# D0 ENGINEERING NOTE

## No. 3740.220-EN-452

# END CALORIMETER TRANSFER BRIDGE MODIFICATION

July 10, 1996

H.J. Stredde

Approved: H.J. Stredde

During the assembly of major components into the D0 Detector, a transfer bridge was required to move the North-End Calorimeter from the clean room,over the cable bridge and onto the north sidewalk of the assembly hall.

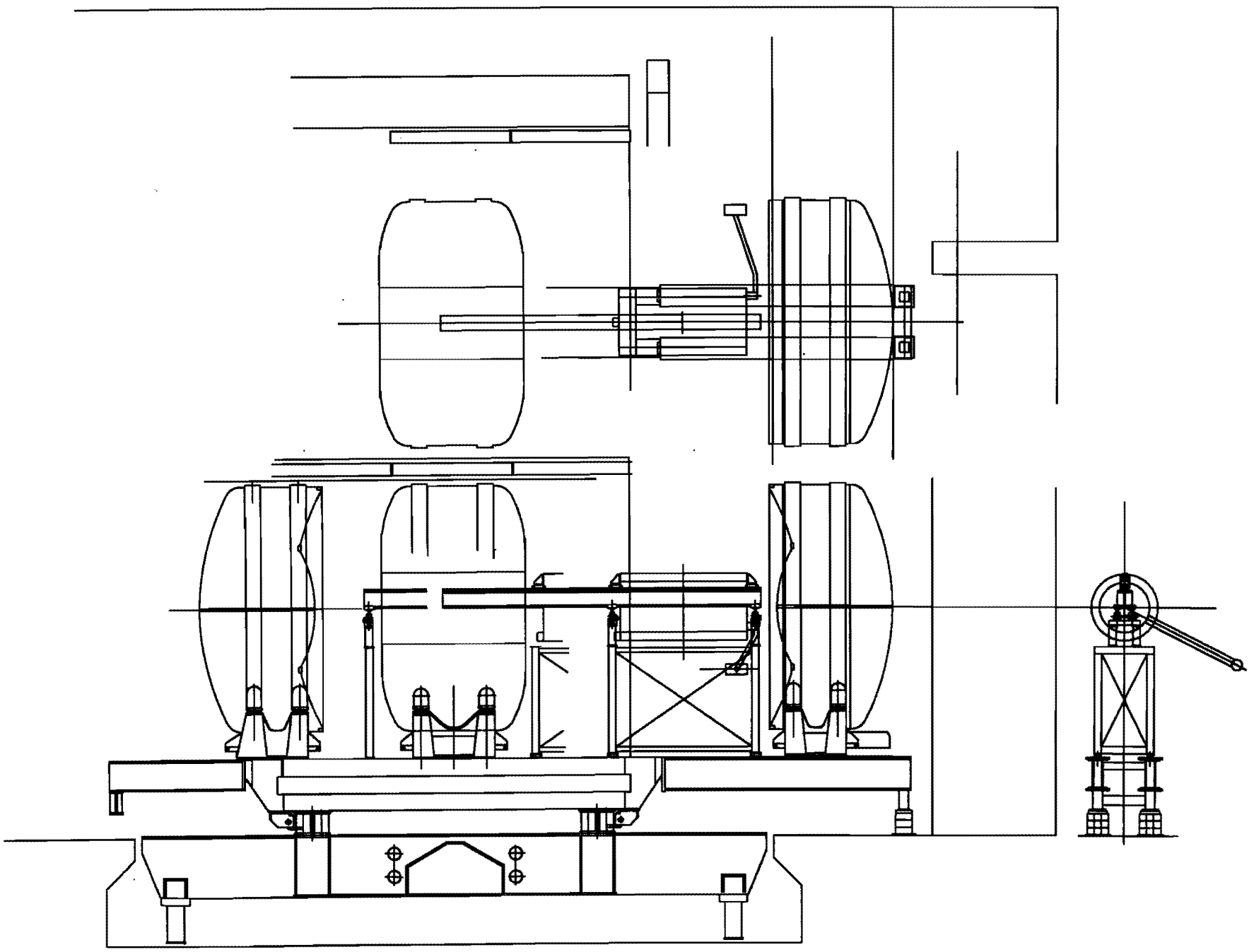
This experiment is now at the beginning stages of the next phase, namely the upgrade of this Detector for future physics research. A major piece of this upgrade is the installation of a solenoid magnet into the Central Calorimeter. In order to accomplish this, the South End Calorimeter has to be removed from the detector and the North End Calorimeter must be moved an additional 20" from its nominal open position.(total 60" movement).

