SSCL-N-689

Superconducting Super Collider Laboratory
2550 Beckleymeade, Building 4
Dallas, Texas 75237-3946

Conventional Construction Division

MEMORANDUM

TO: Distribution

FROM: Tracy Lundin TKL

DATE: January 8, 1990

SUBJECT: Underground Enclosures

Attached is a summary of underground enclosures used for establishing excavation quantities for the recommended design of the project. Note that only the collider and HEB have been studied in sufficient detail to allow for refinement of excavation quantities. Excavation quantities have been included for other components of the machine.

cs

Attachment

Distribution:

Summary Only

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Summary and Calculations

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CCD File
SSC Notes SSCL-N-689

SUMMARY OF UNDERGROUND ENCLOSURES

USED AS THE BASIS FOR QUANTITY CALCULATIONS FOR THE SSC - RECOMMENDED DESIGN. SEE ATTACHED SHEETS FOR SKETCHES OF SOME OF THE MAJOR COMPONENTS FOR THE HEB AND THE COLLIDER RING. THE MEB, LEB, AND LINAC FACILITIES ARE NOT ADDRESSED HEREIN.

SHAFTS

HEB

3 - 3'ϕ Shafts at H1, H3, & H5
3 - 8'ϕ Shafts at H2, H6, & H8 with ladders
2 - 30'ϕ Shafts at H4 & H7 with elevators and stairs
1 - 16'ϕ Shaft at HEB Kicker Enclosure with Elevator and ladder

COLLIDER

10 - 30'ϕ Shafts at E Sites with elevators and stairs
8 - 8'ϕ Shafts at F Sites with ladders
2 - 30'ϕ Shafts at RF Locations with elevators and stairs

TUNNEL ENLARGEMENTS

HEB

16 - Electrical Niches ; 10' x 10'ϕ
8 - Cryogenic Alcoves ; 20' x 20' x 10'
1 - Starter Tunnel at H4
6 - Shaft Connections at H1, H2, H3, H5, H6 & H8
1 - Cryogenic Bypass at H3
1 - Cryogenic Bypass / Transfer to Collider at H-7
2 - 12'ϕ Beam Aborts
2 - Kicker Enclosure Galleries
1 - Klystron Gallery
1 - RF Cavity
2 - Transfer Lines to Collider Ring
1 - Test-Beam

COLLIDER RING

80 - Electrical Niches ; 230 ft² x 12'
60 - Electrical Niches ; 300 ft² x 12'
18 - Cryogenic Alcoves ; 400 ft² x 12'
18 - Starter Tunnel Connections
2 - 12'ϕ Beam Aborts
2 - Klystron Galleries
2 - Kicker Enclosures
2 - RF Cavities
1 - Cryogenic Bypass / Transfer Area from HEB

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HEB/Collider Ring Connection

Excavated Volume Summary

Collider Ring

• Klystron Gallery	(2 x 3,030)	= 6,060 yd³	in Shale
• Kicker Enclosure	(2 x 1,110)	= 2,220 yd³	in Shale
• RF Enlargement w/o Tunnel Volume	(2 x 980)	= 1,960 yd³	in Shale
• Corridors	(2 x 1,500 yd³)	= 3,000 yd³	in Shale
• 30"ϕ Horz. Connections	(4 x 30')	= 120 LF	in Shale
• 12"ϕ Horz. Connections	(5 x 30')	= 150 LF	in Shale
• Collider Abort Intersection	(2 x 6800 yd³)	= 13,600 yd³	in Shale
Already in estimate { • Backstop Transfer Line	(2 x 24,420)	= 48,840 yd³	in Shale
Already in estimate { • Backstop	(2 x 1,160)	= 2,320 yd³	in Shale

Total = 26,840 yd³ w/o Backstop & Backstop Transfer

HEB

• Kicker Enclosure	= 3,440 yd³	in Chalk
• Kicker Corridor	= 200 yd³	in Chalk
• HEB/RF Kicker Enclosure	= 3,440 yd³	in Chalk
• HEB Klystron Area	= 3,030 yd³	in Chalk
• RF Enlargement w/o Tunnel Volume	= 1,100 yd³	in Chalk
• Corridor @ RF	= 2,130 yd³	in Chalk
• 12"ϕ Horz Connections	(10 x 30' + 4 x 52') = 508 LF	in Chalk
• 30"ϕ Horz. Connections	(4 x 30') = 120 LF	in Chalk
• Test Beam Intersection	= 4,710 yd³	in Chalk

Total = 18,050 yd³

Transfer Area

• Lower End Of Transfer	(2 x 2,890)	= 5,780 yd³	in Shale
• Upper End Of Transfer	(2 x 2,650)	= 5,300 yd³	in Chalk
• Transfer Line	(2 x 780)	= 1,560 yd³	in Shale

Total = 12,640 yd³

Overall Total = 57,530 yd³ { 29,130 in Chalk; 28,400 in Shale }

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Collider Ring

Klystron Gallery - in shale
See Sketch On Page 6 Of 8 For Dimensional Plan & Profile.

$$\text{Volume} = \frac{1}{27}(150ft)(26ft)(21ft) = \underline{\underline{3{,}030}}\,yd^3$$

