Fermilab

TM-1212
0102.000
March 27, 1983

TUNNEL CONSTRUCTION FOR A DESERTRON

H. Hinterberger and F. R. Huson

The tunnel in this model of construction is 3½ feet wide by 5 feet high (see Figure 1). It is assumed that the tunnel contains a rail system and guidance system for:

1. An enclosed car used for transport of 2 people and some tools. The people could sit in comfortable seats and travel at perhaps 25 miles per hour (this would be similar to the London tube but much smaller). The car would be equipped with oxygen in case of helium in the tunnel. There would be bypasses at the service buildings for passing and storage of cars. A computer system would control the cars. There may be as many as 50 cars.

2. Magnet mover. This "robot" could pick up a magnet and transport it at about 10 miles per hour. Each of six machine straight sections would have openings for insertion and extraction of magnets. The openings would be covered by moveable shielding. The magnet mover would look something like a long centipede and be controlled by the computer system.

3. Alignment Robot. The alignment robot would intercept E.M. waves (microwaves, lasers, (see alignment paper) to determine its position in the tunnel (the sagitta over 150 m is only 15 cm). A very accurate on-board digital level can give level to less than a milli-radian. The robot would have an arm to grab the outside of

the magnet, it would know the relative position of the magnet and the E.M. wave. It would have another arm to loosen (or tighten) the one bolt that holds the magnet in place. These bolts would hold the steel support on the magnet to the support on the tunnel floor. These supports are located about every 10 feet. It could position the magnet and tighten the bolt. This robot would have to be quite heavy ($\sim$ 10 tons) for stability. There could be 2 dozen of these robots working at all times. Their on-board computer would be connected to a central computer for coordinated alignment.

METHOD OF CONSTRUCTION

We assume the site is relatively flat (see below) and made up of reasonable earth (easy digging). We also assume the right-of-way of about 300 feet is free (given by the State?).

The first step would be to establish a level (to within a few inches) terrain at least 20 feet wide around the whole accelerator. Fills would be 300 feet wide to the outside for muon shielding. A blacktop roadway would be constructed near the tunnel area. It would more or less follow the terrain. Backhoes would be used to trench 20 feet deep. The trench bottom would ~~lead~~ be level to within a few inches. Following this would be a rigging crew to place a reinforcement wire mesh in the tunnel. Then concrete would be poured into the bottom of the trench. A machine similar to a sophisticated snowmobile, that could be controlled remotely, would vibrate and level the concrete to better than 1 inch. Corrugated galvanized metal tunnel hoops (see Figure 1) would be set in place.

Then workers could come along inside the tunnel hoop and "nail" it together and to the floor. The trench would then be back-filled with a 1 foot berm on top. A rail system would be installed and a support stand for the magnet.

Cost estimate for Tunnel.

Site preparation

Cut on average 15' deep with 20' bottom for .6 miles and ~~average~~ fill 3' deep and 300' wide to the outside for .4 miles	$ 157K/mi
24 foot wide blacktop road $60/ft	$ 300K/mi
Surveying, special cases, etc.	$ 43K/mi
	$ 500K/mi

Tunnel.