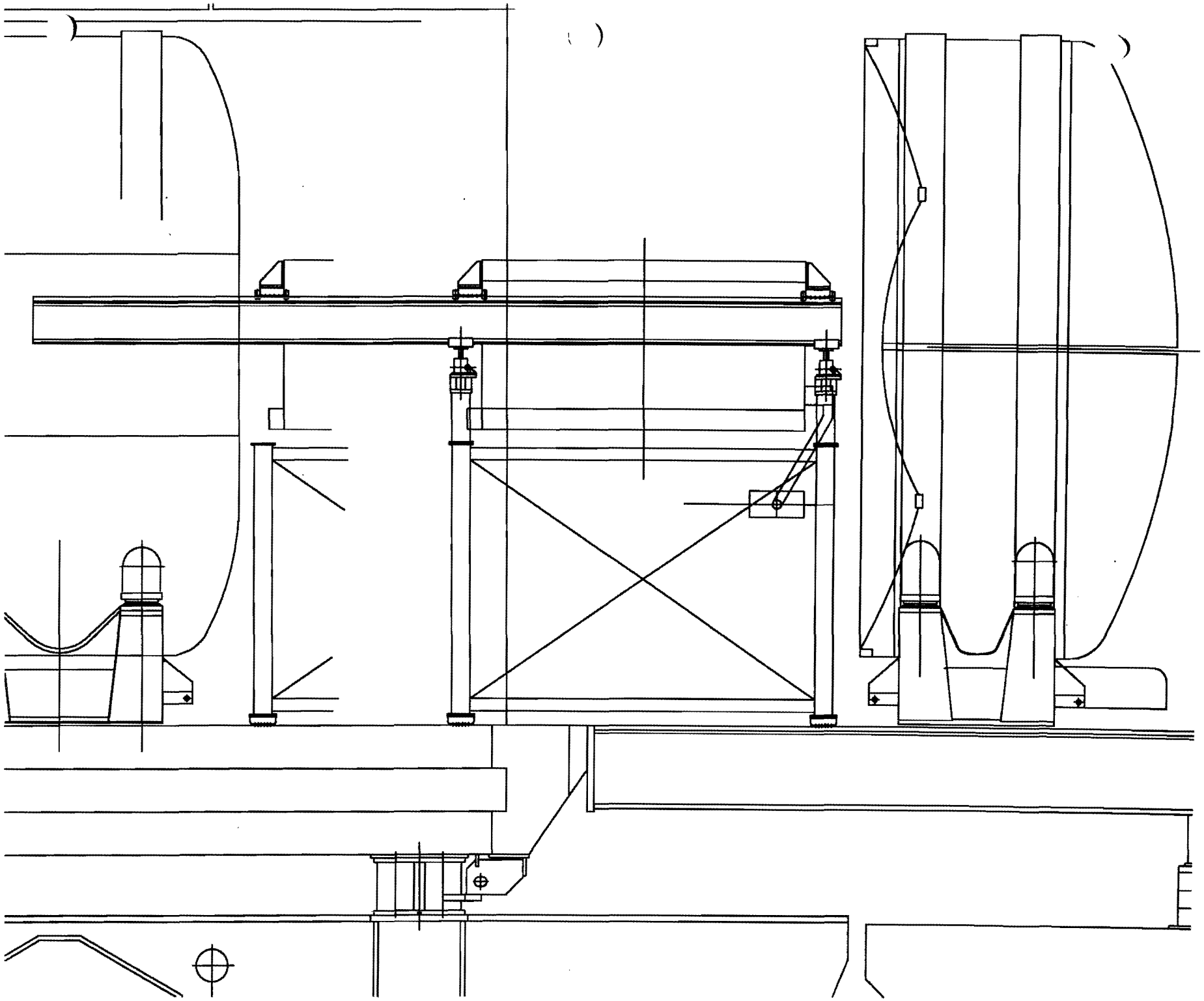
The South End Calorimeter will be removed from the detector using the equipment designed for its installation. The calorimeter will be staged on the south sidewalk during the installation of the solenoid magnet and the central tracking systems.

