D0 ENGINEERING NOTE

No. 3740.220-EN-451

**END CALORIMETER TRANSFER BRIDGE
DESIGN AND INSTALLATION PROCEDURES**

Feb. 25, 1991

H.J. Stredde

Approved: _____

NORTH ENDCAP CALORIMETER
INSTALLATION

Prepared by: HJ Stredde
February 25, 1991

NEC INSTALLATION

The North Endcap Calorimeter(NEC) is to be moved from the clean room to the north sidewalk in preparation for the final installation on the D0 detector center beam. In order to make this move, the cable bridge must be "flattened" and the NEC lifted to move over it.

The detector is moved west, approximately 24 feet, while the moveable counting house remains stationary. This movement allows the cable bridge to "flatten" i.e. become horizontal. The cable bridge lowering is steadied and stabilized by 7.5 ton hoist mounted on the moveable counting house. By moving the detector to lower the bridge, a vacancy has been created in the pit that must be filled to the level of the clean room rail elevation. This filler will consist of concrete shield blocks, stacked in two rows. These rows are spaced appropriately to match the wheel base of the EC transporter. A steel plate is placed on top of each row of shield blocks and leveled to the elevation of the clean room rails.

Steel plates will be installed and leveled on the north sidewalk similar to those used on the south sidewalk for the CC installation.

These plates are used as rails for the Hilman rollers, bearing surfaces for shim blocks used during lifting and anchors for holding the transporter extension units and the transfer bridge.

After the plates are installed, the transfer bridge is put in place, spanning the cable bridge, shimmed and leveled. The transporter extension units are positioned next to the transfer bridge on the north sidewalk.

With the completion of this prep work, the actual transfer of the NEC from the clean room can begin. The NEC is pulled from the clean room with the same mechanism(cyl. and chain) that was used for the CC and the pull anchor point will be located at the end of the concrete blocks. The NEC will come out of the north west door in the clean room and move along the temporary rail plates in the pit until it is in line with the transfer bridge. At this point the NEC is ready

to be elevated to the level of the transfer bridge. The elevation process is the same as that used for the CC installation. When the correct elevation is attained the transporter extensions are positioned and fastened to the transporter on the south side. Static column supports will be added underneath the transporter to minimize deflections as the NEC is rolled off. The carriage extensions are now put in place and the Hilman rollers transferred into position under the extensions. The NEC is now ready to be pulled off of the transporter and onto the transfer bridge. Again using the Cyl. and chain mechanism, with the anchor point attached to the transporter extension on the north sidewalk, pull the NEC completely off of the transporter and onto the transfer bridge. Once the NEC is on the transfer bridge a rearrangement of equipment must be done.

The transporter extension on the north sidewalk is decoupled from the transfer bridge and moved against the wall of the fixed counting area. The transporter extension at the south end of the transporter is removed, the transporter is decoupled from and moved to the north side of the transfer bridge. The transporter is supported from the floor at an elevation equal to the transfer bridge and coupled to it. The transporter extension is fastened to the north end of the transporter. The movement of the NEC now continues until it is back on the transporter. At this time the transfer bridge, concrete shield blocks and steel plates in the pit are removed. The detector is moved back to its normal parked position(cable bridge up).

The NEC is lowered to the sidewalk(reverse of elevation procedure). Welding of the heads is then finished prior to final installation on the center beam. The final installation is identical to the CC installation, using all the same equipment.

The finite element analysis of the transfer bridge design was done by Kay Weber of the Accelerator Mechanical Support Group.

SUBJECT

EC-LOADING ON CRYOSTAT FEET
TRANSFER BRIDGE

NAME

H. J. STREDDER

DATE

11-13-90

REVISION DATE

6-10-96

THESE WGTs DO NOT INCLUDE: CRYOSTAT $\approx$ 29 TONS
CARRIAGE $\approx$ 6.5 TONS

ASSUME: CARRIAGE & CRYOSTAT DISTRIBUTES EQUALLY
TO ALL 4 CRYOSTAT FEET, THEN. $14500 + 3250 = 17750$
25000 BECOMES $25000 + 17750 = 42750$ LBS.
AND 187500 BECOMES $187500 + 17750 = 205250$ LBS.
TOTAL $\frac{1}{2}$ WGT. = 248,000 LBS

$$\sum M_O = 0 = \frac{(19)(35500) + (33.542)(212,500)}{35,500 + 212,500} = X$$

$$X = 31.46$$

$$38.125 - 31.42 = 6.665$$

WITH CRYOSTAT NOT EQUALLY DISTRIBUTED
C.G. CHG FROM 4.472" TO 6.665"

