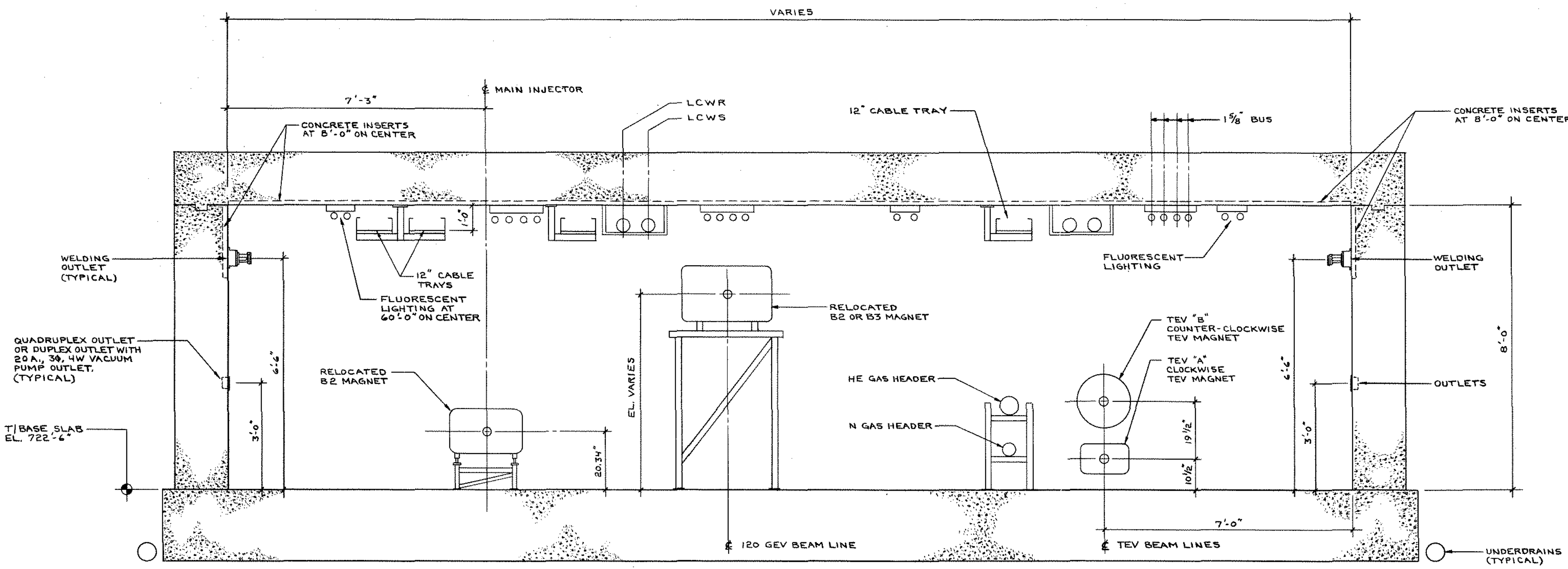
REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	
DRAWN	PAUL F. LAHN
CHECKED	
APPROVED	
SUBMITTED	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

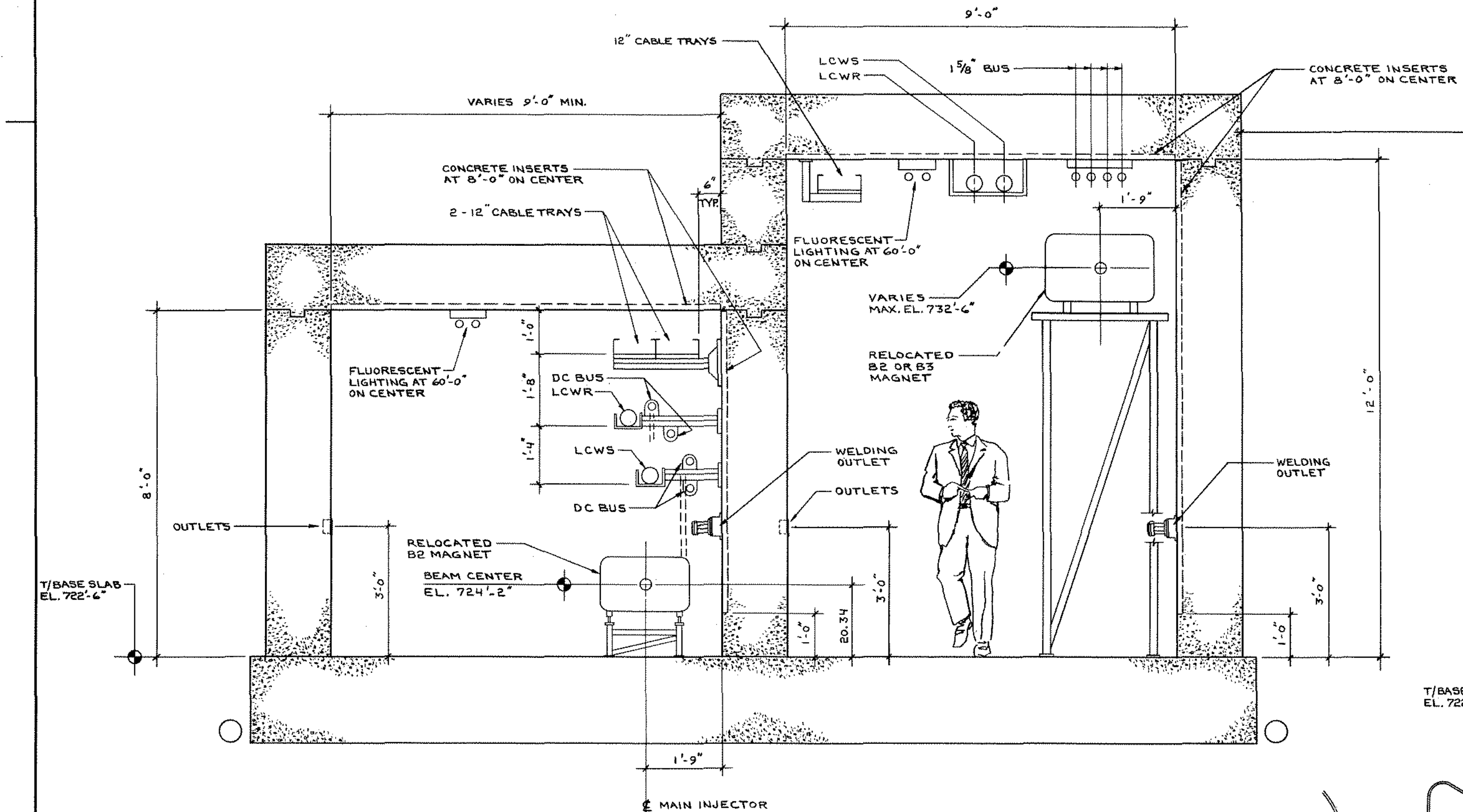
COLLIDER UPGRADE: MAIN INJECTOR
F-0 SERVICE BUILDING SECTIONS

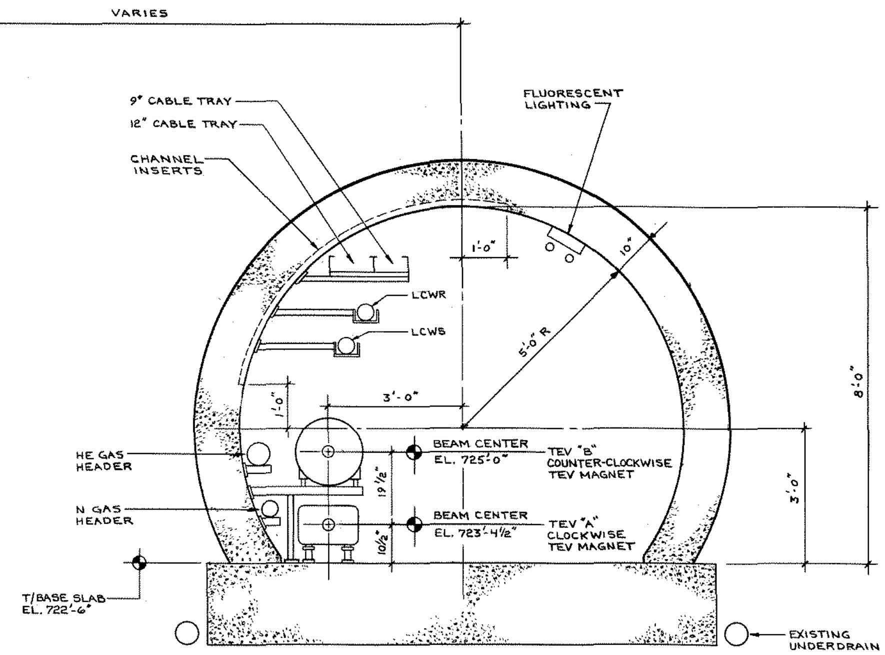
DRAWING NO. 6-5-1 CDR-18 REV.



SECTION (A)

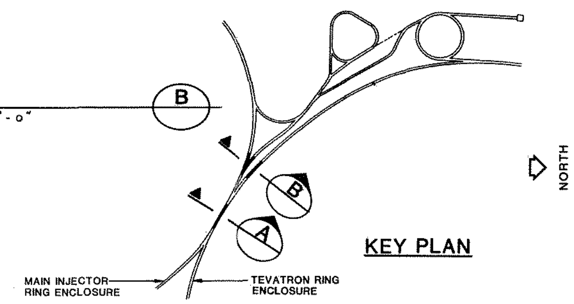
SCALE: 3/4" = 1'-0"





SECTION (B)

SCALE: 3/4" = 1'-0"



KEY PLAN

REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	
DRAWN	DR WAGNER
CHECKED	
APPROVED	
SUBMITTED	

3/4"-1'-0 SCALE 0 1 2 3 FEET

FERMI NATIONAL ACCELERATOR LABORATORY

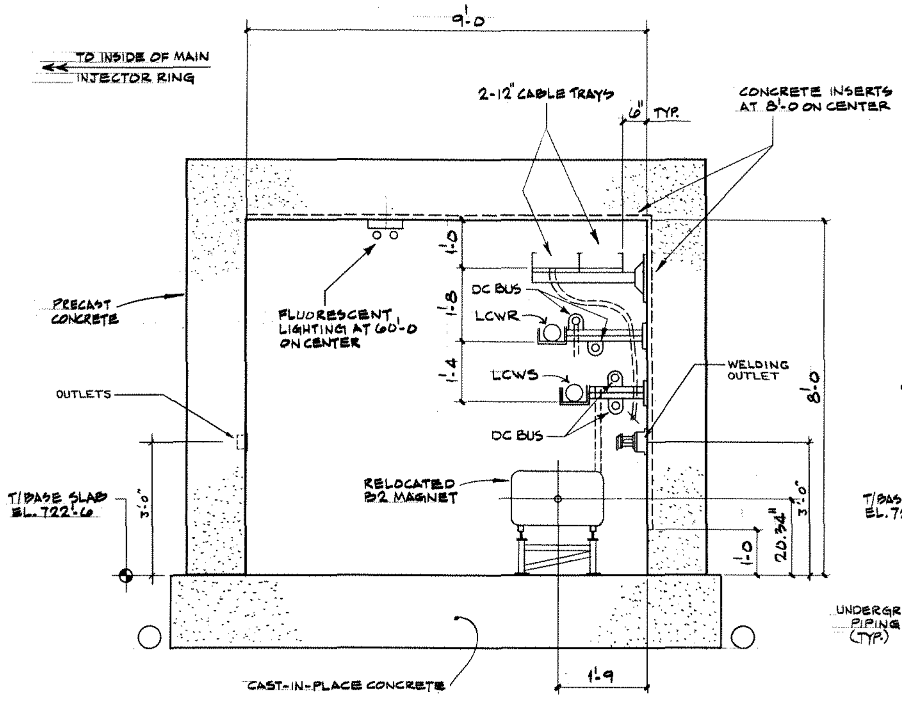
UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR