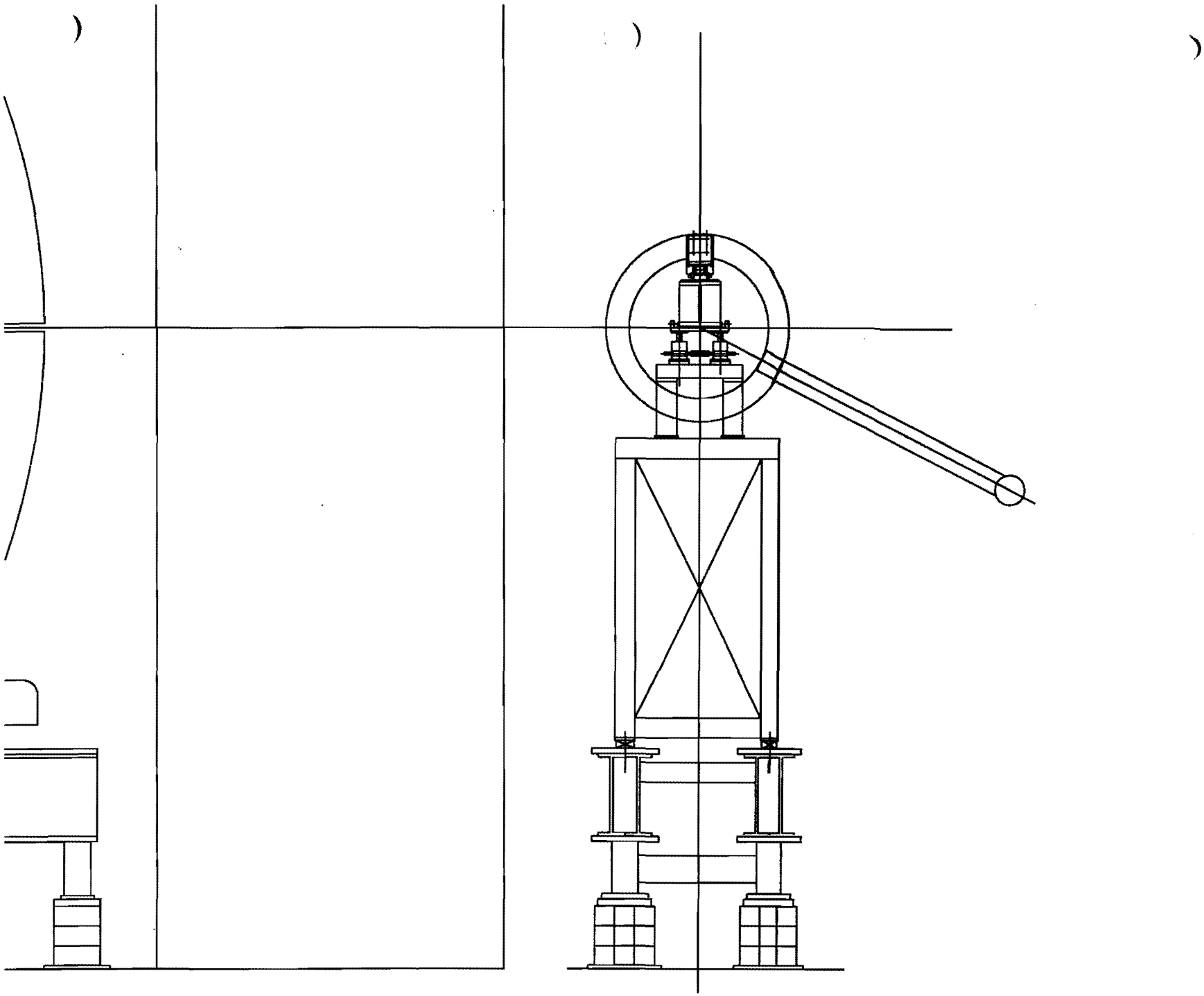
The North End Calorimeter is moved 60" to give more space between calorimeters during magnet, tracker and cable installation work. This movement will allow the calorimeter to remain coupled to the cryo system. However, this movement requires an extension be added to the center beam. This extension will support the rear wheels of the calorimeter and in the case of the end calorimeters, carry the majority of the weight. The extension is to be a modification of the transfer bridge. This modification, basically has T1 steel blocks added to one end and legs to the sidewalk supports at the other. The T1 steel blocks are notched to fit into the center beam porches and are welded to bridge rails. This design is the same as that for the installation bridge(3740.312-ME-273456), including the welds and weld procedures which are identical in both cases.