Injection Kicker Power Supply Enclosure - in shale

$$\text{Volume} = \frac{1}{27}(20ft)(15ft)(100ft) = \underline{\underline{1{,}110}}\,yd^3$$

Corridors - in shale

$$\text{Volume} = \frac{1}{27}(13')(13')(240\,LF) = \underline{\underline{1{,}500}}\,yd^3$$

Miscellaneous - In Shale

4 - 30"ϕ Horz. Connections, Each 30 ft Long
& 5 - 12"ϕ Horz. Connections, Each 30 ft Long

RF Cavity Enlargement - In Shale (w/o Tunnel Volume)

$$\text{Volume} = \frac{1}{27}\left[22'(15')(150') - \pi/4(14')^2(150')\right] = \underline{\underline{980}}\,yd^3$$

HEB

Kicker Enclosure - in chalk (See Sketch On Page 7 Of 8).

$$\text{Volume} = \frac{1}{27}(20')(15')(310') = \underline{\underline{3{,}440}}\,yd^3$$

Kicker Corridor - in chalk

$$\text{Volume} = \frac{1}{27}(10')(12')(45\,LF) = \underline{\underline{200}}\,yd^3$$

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KICKER CONNECTIONS - IN CHALK

7- 12"ϕ HORZ. CONNECTIONS, EACH 30 ft LONG

HEB-RF AREA - IN CHALK (SEE SKETCH ON p. 8 of 8) (1 of 1)

KICKER ENCLOSURE = Same as previous page = 3,440 yd^3

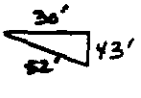
HEB KLYSTRON VOLUME = $\frac{1}{27}(26')(21')(150') = 3{,}030\ yd^3$

RF CAVITY (¾ TUNNEL) VOLUME = $\frac{1}{27}\left[(22')(15')(150') - \frac{3}{4}(13')^2(150')\right]$

VOLUME = 1,100 yd^3

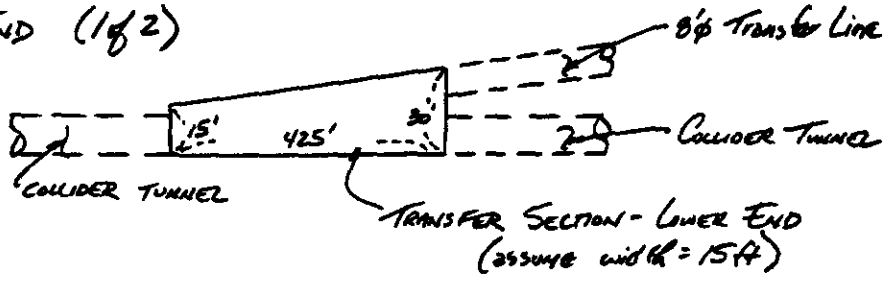
CORRIDOR VOLUME = $\frac{1}{27}(13')(13')(340\,LF) = 2{,}130\ yd^3$

MISCELLANEOUS
3-12"ϕ HORZ. CONNECTIONS, EACH 30 ft LONG
4-12"ϕ HORZ. CONNECTIONS, EACH 52 ft LONG
& 4-30"ϕ HORZ. CONNECTIONS, EACH 30 ft LONG



HEB/COLLIDER TRANSFER - IN SHALE

LOWER END (1 of 2)



VOLUME = $\frac{1}{27}\left[\left(\frac{30'+15'}{2}\right)(425')(15')\right] = 5{,}310\ yd^3$

SUBTRACT OUT COLLIDER VOLUME = $\frac{1}{27}\left(\frac{\pi}{4}\right)(14')^2(425') = 2{,}420\ yd^3$

TOTAL = 2,890 yd^3 EXTRA EXCAVATION

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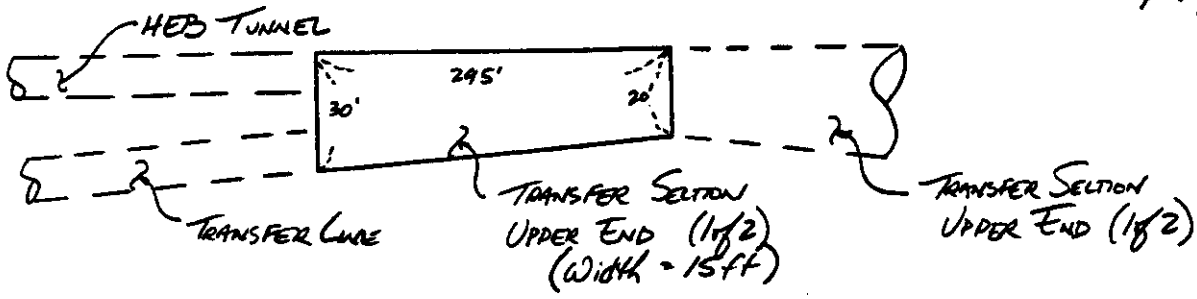
TRANSFER SECTION - UPPER END (1 of 2) IN CHALK



$$\text{VOLUME} = \frac{1}{27}\left[\left(\frac{30'+20'}{2}\right)(15')(295')\right] = 4{,}100\ yd^3$$

$$\text{SUBTRACT OUT HEB VOLUME} = \frac{1}{27}\left(\pi/4\right)(13')^2(295') = 1{,}450\ yd^3$$