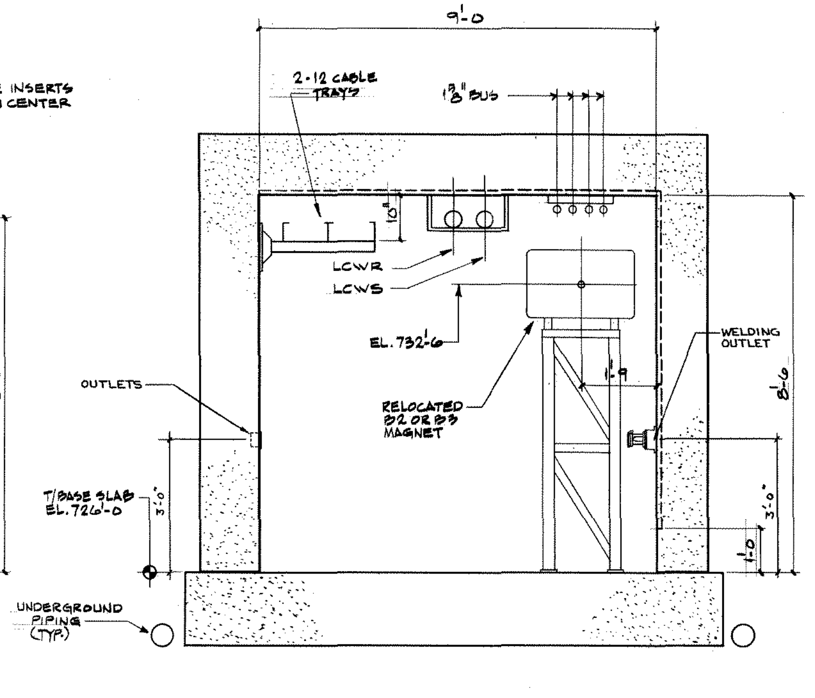
ENCLOSURE SECTIONS - SHEET 1

DRAWING NO. 6-5-1 CDR-19 REV.

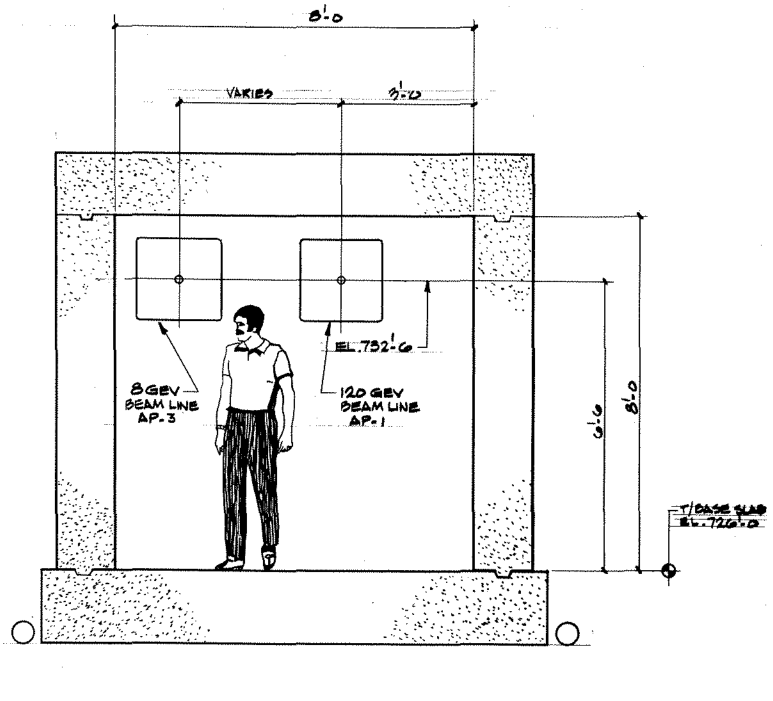
CDR-19



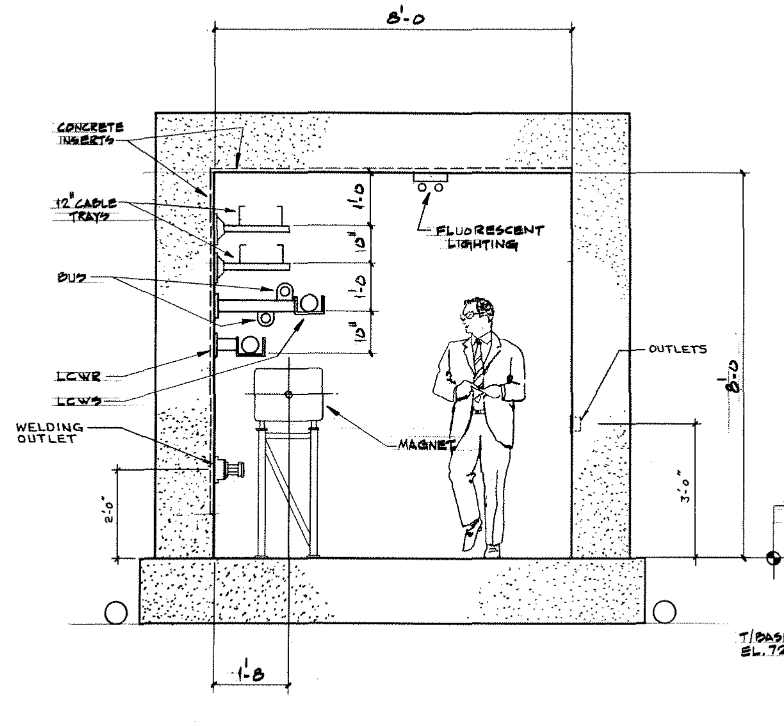
TYPICAL MAIN INJECTOR ENCLOSURE SECTION (C)
3/4" = 1'-0



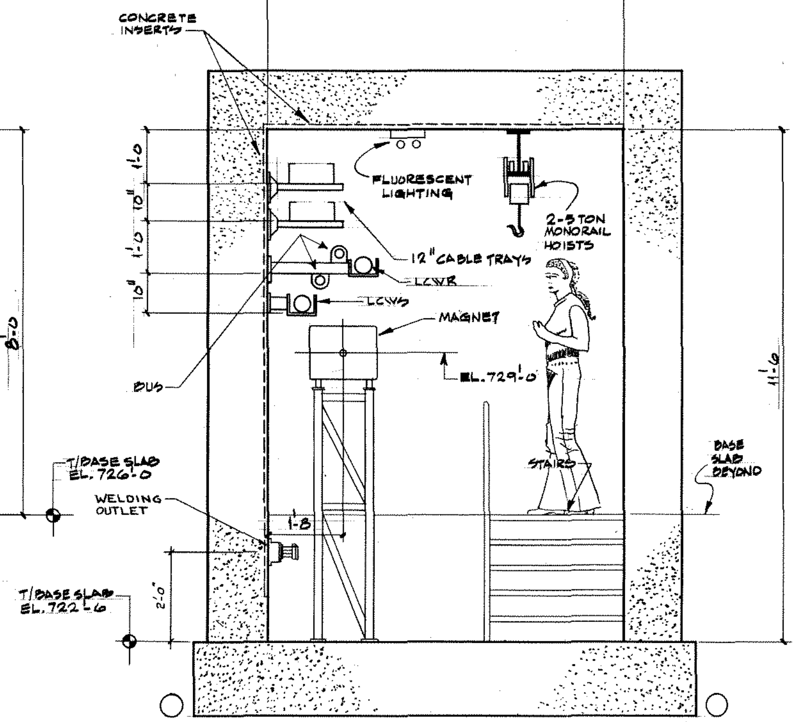
120 GeV & 8 GeV WEST ENCLOSURE SECTION (D)
3/4" = 1'-0



