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Project Title/Work Order Miscellaneous Component Design for Tank 241SY101 Pump Removal N2B2K		EDT No. 608386 ECN No. NA

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Page 1 of 1

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1	/	Cog. Mgr. C. E. Hanson	<i>C. E. Hanson</i>	2/24/95	H5-09	ESA Mngr. R.B. Pan	<i>R.B. Pan</i>	2/8/95	H5-53	1	/
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1	/	Safety G. E. McPherson	<i>G. E. McPherson</i>	1/3/94	I6-10						
1	/	T. C. Mackey	<i>T. C. Mackey</i>	1/3/94	S2-03						
1	/	Indep. Review J. S. Burgess	<i>J. S. Burgess</i>	2/19/94	H5-53						

18. F. H. Huang <i>F. H. Huang</i> Signature of EDT Originator Date 12/9/94	19. <i>M. J. Ostrom</i> M. J. Ostrom 2-24-95 Authorized Representative for Receiving Organization Date	20. <i>C. E. Hanson</i> C. E. Hanson Cognizant/Project Engineer's Manager Date 2/24/95	21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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Document Number: WHC-SD-WM-DA-168, REV 0

Document Title: Miscellaneous Component Design for Tank 241SY101
Pump Removal

Release Date: 2/28/95

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz

February 28, 1995

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SUPPORTING DOCUMENT		1. Total Pages, <u>313</u>
2. Title Miscellaneous Component Design for Tank 241SY101 Pump Removal	3. Number WHC-SD-WM-DA-168	4. Rev No. 0
5. Key Words Analysis, Bending, Mock-up pump Test weight, Support saddle, Spreader beam, Safety factor, weld strength, lifting lug APPROVED FOR PUBLIC RELEASE	6. Author Name: F. H. Huang <i>F. H. Huang</i> Signature Organization/Charge Code 8D430/A226A <u>N2B2K</u>	
7. Abstract The disposal equipment is designed for use in removing the hydrogen mixer pump from tank 241SY101. The design of the structural elements of the equipment is based on the design criteria established for this task as shown in Reference WHC-SD-WM-DA-165. AEC designed and analyzed the lifting beam, support saddles, test weight, and modified mock-up pump. WHC conducted additional analyses on the test weight, mock-up pump, removable support, and saddle modification for air pallets. The calculations meet the strength requirements and verify the equipment with the load chart for the equipment removal system (ERS) for tank 241SY101. <i>CAF 2/24/95</i> <i>KMS 2/29/95</i>		
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MISCELLANEOUS COMPONENT DESIGN FOR TANK 241SY101 PUMP REMOVAL

December 1994

PREPARED BY: F. H. Huang Date 12/9/94
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REVIEWED BY: J. S. Burgess Date 12/9/94
J. S. Burgess
Equipment Stress Analysis

APPROVED BY: R. B. Pan Date 12/15/94
R. B. Pan, Manager
Equipment Stress Analysis

Westinghouse Hanford Company
Hanford Operations and Engineering Contractor
for the
U. S. Department of Energy

MASTER

DESIGN VERIFICATION METHOD

The need for design verification has been reviewed with the method selected as indicated below:

<u> x </u>	Independent Review
<u> </u>	Alternate Calculations
<u> </u>	Qualification Testing
<u> </u>	Formal Design Review

R. B. Pan
Cognizant/Project/Design Manager

SD #WHC-SD-WM-DA-168

ECN # NA

TYPICAL CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed WHC-SD-WM-DA-168

Author F. H. Huang

Yes No N/A

☒	☐	☐	Problem completely defined.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☐	☐	☒	Mathematical derivations checked including dimensional consistency of results.
☐	☐	☒	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors.
☐	☐	☒	Code run streams correct and consistent with analysis documentation.
☒	☐	☒	Code output consistent with input and with results reported in analysis documentation.
☒	☐	☐	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.

MANDATORY Software QA Log Number N/A

J. S. Burgess *J. S. Burgess*
Reviewer

12/9/94
Date

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MISCELLANEOUS COMPONENT DESIGN FOR TANK 241SY101 PUMP REMOVAL

1.0 INTRODUCTION

A mixer pump has been used to mitigate the hydrogen build-up in tank 241SY101 (SY101), located in the 200 West Area of the Hanford Site. New equipment is being prepared for the removal, transport, storage, and disposal of the test pump. The disposal equipment for the test pump now in tank SY101 includes a shipping container, a strongback, a lifting beam, a test weight, container support stands, a modified mock-up pump, a flexible receiver blast shield, a lifting yoke, and a yoke brace. The structural evaluations of container and strongback are detailed in another supporting document (WHC 1994a), the engineering analyses of flexible receiver blast shield/lifting yoke and yoke brace are given in other supporting documents (WHC 1994b, WHC 1994c), respectively. Engineering tasks that were contracted to Advanced Engineering Consultants (AEC) include the design and analysis of the following.

- Two spreader-beam lifting devices.
- Container test weight.
- Container support saddles.
- Mock-up pump modification.

This report documents the work description, design basis, assumptions, and design calculations provided by AEC for the above components. All AEC documents appear in Appendix A. Additional work conducted by Westinghouse Hanford Company (WHC) on the modified container test weight, modification to the mock-up pump, the removable support for the transport assembly, and saddle modification for air pallets also are included in this document.

This supporting document reports on the structural analysis of the equipment based on requirements for safety class 3 (DOE-RL 1993a), the *Manual of Steel Construction* (AISC 1989), and the *Hanford Hoisting and Rigging Manual* (DOE-RL 1993b).

2.0 SUMMARY

The disposal equipment is designed for use in removing the hydrogen mixer pump from tank SY101. The design of the structural elements of the equipment is based on the design criteria established for this task as shown in WHC 1994a. AEC designed and analyzed the lifting beam, support saddles, test weight, and modified mock-up pump. WHC conducted additional analyses on the test weight, mock-up pump, removable support, and saddle modification. The calculations meet the strength requirements and verify the equipment with the load chart for the equipment removal system (ERS) for the tank, as shown in Figure 1, which illustrates the design wind, live, and dead loads for the trailer and strongback.

3.0 DISCUSSION

The design criteria are listed in WHC 1994a and in Appendix A. The following allowable stresses are used for the structural calculations of steel members and connections in those critical components of tank SY101 that are of A-36 steel or other mild steels: 12,000 lbf/in² for bending, tension, axial compression, and bearing stresses; 7,200 lbf/in² for shear stress; 7,200 lbf/in² on the effective area for welds; and one-half the allowable stresses given in AISC 1989 for bolts. Basically, the allowable stresses are one-third the yield strength.

3.1 Spreader Beam

The major part of the 7.5-ft-long spreader beam is made of W18X106. A 3-in-thick lug with a 2 13/16-in diameter hole is full-penetration welded to the top of the W beam. Underneath the lug plate are two 1/2-in. stiffener plates welded to each side of the beam to ensure that stress is transferred from the flange to the web. The calculations consider the stresses of the spreader beam for a design load of 125 kips and a rated load of 100 kips per DOE-RL-92-36 (DOE-RL 1993b).

3.2 Support Saddle

The container support saddles are designed to withstand a linear uniform load of 2,455 lb/ft, concentrated loads of 5,000 and 7,000 lb, and a wind load of 11.43 lbf/ft². The 2,455 lb/ft uniform load is not shown in the Figure 1 load chart because the weight of the radiation shielding material is not included in Figure 1. Also, the 11.43 lbf/ft² wind load differs from the Figure 1 load chart value of 10 lbf/ft² because the container is subjected to different design wind velocities in the vertical position versus the horizontal storage position. Each saddle, measuring 4 by 8 by 1.5 ft in height, is designed to ensure that the Central Waste Complex floor slab is not damaged. Two lugs are welded at the tops of the saddle ends to hold the container with a chain. The calculations check the bending and the tear-out stresses on the lugs. The sliding force and overturning moment from wind meet the required safety factor of 1.5.

3.3 Test Weight

The test weight assembly, used for testing the hydraulic system on the trailer, is designed to simulate the pump weight. During testing, the test weights are attached at the top of the container. The total weight of the test weight assembly (16,324 lb) was determined by evaluating the load chart in Figure 1. Placing the test weight assembly at the top of the container simulates the load on the hydraulic system as if the pump was actually in the container. This weight is equivalent to 125% of the actual weight of the pump lifted by the hydraulic system. The weight assembly consists of a bulkhead

plate, removable filler plates, and support legs. Six 5-ft by 5-ft by 2-in. filler plates are required to make a test weight assembly of 16,324 lb. The center of gravity (C.G.) for the assembly is calculated to determine the location of hole of each filler plate through which a 3-in.-diameter rod is used for horizontal lift. The AEC calculations check the tear-out resistance of the vertical and horizontal lugs. The calculations also check the weld strengths and bending stresses of the support legs (W8X28 beams) and the lug plates. After AEC completed the design, a live load of 3,000 lb was added at the top of the container near the test weight, so the weight of the test weight had to be recalculated. With a hydraulic force of 203,600 lb and an updated container uniform load of 928 lb/ft compared to 1,000 lb/ft shown in Figure 1, the weight of the new test weight is calculated to be 20,657 lb. A slight modification on the AEC design was made by adding two 2-in.-thick filler plates. This change necessitated a reanalysis of the weld strengths and bending stresses of the support legs and the lug plates to ensure that the AISC requirements were still met (see Appendix B).