TOTAL = 2,650 yd^3 EXTRA EXCAVATION

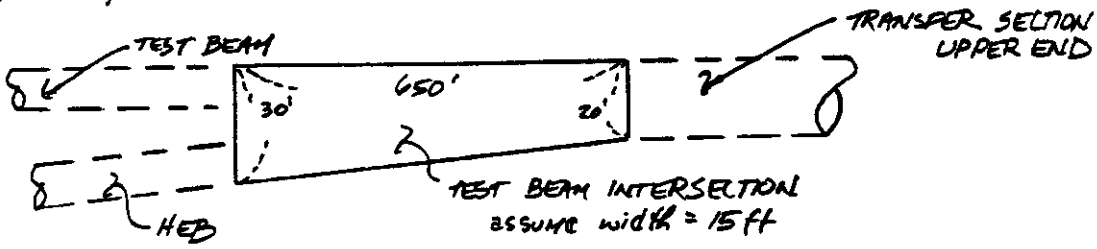
TRANSFER LINE (1 of 2) IN SHALE

ASSUME 330 LF @ 9' ϕ

$$\text{VOLUME} = \frac{1}{27}\left(\pi/4\right)(9')^2(330\,LF) = 780\ yd^3$$

TEST BEAM INTERSECTION (1 of 1) IN CHALK

Assume portion of this intersection is covered in the transition section upper end for the first 100 meters. This leaves the following geometry for the intersection



$$\text{VOLUME} = \frac{1}{27}\left[\left(\frac{30'+20'}{2}\right)(15')(650\,LF)\right] = 9{,}030\ yd^3$$

SUBTRACT OUT TEST BEAM AREA AND HEB AREA AS THEY HAVE ALREADY BEEN COUNTED

$$\text{VOLUME} = \frac{1}{27}\left[\underbrace{\left(\left(\pi/4\right)(13')^2(650\,LF)\right)}_{\text{HEB}} + \underbrace{\left(\left(\pi/4\right)(11')^2(650\,LF)\right)}_{\text{TEST BEAM}}\right] = 5{,}480\ yd^3$$

$$\text{VOLUME TOTAL} = 9{,}030\ yd^3 - 5{,}480\ yd^3 = 3550\ yd^3$$

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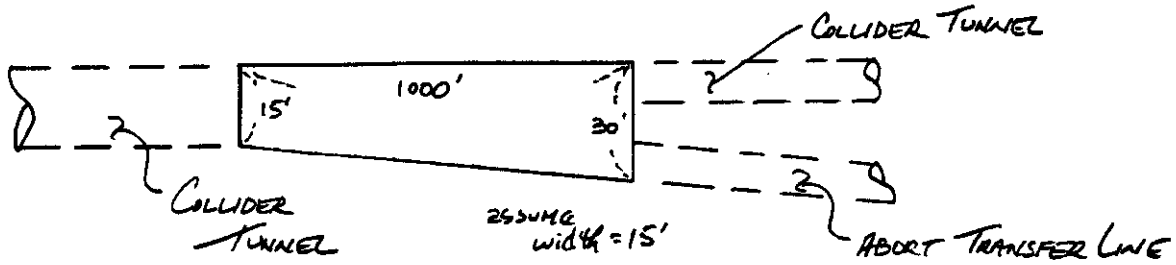
Collider Beam Backstop Intersection (1 of 2) in shale

(Subtract Out Collider Volume As It Has Already Been Counted)



$$\text{Volume} = \frac{1}{27}\Big[\underbrace{\left(\frac{30'+15'}{2}\right)(15')(1000\,\text{LF})}_{\text{Intersection}} - \underbrace{\left(\tfrac{\pi}{4}\right)(14')^2(1000\,\text{LF})}_{\text{Collider Volume}}\Big] = \underline{\underline{6{,}800\,\text{yd}^3}}$$