SUBJECT

EC- LOADING ON CARRIAGE & SUPPORTS
TRANSFER BRIDGE

NAME

H. STREDDE

DATE

11-13-90

REVISION DATE

6-10-96

$$\sum M_{R_L} = 0 = 12 \times 42.75 + 50 \frac{1}{8} \times 205.25 - 70 \frac{1}{8} R_R$$

$$R_R = 154000 \text{ LBS.}$$

$$R_L = 248000 - 154000 = 94000 \text{ LBS}$$

SUBJECT

MOMENT & REACTIONS - EL LOAD-
TRANSFER BRIDGE

NAME

H. J. STREDGE

DATE

11-13-90

REVISION DATE

6-10-96

$$\sum M_{R_L} = 0 = \frac{(248)(86.725)}{2000} = 107.5 K_L$$

$$R_L = 248 - 107.5 K = 140.5 K$$

$$M_A = (140.5)(43.15 + 70.125) - (94)(70.125) = 9323 \text{ K-INS}$$

CHECK

$$M = (107.5)(86.725) = 9323 \text{ K-INS.}$$

$$R_R = \frac{70 \frac{1}{8}}{200} \cdot 154 = 54 K$$

$$R_L = 154 - 54 + 94 = 194 K$$

$$\text{MAX} \Rightarrow R_R = \left[\frac{129 \frac{7}{8} \cdot 94}{200} \right] + 154 = 215 K$$

$$R_L = 94 - 61 = 33 K$$

SUBJECT

NAME

H. J. STREDDER

DATE

10-24-90

REVISION DATE

6-10-96

TRANSFER BRIDGE

TRY $\Rightarrow$ $2 \times S24 \times 121$ w/ $1\frac{1}{2}$ CAP PLATES $\times 18"$ WIDE (23 LBS/FT^2)
TOP CAP PLATE $1\frac{3}{4}" \Rightarrow$ MACHINED TO $1\frac{1}{2}" \rightarrow 34.5 \text{ LBS/FT}$

$S24 \times 121$

$$I = 3160 \text{ IN}^4 \times 2 = 6320 \text{ IN}^4$$

$$S = 258 \text{ IN}^3 \times 2 = 516 \text{ IN}^3$$

$1\frac{1}{2}$ PLATES $\times 18"$ WIDE @ $2\frac{1}{2}$ CTRS

$$I = 351 \times 1.5 \times 18 = 9477 \text{ IN}^4$$

EST. WGT. $\Rightarrow 210$ LG.

$$17.5 \text{ FT} [(2 \times 121) + (2 \times 34.5)]$$

$$= 4357.5 \text{ LBS.}$$

$$= 2.2 \text{ TONS}$$

AREA:

$$2 \times 35.6 \times 2 \times 1\frac{1}{2} \times 18 = 125.2 \text{ IN}^2$$

WGT. PER FT:

$$2 \times 121 + 2 \times 34.5 = 311 \text{ LBS/FT}$$

$$* \text{ TOTAL } I_{x-x} = 6320 + 9477 = 15,797 \text{ IN}^4$$

$$S = \frac{15797}{13.5} = 1170 \text{ IN}^3$$

BENDING STRESS:

$$S = \frac{M}{Z} = \frac{9323 \times 10^3 \text{ IN-LBS}}{1170 \text{ IN}^3} = 7968 \text{ PSI}$$

WEB SHEAR STRESS:

$$S = \frac{P}{A} = \frac{215000}{2 \times 0.813 \times 24.5} = 5400 \text{ PSI}$$

DEFLECTION AT CTR:

$$\Delta_{CTR} = \frac{Pa}{48EI} [3L^2 - 4a^2]$$

$$\Delta_{CTR-A} = \frac{94 \times 10^3 \times 41.11}{48 \times 29 \times 10^6 \times 15095} [3 \times 200^2 - 4 \times 41.11^2] = 0.021" \downarrow$$

$$\Delta_{CTR-B} = \frac{154 \times 10^3 \times 88.765}{48 \times 29 \times 10^6 \times 15095} [3 \times 200^2 - 4 \times 88.765^2] = 0.057" \downarrow$$

$$\text{TOTAL } \Delta_{CTR} = 0.078" \downarrow$$

$A \times d + I_o$

CAP PLATES

$$* I_{y-y} = 2 (35.4 \text{ IN}^2 \times 4 \text{ IN}^2 + 83.3 \text{ IN}^4) + \frac{1}{12} [18^3 \times 1\frac{1}{2} \times 2] = 2757.4 \text{ IN}^4$$