3.4 Mock-up Pump Modification

A mock-up pump is used to simulate installation and removal of the actual pump. To verify the lifting capacity of the cradle and for testing the hydraulic trailer, the mock-up pump is made with its dimensions, weight, and C.G. equivalent to those of the actual pump. AEC made some modifications to the existing mock-up pump to simulate the weight and C.G. of the actual pump and designed removable disks that can be attached to the mock-up pump. To simplify lifting the mock-up pump, a two-point lifting was designed. Both lifting points are at the locations 14 ft from the two ends of the mock-up pump.

The dimensions of the pump sections and the locations of the disks are shown in drawing H-2-83749. The maximum bending stress with an impact factor of 125% during horizontal lifting is 9,200 lbf/in², less than the allowable stress of 12,000 lbf/in² (Appendix C).

3.5 Removable Support for the Transport Assembly

The temporary container support will be attached to the lateral support cradle for the container after the container is raised hydraulically to the vertical position to accept the experimental pump. Once the pump is inserted into the container, both pump and container are rotated and lowered to rest on the removable support, which is inclined 7° with respect to the ground. The container support is inclined to prevent fluid from draining from the contaminated pump while it rests on the support to allow the following tasks: removing the external container funnel from the container inner flange, cutting off the 16-in. pump column, and installing the inner and outer container caps. To minimize contamination during work, an 11- by 11-ft shielding plate is attached vertically to the trailer support. After these

tasks are completed, the container is raised and the removable support for the transport assembly is removed. The container then is lowered to the horizontal position and transported to the shot loading area designated to receive it.

The total weight of the container and pump with an impact factor of 125% is 83,000 lb. The bearing stress of the W30x191 beams, which support the container, the pump, and the shielding plate, is checked to be within the allowable stress. The web crippling of the beams also is found to be below the load limit. Standing above the beams is the shielding plate, which has a face 11 by 11 ft receiving significant wind load. The wind pressure acting on the 11- by 11-ft shielding plate is 19.35 lbf/ft², or a total force of 2,340 lb against the plate, estimated on the basis of SDC 4.1 (DOE-RL 1993a) for safety class 3 structures. Analysis that shows bending of the 1-in. shielding plate as a result of wind load meets the strength requirements of the AISC (1989).

The vertical shielding plate is supported by two braces that consist of L4x3 and L3x3. The strength of each brace is found to satisfy the design criterion. Analysis also shows that the strength of eight 1-in. bolts used to fasten the shielding plate to the existing trailer support is adequate to support the weights of the plate (4,940 lb) and the vertical load of the inclined container (41,347 lb). A significant moment acting on the shielding plate as a result of the eccentric container reactions indicates a need to add stiffeners to reinforce the plate. Calculations determine that three stiffeners ¾-in. thick and 5-in. wide with a spacing of 5 ½ in. meet the strength requirements of the AISC for the combined axial and bending stresses of the reinforced shielding plate (see Appendix D for calculation details). All welds in the removable support are found to have adequate strength.

3.6 Saddle Modification for Air Pallets

Because air pallets will be used to move the container and pump into the 2403WD storage building, the container support saddles are modified to accept two air pallets for each support. The size of the air pallets is determined from the reaction force at a location 68 in. from the top cap of the container. On the basis of the linear uniform load of 2,455 lb/ft and concentrated loads of 5,000 and 7,000 lb, the reaction force is found to be 73,053 lb. With the allowable soil bearing pressure of 2,600 lb/ft², calculations determine that two 5- by 5-ft air pallets are needed to withstand a load of 80,000 lb, which is slightly higher than the half-weight of the container assembly.

The container and pump will be chained to the supports, which rest on the concrete pad. The support is designed to have two air pallets installed underneath and to be capable of resting on the concrete pad without damaging the facility floor. Calculations show that the support need a contact area with the floor of 20 by 120 in. on each side before the air pallets are activated. Thus, the support requires dimensions of 102 by 120 in. with center base area of 62 by 120 in. above the floor to accommodate the two

pallets. To satisfy the AISC strength requirement for bending of the support with a span of 62 in., five W12x19 beams are needed to support the container and pump before the air pallets are inflated. The bending and shear stresses on the 1-in. support plate placed above the beams are calculated to be smaller than the allowable stresses (see Appendix E).

Two fork lifts will guide the assembled container, pump, and saddle support into the facility building after the air pallets are activated and the assembly clears the floor by approximately 1 in. A tow bar is designed to attach to the W12x19 beams on the container support; the end of the tow bar has an eye for connection to the fork lift with a trailer hitch pin. The tow bar eye is located at the intersection of two square tubes (5 by 5 by 1/4 in.) that weld to vertical 1 1/2-in.-thick plates. With pins inserted through the vertical plates and held by the support structure, the tow bar eye is capable of rotating so that it can reach the connector of the fork lift, which is 6 to 12 in. higher than the container support. Because the square tube is much stiffer than the plate, the structural evaluations for the tow bar consider the combined bending and compression of the vertical plate subjected to a maximum load of 18,000 lb and restrained by the square tube. Analysis of an elastic straight beam with one end guided and the other end simply supported (Young 1989) determines that the combined maximum bending and compression stresses of the plate satisfy the strength requirements of the AISC for structural members subjected to combined stresses. Details of the calculations appear in Appendix E.

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- ASNI, 1986, *Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More*, American National Standard Institute, New York, New York.
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- WHC, 1994a, *Analysis of Container and Strongback for Pump Removal from Tank 241SY101*, WHC-SD-WM-DA-165, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1994b, *Analysis of the Flexible Receiver Lifting Yoke and Blast Shield Assembly (Tank 241SY101)*, WHC-SD-WM-DA-160, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994c, *Structural Analysis: Flexible Receiver Yoke Brace for the 241SY101 Mixer Pump*, WHC-SD-WM-DA-157, Westinghouse Hanford Company, Richland, Washington.

Young, 1989, *Roark's Formulas for Stress and Strain*, McGraw-Hill, Inc., New York, New York.

Figure 1 Load Chart of the Equipment Removal System for Tank 241SY101.

Appendix A

Temporary Pump 2 Structural Engineering Support of
Hydrogen Mitigation in Tank SY-101

Advanced Engineering Consultants
San Francisco, California

**Advanced
Engineering
Consultants**

180 Montgomery Street, Suite 850 San Francisco, CA 94104
Telephone: (415) 291-9600 Fax: (415) 291-9696

WHC-SD-WM-DA-168

REV. 0

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July 15, 1994

Mr. Randy Jorissen
Westinghouse Hanford Company
P.O. Box 1970, H5-56
Richland, WA 99352

Subject: Calculations for Temporary Pump 2 Structural
Engineering Support of Hydrogen Mitigation in
Tank SY101, Task 2 of BOA 322666

Dear Mr. Jorissen:

Enclosed is the final set of the subject calculations. This completes our work scope for this Task Order. This has been a challenging and interesting project. Mike Chiao and I have enjoyed working with you and Mr. Tom Mackey on this project, and hope to be able to work with you on future projects.

Please call me if you have any questions.

Very truly yours,

Lincoln E. Malik
President

LEM:rm

Enclosure

Form 3.3-3
Advanced Engineering Consultants
Calculation Cover Sheet

SHEET 1

WHC-SD-WM-DA-168
REV. 0

PAGE A-3

Job Number: 4001-02

Calculation Number: CA 4001-02-1

Client: WESTINGHOUSE HANFORD COMPANY

Project: 241 SY101 MIXER PUMP PROJECT

Title: TEMPORARY PUMP 2 STRUCTURAL ENG SUPPORT FOR HYDROGEN MITIGATION

Total number or pages (Including cover sheet): 126 (1 SHT, COVER; 3 SHTS, TABLE OF CONTENTS; 99 SHTS, CALCS AND; 23 SHTS, ATTACHMENTS)

Total number of computer runs: —

Description: TANK 241SY101 (SY101), LOCATED ON THE HANFORD SITE, IS AN UNDERGROUND REINFORCED CONCRETE STORAGE FACILITY CONTAINING HIGHLY RADIOACTIVE LIQUID AND SEMI-SOLID WASTE. A LONG, SLENDER MIXER PUMP IS INSTALLED IN THE TANK. IF THE PUMP FAILS, IT MUST BE REMOVED IMMEDIATELY AND REPLACED WITH A DIFFERENT PUMP. AEC PROVIDES ENGINEERING SUPPORT FOR THE REMOVAL & INSTALLATION OPERATION; SPECIFICALLY, DESIGNS OF SPREAD-BEAMS, SUPPORT SADDLES FOR CONTAINER IN WHICH THE REMOVED PUMP WILL BE ENCLOSED, AND CONTAINER TEST WEIGHTS THAT SIMULATE ACTUAL PUMP WEIGHTS AND MODIFICATION OF THE EXISTING DUMMY PUMP WILL BE DONE

Design bases/references:

1. ALLOWABLE STRESSES CONTAINED IN DESIGN CRITERIA USED IN WHC C-106 PROJECT ARE USED.
2. REVISED LOAD CHART - 101SY DATED 5/10/94 BY RANDY JORISSEN
3. LOAD CHART, 101SY
4. DWG. H-2-83734, R0, TITLE: HYDROGEN MIXER PUMP STORAGE CONTAINER
5. MPA DUMMY, DWG. SK-2-24086 R0
6. DWG. H-2-80901, R2 BY US DEPT. OF ENERGY, STRL. FOUNDATION, PLAN & DATA

Revision No.