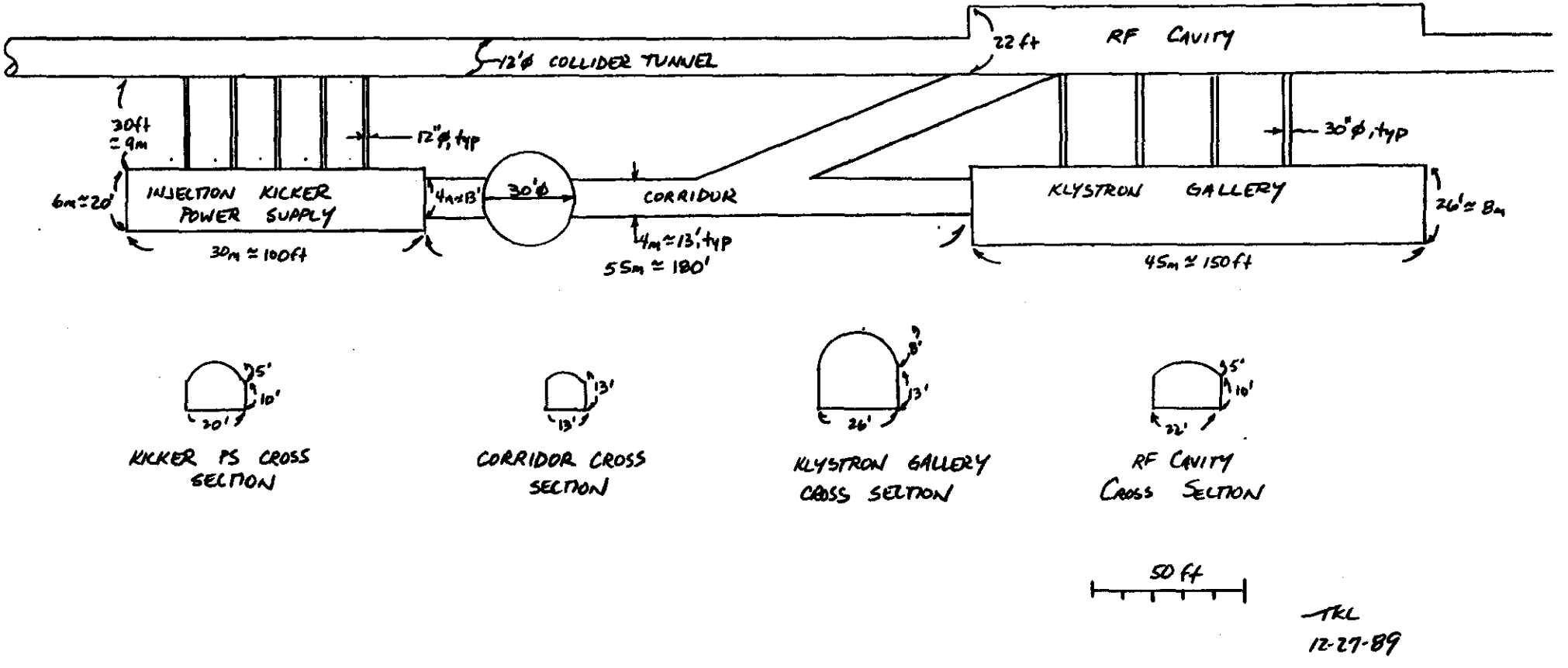
Collider Beam Backstop Transfer Line (1 of 2) in shale

Distance To Beam Dump = 700 meters = 2300 LF $\phi = 12'$

$$\text{Volume} = \frac{1}{27}\left(\tfrac{\pi}{4}\right)(12')^2(2300\,\text{LF}) = \underline{\underline{9630\,\text{yd}^3}}$$

Beam Backstop (1 of 2) in shale

$$\text{Volume} = \frac{1}{27}(20')(23')(68') = \underline{\underline{1{,}160\,\text{yd}^3}}$$



COLLIDER RING - KLYSTRON AREA (1 of 2)

(IN SHALE)

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CHK'D CEH 1-8-90

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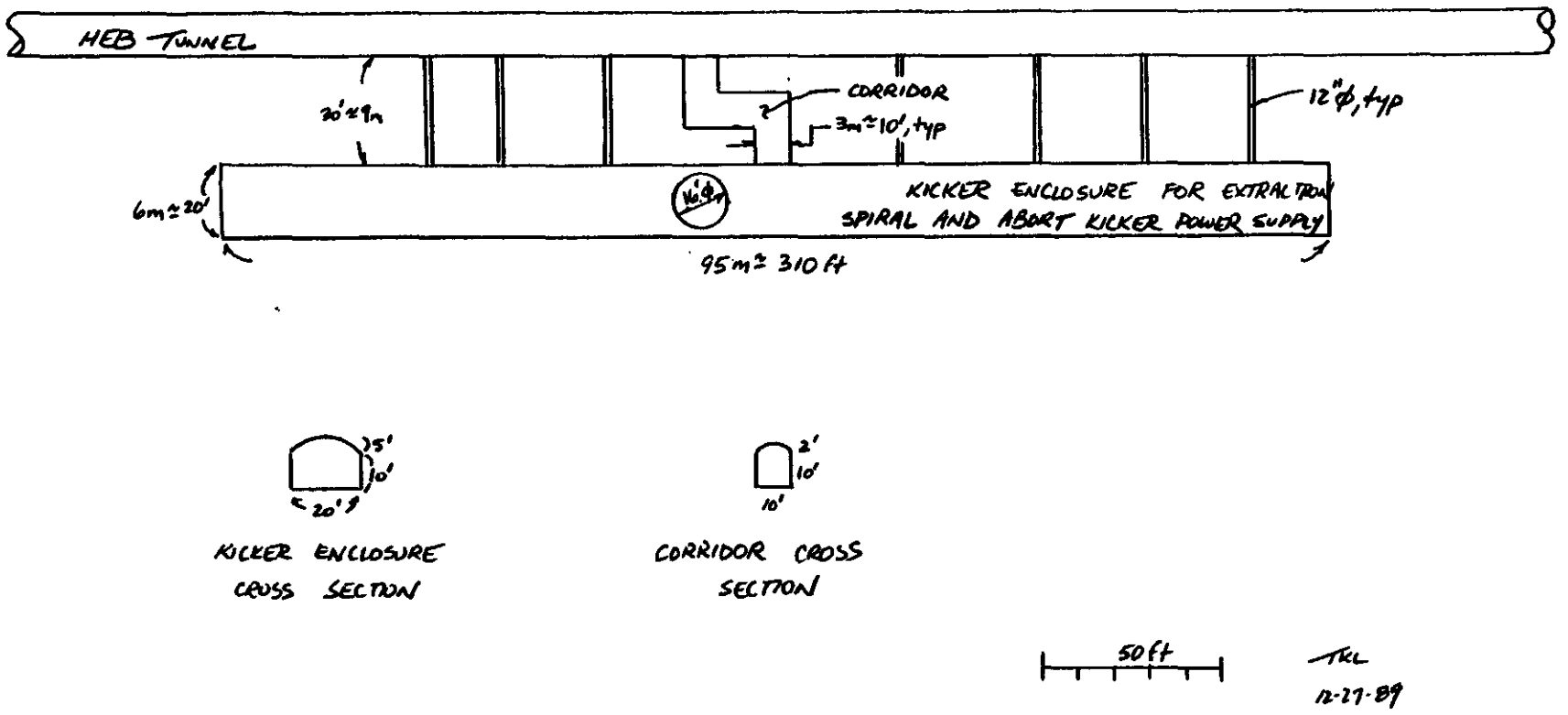