$$I_P = I_{x-x} + I_{y-y} = 15,095 + 2757.4 = 17,852 \text{ IN}^4$$

$$r = \sqrt{\frac{I_P}{A}} = 4.69 \text{ IN}$$

ENGINEERING NOTE

FERMILAB

SECTION

PROJECT

SERIAL-CATEGORY

PAGE
51

SUBJECT

TRANSFER BRIDGE - SECTION

NAME

H. J. STEDOE

DATE

11/1/90

REVISION DATE

SCALE 1"=1'-0"

MAT'L: A-36 & A500B
(36 ksi yield) (46 ksi yield)

FERMILAB

ENGINEERING NOTE

SECTION

PROJECT

SERIAL-CATEGORY

PAGE

SUBJECT

EC-TRANSFER BRIDGE
SIDE ELEVATION

NAME

H. J. STEDDE

DATE

11-15-90

REVISION DATE

COLUMN STRENGTH:

PER AISC, 9TH ED. Pg 3-41

$$8 \times 8 \times \frac{3}{8} = 286 \text{ KIPS FOR } KL = 6$$

$$\text{MAX. REACTION} = 229.2 \text{ K}$$

(SEE PG. 3)

COMPRESSIVE STRESS:

$$\text{TUBES: } S = \frac{P}{A} = \frac{229.2 \text{ KIPS}}{11.1 \text{ IN.}^2} = 20.648 \text{ KSI}$$

SUBJECT

TRANSFER BRIDGE - SEAM WELD

NAME

H. STREDDE

DATE

11-20-90

REVISION DATE

6-10-96

2, S24x121 BEAMS

$$I_{\text{SECT.}} = 6320 \text{ IN}^4$$

$$a = 48 \times 1\frac{1}{16} = 16.99 \text{ IN}^2$$

$$y = 12\frac{1}{4} - \frac{17}{32} = 11.719$$

$$V = 215 \text{ kips}$$

$$f = \frac{215000 \times 16.99 \times 11.719}{6320} = 6,773 \text{ LBS/IN}$$

$$\text{ALLOWABLE} \Rightarrow 14,850 \text{ LBS/IN.}$$

$$w = \frac{6773 \text{ LBS/IN}}{14850 \text{ LBS/IN}} = 0.456 \text{ IN}$$

CAP PLATE WELD:

$$V = 215 \text{ kips}$$

$$a = 18 \times 1\frac{1}{2} = 27 \text{ IN}^2$$

$$y = 12\frac{1}{4} + \frac{3}{4} = 13 \text{ IN.}$$

$$I_{\text{SECT.}} = 15095 \text{ IN}^4$$

$$f = \frac{Vay}{nI} = \frac{215000 \times 27 \times 13}{2 \times 15797} = 2389 \text{ LBS/IN.}$$

$$\text{ALLOWABLE FORCE/IN (1" FILLET)} = 79000 \times .3 \times .70711 = 14,850 \text{ LBS/IN.}$$

$$\text{LEG SIZE, } w = \frac{2389}{14850} = 0.161 \text{ IN}$$

MIN. LEG SIZE BASED ON THICKEST PLATE $\Rightarrow 1\frac{1}{2}$ PLATE $\times \frac{5}{16}$ FILLET WELD

USE $\frac{1}{2}$ FILLET - INTERMITTENT

$$\frac{0.179}{0.500} = 35.8\% \approx 3.6 \text{ "/>10" \approx 9 \text{ "/>24" \Rightarrow$$

FRAME MAC file: NEC BRIDGE; Last modified at 2:30:50 PM on Fri, Feb 8, 1991
 Above each load are the magnitudes in lb, lb/ft, and lb-ft.

FRAME MAC file: NEC BRIDGE; Last modified at 2:30:50 PM on Fri, Feb 8, 1991
 Above each load are the magnitudes in lb, lb/ft, and lb-ft.
 Next to each support are reactions in lb and lb-ft.
 Positive reactions and deformations are to the right, upwards, and counter-clockwise.