Description of revision

Approved by/date

0

Lincoln D. McNeil 7/4/94

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Rev. No. 0
By MLM Date 6/7/94
Chk'd W.K.M Date 6/7/94

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Chk'd W. K. HUI Date 6/7/94

Subject TEMPORARY PUMP 2 -
INTRODUCTION

1. INTRODUCTION

TANK 241 SY 101 (SY 101), LOCATED ON THE HANFORD SITE, IS AN UNDERGROUND REINFORCED CONCRETE STORAGE FACILITY CONTAINING HIGHLY RADIOACTIVE LIQUID AND SEMI-SOLID WASTE. A LONG, SLENDER MIXER PUMP IS INSTALLED IN THE TANK. IF THE PUMP FAILS, IT MUST BE REMOVED IMMEDIATELY AND REPLACED WITH A DIFFERENT PUMP.

THE DESIGN CALCULATION DOCUMENTS THE WORK PERFORMED BY THE ADVANCED ENGINEERING CONSULTANTS (AEC) ON FIVE ENGINEERING TASKS, LISTED BELOW AND AGREED WITH WHC IN "WORK PLAN" DOCUMENT. AEC PROVIDES:

TASK 1: DESIGN CALCULATIONS AND SKETCHES FOR TWO SPREADER-BEAM LIFTING DEVICES;

TASK 2: DESIGN OF CONTAINER SUPPORT SADDLES;

TASK 3: CONTAINER TEST WEIGHTS

TASK 4: CRADLE TEST LOADS

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Subject TEMPORARY PUMP 2 -
REFERENCES

1.1 REFERENCES

1. ALLOWABLE STRESSES CONTAINED IN DESIGN CRITERIA USED IN WHC E-106 PROJECT.
2. REVISED LOAD CHART-101SY DATED 5/10/94 BY RANDY JORISSEN, WHC & LOAD CHART 101SY
3. DWG. H-2-83734, R0, TITLE: HYDROGEN MIXER PUMP STORAGE CONTAINER BY WHC
4. DWG SK-2-24086, R0, MPA DUMMY BY WHC
5. DWG H-2-80901, R2, TITLE: STEEL FOUNDATION, PLAN & DETAILS BY U.S. DEPT. OF ENERGY.
6. CORRESPONDENCES BETWEEN AEC & WHC
7. AISC, ASD, NINE EDITION, STEEL CONSTRUCTION MANUAL
8. UBC, 1991 EDITION
9. "FORMULAS FOR STRESS AND STRAIN" BY ROARK

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Subject TEMPORARY PUMP 2 -

DESIGN CRITERIA

1.2

DESIGN CRITERIA

(FROM PROJECT C106, UNLESS
NOTED)

STRESSES

ALLOWABLE BENDING, TENSION & COMPRESSION:

$$F_b = 12 \text{ ksi}$$

$$F_t = 12 \text{ ksi}$$

$$F_c = 12 \text{ ksi}$$

(WHERE BUCKLING IS NOT A
CONCERN & THERE ARE NO BENDING
MOMENTS)

SHEAR: $F_v = 7.2 \text{ ksi}$

BEARING: $F_p = 12 \text{ ksi}$

CONNECTIONS:

BOLTS - USE HALF THE CAPACITY OF AISC,
ASD 9TH ALLOWABLES.

PINS - $F_p = \frac{0.9 F_u}{2} = 0.45 F_u = 16.2 \text{ ksi}$

RODS -

$$F_t = \frac{0.33 F_u}{2} = 0.16 F_u = 9.57 \text{ ksi (AISC)}$$

$$F_b = \frac{0.75 F_y}{2} = 13.5 \text{ ksi (AISC)}$$

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Subject TEMPORARY PUMP 2 -
DESIGN CRITERIA (CONTINUATION)

WELDS - 7.2 KSI ON EFFECTIVE AREA WHICH EQUALS
TO EFFECTIVE THROAT X WELD LENGTH.
SPECIAL CASE FOR FILLET WELDS - CHECK
STRESS ON WELD LEG, NOT WELD THROAT
(DO NOT USE 0.707 FACTOR TO DETERMINE
THROAT AREA)

LOADS

WIND

(UBC)

IMPACT = 25%

(CORRESPONDENCES)

LOADS ON SADDLE
& TEST WEIGHTS

(REVISED 1015Y
LOAD CHART)

LOADS ON LIFTING BEAM = 125^K

(CORRESPONDENCE)

CONSIDER WIND LOAD ONLY,
NO SEISMIC LOAD

(CORRESPONDENCE)

SPEC

USE AISC, ASD. MANUAL FOR STEEL DESIGN

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Subject TEMP. PUMP 2
LIFTING BEAM ASSEMBLIES

2. LIFTING BEAM ASSEMBLIES

2.1 GEOMETRY & LOADS

AS PER CORRESPONDENCE (A FOLLOW-UP TO LINCOLN

MAUK & RANDY JORISSEN'S CONVERSATION ON 5/13/94):

- EACH LIFTING BEAM $\frac{150}{2} \times 1.25 \approx 94^k$

BUT INCREASES TO 125^k FOR DESIGN

- LIFTING LUG AT THE CENTER OF LIFTING

BEAM WILL HAVE A $2\frac{13}{16}" \phi$ HOLE FOR $2\frac{3}{4}" \phi$

PIN

- LIFTING LUGS ON THE SIDES OF THE CANISTER

HAVE BEEN MOVED OUTBOARD; THE REVISED

LOCATION IS $3'-2"$ FROM CENTERLINE OF

CANISTER TO INSIDE FACE OF LUG PLATE.

DISTANCE BETWEEN CENTERLINES OF LIFTING LUGS

$$L = 2 \times (3'-2") + 2" \text{ (LUG PLATE THICKNESS ON CANISTER)}$$
$$= 6'-6"$$

Subject TEMP PUMP 2
LIFTING BEAM ASSEMBLIES

LENGTH OF BEAM

$$= (6'-6") + 1' \quad (6" \text{ EACH END TO ACCOMMODATE CLEVISES \& END PLATES})$$
$$= 7'-6"$$

2.2 LIFTING BEAMS

IGNORE DEAD WT. OF THE BEAM ($1^k \pm$)

$$M = \frac{1}{4} \times 125 \times 78 = 2,437.5 \text{ K-"}^1$$

$$S = \frac{2,437.5}{12} = 203.1 \text{ IN}^3$$

$$V = 62.5 \text{ K}$$

MIN. WEB THICKNESS REQ'D, WEB YIELDING CRITERIA:

ASSUME $K = 1\frac{1}{2}"$, 12" BASE DIMENSION FOR 125^K

$$F_t \cdot t_w (12 + 5 \times 1.5) = 125^K$$

$$t_w = 0.534"$$

CHOOSE W18 x 106, $L_c = 11.8' > 6.5'$

$$t_w = 0.590", \quad d = 18.73", \quad b_f = 11.20", \quad t_f = 0.94"$$

$$S = 204 \text{ IN}^3 > 203.1 \text{ IN}^3$$

$$K = 1\frac{5}{8}" > 1\frac{1}{2}" \text{ (ASSUMED)}$$

OK!

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Subject TEMP Pump 2
LIFTING BEAM ASSEMBLIES

$$AU.V = 0.59 \times 18.73 \times 7.2 = 79.6^k > 62.5^k$$

OK!

2.3 LIFTING LUGS (LUG PLATES + PINS)

(i) LUG FOR 125^k:

AS PER WHC, PIN SIZE $2\frac{3}{4}" \phi$

MIN. LUG PLATE THICKNESS

$$F_p = 16.2^{ksi}, \quad t = \frac{125}{2.75 \times 16.2} = 2.81"$$

USE 3"

NET AREA AT CROSS SECTION TRANSVERSE

TO THE HOLE ($2\frac{3}{4} + \frac{1}{16} = 2\frac{13}{16}" \phi$) AND NORMAL

TO THE LOAD:

$$A_n = \frac{125}{12} = 10.42^{in^2}$$

$$EDGE \ DISTANCE = \frac{1}{2} \times \frac{10.42}{2.875} = 1.81" < 4 \times 3$$

OK!