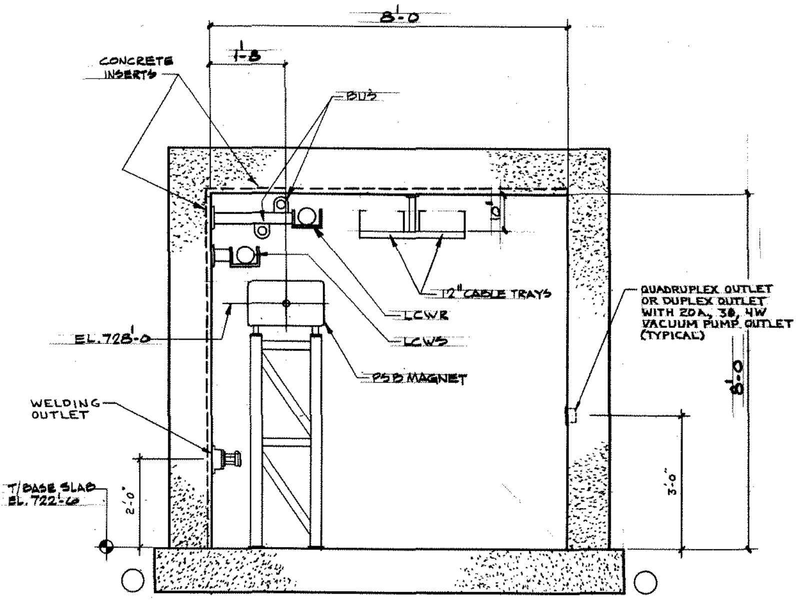
EXISTING PRETARGET ENCLOSURE SECTION (E)
LOOKING TOWARDS MAIN INJECTOR



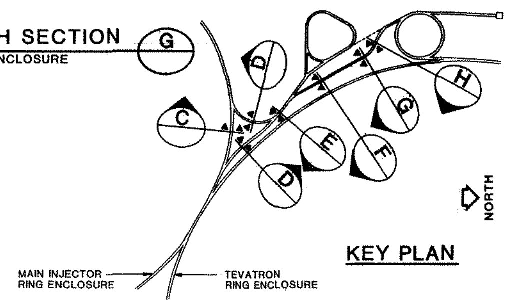
8 GeV NORTH SECTION (F)
TOWARD EXISTING ANTI-PROTON TRANSPORT



8 GeV NORTH SECTION (G)
TRANSITION ENCLOSURE



8 GeV NORTH SECTION (H)
LOOKING FROM THE BOOSTER ENCLOSURE



KEY PLAN

3/4"=1'-0" SCALE 0 1 2 3 FEET

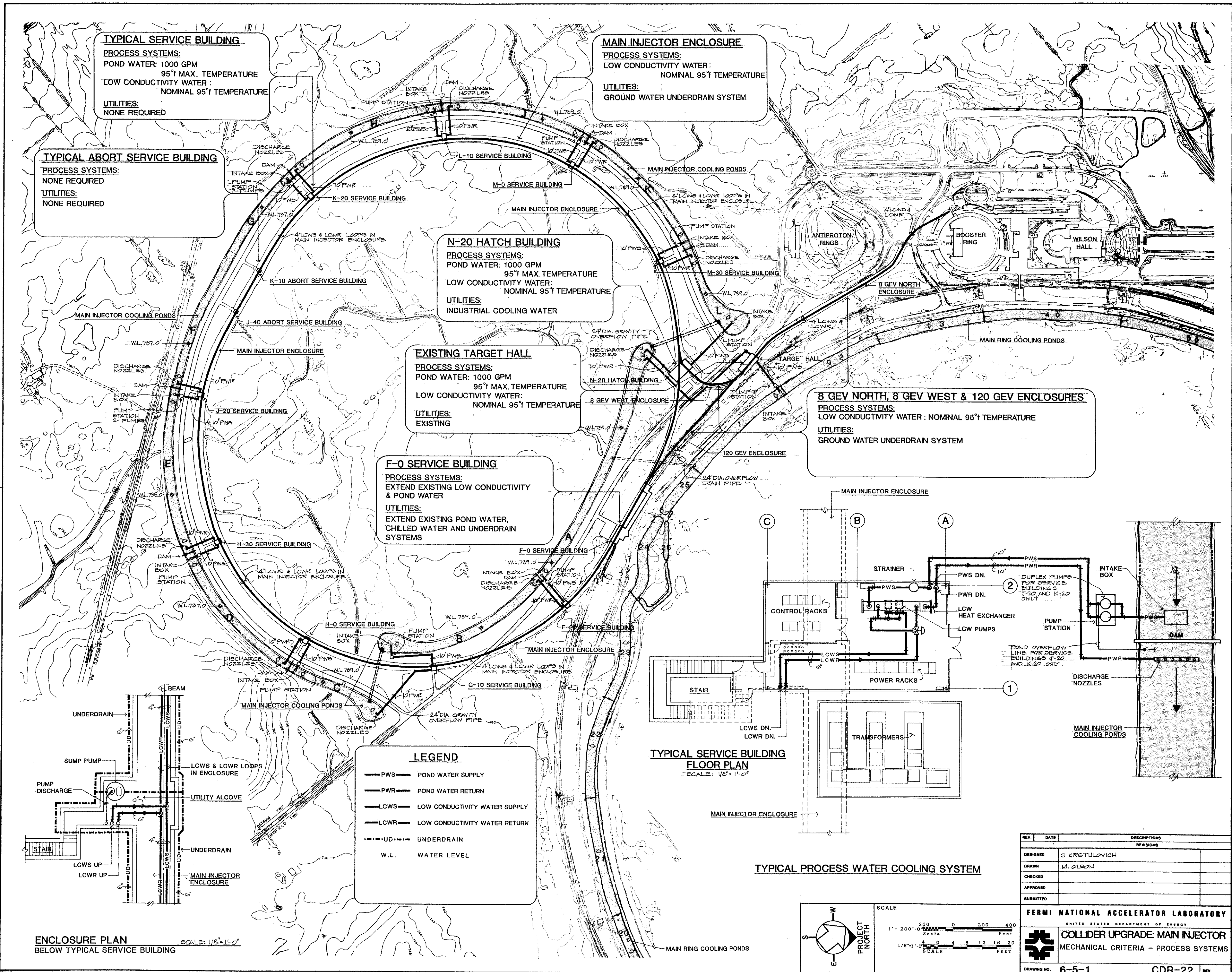
REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	
DRAWN	DICK KILLIAN
CHECKED	
APPROVED	
SUBMITTED	

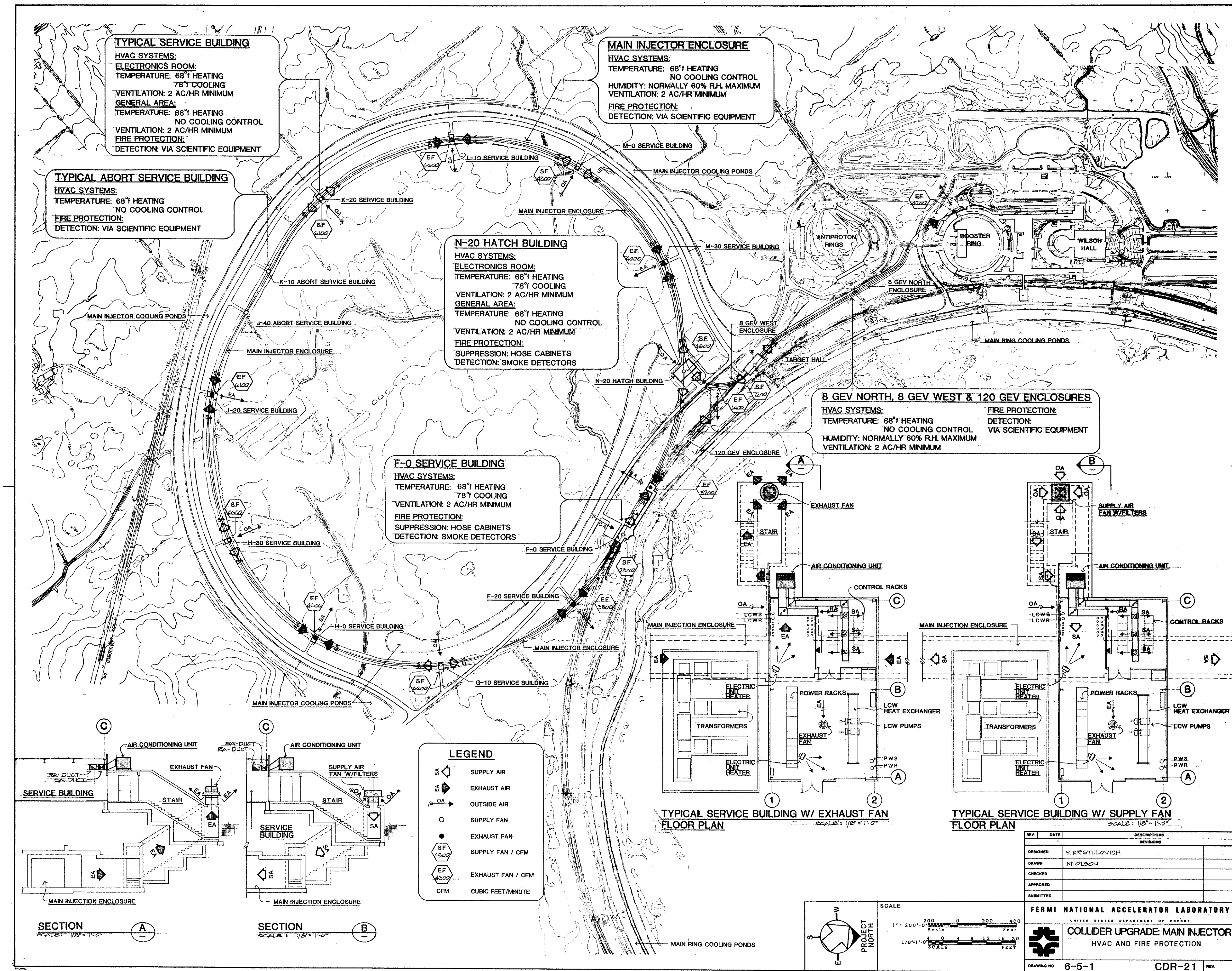
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