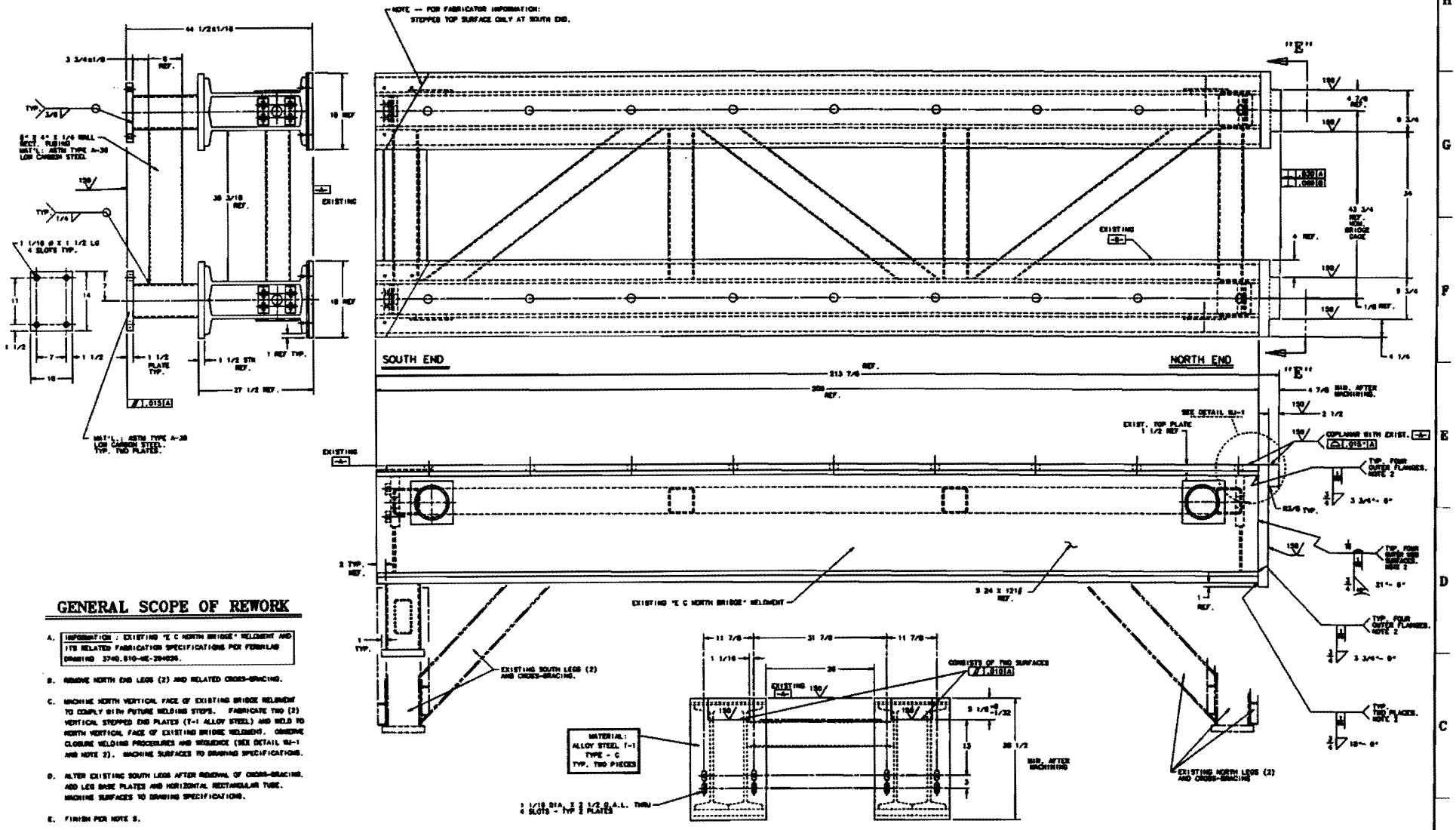
Since load testing is impractical, the critical welds will be non-destructive tested by ultrasonic means. The laboratory, through the FESS Department, has a contract with M.Q.S. Inspection Inc. The results of this testing will be submitted to the panel for review before the bridge is put into use.

It is noted here, that M.Q.S. did perform an ultrasonic test on the critical welds of the EC-CC installation bridge on Oct. 2, 1990. That test demonstrated the weld penetrations between the T1 and A-36 materials. Copies were given to the committee at that time. A copy of the original North End Cap Calorimeter Installation Note is attached for reference.










## GENERAL SCOPE OF REWORK

A. INFORMATION : EXISTING "E C NORTH BRIDGE" WELDMENT AND ITS RELATED FABRICATION SPECIFICATIONS PER FERMILAB DRAWING 3740.010-ME-294026.

B. REMOVE NORTH END LEGS (2) AND RELATED CROSS-BRACING.

C. MACHINE NORTH VERTICAL FACE OF EXISTING BRIDGE WELDMENT TO COMPLY WITH FUTURE WELDING STEPS. FABRICATE TWO (2) VERTICAL STEPPED END PLATES (T-1 ALLOY STEEL) AND WELD TO NORTH VERTICAL FACE OF EXISTING BRIDGE WELDMENT. OBSERVE CLOSURE WELDING PROCEDURES AND SEQUENCE (SEE DETAIL W1-1 AND NOTE 2). MACHINE SURFACES TO DRAWING SPECIFICATIONS.