HEB - KICKER ENCLOSURE (1 of 1)

(IN CHACK)

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CHK'D CEH 1-4-90
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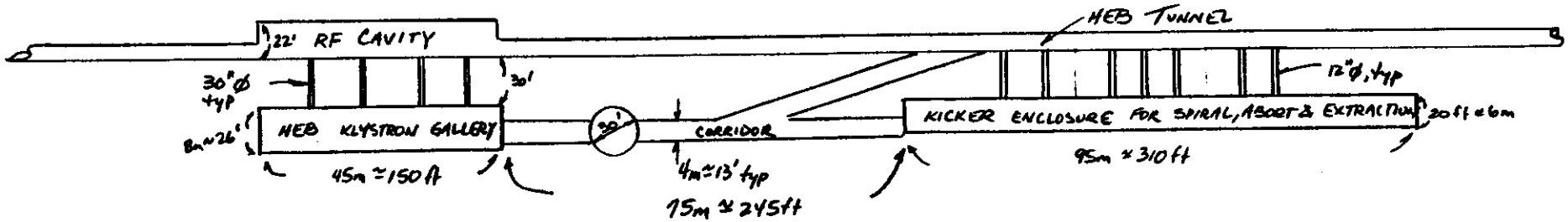
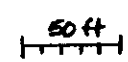


HEB KLYSTRON GALLERY CROSS SECTION

RF CAVITY CROSS SECTION

KICKER ENCLOSURE CROSS SECTION

CORRIDOR CROSS SECTION



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HEB - RF AREA (1 of 1)

(IN CHALK)

chk'd TKL 1-3-90
CEH 1-4-90
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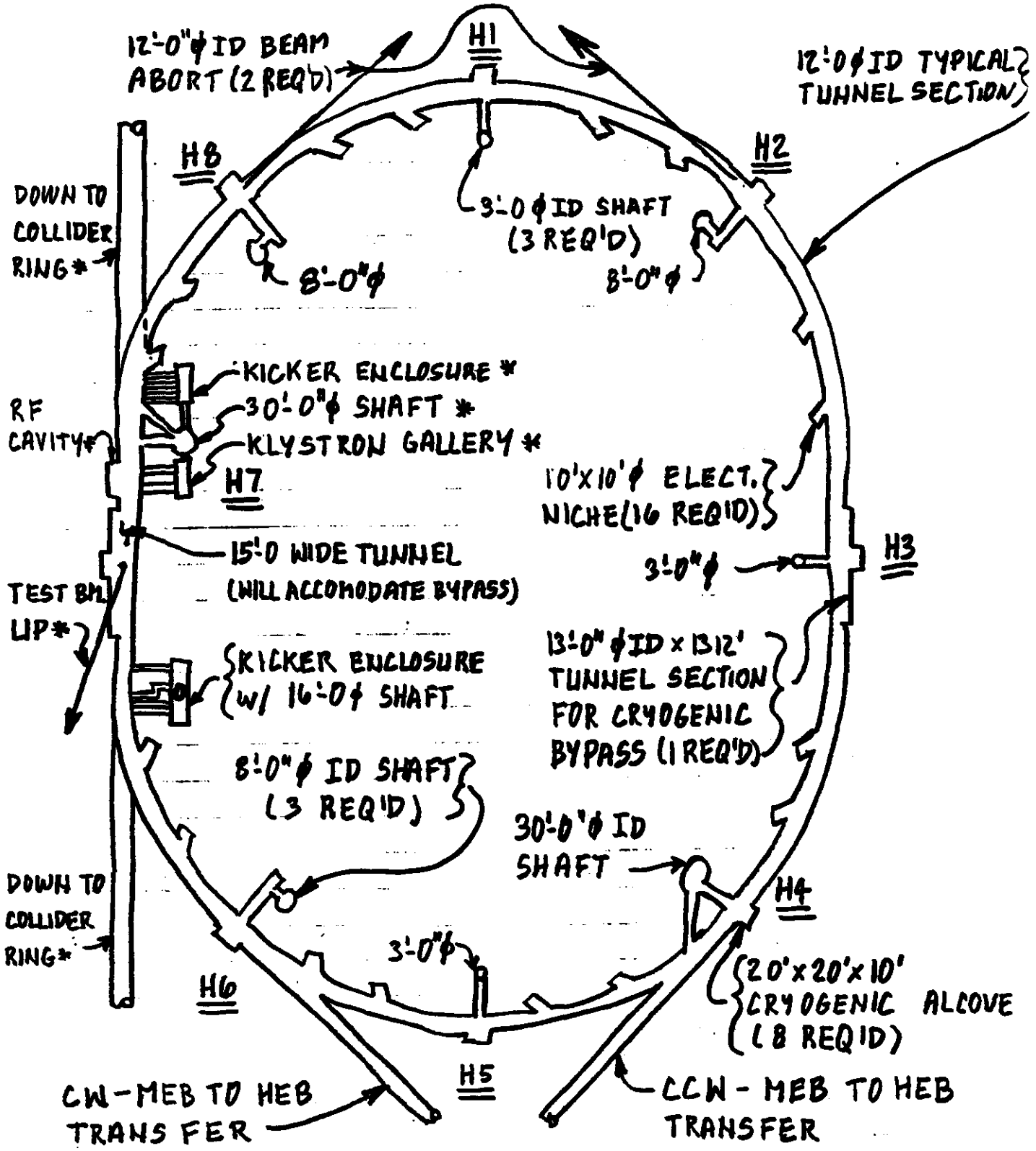
SHEET NO. 1 OF 1
DATE 1-3-90
BY LEH CHKD