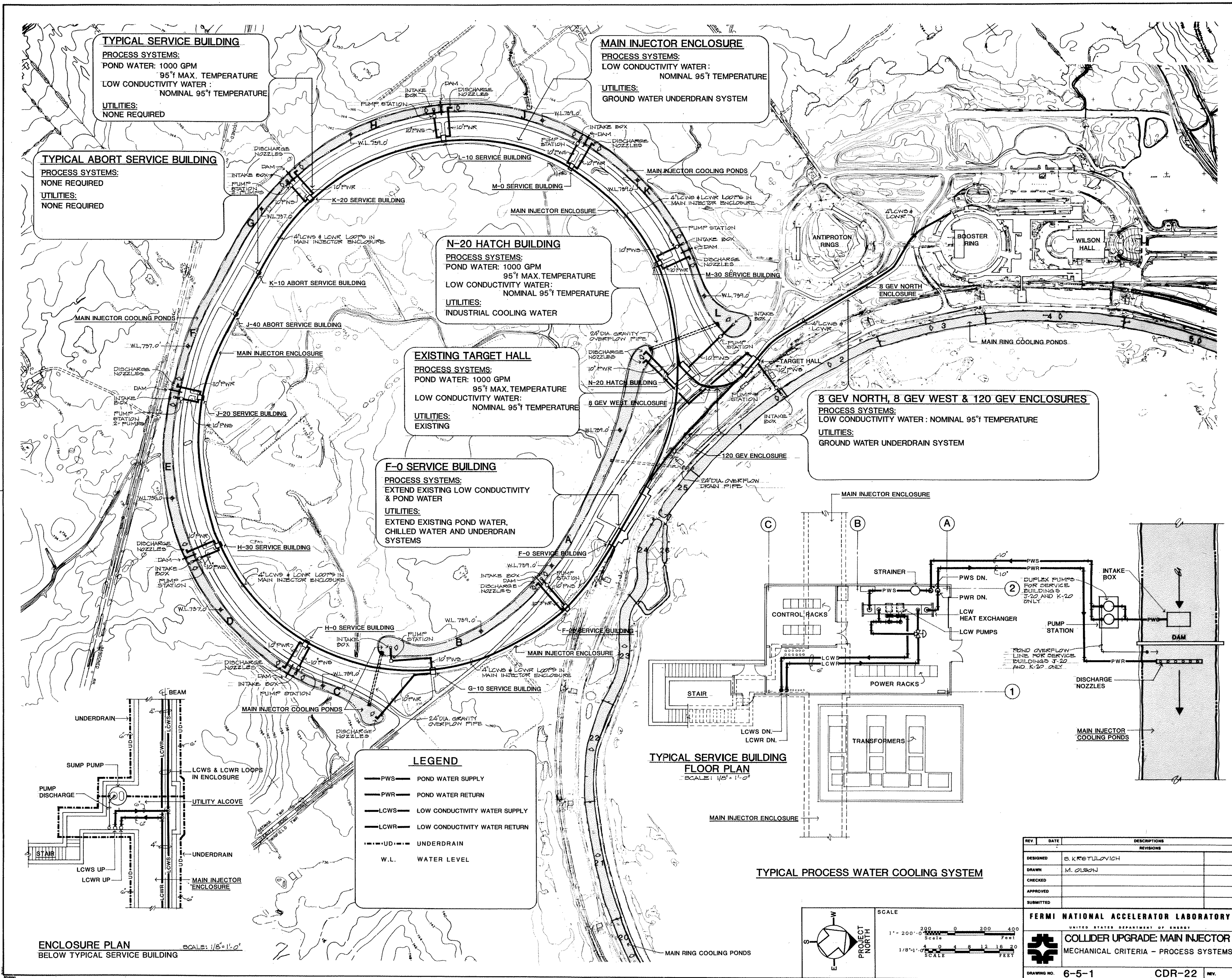
COLLIDER UPGRADE: MAIN INJECTOR
ENCLOSURE SECTIONS – SHEET 2

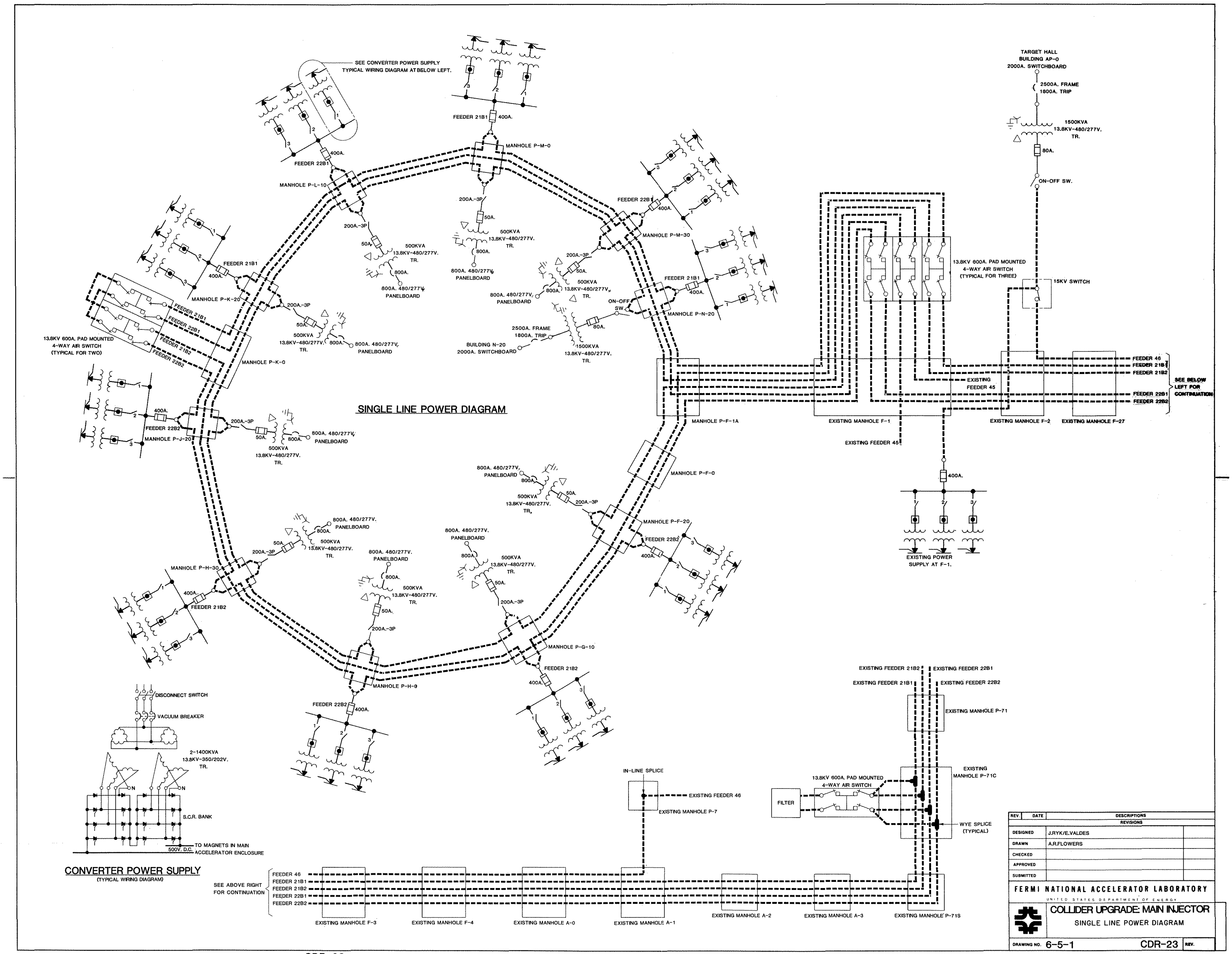
DRAWING NO. 6-5-1 CDR-20 REV.

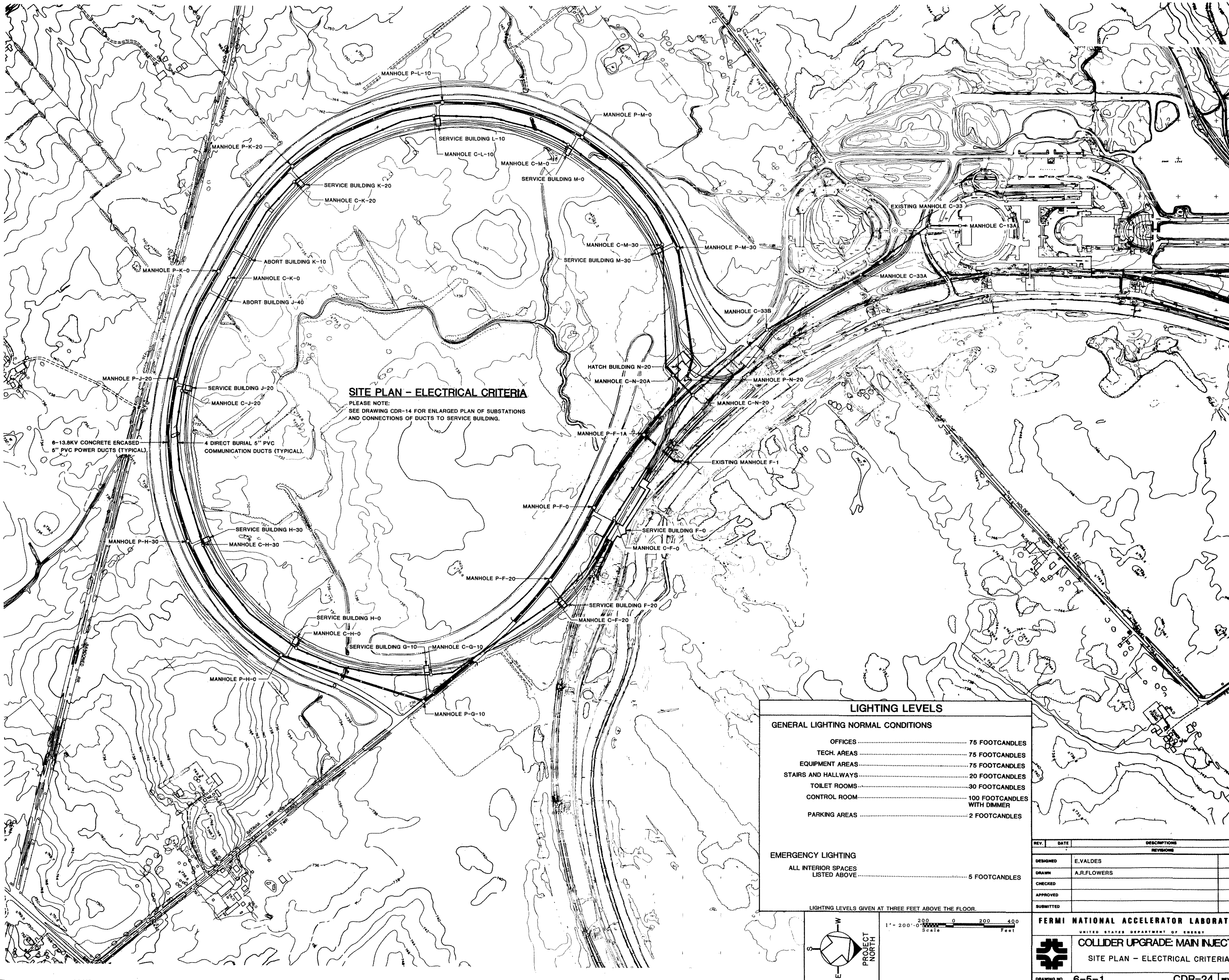


TYPICAL SERVICE BUILDING
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER :
NOMINAL 95°f TEMPERATURE
UTILITIES:
NONE REQUIRED
MAIN INJECTOR ENCLOSURE
PROCESS SYSTEMS:
LOW CONDUCTIVITY WATER :
NOMINAL 95°f TEMPERATURE
UTILITIES:
GROUND WATER UNDERDRAIN SYSTEM
TYPICAL ABORT SERVICE BUILDING
PROCESS SYSTEMS:
NONE REQUIRED
UTILITIES:
NONE REQUIRED
N-20 HATCH BUILDING
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER:
NOMINAL 95°f TEMPERATURE
UTILITIES:
INDUSTRIAL COOLING WATER
EXISTING TARGET HALL
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER:
NOMINAL 95°f TEMPERATURE
UTILITIES:
EXISTING
8 GEV NORTH, 8 GEV WEST & 120 GEV ENCLOSURES
PROCESS SYSTEMS:
LOW CONDUCTIVITY WATER : NOMINAL 95°f TEMPERATURE
UTILITIES:
GROUND WATER UNDERDRAIN SYSTEM
F-0 SERVICE BUILDING
PROCESS SYSTEMS:
EXTEND EXISTING LOW CONDUCTIVITY
& POND WATER
UTILITIES:
EXTEND EXISTING POND WATER,
CHILLED WATER AND UNDERDRAIN
SYSTEMS
L-10 SERVICE BUILDING
M-0 SERVICE BUILDING
K-20 SERVICE BUILDING
K-10 ABORT SERVICE BUILDING
J-40 ABORT SERVICE BUILDING
J-20 SERVICE BUILDING
H-30 SERVICE BUILDING
H-0 SERVICE BUILDING
G-10 SERVICE BUILDING
F-0 SERVICE BUILDING
M-30 SERVICE BUILDING
N-20 HATCH BUILDING
8 GEV WEST ENCLOSURE
8 GEV NORTH ENCLOSURE
120 GEV ENCLOSURE
MAIN INJECTOR ENCLOSURE
MAIN INJECTOR COOLING PONDS
MAIN RING COOLING PONDS
ANTIPROTON RINGS
BOOSTER RING
WILSON HALL
TARGET HALL
PUMP STATION
INTAKE BOX
DAM
DISCHARGE NOZZLES
24"DIA. GRAVITY OVERFLOW PIPE
24"DIA. OVERFLOW DRAIN PIPE
4"LCWS & LCWR LOOPS IN MAIN INJECTOR ENCLOSURE
ENCLOSURE PLAN
BELOW TYPICAL SERVICE BUILDING
SCALE: 1/8"=1'-0"
UNDERDRAIN
SUMP PUMP
PUMP DISCHARGE
LCWS & LCWR LOOPS IN ENCLOSURE
UTILITY ALCOVE
LCWS UP
LCWR UP
STAIR
BEAM
TYPICAL SERVICE BUILDING FLOOR PLAN
SCALE: 1/8"=1'-0"
STRAINER
PWS DN.
PWR DN.
DUPLEX PUMPS FOR SERVICE BUILDINGS J-20 AND K-20 ONLY
LCW HEAT EXCHANGER
LCW PUMPS
CONTROL RACKS
POWER RACKS
TRANSFORMERS
LCWS DN.
LCWR DN.
POND OVERFLOW LINE FOR SERVICE BUILDINGS J-20 AND K-20 ONLY
INTAKE BOX
PUMP STATION
DISCHARGE NOZZLES
TYPICAL PROCESS WATER COOLING SYSTEM
LEGEND
PWS — POND WATER SUPPLY
PWR — POND WATER RETURN
LCWS — LOW CONDUCTIVITY WATER SUPPLY
LCWR — LOW CONDUCTIVITY WATER RETURN
UD — UNDERDRAIN
W.L. — WATER LEVEL
PROJECT NORTH
SCALE
1"=200'-0"
1/8"=1'-0"
DESIGNED S. KRETULOVICH
DRAWN M. OLSON
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
MECHANICAL CRITERIA - PROCESS SYSTEMS
DRAWING NO. 6-5-1 CDR-22