EDGE DISTANCE PARALLEL TO THE LOAD:

MAX EDGE DISTANCE ALLOWED

$$= 0.8 \times 2\frac{13}{16} = 2.25"$$

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Subject TEMP. PUMP 2

LIFTING BEAM ASSEMBLIES

ALLOWABLE SHEAR CAPACITY

$$= 2 \times 3 \times \left(2.25 + \frac{2.75}{2}\right) \times 7.2$$

$$= 156.6^k > 125^k$$

OK

CROSS SECTIONAL AREA // LOAD REQ'D

$$A = \frac{2}{3} \times 10.42^{in} = 6.95^{in}$$

$$EDGE DISTANCE = \frac{6.95}{3} = 2.32^{in} \approx 2.25^{in}$$

$$RADIUS = 2.32 + \frac{1}{2} \times 2\frac{13}{16} = 3.72^{in}$$

USE 4" R, PL 3" THICK.

USE FULL PENETRATION TO WELD

THE LUG PLATE TO THE BEAM.

ADD 4 - $\frac{1}{2}$ " STIFFENER PLATES CENTERED

ON LUG PLATE AND WELD TO THE

BEAM WITH FILLET WELDS

TO INSURE THE

STRESS TRANSFER

FROM FLANGE TO

WEB.

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By M. K. M. Date 5/23/94

Chk'd W. K. M. Date 5/24/94

Subject TEMP. PUMP 2

LIFTING BEAM ASSEMBLIES

(ii) LUGS @ BOTH ENDS OF BEAM

USE WEB OF BEAM & ADD
REINFORCING PLATES.

PIN -

IT IS SUBJECTED TO
DOUBLE SHEAR.

$$A_v = \frac{62.5}{2} \times \frac{1}{7.2} = 4.34 \text{ in}^2$$

$$\frac{\pi d^2}{4} = 4.34 \quad d = 2.35 \text{ in}$$

USE $2\frac{1}{2} \text{ in } \phi$

LUG PLATES -

BENDING $F_p = 16.2 \text{ ksi}$

$$t = \frac{62.5}{2.5 \times 16.2} = 1.54 \text{ in}$$

USE $1\frac{3}{4} \text{ in}$

CHECK NET AREA @ CROSS SECTION THROUGH
PIN-HOLE IN $\perp$ TO THE LOAD DIRECTION.

EDGE DISTANCE FURNISHED

$$a = \left\{ 6 - \frac{1}{2} (2.5 + \frac{1}{16}) \right\} = 4.72 \text{ in}$$

TELEPHONE CONFERENCE M

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Company: WESTINGHOUSE HANFORD

Address: HANFORD 200 EAST

[] INCOMING

☒ OUTGOING

DATE: 8/25/94

TIME: 9:30

WITH: LINCOLN E. MALIK

OF: AEC

PHONE: 415-291-9696

WITH: TOM MARKEY

OF: WHC

PHONE: 509-373-3823

Copies to:

Name

Address

Subject: PINS FOR LIFTING BEAMS

Department

Telephone #

Summary of Conference

THE PINS "AS PROVIDED" ARE OK.
DESIGN OF PINS WAS BASED ON A36
AND ACTUAL PINS ARE HIGH STRENGTH.
SEE ATTACHED SHEET.

1. As required by AISC pg 4-151

2 pins @ $2\frac{1}{2}"\phi \times 6\frac{1}{4}"$ Long

$4\frac{1}{4}"$ between holes

2 pins @ $2\frac{1}{2}"\phi \times 6"$ Long

4" between holes

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2. As called out on drawing

2 pins @ $2\frac{1}{2}"\phi \times 6\frac{3}{4}"$ Long

$4\frac{3}{4}"$ between holes

2 pins @ $2\frac{1}{2}"\phi \times 7"$ Long

5" between holes

3. As provided

4 pins @ $2\frac{1}{2}"\phi \times 6\frac{1}{2}"$ Long

$5\frac{1}{4}"$ between holes

AISI 1035 Material per

Andrea @ Cleveland City Forge

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Subject TEMP. PUMP 2
LIFTING BEAM ASSEMBLIES

$$a = 4.72" < 4 \times 1.75 = 7.00" \\ \text{OK!}$$

A_n REQUIRED

$$= \frac{62.5}{12} = 5.21"$$

MIN. EDGE DISTANCE REQ'D

$$a = \frac{1}{2} \frac{5.21}{1.75} = 1.49" < 4.72" \\ \text{OK!}$$

EDGE DISTANCE // LOAD (MIN.)

$$a = \frac{2}{3} \times 5.21 \times \frac{1}{1.75} = 1.98" < 0.8 \times (2.5 + \frac{1}{16}) = 2.05"$$

REQ'D PER TEAR-OFF RESISTANCE

$$P = 62.5^k = 2 \times t \times (a + \frac{d}{2}) \times F_u$$

$$a = \frac{62.5}{2 \times 7.2 \times 1.75} - \frac{2.5}{2} = 1.23"$$

$$\therefore a = 1.98"$$

FROM CENTER OF PIN-HOLE TO LOWER
EDGE OF WEB

$$= \frac{1}{2} (2.5 + \frac{1}{16}) + 1.98$$

$$= 3.26" \quad \text{USE } 4"$$

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Chk'd Date

Subject TEMP. PUMP 2
LIFTING BEAM ASSEMBLIES

CHECK LOCAL STRESSES

$$V = 62.5 \text{ k}$$

$$f_v = \frac{62.5}{(17.73 - 2.5 - \frac{1}{16}) \times 1.75}$$

$$= 235 \text{ ksi} < 7.2 \text{ ksi}$$

ok

I : STATIC MOMENT ABT.
C OF WEB

$$(11.2 \times 0.94 + 17.73 \times 1.75) \bar{Y}$$

$$= 11.2 \times 0.94 \times \frac{17.73}{2} = 93.33$$

$$\bar{Y} = 2.25"$$

$$I = \frac{1}{12} \times 1.75 \times (17.73 - 0.94)^3$$

$$+ (17.73 - 0.94) \times 1.75 \times 2.25^2 \quad \text{WEB}$$

$$+ (11.2 \times 0.94) \times \left(\frac{17.73}{2} - 2.25\right)^2 \quad \text{FLANGE}$$

$$= 1,300 \text{ in}^4$$

SHEAR STRESS @ FLANGE + WEB JUNCTION AREA

$$Q = AY = 11.2 \times 0.94 \times 6.62 = 69.70 \text{ in}^3$$

$$\tau = \frac{62.5 \times 69.70}{1,300} = 3.35 \text{ ksi}$$

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Subject TEMP PUMP 2
LIFTING BEAM ASSEMBLIES

FILLET WELD PER $\frac{1}{16}$ " ALL $N = \frac{1}{16} \times 7.2 = .45 \frac{k}{in}$

WELD BOTH SIDES, SIZE WELD "D" IN $\frac{1}{16}$ "

$$\therefore 2 \times 0.45 \times D = 3.35$$

$$\therefore D = 3.7 \quad \text{OR} \quad \frac{4}{16} \text{ BUT MIN } \frac{5}{16} \text{ FOR PL } > \frac{3}{4}$$

FLEXURAL STRESS

$$M = 62.5 \times 6 = 375 \text{ k-in}$$

$$f_b = \frac{375}{1300} \times \left(\frac{17.73 - 0.94}{2} + 2.25 \right)$$

$$= 3.1 \text{ ksi} < 12 \text{ Low}$$

CHECK 1" STIFFENER PLATE @

1" OFFSET

$$h = 1 - \frac{0.94}{2} = 0.53$$

$$F = \frac{62.5 \times 7}{18.73 - 0.94} = 24.6 \text{ k}$$

$$S = \frac{1}{6} \times 11.2 \times 1^2 = 1.87 \text{ ksi}$$

$$f_b = \frac{24.6 \times 0.53}{1.87} = 7.0 \text{ ksi} < 12$$

OK!