HEB TUNNEL PLAN

NTS

NOTE: *INDICATES QUANITIES ARE IN ANOTHER ESTIMATE

SVERDRUP

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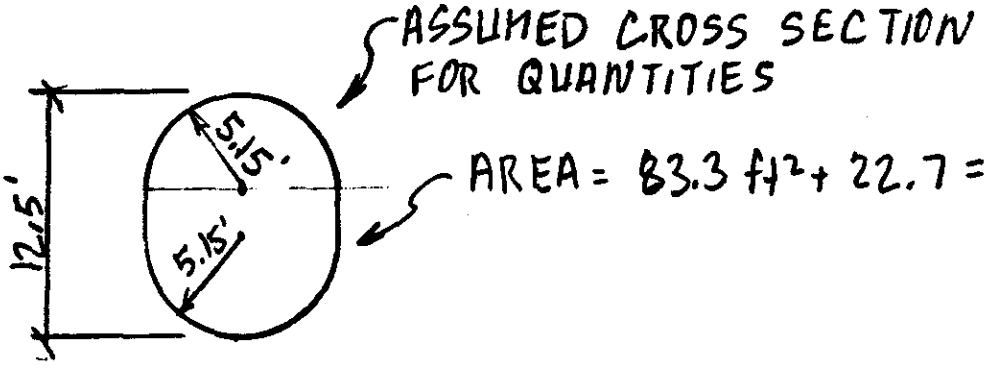
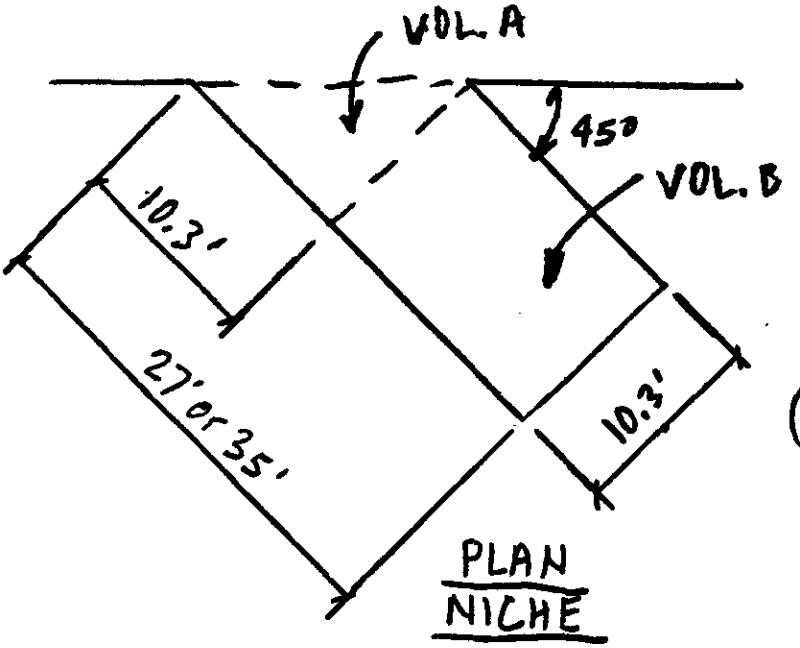
SHEET NO. 1 OF 1