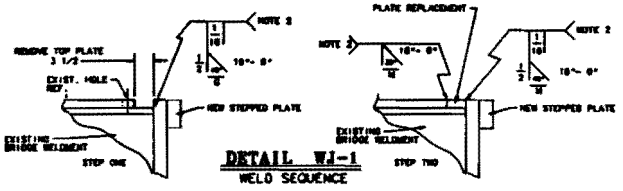
D. ALTER EXISTING SOUTH LEGS AFTER REMOVAL OF CROSS-BRACING. ADD LEG BASE PLATES AND HORIZONTAL RECTANGULAR TUBE. MACHINE SURFACES TO DRAWING SPECIFICATIONS.

E. FINISH PER NOTE 5.

## VIEW "E-E"

WELD NOTES:

1. ALL WELDS SHOULD COMPLY WITH AMERICAN WELDING SOCIETY (A.W.S.) D1.1 STRUCTURAL WELDING CODE.
2. AN UNDERSTANDING OF CORRECT WELDING PROCEDURES IS REQUIRED FOR THE WELDING OF T-1 ALLOY STEEL. THE METHODS ARE OUTLINED IN THE BOOKLET "HOW TO WELD T-1 CONSTRUCTIONAL ALLOY STEELS" MARCH, 1967 EDITION, LATEST REV. - U.S. STEEL PUB., AND SHALL BE FOLLOWED IN FABRICATION.
3. WELD ELECTRODE SHALL BE TYPE E7018, AS PER A.W.S. A5.1
4. WELDING SHALL BE DONE USING THE ELECTRIC ARC PROCESS BY WELDERS HOLDING CURRENT A.W.S. WELDING CERTIFICATES FOR EACH REQUIRED WELDING PROCEDURE.
5. FINISH: DEGREASE-PAINT: PRIME COAT SHOP PROOF RED RUSTOLEUM #769 OR EQUAL-EXCEPT DO NOT PAINT MACHINED SURFACES
6. EST. WT. 17000 LBS.




**DETAIL W1-1**
WELD SEQUENCE
ALTERATIONS TO EXISTING BRIDGE (NORTH FACE)

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

D-ZERO DETECTOR
END CALORIMETER NORTH BRIDGE MODIFICATION

3740.312-ME-295598

Plotted by gjs on 29-May-96

FERMILAB
# ENGINEERING NOTE

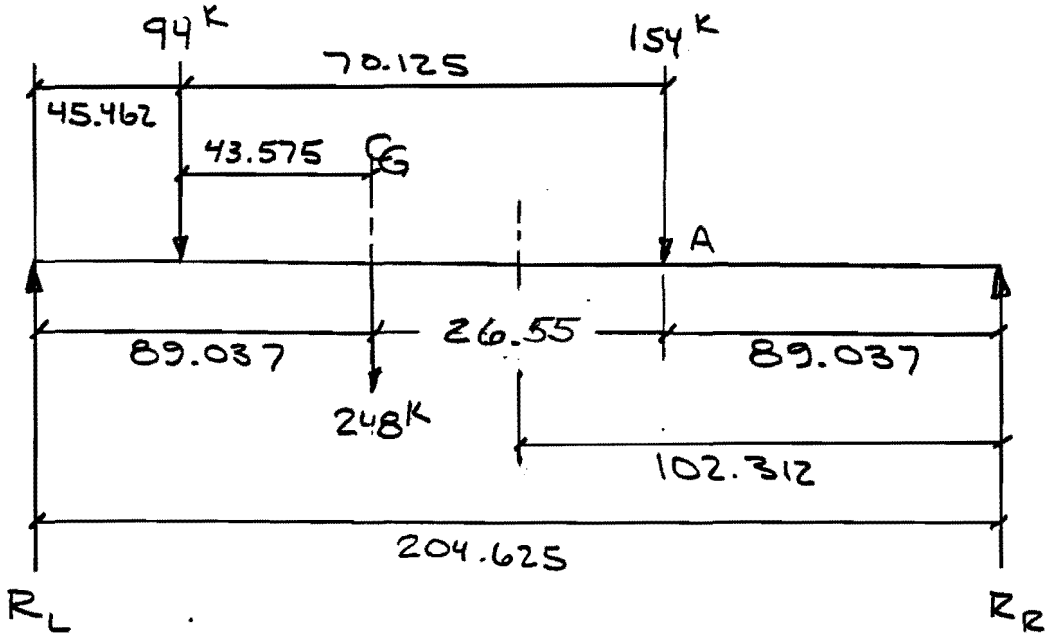
| SECTION | PROJECT | SERIAL-CATEGORY | PAGE |
|---|---|---|---|
| | | | 1/3 |

SUBJECT: MOMENT & REACTIONS - EC LOAD MODIFIED TRANSFER BRIDGE (ME-295598)

NAME: H. STREDDE

DATE: 6-6-96

REVISION DATE:



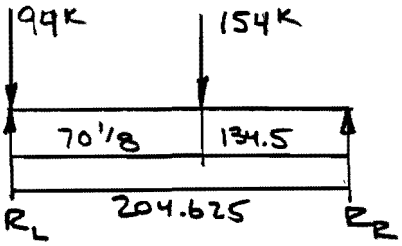

$$\overset{+}{\circlearrowright} \Sigma M_{R_L} = 0 = (248^K)(89.037) - (204.625)(R_R)$$

$$R_R = 107.9^K$$

$$R_L = 140.1^K$$

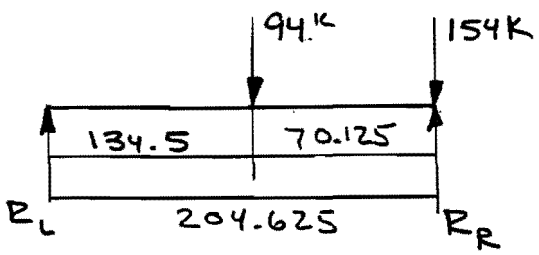
$$M_{max} = 140.1^K(45.462 + 70.125) - 94^K(70.125)$$

$$(\xi_A) = \boxed{9602 \text{ K-in.}}$$




$$R_R = \frac{70.125}{204.625} \times 154^K = 53^K$$

$$R_L = 154 - 53 + 94 = 195^K$$




MAX $\Rightarrow$ $$R_R = \frac{134.5}{204.625} \times 94^K + 154 = 216^K$$

$$R_L = 94 - 62 = 32^K$$

SECTION PROPERTIES:

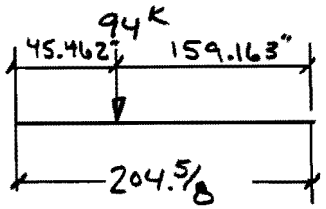
2- S24x121 BEAMS WELDED TOGETHER W/ 1½x18 TOP & BOTTOM CAP PLATES.

$I = 15{,}797 \text{ in}^4$; $S = 1170 \text{ in}^3$.

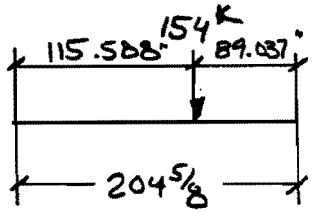
$$\text{Max } f_b = \frac{M}{S} = \frac{9602 \text{ k-in}}{1170} = 8{,}207 \text{ psi}$$

$$\text{WEB SHEAR} = \frac{216000}{2 \times .813 \times 24.5} = 5425 \text{ psi}$$

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




(A)




(B)

$\Delta_{CTR-A} = 0.023" \downarrow$

$\Delta_{CTR-B} = 0.058" \downarrow$

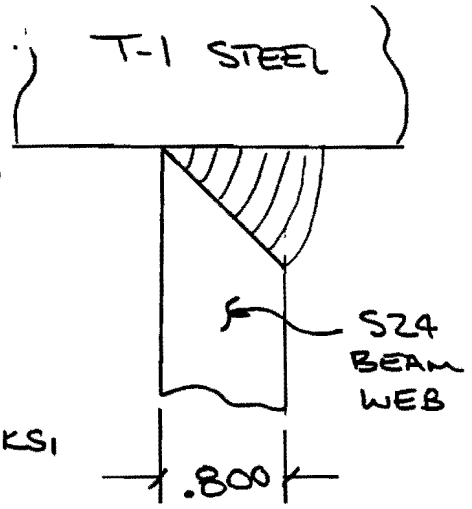
TOTAL $\Delta_{CTR} = 0.081" \downarrow$

SUBJECT: MODIFIED TRANSFER BRIDGE - WELD STRESS (T-1 STEEL TO I-BEAM WEB)

NAME: H. STREDDE

DATE: 7-9-96 REVISION DATE:

MAX. LOAD = 216 KIPS
AREA OF WEB = $24.5 \times .8 = 19.6$ IN.$^2$
ALLOWABLE SHEAR STRESS (WEB) = $.4 \times 36$ KSI = 14.4 KSI
ALLOWABLE SHEAR STRESS (WELD) = $.3 \times 70$ KSI = 21 KSI




WEB SHEAR STRESS

$$\tau = \frac{216 \text{ KIPS}}{19.6 \text{ IN}^2 \times 2} = 5.10 \text{ KSI} < 14.4 \text{ KSI}$$

WELD SHEAR STRESS (FULL PENETRATION)

$$\tau = \frac{216 \text{ KIPS}}{19.6 \text{ IN}^2 \times 2} = 5.10 \text{ KSI} < 21 \text{ KSI}$$

July 9, 1996

TO: Richard Andrews, Chair D0 Mech. Safety Review Panel

FROM: H. J. Stredde, D0 Mech. Group

SUBJECT: Non-Destructive Weld Inspection

The critical welds of the modified Transfer Bridge were inspected on June 14 at D0 by a technician representing STS Consulting Engineers. The method of inspection was an ultrasonic review. The critical welds were the single bevel groove welds connecting the T-1 steel section to the I-Beam webs. The result of this inspection is shown on the attached copy of the field report. The report indicates that the welds are acceptable, with no voids and are full penetration as specified.