Subject TEMP PUMP 2 -
LIFTING BEAM ASSEMBLIES

WELDS =

1. SEE FOR DETAIL OF LUG @ CENTER OF THE
BEAM.

2. LUG @ BOTH ENDS OF THE BEAM

a.) WEB PLATE $1\frac{3}{4}$ "

- TO FLANGE $\frac{5}{16}$ " FILLET WELDS, SEE P. 10

- TO $\frac{1}{2}$ " END PLATE, USE $\frac{5}{16}$ " FILLET WELDS (MIN.
AISC REQUIREMENT)

- TO 1" STIFFENER PLATE

TO BE CONSERVATIVE, IGNORE FLANGE AND

USE FILLET WELDS ON WEB TO RESIST

$$V = 62.5 \text{ K}, \quad M = 375 \text{ K-in}$$

$$f_v = \frac{62.5}{2 \times 16.79} = 1.87 \text{ K/in}$$

$$S = 2 \times \frac{1}{6} \times (16.79)^2 = 94.0 \text{ in}^3$$

$$f_b = \frac{375}{94.0} = 3.99 \text{ K/in}$$

$$f = \left[1.87^2 + 3.99^2 \right]^{\frac{1}{2}} = 4.39 \text{ K/in}$$

Subject

LIFTING BEAM ASSEMBLIES

$$\text{SIZE OF WELD} = \frac{4.39}{7.2} = 0.61" > \frac{5}{16}"$$

USE PARTIAL PENETRATION

$$E = 0.31" \quad \text{FOR } 1\frac{3}{4}" \text{ PLATE, MIN } E = \frac{3}{8}"$$

$$2 \times \frac{3}{8} < 1" \quad (\text{STIFFENER PLATE})$$

USE $\frac{3}{8}"$ PARTIAL PENETRATION &

REINFORCING $\frac{5}{16}"$ FILLET WELDS TO

ALLOW FOR TWISTING RESULTED FROM

MISALIGNING OF $1\frac{3}{4}"$ WEB PLATE &

BEAM WEB &

b) 1" STIFFENER PLATE

- TO TOP FLANGE

USE MIN. $\frac{5}{16}"$ FILLET WELDS

- TO BOTTOM FLANGE

... FULL PENETRATION AND GRIND FLUSH

- TOP WEB

USE MIN. $\frac{5}{16}"$ FILLET WELDS

$$2 \times \frac{5}{16} > t_w - 0.59"$$

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Subject: TEMP PUMP 2
LIFTING BEAM ASSEMBLIES

2.4 CLEVISES & RODS

RODS: $F_t = 9.57 \text{ ksi}$

$$\frac{\pi}{4} d^2 = \frac{62.5}{9.57}$$

$$d = 2.88" \phi$$

USE $3" \phi$ ROD

CLEVISES -

PIN $2\frac{1}{2}" \phi$ + ROD $3" \phi$

7 CLEVIS PER AISC 4-148

$$\text{CAPACITY} = 68.5^k > 62.5^k$$

RETAIN THE PINS W/ RECESSED PIN NUTS

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Subject

TEMP PUMP 2

LIFTING BEAM ASSEMBLIES

GRIP

BEAM SIDE

$$\text{GRIP} = \frac{1}{4} + 1.75 = 2.0"$$

USE 2"

CANISTER SIDE

$$\text{GRIP} = \frac{1}{4} + 2 = 2\frac{1}{4}"$$

CHECK BENDING ON PIN

BEAM SIDE IS MORE CRITICAL.

$$L = 2 + 1 = 3"$$

LOAD @ MID-SPAN

$$M = \frac{1}{2} \times 62.5 \times \frac{1}{2} \times \left(\frac{1}{4} + 1\right)$$

$$= 19.5 \text{ K-IN}$$

LOAD @ LUG PLATE AGAINST
CLEVIS CONDITION

$$\Delta L = \frac{1}{2} \times 1 + \frac{1}{4} = 0.75"$$

$$R = 62.5 \times \frac{1}{2} (1.75 + 1) \times \frac{1}{3} = 28.6 \text{ K}$$

$$M = R \cdot \Delta L = 0.75 \times 28.6 = 21.45 \text{ K-IN} \leftarrow \text{CONTROLS}$$

$$F_b = \frac{0.75}{2} F_y = 13.5 \text{ KSI}$$

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LIFTING BEAM ASSEMBLIES

$$S_{REQ'D} = \frac{21.45}{13.5} = 1.59 \text{ IN}^3$$

$$\frac{\pi R^3}{4} = 1.59 \quad R = 1.26''$$

$$\therefore d = 2.52'' \approx 2\frac{1}{2}''$$

OK!

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Subject TEMP PUMP 2 -
SADDLES

3. SADDLES

3.1 GEOMETRY & LOADS

DL:

LOAD CHART 101SY

$$\text{UNIF LOAD} = 210 + 1000 + 1245$$

$$w = 2455 \text{ PLF}$$

$$\text{CONCENTRATED LOAD} = 5,000 + 7,000 = 12,000 \text{ \#}$$

$$\text{TOTAL UNIF LOAD} = 52.20 \times 2455 = 128,151 = 128.2 \text{ K}$$

$$\text{RESULTANT @ } \frac{52.20}{2} - 5.33 = 20.77' \\ \text{FROM SUPPORT A}$$

$$\Sigma M_A = 0$$

$$R_B = [128.2 \times 20.77 + 7 \times (24.17 - 5.33) - 5 \times (5.33 - 0.83)] \times \frac{1}{43.58} \\ = 63.6 \text{ K}$$

$$R_A = 12 + 128.2 - 63.6 = 76.6 \text{ K} = \text{CONTROLS}$$

$$\text{DESIGN DL} = 76.6 \text{ PLUS DL OF}$$

$$\text{WIND LOAD: UBC SADDLE} = 80 \text{ K}$$

$$p = C_e C_g g_s I$$

$$C_e = 1.06 \text{ (EXPOSURE C)}$$

$$g_s = 12.6 \text{ PSF (70 MPH)}$$

$$C_g = 0.8 \text{ (ROUND)}$$

$$I = 1.07$$

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Chk'd W. Kim Date 6/3/95

Subject TEMP. PUMP 2 -

SADDLES

$$p = 1.06 \times 12.6 \times 0.8 \times 1.07 = 11.43 \text{ PSF}$$

$$\begin{aligned} \text{TOTAL WIND LOAD} &= 11.43 \times 52.20 \times 5.75 = 4,436 \text{ \#} \\ &= 3.43 \text{ K} \end{aligned}$$

$$H_B = \frac{3.43 \times 20.77}{43.58} = 1.63 \text{ K}$$

$$H_A = 3.43 - 1.63 = 1.8 \text{ K} \leftarrow \text{CONTROLS}$$

OVERTURNING MOMENT

$$\begin{aligned} &= 1.8 \times \left(\frac{1}{2} \times 71.625 + 1 + 4.75 + 1 + \frac{3}{4} \right) \times \frac{1}{12} \\ &= 6.5 \text{ K-1} \end{aligned}$$

@ SUPPORT A, COL 4 & 5 RING ($1\frac{1}{2}$ " EA)

@ SUPPORT B, COL 22-23 RING ($1\frac{1}{2}$ " EA)

$$\text{OD OF THE RING} = 5' - 11\frac{5}{8}" = 71.625"$$

TRY SADDLE TO SUPPORT $\frac{1}{4}$ OF RING.

$$\text{ARC LENGTH} = \frac{\pi \times 71.625}{4} = 56.254"$$

$$\text{CHORD} = 2R \sin \frac{A}{2} = 71.625 \sin \frac{90}{2} = 50.65"$$

$$\text{RISE} = 50.65 \times \tan \frac{90}{4} = 10.49"$$

3.2 SIZE OF SADDLES

MIN. HEIGHT OF SADDLES:

$$= 10.49" + 1 + 4.75 + 1 = 17.24"$$

USE 1'-6"

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Rev. No. 0

By mm Date 5/11/94

Chk'd W Kan Date 6/14/94

Subject TEMP PUMP 2 -

SADDLES

TOP OF SADDLE, MIN. WIDTH REQ'D.

11" OUT TO OUT RING SPACING

2 1" CLEARANCE BETWEEN RING &
RING KEEPER BARS

2 RING KEEPER BARS, 1" EACH

$2 \times \frac{1}{2}$ SPACE FOR WELDS

TOTAL 16"

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By ucm Date 5/16/94

Chk'd W/K Date 5/17/94

Subject TEMP. Pump 2 -
SADDLES

DESIGN:

INVESTIGATE TWO LOADING CONDITIONS
AND LIMIT SOIL BEARING PRESSURE
TO 2.6 KSF.

1. DEAD LOAD ONLY

$$P = 80^k$$

$$\text{BEARING AREA REQ'D} = \frac{80}{2.6} = 30.8^{\circ}$$

TRY 8' LONG SADDLE

$$\text{MIN. WIDTH} = \frac{30.8}{8} = 3.85' = 46.2''$$

USE 4'-0"

CHECK W/ 1/2" ECCENTRICITY

$$S = \frac{1}{6} \times 8 \times 4^2 = 21.33 \text{ FT}^3$$

$$p = \frac{80}{8 \times 4} + \frac{80 \times \frac{1}{2}}{21.33 \times 12} = 2.66 \text{ KSF}$$

2%
OVER
ALLOWABLE
PRESSURE

SAY OK!