FRAME MAC file: NEC BRIDGE; Last modified at 2:30:50 PM on Fri, Feb 8, 1991

Node 1	Elem 1,2	Node 2	Elem 2,3	Node 3	Elem 3,4	Node 4	Elem 4,5	Node 5	Elem
5.00e+0	L= 8.71e-1	5.87e+0	L= 8.71e-1	6.74e+0	L= 8.71e-1	7.61e+0	L= 8.71e-1	8.48e+0	L= 8.71
1.00e+1	BRIDGE	1.00e+1	BRIDGE	1.00e+1	BRIDGE	1.00e+1	BRIDGE	1.00e+1	BRIDGE
---	E= 2.90e+7	---	E= 2.90e+7	---	E= 2.90e+7	---	E= 2.90e+7	---	E= 2.90

ANSYS 4.4)
FEB 4 1991
19:38:52
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.046219
SMN =38.874
SMX =13384
SMXB=20951

XV =1
YV =1
ZV =1
DIST=105.395
YF =-5.442
A =780.262
B =2263
C =3746
D =5229
E =6711
F =8194
G =9677
H =11160
I =12642

ANSYS 4.4)
 FEB 4 1991
 19:40:30
 PLOT NO. 2
 POST1 STRESS
 STEP=1
 ITER=1
 SI (AVG)
 TOP
 DMX =0.043307
 SMN =182.931
 SMX =8591
 SMXB=9898

XV =1
 YV =1
 ZV =1
 DIST=101.506
 YF =12.455
 A =650.054
 B =1584
 C =2519
 D =3453
 E =4387
 F =5321
 G =6256
 H =7190
 I =8124

MAX PRINCIPAL STRESS = 9137 PSI
 AT END OF BRIDGE, INSIDE WEB, AT FLANGE

webs

MAX PRINCIPAL STRESS = 9554 PSI
CENTER OF BRIDGE UNDER LOAD

flanges

ANSYS 4.4/)
FEB 4 1991
19:41:14
PLOT NO. 3
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.046219
SMN =38.874
SMX =9554
SMXB=11017

XV =1
YV =1
ZV =1
DIST=105.395
YF =12.455
A =567.505
B =1625
C =2682
D =3739
E =4797
F =5854
G =6911
H =7968
I =9026

1

)

ANSYS 4.4A)
FEB 4 1991
19:41:37
PLOT NO. 4
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.037689
SMN =417.119
SMX =12134
SMXB=18770

XV =1
YV =1
ZV =1
DIST=99.951
YF =-17.897
A =1068
B =2370
C =3672
D =4974
E =6275
F =7577
G =8879
H =10181
I =11483

MAX PRINCIPAL STRESS = 15101 PSI
AT THE FOOT

supports

1

)

)

ANSYS 4.4A)

FEB 4 1991

19:41:53

PLOT NO. 5

POST1 STRESS

STEP=1

ITER=1

SI (AVG)

TOP

DMX =0.025391

SMN =358.883

SMX =5035

SMXB=6936

XV =1

YV =1

ZV =1

DIST=95.284

YF =17.455

A =618.664

B =1138

C =1658

D =2177

E =2697

F =3216

G =3736

H =4256

I =4775

MAX PRINCIPAL STRESS = 5124 PSI

holes

ANSYS 4.4A)
FEB 4 1991
19:42:05
PLOT NO. 6
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.037587
SMN =375.373
SMX =6146
SMXB=9030

XV =1
YV =1
ZV =1
DIST=105.395
YF =-5.442
A =695.983
B =1337
C =1978
D =2620
E =3261
F =3902
G =4543
H =5185
I =5826

MAX. PRINCIPAL STRESS: 6227 PSI
AT WEB CONNECTION

cross members

1

)

)

ANSYS 4.4A)
FEB 4 1991
19:42:12
PLOT NO. 7
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.035215
SMN =189.879
SMNB=8.296
SMX =5092
SMXB=5368

XV =1
YV =1
ZV =1
DIST=105.395
YF =-5.442
A =462.227
B =1007
C =1552
D =2096
E =2641
F =3186
G =3730
H =4275
I =4820

MAX. PRINCIPAL STRESS = 5092 PSI
AT CONNECTION TO SUPPORTS

end crosses

1

)

)

ANSYS 4.4)
FEB 4 1991
19:42:17
PLOT NO. 8
POST1 STRESS
STEP=1
ITER=1
SI (AVG)
TOP
DMX =0.037689
SMN =412.239
SMX =15884
SMXB=18999

XV =1
YV =1
ZV =1
DIST=105.395
YF =-5.442
A =1272
B =2991
C =4710
D =6429
E =8148
F =9867
G =11586
H =13305
I =15024

MAX. PRINCIPAL STRESS: 15884 PSI
AT THE EDGES

feet