DATE 1-2-90

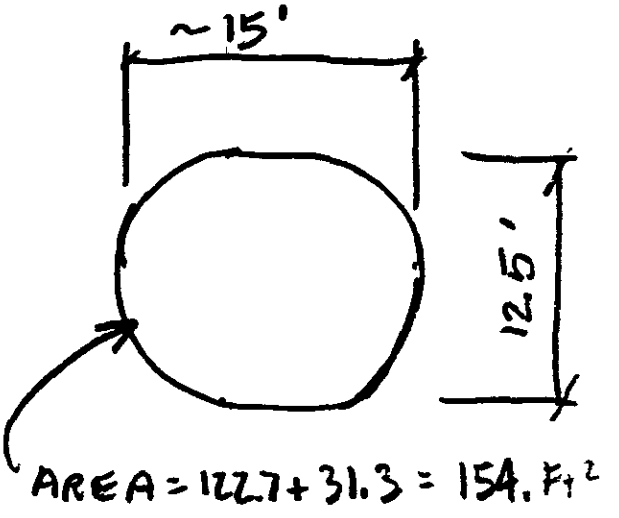
BY CEH CHKD TKL 1-4-90

COMPUTATIONS FOR QUANTITIES OF EXCAVATION FOR TYPICAL NICHE - COLLIDER RING





PLAN
NICHE



SECTION THROUGH INTERSECTION

VOL. A ≈ $\left(\frac{106.+154}{2}\right)(10.3/2)/27$ = 24.8 CY

VOL. B = 106' (16.7') / 27 = 65.6 CY

106' (24.7') / 27 = 97.0 CY

VOLUME OF SMALL NICHE = 90.4 CY ←

" " LARGE NICHE = 121.8 CY ←

TKL 1-5-90

HEB - Miscellaneous Excavation Items

Excavated Volume Summary

Niches = 16 x 67 yd³ = 1072 yd³
Alcoves = 8 x 215 yd³ = 1720 yd³
Cryogenic Bypass = 1 x 1100 yd³ = 1110 yd³

Shaft Connections To Tunnels
3'ϕ Shaft to Tunnel (H1, H3, H5) = 3 x 90 yd³ = 270 yd³
8'ϕ Shaft to Tunnel (H2, H6, H8) = 3 x 340 yd³ = 1020 yd³
30'ϕ Shaft at H4 = 1 starter tunnel - already in estimate
30'ϕ Shaft at H7 = 1 starter tunnel - already in estimate @ HEB RF

HEB Abort
Abort Intersection (HEB % Tunnel Volume) = 2 x 9960 yd³ = 19,920 yd³
Abort Tunnel = 2 x 125 LF = 250 LF
Abort Backstop = 2 x 145 yd³ = 290 yd³

HEB Misc. Excavation Volume = 25,402 yd³
Plus 250 LF of 12'ϕ Abort Tunnel

1-3-90
by CEH chk'd TK 1-4-90

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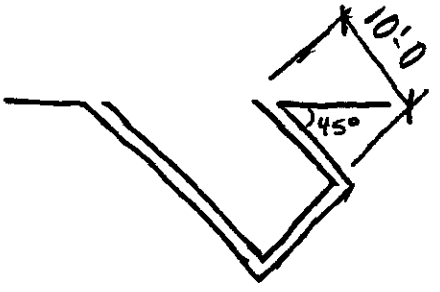
ELECTRICAL NICHES (USE 12'-0 O.D)



VOL. = (1/27)(π/4)(12)² (11 + 10/2)
= 67 CY

CRYOGENIC ALCOVES

VOL. = (1/27)(22')(22')(12') = 215. CY

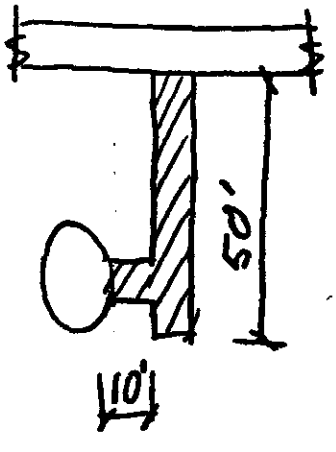
CRYOGENIC BYPASS: (@ H3)

VOL. = 1/27 [π/4 (15)² − π/4 (14)²] (1312') = 1110. CY

3'-0 ϕ ID SHAFT (ASSUME 8'x6' INSIDE & 10'x8' EXCAVATION)