TYPICAL SERVICE BUILDING
HVAC SYSTEMS:
ELECTRONICS ROOM:
TEMPERATURE: 68°f HEATING
78°f COOLING
VENTILATION: 2 AC/HR MINIMUM
GENERAL AREA:
TEMPERATURE: 68°f HEATING
NO COOLING CONTROL
VENTILATION: 2 AC/HR MINIMUM
FIRE PROTECTION:
DETECTION: VIA SCIENTIFIC EQUIPMENT
TYPICAL ABORT SERVICE BUILDING
HVAC SYSTEMS:
TEMPERATURE: 68°f HEATING
NO COOLING CONTROL
FIRE PROTECTION:
DETECTION: VIA SCIENTIFIC EQUIPMENT
MAIN INJECTOR ENCLOSURE
HVAC SYSTEMS:
TEMPERATURE: 68°f HEATING
NO COOLING CONTROL
HUMIDITY: NORMALLY 60% R.H. MAXIMUM
VENTILATION: 2 AC/HR MINIMUM
FIRE PROTECTION:
DETECTION: VIA SCIENTIFIC EQUIPMENT
N-20 HATCH BUILDING
HVAC SYSTEMS:
ELECTRONICS ROOM:
TEMPERATURE: 68°f HEATING
78°f COOLING
VENTILATION: 2 AC/HR MINIMUM
GENERAL AREA:
TEMPERATURE: 68°f HEATING
NO COOLING CONTROL
VENTILATION: 2 AC/HR MINIMUM
FIRE PROTECTION:
SUPPRESSION: HOSE CABINETS
DETECTION: SMOKE DETECTORS
F-0 SERVICE BUILDING
HVAC SYSTEMS:
TEMPERATURE: 68°f HEATING
78°f COOLING
VENTILATION: 2 AC/HR MINIMUM
FIRE PROTECTION:
SUPPRESSION: HOSE CABINETS
DETECTION: SMOKE DETECTORS
8 GEV NORTH, 8 GEV WEST & 120 GEV ENCLOSURES
HVAC SYSTEMS:
TEMPERATURE: 68°f HEATING
NO COOLING CONTROL
HUMIDITY: NORMALLY 60% R.H. MAXIMUM
VENTILATION: 2 AC/HR MINIMUM
FIRE PROTECTION:
DETECTION:
VIA SCIENTIFIC EQUIPMENT
L-10 SERVICE BUILDING
M-0 SERVICE BUILDING
MAIN INJECTOR COOLING PONDS
K-20 SERVICE BUILDING
MAIN INJECTOR ENCLOSURE
M-30 SERVICE BUILDING
K-10 ABORT SERVICE BUILDING
J-40 ABORT SERVICE BUILDING
J-20 SERVICE BUILDING
H-30 SERVICE BUILDING
H-0 SERVICE BUILDING
G-10 SERVICE BUILDING
F-0 SERVICE BUILDING
F-20 SERVICE BUILDING
N-20 HATCH BUILDING
8 GEV NORTH ENCLOSURE
8 GEV WEST ENCLOSURE
TARGET HALL
120 GEV ENCLOSURE
MAIN RING COOLING PONDS
ANTIPROTON RINGS
BOOSTER RING
WILSON HALL
SERVICE BUILDING
AIR CONDITIONING UNIT
EXHAUST FAN
SUPPLY AIR FAN W/FILTERS
STAIR
MAIN INJECTION ENCLOSURE
SECTION A
SCALE: 1/8" = 1'-0"
SECTION B
SCALE: 1/8" = 1'-0"
LEGEND
SA SUPPLY AIR
EA EXHAUST AIR
OA OUTSIDE AIR
SUPPLY FAN
EXHAUST FAN
SF 4500 SUPPLY FAN / CFM
EF 4300 EXHAUST FAN / CFM
CFM CUBIC FEET/MINUTE
CONTROL RACKS
POWER RACKS
LCW HEAT EXCHANGER
LCW PUMPS
TRANSFORMERS
ELECTRIC UNIT HEATER
TYPICAL SERVICE BUILDING W/ EXHAUST FAN FLOOR PLAN
SCALE: 1/8" = 1'-0"
TYPICAL SERVICE BUILDING W/ SUPPLY FAN FLOOR PLAN
SCALE: 1/8" = 1'-0"
PROJECT NORTH
SCALE
1" = 200'-0"
1/8" = 1'-0"
DESIGNED S. KRSTULOVICH
DRAWN M. OLSON
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
HVAC AND FIRE PROTECTION
DRAWING NO. 6-5-1
CDR-21


TYPICAL SERVICE BUILDING
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER :
NOMINAL 95°f TEMPERATURE
UTILITIES:
NONE REQUIRED
TYPICAL ABORT SERVICE BUILDING
PROCESS SYSTEMS:
NONE REQUIRED
UTILITIES:
NONE REQUIRED
MAIN INJECTOR ENCLOSURE
PROCESS SYSTEMS:
LOW CONDUCTIVITY WATER :
NOMINAL 95°f TEMPERATURE
UTILITIES:
GROUND WATER UNDERDRAIN SYSTEM
N-20 HATCH BUILDING
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER:
NOMINAL 95°f TEMPERATURE
UTILITIES:
INDUSTRIAL COOLING WATER
EXISTING TARGET HALL
PROCESS SYSTEMS:
POND WATER: 1000 GPM
95°f MAX. TEMPERATURE
LOW CONDUCTIVITY WATER:
NOMINAL 95°f TEMPERATURE
UTILITIES:
EXISTING
F-0 SERVICE BUILDING
PROCESS SYSTEMS:
EXTEND EXISTING LOW CONDUCTIVITY
& POND WATER
UTILITIES:
EXTEND EXISTING POND WATER,
CHILLED WATER AND UNDERDRAIN
SYSTEMS
8 GEV NORTH, 8 GEV WEST & 120 GEV ENCLOSURES
PROCESS SYSTEMS:
LOW CONDUCTIVITY WATER : NOMINAL 95°f TEMPERATURE
UTILITIES:
GROUND WATER UNDERDRAIN SYSTEM
L-10 SERVICE BUILDING
M-0 SERVICE BUILDING
K-20 SERVICE BUILDING
K-10 ABORT SERVICE BUILDING
J-40 ABORT SERVICE BUILDING
J-20 SERVICE BUILDING
H-30 SERVICE BUILDING
H-0 SERVICE BUILDING
G-10 SERVICE BUILDING
F-0 SERVICE BUILDING
M-30 SERVICE BUILDING
N-20 HATCH BUILDING
8 GEV WEST ENCLOSURE
8 GEV NORTH ENCLOSURE
120 GEV ENCLOSURE
TARGET HALL
MAIN INJECTOR ENCLOSURE
MAIN INJECTOR COOLING PONDS
MAIN RING COOLING PONDS
24"DIA. GRAVITY OVERFLOW PIPE
24"DIA. OVERFLOW DRAIN PIPE
4"LCWS & LCWR LOOPS IN MAIN INJECTOR ENCLOSURE
INTAKE BOX
DAM
DISCHARGE NOZZLES
PUMP STATION
PUMP STATION 2-PUMPS
ANTIPROTON RINGS
BOOSTER RING
WILSON HALL
LEGEND
PWS — POND WATER SUPPLY
PWR — POND WATER RETURN
LCWS — LOW CONDUCTIVITY WATER SUPPLY
LCWR — LOW CONDUCTIVITY WATER RETURN
UD — UNDERDRAIN
W.L. — WATER LEVEL
ENCLOSURE PLAN
SCALE: 1/8"=1'-0"
BELOW TYPICAL SERVICE BUILDING
BEAM
UNDERDRAIN
SUMP PUMP
PUMP DISCHARGE
LCWS & LCWR LOOPS IN ENCLOSURE
UTILITY ALCOVE
STAIR
LCWS UP
LCWR UP
MAIN INJECTOR ENCLOSURE
TYPICAL SERVICE BUILDING FLOOR PLAN
SCALE: 1/8"=1'-0"
STRAINER
PWS DN.
PWR DN.
LCW HEAT EXCHANGER
LCW PUMPS
CONTROL RACKS
POWER RACKS
TRANSFORMERS
LCWS DN.
LCWR DN.
DUPLEX PUMPS FOR SERVICE BUILDINGS J-20 AND K-20 ONLY
POND OVERFLOW LINE FOR SERVICE BUILDINGS J-20 AND K-20 ONLY
INTAKE BOX
PUMP STATION
DAM
DISCHARGE NOZZLES
MAIN INJECTOR COOLING PONDS
TYPICAL PROCESS WATER COOLING SYSTEM
PROJECT NORTH
SCALE
1"=200'-0"
1/8"=1'-0"
DESIGNED S. KRSTULOVICH
DRAWN M. OLSON
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
MECHANICAL CRITERIA - PROCESS SYSTEMS
DRAWING NO. 6-5-1
CDR-22


SINGLE LINE POWER DIAGRAM
SEE CONVERTER POWER SUPPLY TYPICAL WIRING DIAGRAM AT BELOW LEFT.
FEEDER 21B1
400A.
MANHOLE P-M-0
FEEDER 22B1
MANHOLE P-L-10
200A.-3P
50A.
500KVA
13.8KV-480/277V.
TR.
800A.
800A. 480/277V.
PANELBOARD
MANHOLE P-M-30
MANHOLE P-K-20
MANHOLE P-N-20
ON-OFF SW.
2500A. FRAME
1800A. TRIP
BUILDING N-20
2000A. SWITCHBOARD
1500KVA
13.8KV 600A. PAD MOUNTED
4-WAY AIR SWITCH
(TYPICAL FOR TWO)
FEEDER 21B2
FEEDER 22B2
MANHOLE P-K-0
MANHOLE P-J-20
MANHOLE P-F-1A
MANHOLE P-F-0
MANHOLE P-F-20
MANHOLE P-H-30
MANHOLE P-H-0
MANHOLE P-G-10
TARGET HALL
BUILDING AP-0
2000A. SWITCHBOARD
2500A. FRAME
1800A. TRIP
1500KVA
13.8KV-480/277V.
TR.
80A.
ON-OFF SW.
13.8KV 600A. PAD MOUNTED
4-WAY AIR SWITCH
(TYPICAL FOR THREE)
15KV SWITCH
FEEDER 46
FEEDER 21B1
FEEDER 21B2
FEEDER 22B1
FEEDER 22B2
EXISTING FEEDER 45
SEE BELOW LEFT FOR CONTINUATION
EXISTING MANHOLE F-1
EXISTING MANHOLE F-2
EXISTING MANHOLE F-27
EXISTING FEEDER 45
EXISTING POWER SUPPLY AT F-1.
DISCONNECT SWITCH
VACUUM BREAKER
2-1400KVA
13.8KV-350/202V.
TR.
S.C.R. BANK
500V. D.C.
TO MAGNETS IN MAIN ACCELERATOR ENCLOSURE
CONVERTER POWER SUPPLY
(TYPICAL WIRING DIAGRAM)
IN-LINE SPLICE
EXISTING FEEDER 46
EXISTING MANHOLE P-7
EXISTING FEEDER 21B2
EXISTING FEEDER 22B1
EXISTING FEEDER 21B1
EXISTING FEEDER 22B2
EXISTING MANHOLE P-71
EXISTING MANHOLE P-71C
13.8KV 600A. PAD MOUNTED
4-WAY AIR SWITCH
FILTER
WYE SPLICE (TYPICAL)
SEE ABOVE RIGHT FOR CONTINUATION
EXISTING MANHOLE F-3
EXISTING MANHOLE F-4
EXISTING MANHOLE A-0
EXISTING MANHOLE A-1
EXISTING MANHOLE A-2
EXISTING MANHOLE A-3
EXISTING MANHOLE P-71S
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED J.RYK/E.VALDES
DRAWN A.R.FLOWERS
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
SINGLE LINE POWER DIAGRAM
DRAWING NO. 6-5-1
CDR-23
REV.



LIGHTING LEVELS

GENERAL LIGHTING NORMAL CONDITIONS

OFFICES	75 FOOTCANDLES
TECH. AREAS	75 FOOTCANDLES
EQUIPMENT AREAS	75 FOOTCANDLES
STAIRS AND HALLWAYS	20 FOOTCANDLES
TOILET ROOMS	30 FOOTCANDLES
CONTROL ROOM	100 FOOTCANDLES WITH DIMMER
PARKING AREAS	2 FOOTCANDLES

EMERGENCY LIGHTING

ALL INTERIOR SPACES LISTED ABOVE	5 FOOTCANDLES

LIGHTING LEVELS GIVEN AT THREE FEET ABOVE THE FLOOR.