I had the technician also check the welds on the original CC installation bridge. This weldment was originally checked by a different company, MQS and a copy of that test result is included. It is obvious that the report by MQS is more detailed than that of the current company the Lab. now uses. However, the overall results of both tests seem to agree, i.e. no voids and good fusion between members.

The attached copy of the STS report needs some clarification. The weld joint is identified as TC-U4A. This joint designation is shown on the attached copy of Figure 2.4 section 2.9.1, page 13 of AWS D 1.1 Welding Standard. Under remarks, the term NOT VOLUMETRIC is used. This means the weld was reviewed from one side only. A both side review is not possible. The weld locations are noted as member 1, welds 1 & 2, which are the newly modified bridge and member 2, welds 1 & 2, which are those of the CC Installation Bridge (previously checked by MQS). The STS report indicates no type of discontinuity.

Further, in response to the Panel's request, the original calculations of the transfer bridge were reviewed and revised, to correct some errors. Additionally, calculations have been added to determine the shear stress on the weld connection between the T-1 and I-beam web of the modified structure. These calculations are included with this memo.

# TEST REPORT

# MODIFIED BRIDGE

# FIELD REPORT
## Construction Technology Group

NOTE: The responsibilities and authority of STS and STS' Field Personnel include neither the responsibilities nor the authority of the "Competent Person" for the project site as defined by OSHA Regulations: 29 CFR 1926 Subpart P.

____ of ____

Project Fermi Lab
Project No. 12050
Location Bldg D-0
Contractor DSE

Report No. ____
Day/Date Fri 6-14-96
Weather/Temp. 75° Sunny
Client DOE

Project Competent Person per 29 CFR Part 1926 (Subpart P)
NAME: ____
FIRM: ____
ADDRESS: ____
PHONE: ____
Present on Site ☐YES ☐NO

Equipment Rental —
Tolls $ —
Parking $ —
Mileage —
Project Preparation Time ____

Arrive Job 7 00
Depart Job 9 45
Total Hours on Job 2.75
Travel Time .25

TOTAL CHARGEABLE HOURS
4 hour minimum
3.0

Summary of technical and/or engineering services performed, including field test data. Locations, elevations and depth are estimated.

Performed Ultrasonic Reviews of the accessible Full Penetration Groove Welds @ the Bridge Support Members. The reviews conform to AWS D1.1-94 (Sec. 6 & 8 requirements (Ref UT Record #1)

* ☐ Field Test Data is Estimated - Pending Final Laboratory Test Results

Field Representative W. Miller
Position ____
Company ____

Site Sketch: Indicate North

By Gerald V. White
Title NDT Level III
STS Consultants Ltd.

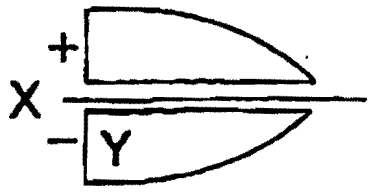
White - Office White - Field Yellow - Time Card 1/96pp7.5k

STS Consultants Ltd.
Consulting Engineers

# STS Construction Services Group
# Ultrasonic Test Record No. 1

Project Fermi Lab — STS Project No. 12050 D-

Location Bldg. D-0 — Date 6-14-96




Plan View

Weld Identification Single Bevel / Groove

Material Thickness 3/4" & 1 1/2

Weld Joint AWS TC-U4a

Welding Process —

Quality Requirements - Section No. AWS D1.1-94 (Sec 6 in part)