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0

By

Date 5/16/94

Chk'd

Date 5/16/94

Subject

TEMP. PUMP 2 -

SADDLES

2. DEAD LOAD PLUS WIND

$$\text{ALLOWABLE PRESSURE} = 2.6 \times 1.33 = 3.46 \text{ KSF}$$

$$P = 80 \text{ K}, \quad M = 6.5 \text{ K-1}$$

$$S = 21.33 \text{ FT}^3$$

$$p = \frac{80}{8 \times 4} + \frac{6.5}{21.33} = 2.80 \text{ KSF} < 3.46 \text{ KSF}$$

OK!

SUMMARY: USE 4' x 8' x 1'-6" SADDLE

CROSS SECTION

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Subject

TEMP. PUMP 2 -

SADDLES

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By

Date

5/16/94

Chk'd

Date

6/2/94

TOP PLATE

TRY 5 STIFFENERS, 4 EQUALLY SPACED

$$\text{SPACING} = \frac{50.65}{4} = 12.66"$$

$$\text{UNIT PRESSURE ON PLATE} = \frac{77}{50.65} = 1.58 \text{ } \frac{\text{K}}{\text{IN}}^2$$

$$W = 1.52 \times 12.66 = 19.24 \text{ K}$$

USE FORMULAS FOR FLAT PLATES
IN "FORMULAS FOR STRESS & STRAIN"
BY ROARK

$$b = 12.66", \quad a = 24"$$

$$b_1 = 12.66", \quad a_1 = 11"$$

$$\frac{a}{b} = 1.9, \quad \frac{a_1}{b} = \frac{11}{12.66} = 0.87, \quad \frac{b_1}{b} = 1$$

$$a = 1.4b \quad \beta \quad a = 2b \quad a = 1.9b$$

$$\frac{a_1}{b} = 0.87$$

$$\frac{b_1}{b} = 1$$

$$0.454$$

$$0.516$$

$$0.506$$

$$f_b = \beta \frac{W}{t^2} \quad \text{OR} \quad t^2 = 0.506 \times \frac{19.24}{12}$$

$$t = 0.9", \quad \text{USE } 1" \text{ PLATE}$$

CHECK SHEAR

$$v = 1.5 \times \frac{19.24}{2} \times \frac{1}{1 \times 11} = 1.3 \text{ KSI} < 7.2 \text{ KSI}$$

OK!

Subject TEMP PUMP 2 -
SADDLES

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CHECK LOCAL WEB YIELDING

$$P = 77 \text{ K}$$

IGNORE STIFFENERS (CONSERVATIVE)

TWO WEB EACH $50.65" \times \frac{1}{2}"$ ($2st = 12.5" \approx 12.66"$)

$$f_w = \frac{77}{2} \times \frac{1}{50.65 \times 0.5} = 1.52 \text{ KSI}$$

STRESS IS VERY LOW

CHECK FLEXURAL OF BUILT-UP SECTION

M_{max} @ CENTER

$$= \frac{77}{2} \times \left(\frac{4}{2} \times 12 - \frac{50.65}{2} \times \frac{1}{2} \right)$$

$$= 436.5 \text{ K-in}$$

STATIC MOMENT @ MIDHEIGHT

$$(1 \times 32 + 2 \times 4.75 \times 0.5 + 1 \times 48) \bar{y} = \left(\frac{4.75}{2} + 0.5 \right) \times (32 - 48)$$

$$84.75 \bar{y} = -2.875 \times 16$$

$$\bar{y} = 0.54"$$

$$I = 1 \times 32 \times \left(\frac{4.75}{2} + 0.5 + 0.54 \right)^2 \quad \text{TOP FLANGE}$$

$$+ 2 \times \frac{1}{12} \times 0.5 \times 4.75^3 + 2 \times 4.75 \times 0.5 \times (0.54)^2 \quad \text{WEB}$$

$$+ 1 \times 48 \times \left(\frac{4.75}{2} + 0.5 - 0.54 \right)^2 \quad \text{BOTTOM FLANGE}$$

$$= 373.2 + 8.9 + 1.4 + 261.7$$

$$= 645.2 \text{ in}^4$$

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By WV Date 5/16/24

Chk'd WV Date 5/22/24

Subject TRND. PUMP 2 -
SADDLES

$$f_b = \frac{436.5 \times \left(\frac{6.75}{2} + 0.50 \right)}{645.2}$$

$$= 2.6 \text{ ksi} < 12 \text{ ksi}$$

Assume 77k AS A POINT LOAD, $M = \frac{77}{2} \times 2 \times 12 = 924 \text{ k-in}$

$$f_b = 5.6 \text{ ksi} < 12 \text{ ksi} \text{ OK}$$

BOTTOM PLATE

FLEXURAL DEMAND ON THE BASE PLATE

IS LESS CRITICAL THAN TOP FLANGE PLATE

EXCEPT 1" OVERLAP THAT NEEDS CHECKING

$$w = \frac{80}{8 \times 12 \times 48} = 0.02 \text{ k/in}$$

$$M = 0.02 \times 12 \times \frac{12}{2} = 1.44 \text{ k-in}$$

$$M_R = \frac{1 \times 1^3}{6} \times 12 = 2 > 1.44 \text{ k-in}$$

OK

$$v = 1.5 \times \frac{0.02 \times 12}{1 \times 1} = 0.36 \text{ ksi} < 7.2 \text{ ksi}$$

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Subject

TEMP. PUMP 2 -

SADDLES

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By [Signature] Date 5/16/94

Chk'd [Signature] Date 6/6/94

3.3 TOTAL WEIGHT OF SADDLE (ACTUAL HEIGHT = 18")

$$\text{TOP PLATE} \left(\frac{\pi (3.03)^2}{2} \times \frac{32}{12} + \frac{2 \times 22.68 \times 32}{144} \right) \frac{1}{12} = 1.90 \text{ FT}^3$$

BOTTOM PLATE

$$4 \times 8 \times \frac{1}{12} = 2.67$$

$$\begin{aligned} \text{WEBS} \quad & 2 \left(1.5 - \frac{2}{12} \right) \times \left(8 - \frac{1}{12} \right) \times \frac{0.5}{12} \\ & - 2 \times \frac{1}{2} \left[\frac{56.25 \times 3.07}{12} - 4.34 (3.07 - 0.90) \right] \times \frac{0.5}{12} \\ & = 0.67 \end{aligned}$$

$$\text{KEEPER BARS} \quad 2 \times 1 \times 1 \times \frac{\pi \times 2.94}{2} \times \frac{1}{144} = 0.06$$

$$\text{STIFFENERS} \quad 2 \times \left(\frac{2.67 + 4}{2} \right) \times 1.5 \times \frac{0.5}{12} = 0.42$$

$$\left(\frac{32 + 48}{2} \times \frac{1}{12} \right) \left(\frac{4.75}{12} + 2 \times 0.65 + 2 \times 1.33 \right) \times \frac{0.5}{12} = 0.60$$

$$\text{TOTAL} \quad 6.32 \text{ FT}^3$$

$$\text{WT.} = 6.32 \times 490 = 3,097 \text{ \#} \approx 3.1 \text{ K}$$

$$< 3.4 \text{ K (ASSUMED)}$$

OK

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By 100 Date 5/16/94
Chk'd 100 Date 6/6/94

Subject TEMP PUMP 2 -
SADDLES

3.4 STABILITY

FACTOR OF SAFETY AGAINST

SLIDING :

$$\text{LATERAL FORCE} = 3.43 \text{ K} + \frac{4 + 2.67}{2} \times 1.5 \times \frac{11.43}{1000} = 3.5 \text{ K}$$

$$\text{RESISTING FORCE} = (76.6 + 3.0) \times 0.2 = 15.92 \text{ K}$$

$$SF = \frac{15.92}{3.5} = 4.5 \gg 1.5 \text{ (UBC)}$$

OVERTURNING :

'PIVOT AT PT "O"'

OVERTURNING MOMENT =

$$\left(\frac{71.625}{2} - 10.49 \right) \times \frac{1}{12} \times 3.43 = 7.25 \text{ K-1}$$

RESTORING MOMENT =

$$76.6 \times \frac{50.65}{2 \times 12} = 161.7 \text{ K-1}$$

$$FS = \frac{161.7}{7.25} = 22 \gg 1.5$$

OK !

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By MCW Date 6/17/94
Chk'd SL/SM Date 6/21/94

Subject TEMP PUMP 2 -
SADDLES

3-5 LUGS

PROVIDE LUGS FOR SHACKLES

TO INTERCONNECT THE SADDLE

± THE CONTAINER WITH A CHAIN.

LOAD =

SADDLE WEIGHT 3.1^k

$$\text{DESIGN LOAD} = 3.1 \times \frac{1}{2} \times 1.25 = 1.94^k$$

SELECT SHACKLE:

CROSBY FORGED SHACKLES

G209, WORKING LOAD LIMIT $3\frac{1}{4}$ TONS.

PIN SIZE $\frac{3}{4}" \phi$, FOR EASE OF OPERATION.