VOL. = 10'(8')(30')/27 = 90. CY

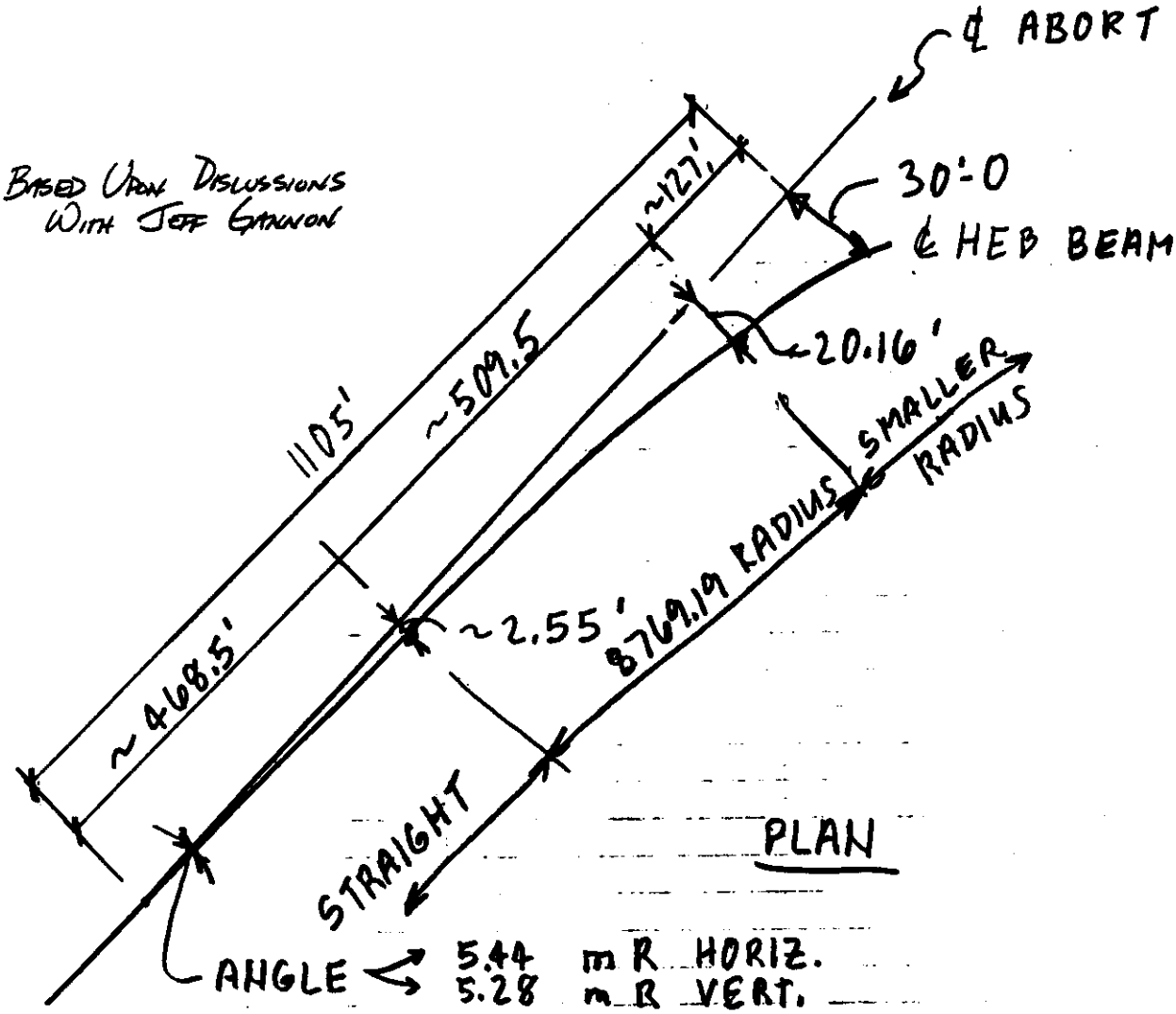
8'-ϕ ID SHAFT (ASSUME 12'-0"ϕ ID x 60')

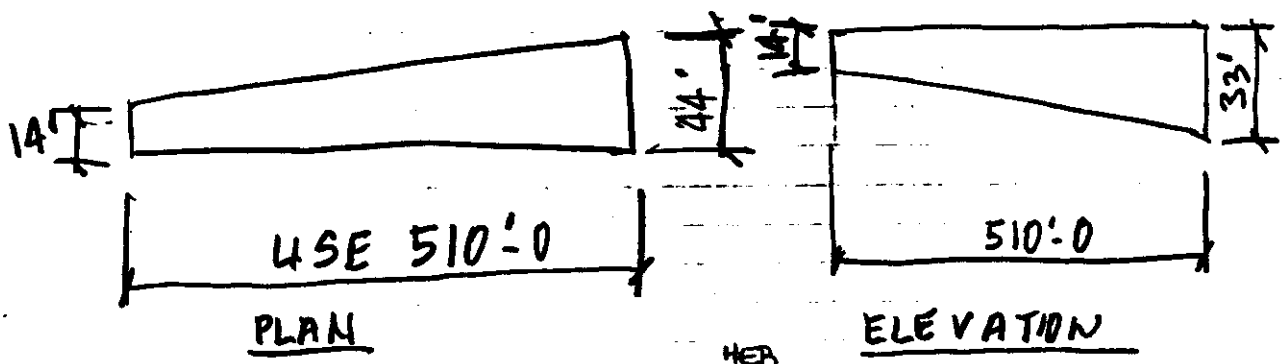


VOL. = 1/27 (π/4)(14')²(60') = 340 cy

HEB ABORT

Based Upon Discussions With Jeff Gannon





$$\text{VOL.} = \tfrac{1}{27}\left[\left(\frac{14+44}{2}\right)\left(\frac{14+33}{2}\right)(510) - \overbrace{(\pi/4)(14)^2(510)}^{\text{HEB}}\right] = \underline{9960\ \text{CY}}$$

TUNNEL EXTENSION VOL. $= \tfrac{1}{27}(\pi/4)(14)^2(127) = \underline{725.\ \text{CY}}$

ABORT CHAMBER $\approx (14)^2(20)/27 = \underline{145.\ \text{CY}}$

TOTAL $= \underline{10830.\ \text{CY}}$

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