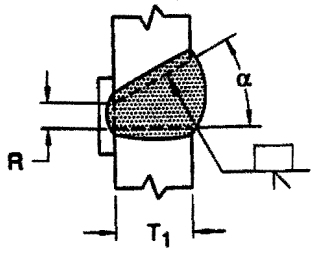
Remarks Primer is on members tested / Some welds not volumetric Reviewed

| Date | Weld Location | Acceptable | Rejectable | Procedure Legend No. | Transducer Angle | Node | Data Described in AWS D 1.1-86, Section 6 — Decibels: Defect Level (A) | Reference Level (B) | Attenuation Factor (C) | Defect Rating (D) | Discontinuity: Angular Distance (Round Path) | Length | Depth from "A" Surface | Distance from Weld Center "X" | Distance from Weld End "Y" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-14-96 | Member ① to ② weld ② | ✓ | | 1 | 70° | 1/2 | | 41 | | | | | | | |
| 〃 | Member ① weld ① | ✓ | | 1 | 70° | 1/2 | | 41 | | | | | | | |
| 〃 | Member ② weld ① | ✓ | | 1 | 70° | 1/2 | | 41 | | | | | | | |
| 6-14-96 | Member ⑤ weld ② | ✓ | | 1 | 70° | 1/2 | | 41 | | | | | | | |

Manufacturer or Contractor _____

STS Representative Gerald V. White

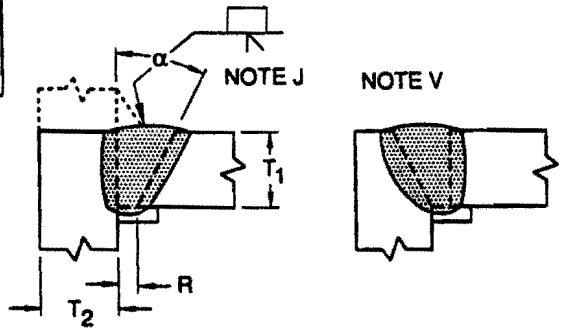
Single-bevel-groove weld (4)
Butt joint (B)




| Tolerances | |
|---|---|
| As Detailed (see 2.9.2) | As Fit Up (see 3.3) |
| R=+1/16,-0 | +1/4,-1/16 |
| α = +10°, - 0° | +10°, - 5° |

| Welding Process | Joint Designation | Base Metal Thickness (U = unlimited) $T_1$ | Base Metal Thickness (U = unlimited) $T_2$ | Groove Preparation: Root Opening | Groove Preparation: Groove Angle | Permitted Welding Positions | Gas Shielding for FCAW | Notes |
|---|---|---|---|---|---|---|---|---|
| SMAW | B-U4a | U | — | R=1/4 | α = 45° | All | — | Br,N |
| | | | | R=3/8 | α = 30° | All | — | Br,N |
| GMAW FCAW | B-U4a-GF | U | — | R=3/16 | α = 30° | All | Required | A,Br,N |
| | | | | R=1/4 | α = 45° | All | Not req. | A,Br,N |
| | | | | R=3/8 | α = 30° | F | Not req. | A,Br,N |

Single-bevel-groove-weld (4)
T-joint (T)
Corner joint (C)




| Tolerances | |
|---|---|
| As Detailed (see 2.9.2) | As Fit Up (see 3.3) |
| R=+1/16,-0 | +1/4,-1/16 |
| α = +10°, - 5° | +10°, - 5° |

| Welding Process | Joint Designation | Base Metal Thickness (U = unlimited) $T_1$ | Base Metal Thickness (U = unlimited) $T_2$ | Groove Preparation: Root Opening | Groove Preparation: Groove Angle | Permitted Welding Positions | Gas Shielding for FCAW | Notes |
|---|---|---|---|---|---|---|---|---|
| SMAW | TC-U4a | U | U | R=1/4 | α = 45° | All | — | J,Q,V |
| | | | | R=3/8 | α = 30° | F,V,OH | — | J,Q,V |
| GMAW FCAW | TC-U4a-GF | U | U | R=3/16 | α = 30° | All | Required | A,J,Q,V |
| | | | | R=3/8 | α = 30° | F | Not req. | A,J,Q,V |
| | | | | R=1/4 | α = 45° | All | Not req. | A,J,Q,V |
| SAW | TC-U4a-S | U | U | R=3/8 | α = 30° | F | — | J,Q,V |
| | | | | R=1/4 | α = 45° | | | |

Note A: Not prequalified for gas metal arc welding using short circuiting transfer. Refer to Appendix A.

Note Br: Dynamic load application limits these joints to the horizontal position (see 9.12.5).

Note C: Backgouge root to sound metal before welding second side.

Note J: If fillet welds are used in statically loaded structures to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 $T_1$, but need not exceed 3/8 in. Groove welds in corner and T-joints of dynamically loaded structures shall be reinforced with fillet welds equal to 1/4 $T_1$, but not more than 3/8 in.

Note N: The orientation of the two members in the joints may vary from 135° to 180° provided that the basic joint configuration (groove angle, root face, root opening) remain the same and that the design weld size is maintained.

Note Q: For corner and T-joints, the member orientation may be changed provided the groove angle is maintained as specified.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

**Figure 2.4 (continued) — Prequalified Complete Joint Penetration Groove Welded Joints (see 2.9.1)**