USE $\frac{1}{2}"$ LUG.

$$f_p = \frac{1.94}{\frac{1}{2} \times 0.75} = 5.2^{ksi} < 16.2^{ksi}$$

OK!

MAX. 4t EDGE DISTANCE NORMAL TO FORCE

ACTUAL TOTAL EDGE DISTANCE

$$= 4 - \frac{13}{16} = 3.19" > 4t = 2"$$

USE 2"

$$\text{ALL TENSION CAPACITY} = 2 \times \frac{1}{2} \times 12$$

$$= 12^k \gg 1.94^k$$

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By MEW Date 6/17/94
Chk'd 11.1.94 Date 11/1/94

Subject TEMP PUMP 2 -
SADDLE

BENDING ON SHACKLE PIN

CASE 1. MOMENT @ FACE OF PLATE

$$= \frac{1.94 \times 0.25}{1.06} \times 0.56$$

$$= 0.26 \text{ K-IN}$$

CASE 2 $M = \frac{1.94}{2} \times 0.28 = 0.27 \text{ K-IN}$

CONTROLS

$$S = \frac{\pi D^3}{32} = 0.0414 \text{ IN}^3$$

$$\therefore f_b = \frac{0.27}{0.0414} = 6.6 \text{ KSI} < \frac{0.75 F_y}{2} = 13.5 \text{ KSI}$$

ASSUME CHAIN 60° W/ HORIZ

$$f_b = 6.6 \times \frac{1}{\sin 60^\circ} = 7.6 \text{ KSI}$$

OK!

CHECK TEAR-OFF

MAX EDGE DISTANCE PERMITTED

$$= 0.8 \times \frac{3}{4} = 0.6 \text{ IN} < \text{ACTUAL } 2 - \frac{1}{2} \times \frac{13}{16} = 1.59 \text{ IN}$$

USE 0.6"

$$A_v = 2 \times \frac{1}{2} \times (0.6 + \frac{1}{2} \times \frac{3}{4}) = 0.98 \text{ IN}^2$$

$$\text{ALLOWABLE CAPACITY} = 0.98 \times 7.2 = 7.02 > 1.94 \text{ K}$$

OK

CHECK BENDING ON LUG

$$M = 1.94 \times 2 = 3.88 \text{ K-IN}$$

$$S = \frac{1}{6} \times 0.5 \times (4)^2 = 1.33 \text{ IN}^3$$

$$f_b = \frac{3.88}{1.33} = 2.9 \text{ KSI} < 12 \text{ KSI}$$

OK!

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By MLM Date 6/17/94

Chk'd MLM Date 6/25/94

Subject TEUP PUMP 2 -
SADDLES

CHECK SADDLE PLATE, 1" THICK,
BENDING, EFFECTIVE WIDTH
 $E = 4 + 12 = 16"$

PLAN

USE 10"

$$P/'' = \frac{1.94}{10} = 0.2 \text{ k/''}$$

$$\begin{aligned} \text{MAX. } M &= \frac{1}{4} PL \\ &= \frac{1}{4} \times 0.2 \times 24 = 1.2 \text{ k-''} \end{aligned}$$

$$V = 0.10 \text{ k/''}$$

$$S = \frac{1}{6} \times 1 \times 1^3 = \frac{1}{6} \text{ in}^3$$

$$f_b = \frac{1.2}{S} = 7.2 \text{ ksi} < 12 \text{ ksi} \quad \text{OK!}$$

$$f_v = 1.5 \times \frac{V}{bd} = 1.5 \times \frac{0.1}{1 \times 1} = 0.15 \text{ ksi} < 7.2 \text{ ksi} \quad \text{OK!}$$

WELDS:

USE FILLET WELDS $\frac{1}{4}"$

$$M = 1.94 \times 2 = 3.88 \text{ k-''}$$

$$V = 1.94 \text{ k}$$

$$f_v = \frac{1.94}{2 \times 4} = 0.24 \text{ k/''}, \quad S = 2 \times \frac{1}{6} \times 4^3 = 5.33 \text{ in}^3$$

$$f_b = \frac{3.88}{5.33} = 0.73 \text{ k/''}$$

$$f = (0.73^2 + 0.24^2)^{1/2} = 0.77 \text{ k/''} < \text{ALL } \frac{1}{4} < 7.2 = 1.80 \text{ k/''} \quad \text{OK}$$

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

4. CONTAINER TEST WEIGHTS

4.1 PURPOSE = THE TEST WEIGHTS WILL BE USED TO TEST THE HYDRAULIC SYSTEM OF A TRAILER SPECIFICALLY DESIGNED TO LIFT A PUMP CONTAINED IN A CANISTER & ITS SUPPORTING COMPONENTS. THE WEIGHTS WILL BE ADDED TO THE TOP OF THE CANISTER VESSEL TO SIMULATE THE PUMP DURING THIS TEST. THE PURPOSE OF THIS DESIGN IS :

- TO FIND EQUIVALENT PUMP WEIGHTS THAT WILL SIMULATE SAME EFFECT ON JACK SYSTEM BY THE ACTUAL PUMP;
- TO DESIGN TEST WEIGHTS THAT INCLUDE REMOVABLE WEIGHTS PLUS THEIR HOLDER.

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Rev. No. 0
By MCW Date 5/27/94
Chk'd W. Kian Date 6/3/94

Subject TEMP. PUMP 2
CONTAINER TEST WEIGHTS

4.2 GEOMETRY & EQUIVALENT WEIGHTS

$$\begin{aligned} \text{TOTAL WT. OF PUMP} &= 12.75 \times 150 + 53.25 \times 210 + 5000 \\ &+ 7000 = 25,096 \text{ \#} \end{aligned}$$

PURPOSE: FIND TEST WTS TO SIMULATE PUMP WT. DURING
TESTING OF TRAILER ON JACKETING OPERATION.

LOADS: 101 SY LOAD CHART

Subject TEMP PUMP 2
CONTAINER TEST WEIGHTS

ANALYSIS:

(1) HORIZONTAL POSITION

$$\Sigma M_O = 0$$

$$\bar{AO} = 19.5 \times \frac{4.65}{5.05} = 17.96'$$

$$H_A \times 17.96 = 150 \times 12.75 \left(66 - \frac{12.75}{2}\right)$$

$$+ 210 \times 53.25 \times \left(53.25 - \frac{53.25}{2}\right)$$

$$+ 5000 \times 52.42 + 7000 \times 29.08$$

$$= 877,426 \text{ #}$$

$$H_A = 48,854 \text{ #}$$

@ JACK

$$H = 48,854 \text{ #}, V = \frac{4.65}{5.05} \times 48,854 = 44,984 \text{ #}$$

$$V_A = 25,096 - 44,984 = -19,888 \downarrow$$

TO CREATE SAME REACTION @ HYDRAULIC JACK

WTS. ARE PLACED AT 53'-3" FROM SUPPORT 'A'

TOTAL THICKNESS OF WEIGHT = 12"

$$W \times \left(53.25 + \frac{1}{2}\right) = 877,426$$

$$W = 16,324 \text{ #}$$

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By W. K. A. Date 5/27/94
Chk'd W. K. A. Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WTS

TO CREATE SAME VERTICAL REACTION @ A.

$$V_A = \# \downarrow$$

$$L = \frac{\bar{A}D}{4.65} \times 5.05$$

$$= 19.5'$$

TEST WTS. REQ'D

$$W \times (53.25 - 19.5 + 0.5) = 19,909 \times 19.5$$

$$W = 11,335 \# < 16,324 \#$$

Subject TEMP. PUMP 2 -
CONTAINER TEST WT.

(ii) HYDRAULIC JACK IN VERTICAL POSITION

$$\theta = \cos^{-1} \frac{15}{19.5} + \sin^{-1} \frac{1.25}{19.5} = 43.39^\circ$$

$$W_1 = 150 \times 12.75 \\ = 1,913 \text{ \#}$$

$$W_2 = 53.25 \times 210 \\ = 11,183 \text{ \#}$$

$$L_1 = 15'$$

$$L_2 = (53.25 - \frac{53.25}{2}) \cos 43.39 - \frac{5.75}{2} \sin 43.39 \\ = 17.38'$$

$$L_3 = (66.00 - \frac{12.75}{2}) \cos 43.39 - \frac{5.75}{2} \sin 43.39 \\ = 41.37'$$

$$L_4 = 53.25 \cos 43.39 - \frac{5.75}{2} \sin 43.39 \\ = 36.73'$$

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By Mcw Date 5/27/94
Chk'd H. Kan Date 6/3/94