REV.	DATE	DESCRIPTIONS
		REVISIONS

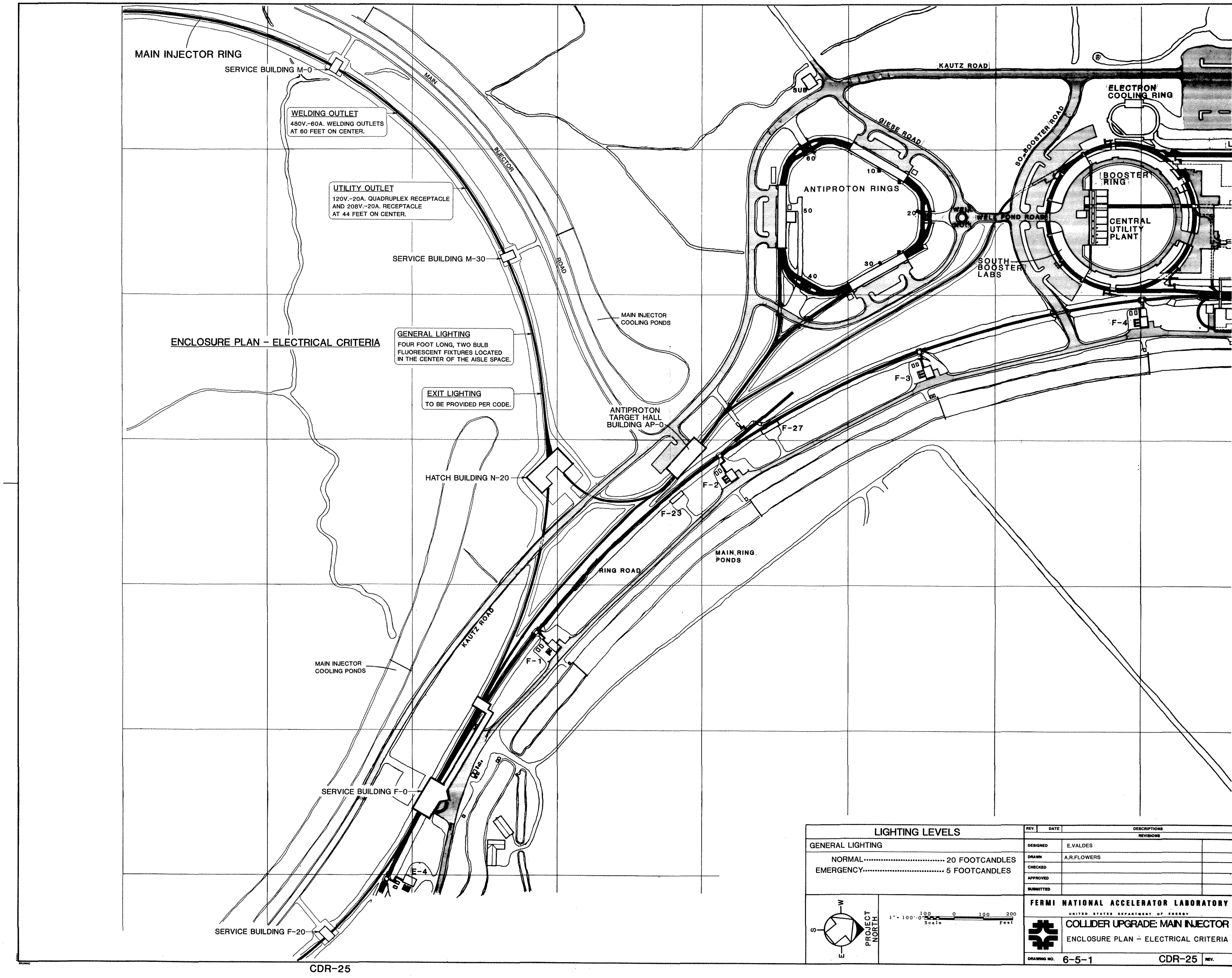
DESIGNED	E.VALDES
DRAWN	A.R.FLOWERS
CHECKED	
APPROVED	
SUBMITTED	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

COLLIDER UPGRADE: MAIN INJECTOR

SITE PLAN - ELECTRICAL CRITERIA

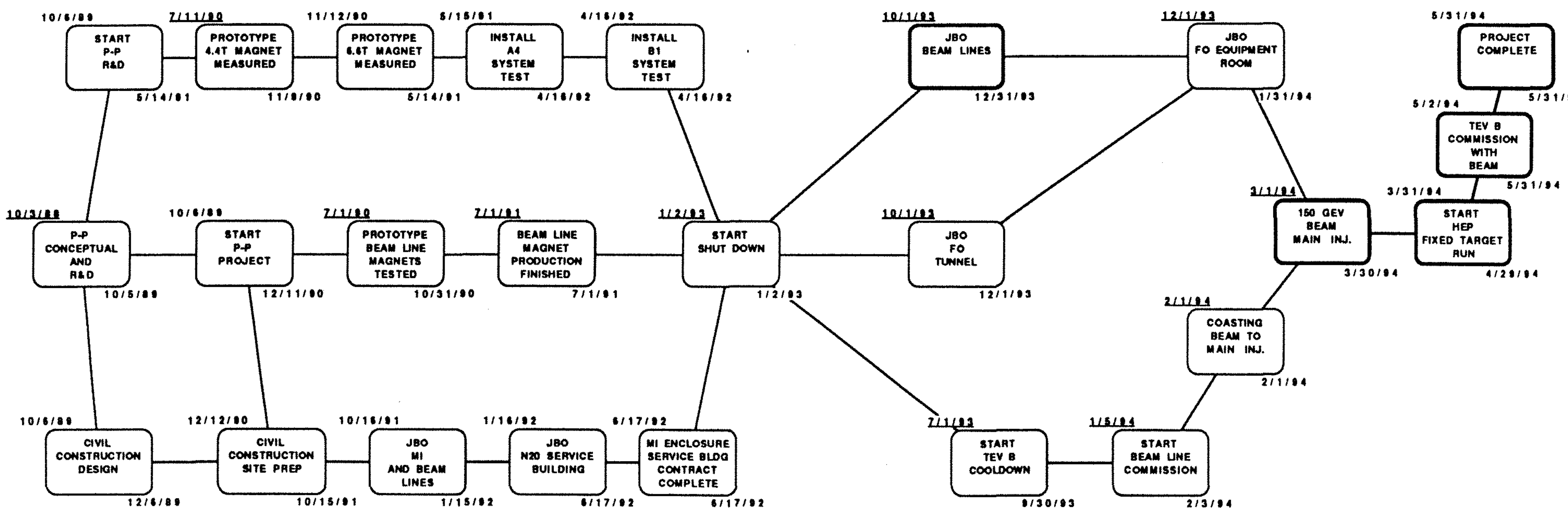
DRAWING NO. 6-5-1 CDR-24 REV.

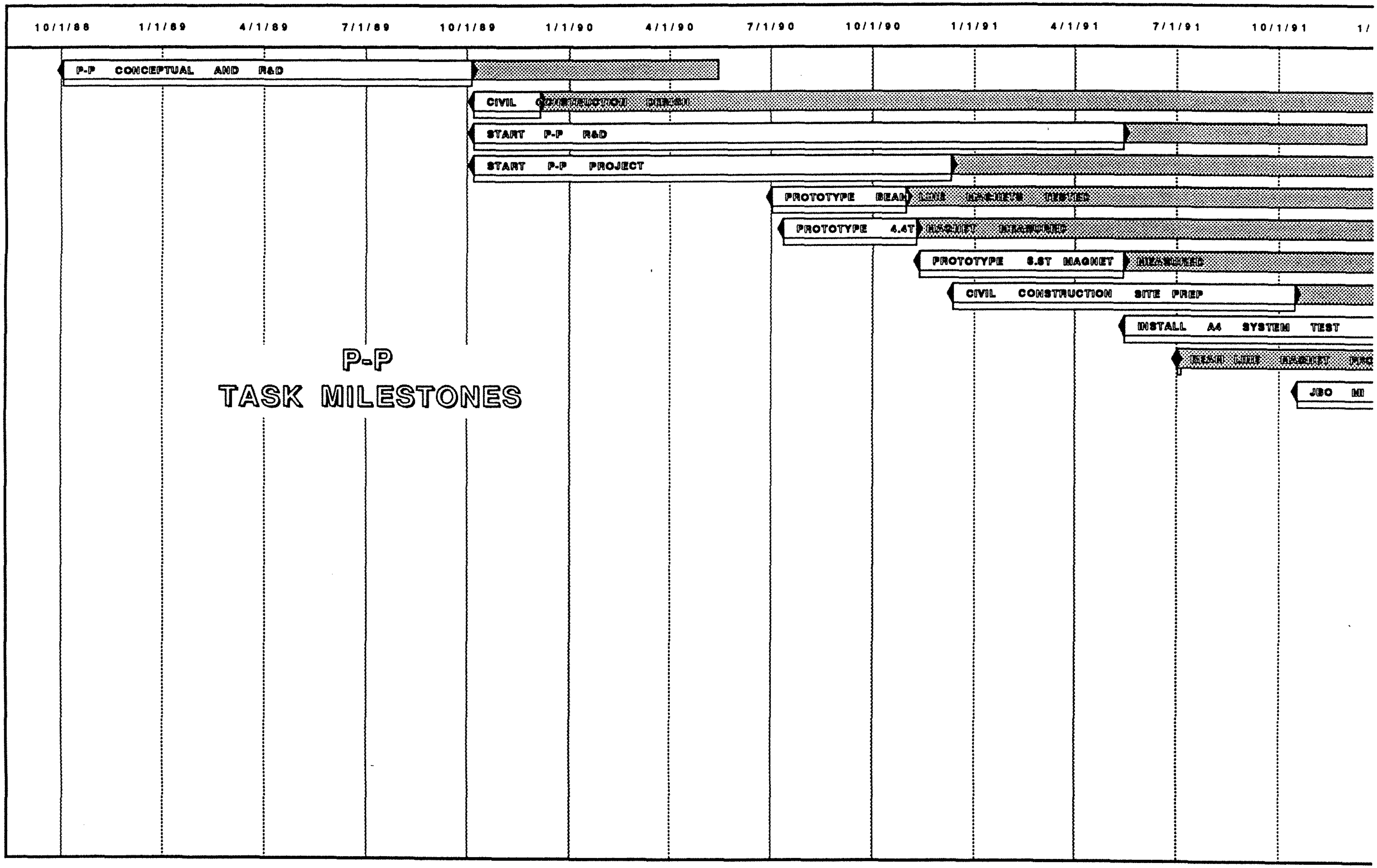

MAIN INJECTOR RING
SERVICE BUILDING M-0
WELDING OUTLET
480V.-60A. WELDING OUTLETS AT 60 FEET ON CENTER.
UTILITY OUTLET
120V.-20A. QUADRUPLEX RECEPTACLE AND 208V.-20A. RECEPTACLE AT 44 FEET ON CENTER.
SERVICE BUILDING M-30
ENCLOSURE PLAN - ELECTRICAL CRITERIA
GENERAL LIGHTING
FOUR FOOT LONG, TWO BULB FLUORESCENT FIXTURES LOCATED IN THE CENTER OF THE AISLE SPACE.
EXIT LIGHTING
TO BE PROVIDED PER CODE.
MAIN INJECTOR ROAD
MAIN INJECTOR COOLING PONDS
ANTIPROTON TARGET HALL BUILDING AP-0
HATCH BUILDING N-20
KAUTZ ROAD
SUB
GIESE ROAD
ANTIPROTON RINGS
60
10
50
20
30
40
WELL POND ROAD
SO. BOOSTER ROAD
ELECTRON COOLING RING
BOOSTER RING
CENTRAL UTILITY PLANT
SOUTH BOOSTER LABS
F-4
F-3
F-27
F-2
F-23
MAIN RING PONDS
RING ROAD
KAUTZ ROAD
F-1
MAIN INJECTOR COOLING PONDS
SERVICE BUILDING F-0
E-4
SERVICE BUILDING F-20
LIGHTING LEVELS
GENERAL LIGHTING
NORMAL.................................20 FOOTCANDLES
EMERGENCY...............................5 FOOTCANDLES
PROJECT NORTH
W
S
E
1" = 100'-0"
100 0 100 200
Scale Feet
REV. DATE DESCRIPTIONS
REVISIONS
DESIGNED E.VALDES
DRAWN A.R.FLOWERS
CHECKED
APPROVED
SUBMITTED
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
COLLIDER UPGRADE: MAIN INJECTOR
ENCLOSURE PLAN - ELECTRICAL CRITERIA
DRAWING NO. 6-5-1
CDR-25
REV.