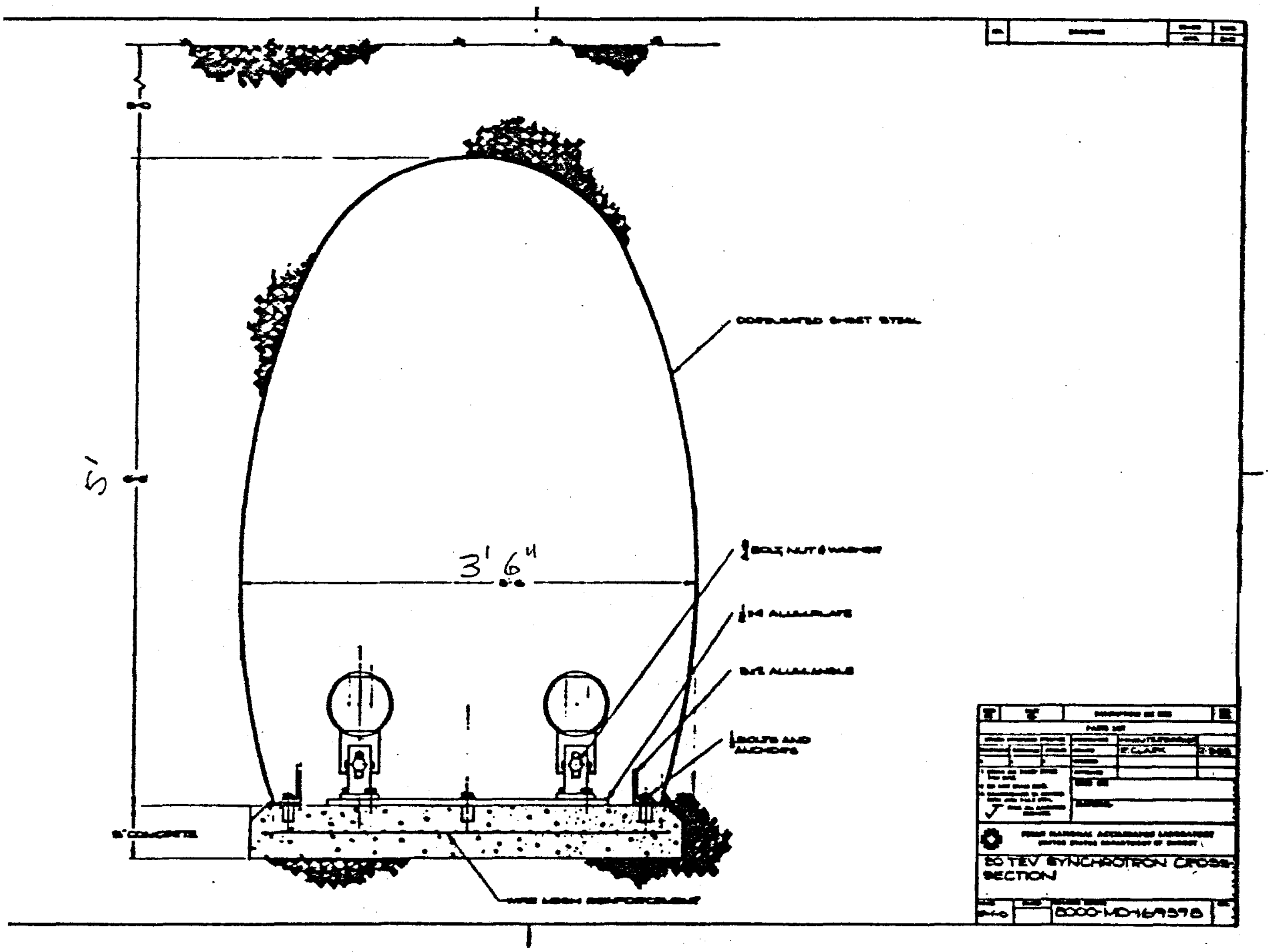
Backhoe trenching of 8' wide x 20' deep. (31 K yds / mile x $120/hr)/(60 yds/hr)	$ 62K/mi
Surveying, helpers etc.	15K/mi
Rigging crew for wire grid 5K/wk	5K/mi
Machines for crew 5K/wk	5K/mi
Concrete bottom $10/ft.	50K/mi
Leveling of concrete. 1 machine/10 miles at $200K	20K/mi
Corrugated tunnel at $24/ft.	127K/mi
Sealing materials $10/ft	50K/mi
2 Rigging crews to place tunnel + machines.	20K/mi
Backfill	60K/mi
Special problems.	40K/mi
Contingency	200K/mi

Service buildings and Straight sections

80 service buildings @ $100K	$ 8.0 M
6 straight sections (500 m) @ $5K/m.	$ 15.0 M
	$ 23.0 M

Complete tunnel and machine straigh[t] for R = 20 Km.

Site preparation	$ 39.0 M
Tunnel	$ 51.0 M
Service buildings & Straights	$ 23.0 M
	$ 113.0 M


5'
3' 6"
20 TEV SYNCHROTRON CROSS-SECTION
8000-MD-169378

100 MILE RING CUT & FILL

J.G., 3-8-8

USE $1.65/C.Y. FOR CUT & FILL COST
plus $.50/c.y. for compacting.

USE COMBINATION (1) & (2A)

58.7 MILES OF (1) CUT WILL FILL 41.3 MILES OF (2A)

15' DP. x 42.5' WIDE x 58.7 MILES (309936') = 7,318,000 C.Y.

7,318,000 C.Y. CUT @ $1.65 = $12,075,000

FOR TOTAL CUT OF 58.7 MILES & FILL OF 41.3 M

7,318,000 @ 2.15 = $15,733,700.

∴ $157,337/mile

USE COMBINATION (1) & (2B)

15' DP. x 42.5' WIDE x 50 MILES (264,000') = 6,234,000 C.Y.