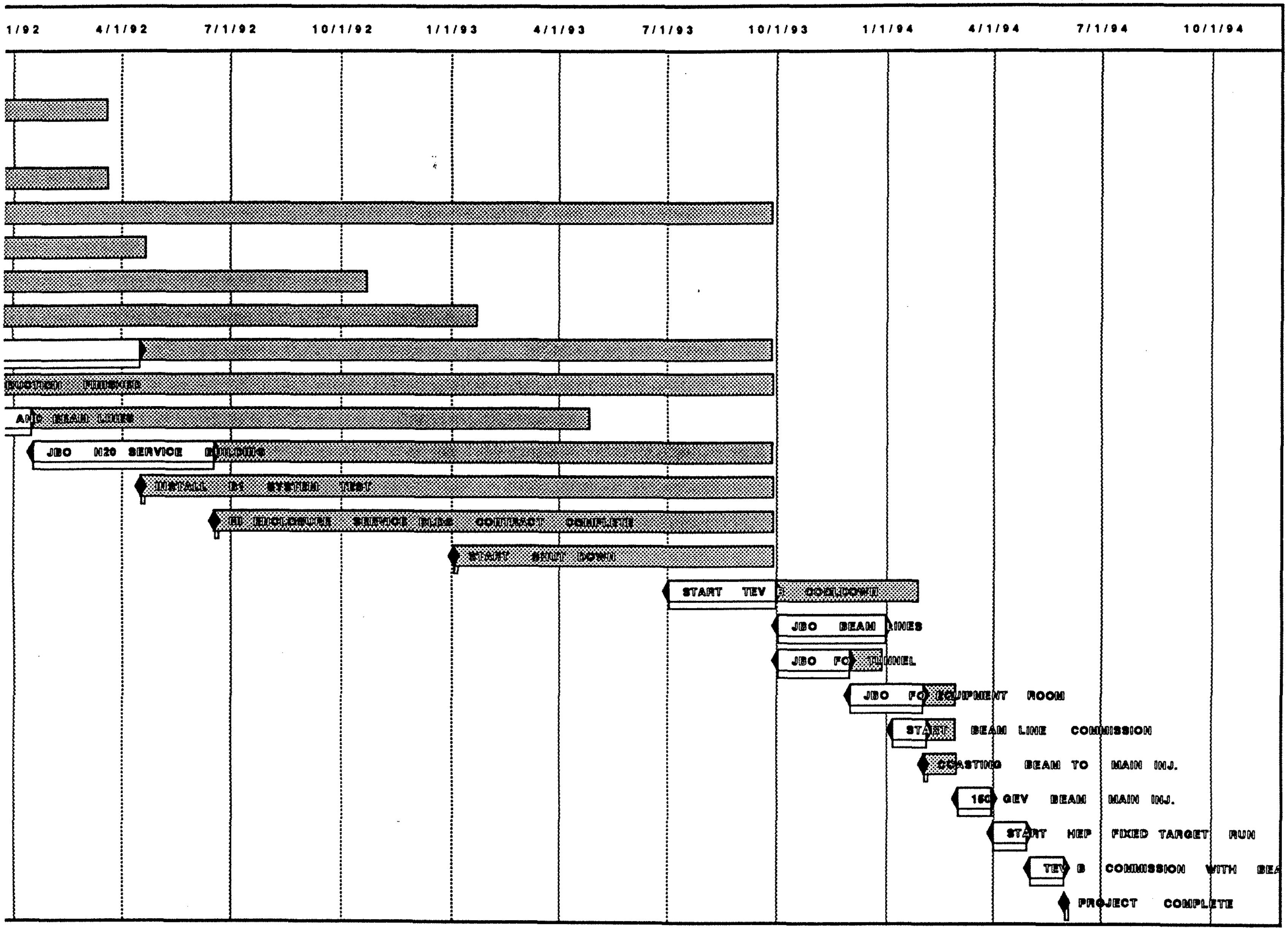
APPENDIX E

Schedule Charts

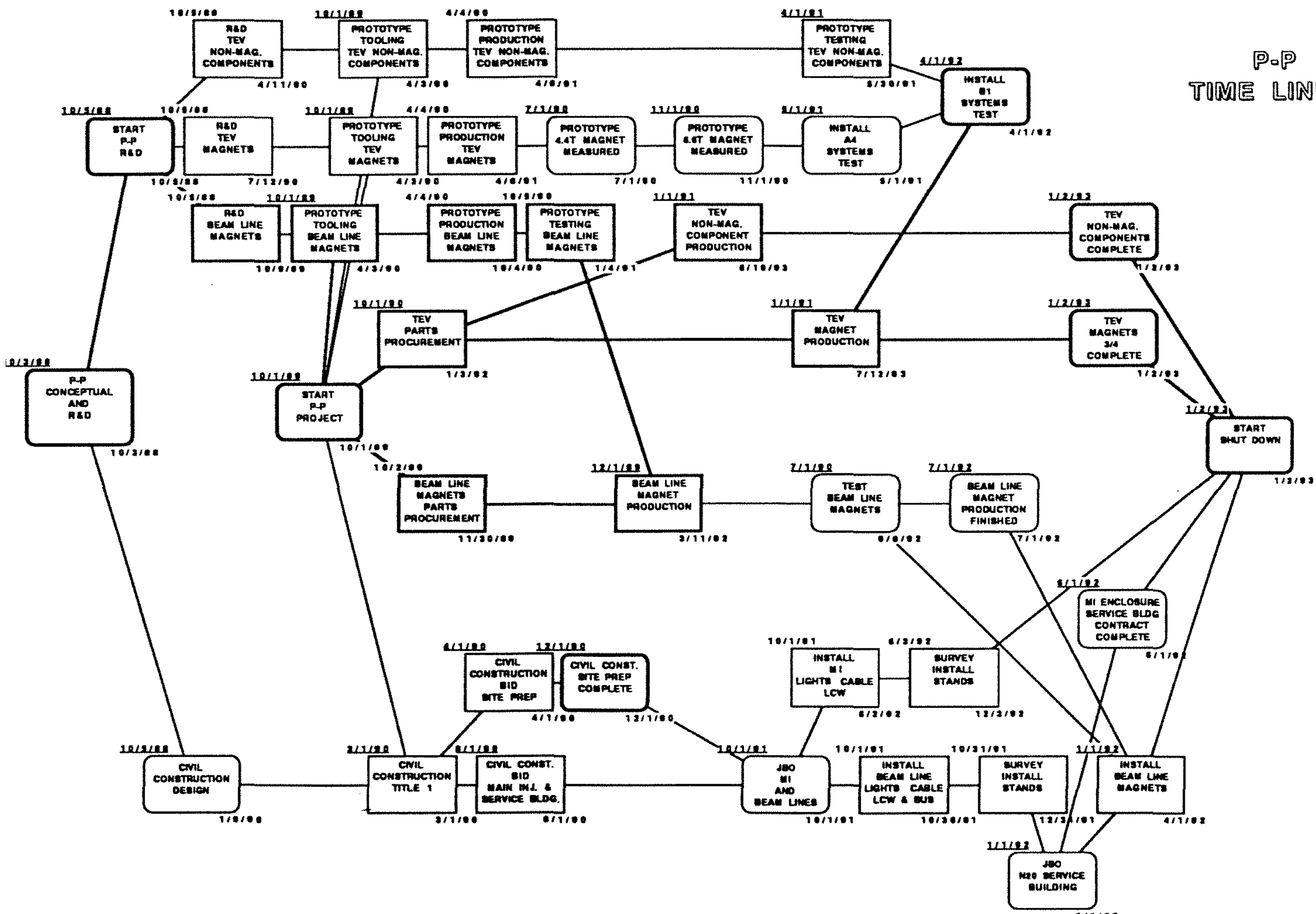
P-P
MILESTONE TIMELINE




P-P
TASK MILESTONES
10/1/88
1/1/89
4/1/89
7/1/89
10/1/89
1/1/90
4/1/90
7/1/90
10/1/90
1/1/91
4/1/91
7/1/91
10/1/91
P-P CONCEPTUAL AND R&D
CIVIL
START P-P R&D
START P-P PROJECT
PROTOTYPE BEAM
PROTOTYPE 4.4T
PROTOTYPE 6.6T MAGNET
CIVIL CONSTRUCTION SITE PREP
INSTALL A4 SYSTEM TEST
JBO MI

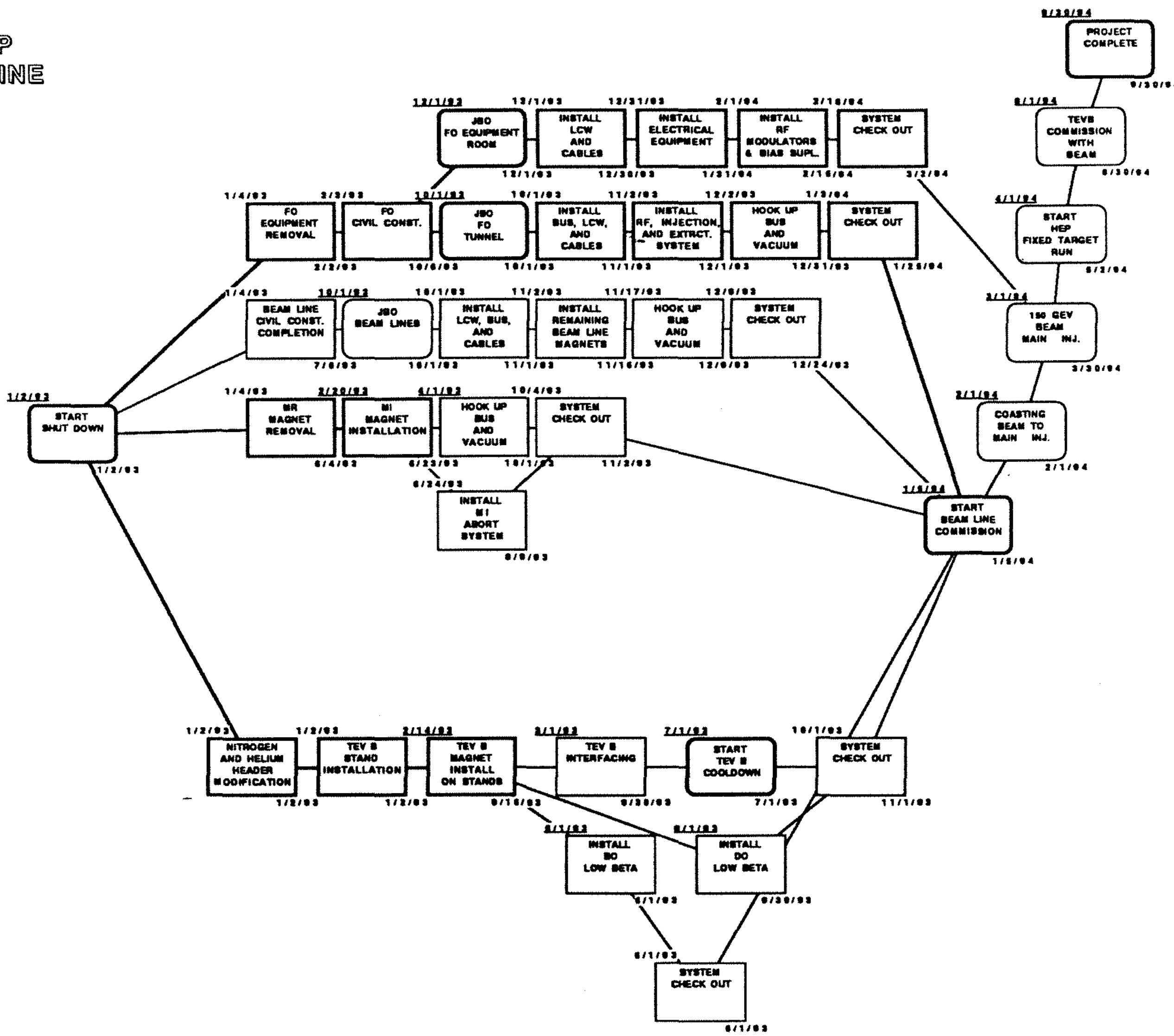

1/92
4/1/92
7/1/92
10/1/92
1/1/93
4/1/93
7/1/93
10/1/93
1/1/94
4/1/94
7/1/94
10/1/94
JBO H20 SERVICE
INSTALL B1 SYSTEM TEST
START SHUT DOWN
START TEV
COOLDOWN
JBO BEAM
LINES
JBO
TUNNEL
JBO
EQUIPMENT ROOM
BEAM LINE COMMISSION
COASTING BEAM TO MAIN INJ.
GEV BEAM MAIN INJ.
START HEP FIXED TARGET RUN
B COMMISSION WITH
PROJECT COMPLETE