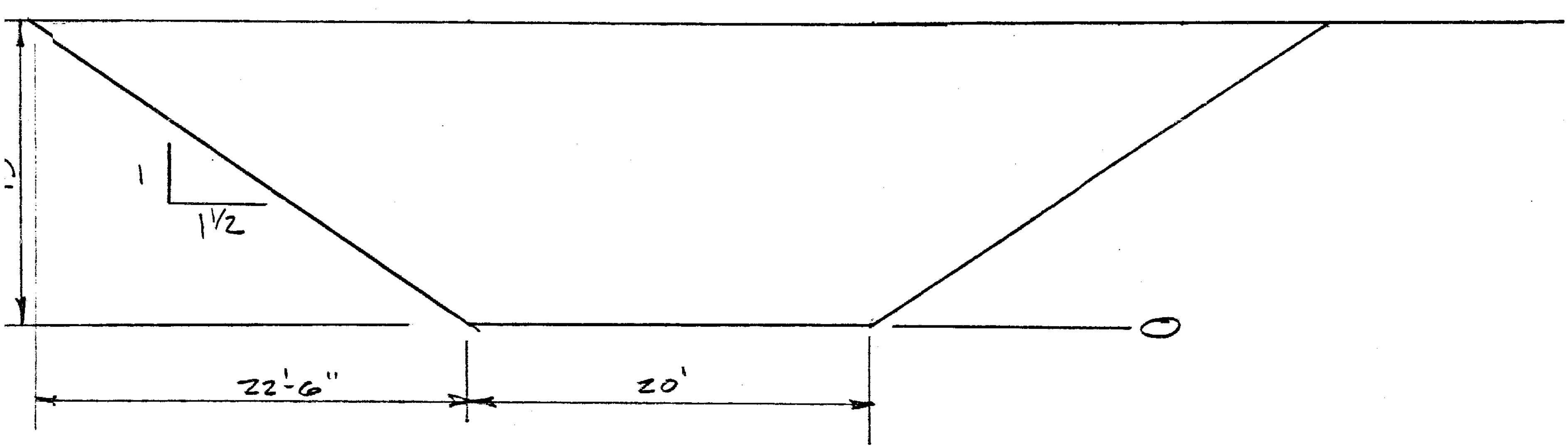
6,234,000 C.Y. @ $1.65 = $10,286,00

FOR TOTAL CUT OF 50 MILES & FILL OF 50 MILES

3/10 Joe – Compaction, add $.50/yd.

6,234,000 @ 2.15 = $13,403,100

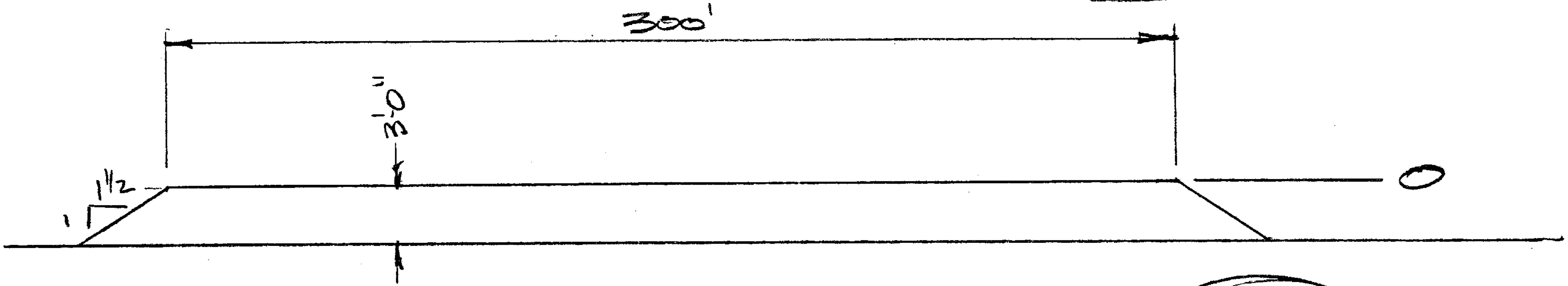
15' DP. X 42.6 X 1-MILE (5280') = 125 000 C.Y. CUT



(1)

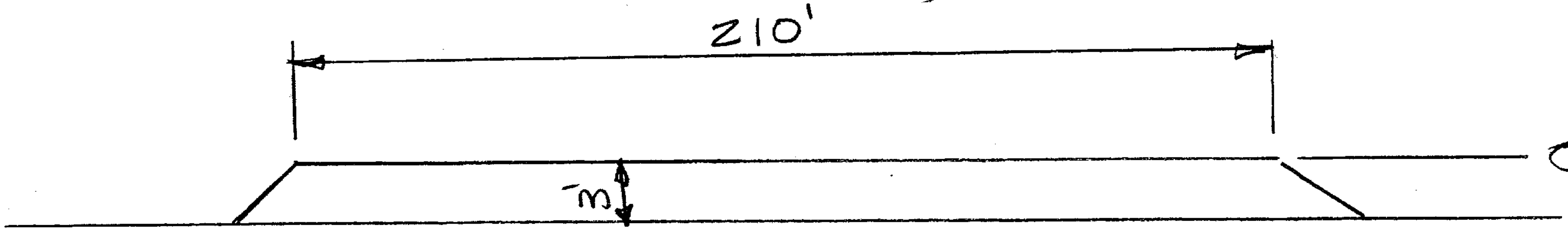
3' DP. X 304 X 1-MILE (5280') = 178 000 C.Y. FILL

3' DP. X 304 X 3700' = 125000 C.Y. FILL



2A

3' DP. X 214' X 1-MILE (5280') = 125,000 C.Y. FILL



2B