P-P TIME LINE



P-P CONCEPTUAL AND R&D
START P-P R&D
R&D TEV NON-MAG. COMPONENTS
PROTOTYPE TOOLING TEV NON-MAG. COMPONENTS
PROTOTYPE PRODUCTION TEV NON-MAG. COMPONENTS
PROTOTYPE TESTING TEV NON-MAG. COMPONENTS
INSTALL B1 SYSTEMS TEST
R&D TEV MAGNETS
PROTOTYPE TOOLING TEV MAGNETS
PROTOTYPE PRODUCTION TEV MAGNETS
PROTOTYPE 4.4T MAGNET MEASURED
PROTOTYPE 6.6T MAGNET MEASURED
INSTALL A4 SYSTEMS TEST
R&D BEAM LINE MAGNETS
PROTOTYPE TOOLING BEAM LINE MAGNETS
PROTOTYPE PRODUCTION BEAM LINE MAGNETS
PROTOTYPE TESTING BEAM LINE MAGNETS
TEV NON-MAG. COMPONENT PRODUCTION
TEV NON-MAG. COMPONENTS COMPLETE
TEV PARTS PROCUREMENT
TEV MAGNET PRODUCTION
TEV MAGNETS 3/4 COMPLETE
START P-P PROJECT
START SHUT DOWN
BEAM LINE MAGNETS PARTS PROCUREMENT
BEAM LINE MAGNET PRODUCTION
TEST BEAM LINE MAGNETS
BEAM LINE MAGNET PRODUCTION FINISHED
MI ENCLOSURE SERVICE BLDG CONTRACT COMPLETE
CIVIL CONSTRUCTION BID SITE PREP
CIVIL CONST. SITE PREP COMPLETE
INSTALL MI LIGHTS CABLE LCW
SURVEY INSTALL STANDS
CIVIL CONSTRUCTION DESIGN
CIVIL CONSTRUCTION TITLE 1
CIVIL CONST. BID MAIN INJ. & SERVICE BLDG.
JBO MI AND BEAM LINES
INSTALL BEAM LINE LIGHTS CABLE LCW & BUS
SURVEY INSTALL STANDS
INSTALL BEAM LINE MAGNETS
JBO N20 SERVICE BUILDING

P-P
TIME LINE

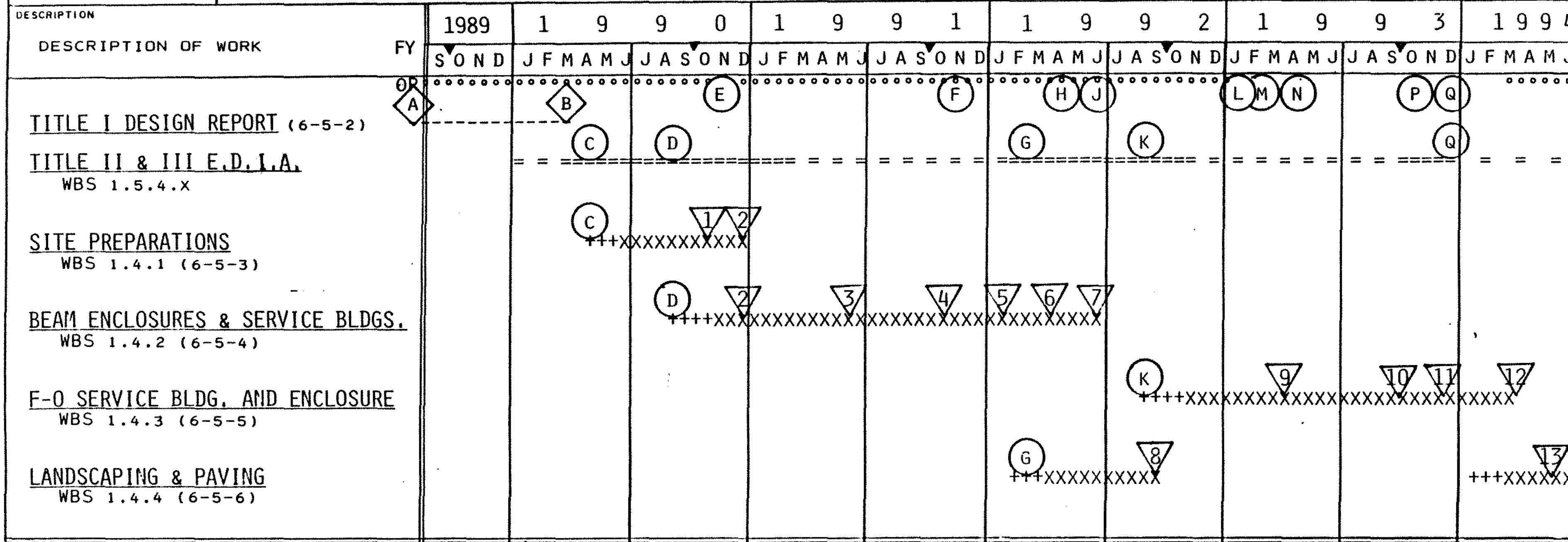


START SHUT DOWN
1/2/93
FO EQUIPMENT REMOVAL
FO CIVIL CONST.
JBO FO TUNNEL
INSTALL BUS, LCW, AND CABLES
INSTALL RF, INJECTION, AND EXTRCT. SYSTEM
HOOK UP BUS AND VACUUM
SYSTEM CHECK OUT
JBO FO EQUIPMENT ROOM
INSTALL LCW AND CABLES
INSTALL ELECTRICAL EQUIPMENT
INSTALL RF MODULATORS & BIAS SUPL.
SYSTEM CHECK OUT
BEAM LINE CIVIL CONST. COMPLETION
JBO BEAM LINES
INSTALL LCW, BUS, AND CABLES
INSTALL REMAINING BEAM LINE MAGNETS
HOOK UP BUS AND VACUUM
SYSTEM CHECK OUT
MR MAGNET REMOVAL
MI MAGNET INSTALLATION
HOOK UP BUS AND VACUUM
SYSTEM CHECK OUT
INSTALL MI ABORT SYSTEM
START BEAM LINE COMMISSION
1/5/94
COASTING BEAM TO MAIN INJ.
150 GEV BEAM MAIN INJ.
START HEP FIXED TARGET RUN
TEVB COMMISSION WITH BEAM
PROJECT COMPLETE
9/30/94
NITROGEN AND HELIUM HEADER MODIFICATION
TEV B STAND INSTALLATION
TEV B MAGNET INSTALL ON STANDS
TEV B INTERFACING
START TEV B COOLDOWN
SYSTEM CHECK OUT
INSTALL BO LOW BETA
INSTALL DO LOW BETA
SYSTEM CHECK OUT

FERMILAB SCHEDULE

PROJECT TITLE: COLLIDER UPGRADE - MAIN INJECTOR
OVERVIEW CONSTRUCTION SCHEDULE

NO. 6-5-1 | DATE MAY 1988 | REVISION DATE | PAGE 1/1



D.O.E. & FERMILAB MILESTONES

- (A) Sept 1989 — A-E firm selected & contract awarded; ready to start
- (B) Mar. 1990 — Title I Design Report reviewed and approved by D.O.E.
- (C) Apr. 1990 — Release Bid Package for Main Injector Site Preparations
- (D) Aug. 1990 — Release Bid Package for Main Injector Beam Enclosures and Service Buildings
- (E) Nov. 1990 — Accelerator Off 4 weeks maint. Equipment removed from PreTarget Enclosure
- (F) Nov. 1991 — Start Installation of Beam Transfer Enclosure Services and Stands
- (G) Feb. 1992 — Release Bid Package for Landscaping and Paving
- (H) Apr. 1992 — Start Installation of Main Injector Enclosure Services and Stands
- (J) June 1992 — Start Installation of Main Injector Equipment in Service Buildings
- (K) Aug. 1992 — Release Bid Package for F-0 Service Building & Main Injector Enclosure
- (L) Jan. 1993 — ACCELERATOR OPERATION OFF
- (M) Feb. 1993 — Tevatron Warmed Up. Accelerator Equipment Removed at F-28/32, B-45 and Booster Extension.
- (N) Apr. 1993 — Start Installation of Services in B-45 Abort Area and Booster Enclosure
- (P) Oct. 1993 — Start Installation of Main Injector/Tevatron Services in F-0 Enclosure
- (Q) Dec. 1993 — Start Installation of Main Injector/Tevatron Equipment in F-0 Service Building

CONSTRUCTION CONTRACT MILESTONES

- (1) Oct. 1990 — Beneficial Occupancy of Main Injector Road
- (2) Dec. 1990 — F-19/21 Retention Wall Installed and PreTarget Hall Demolished. Site Preparations Subcontract Complete
- (3) June 1991 — Main Injector Excavation and Concrete Base Slab Complete
- (4) Oct. 1991 — Beneficial Occupancy of Beam Enclosure 8 GeV N,8 GeV W and 120 GeV
- (5) Jan. 1992 — Benefical Occupancy of Main Injector Enclosure, N-20 Service Building and Access Hatches
- (6) Apr. 1992 — Beneficial Occupancy of Main Injector Service Buildings
- (7) June 1992 — Beam Enclosures and Service Buildings Subcontract Complete
- (8) Sep. 1992 — Landscaping and Paving Subcontract Complete
- (9) Apr. 1993 — F-0 Retention Wall Installed and F-0 Service Bldg Add. and F-0 Enclosure Demolished
- (10) Oct. 1993 — Beneficial Occupancy of F-0 Enclosure with Elevator and Relocated Kautz Road
- (11) Dec. 1993 — Beneficial Occupancy of F-0 Service Building Addition
- (12) Mar. 1994 — F-0 Service Building and Injector Enclosure Subcontract Complete
- (13) June 1994 — F-0 Landscaping & Paving Subcontract Complete

LEGEND: 0000 OPERATIONS TIME; ---- CONCEPTUAL DESIGN; ==== FINAL DESIGN; ++++ BID TIME; XXXX CONSTRUCTION TIME; %%%% PROCUREMENT TIME; IIII INSTALLATION TIME; ▽ MILESTONE NUMBER

APPENDIX F

Supplementary Project Data for Strategic Facilities

TITLE AND LOCATION OF PROJECT:

PROTON-PROTON COLLIDER UPGRADE:
NEW MAIN INJECTOR, TEVATRON B
FERMI NATIONAL ACCELERATOR LABORATORY

Project No: BAKALID
90-CH-400
Line Item

Supplementary Project Data for Strategic Facilities

Site Wide Requirements/Assets fo CATEGORY: 70, Research and Development

Other Projects Affecting this Category: BAKALIC 90-CH-0400; FOOTPRINT GALLERY UPGRADE

Unit of Measure: Square Foot

	CURRENT	THIS PROJECT	RESULT
A. Total Existing Assets (in this category)	222,400	27,100	249,500
	-	-	-
B. less: Substandard assets (in this category)	0	0	0
	=	=	=
C. Amount Adequate: (in this category)	222,400	27,100	249,500
	-		-
D. less: Amount Required: (in this category)	285,900	XXXXXX	285,900
	=	+	=
E. Excess/(Deficiency) of Adequate Assets	(63,500)	27,100	(36,400)
			=
F. Excess/(Deficiency) of Total Assets (A-D)	(63,500)	27,100	(36,400)