Subject TEMP. PUMP 2
CONTAINER TEST WEIGHTS

$$L_5 = 29.08 \times \cos 43.39^\circ - 1.98 = 19.16'$$

$$L_6 = 52.42 \times \cos 43.39^\circ - 1.98 = 36.13'$$

$$\Sigma M_A = 0$$

$$\begin{aligned} R_J \times 15 &= 1,913 \times 41.37 + 11,183 \times 17.38 \\ &+ 5,000 \times 36.13 + 7,070 \times 19.16 \\ &= 588,271 \end{aligned}$$

$$R_J = 39,218^\# \quad , \quad V_A = 25,096 - 39,218 = -14,122^\#$$

TEST WEIGHTS TO CREATE SAME R_J

$$W \times (36.73 + 0.5 \cos 43.39^\circ) = 588,271$$

$$W = 15,861^\# < 16,324^\#$$

TEST WEIGHTS TO CREATE SAME V_A

$$W \times (37.09 - 15) = 14,122 \times 15$$

$$W = 9,589^\# < 16,324^\#$$

SUMMARY:

EQUIVALENT PUMP WEIGHTS

$$= 16,324^\#$$

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Chk'd WJK Date 6/3/94

Subject TEMP PUMP 2 -
CONTAINER TEST WEIGHTS

4.3. WEIGHT HOLDERS & REMOVABLE WEIGHTS

$$\text{DESIGN LOAD} = \text{TEST WEIGHTS} \times 1.25$$

$$\text{TOTAL WEIGHTS} = 16,324^{\#} \quad (\text{P. 4-6})$$

say 16,400[#]

$$\text{WITH IMPACT} = 16,400 \times 1.25$$

$$= 20,500^{\#}$$

$$\text{USE } 21,000^{\#}$$

WEIGHT HOLDER CONSISTS OF:

- BULKHEAD PLATE (2" THICK)
- FILLER PLATE (2" THICK)
- VERTICAL LIFTING LUG
- HORIZONTAL LIFTING LUG
- SUPPORT LEG (TWO WIDE FLANGE BEAMS)

Subject

TEMP Pump 2 -

CONTAINER TEST WEIGHTS

TEST WEIGHT HOLDER:

BULK HEAD PLATE =

BOLT CIRCLE 5'-1" ϕ

SIZE OF BOLT = 1" ϕ

MIN. EDGE DISTANCE 1 1/4"

USE 2 1/2"

OUTER EDGE DIMENSION = (5'-1" + 2x2.5

= 5'-6"

INSIDE DIAMETER OF OUTER

CONTAINER FLANGE = 4'-10" ID

FILTER PLATE DIA = 4'-10 3/8"

HOLDER BEAMS:

USE W 8 X 28

d = 8.06", bf = 6.54", t_f = 0.465"

t_w = 0.285"

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By ucm Date 5/27/94
Chk'd W. Kian Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

WEIGHTS OF HOLDER (SEE DESIGN SKETCHES 1-7 THEN 6-10)

BULKHEAD:

$$6.08 \times 5.5 \times \frac{2}{12} \times 490 = 2730.9$$

FILLER:

$$\frac{\pi}{4} (4.86)^2 \times \frac{2}{12} \times 490 = 1515.0$$

VERTICAL LUG (1" THICK)

$$\left[\frac{\pi}{8} (3.75)^2 + (4.0 \times 3.75) - \frac{\pi}{4} (1.563)^2 + \frac{1}{2} \times 3.75 \times 3.813 \right] \times \frac{1}{1728} \times 490 = 7.3$$

HORIZONTAL LUG (3" ϕ SOLID ROD)

LENGTH
ROD (FROM FACE OF PLATES) = 37.1
 $\rightarrow 1.54' \times 24.05$

$$\text{LESS } \frac{\pi}{4} \times (1.563)^2 \times 3 \times \frac{1}{1728} \times 490 = -1.6$$

SUPPORT LEGS (1'-8" PLUS STIFFENER PLS)

$$\text{BEAM } 1.67 \times 28 \times 2 = 93.5$$

$$\text{STIFFENER PLS: } 8.06 \times 6.54 \times \frac{1}{4} \times \frac{490}{1728} \times 2 = 7.5$$

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Chk'd AKA Date 6/3/94

Subject TEMP PUMP 2 -
CONTAINER TEST WEIGHTS

$$4 \times 7.19 \times 3.13 \times \frac{1}{4} \times \frac{190}{1728} = 6.4 \text{ \#}$$

TOTAL 4396.1 \#

REMOVABLE WEIGHTS:

TOTAL EQUIV. WT. = 16,330 \#

TRY 6 PIECES OF WEIGHTS

$$\begin{aligned} \text{EACH} &= \frac{16330 - 4396.1}{6} \\ &= 1989.0 \approx 1990 \text{ \#} \end{aligned}$$

USE 2" THICK,

HEIGHT FROM TOP OF SUPPORT LEGS
TO C.G. OF CANISTER = 2'-6"
HEIGHT 5'

$$\text{WIDTH REQ'D} = \frac{1990}{5 \times 490 \times \frac{2}{12}} = 4.87'$$

USE 5'-0"

USE 6 - PL 2" X 60" X 5'-0"

EACH WT = 2041.7 \#

FIND CG. IN 'X' DIRECTION, HOLDER ONLY

$$\begin{aligned} &(2730.9) \cdot 1' - 1515.0 \times 1 - (93.5 + 7.5 + 6.4) \times 10.125 \\ &- (35.5)(9.25 + 2) = 4396.1 \bar{x} \end{aligned}$$

$$\bar{x} = -0.06 \approx -\frac{1}{16}''$$

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Job/Calc. No. CA 4001-02-1
Rev. No. 0
By hcm Date 5/27/94
Chk'd id Kam Date 6/3/94

Subject TEMP. PUMP 2
CONTAINER TEST WEIGHTS

FIND CG IN "Y" DIRECTION, HOLDER, PLUS ALL
REMOVABLE WEIGHTS - LOCATING LIFTING PT. FOR
THE HORIZONTAL LUG.

DESCRIPTION	W (#)	$\bar{Y}$ (")	WY
BULK HEAD	2730.9	$-(\frac{73}{2} - 33) = -3.5$	-9,558.2
FILLER	1515	0	0
VERTICAL LUG	7.3	$\approx 34"$	248.2
HORIZ LUG	35.5	$TOL = 1"$	-35.5
SUPPORT LEGS	$(93.5 + 7.5 + 6.4) = 107.4$	$-(30 + \frac{8.06}{2}) = -34.03$	-3641.2
TEST WTS	6×2041.7 $= 12,250.2$ $16,776.3$ $> 16,400 \#$	$130 \#$ (SHACKLES + LUGS) ESTIMATED	0 -12,986.7

$$\bar{Y} = -0.77 \approx -\frac{3}{4}"$$

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Rev. No. 0
By mcw Date 5/27/94
Chk'd W/Kau Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

CG IN "X" DIRECTION, HOLDER IS FULLY LOAD

STATIC MOMENT ABOUT AXIS THRU INTERFACE OF
HOLDER PLATES.

$$4396.1(-0.06) + 12,250X(-6-2) = 16,776.3 \bar{X}$$

$$\bar{X} = -5.9"$$

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Job/Calc. No. CA 4001-02-1
Rev. No. 0
By W. Han Date 5/26/94
Chk'd MEM Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WTS

Veil LIFTING LUGS

DESIGN LOAD = 21,000 #

DESIGN CRITERIA:

$$F_b = F_t = F_a = 12 \text{ ksi} \quad (\text{Allow. Bending, Tension \& Comp. Stresses})$$

$$F_v = 7.2 \text{ ksi} \quad (\text{Allow. Shear})$$

$$F_p = 12 \text{ ksi} \quad (\text{Allow. Bearing})$$

Bolts

$$F_p = \frac{0.9}{2} F_y = 0.45 F_y = 16.2 \text{ ksi}$$

$$F_t = \frac{0.33 F_u}{2} = 9.57 \text{ ksi}$$

PINS

Double shear

$$A_v = \frac{21}{2} \times \frac{1}{7.2} = 1.46 \text{ in}^2$$

$$\frac{\pi}{4} d^2 = 1.46 \quad d = 1.36 \text{ in}$$

USE $1\frac{1}{2} \text{ in } \phi$

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Sheet No. 4-14
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By W. Kan Date 5/26/94
Chk'd mm Date 6/3/94

Subject TEMP. PUMP 2 -
COMPIVER TEST WTS

Lug plates

Bearing $f_p = 16.2 \text{ ksi}$

$$t = \frac{21}{1.5 \times 16.2} = 0.86''$$

use $1\frac{1}{2}''$ PL TO ALLOW LOCAL BENDING

Check net area @ cross section through pin-hole and
⊥ load

$$A_{net} = \frac{12}{F_t} = \frac{21}{12} = 1.75''^2$$

$$\text{edge distance} = \frac{1}{2} \times \frac{1.75}{1.5} = 0.58'' < 4 \times 1.5$$

OK

EDGE DISTANCE

$$= \frac{1}{2} (3\frac{3}{4} - 1\frac{9}{16}) = \frac{1}{2} (3.75 - 1.56) = 1.10'' \times 0.8 \times 1\frac{9}{16} = 1.10''$$

OK

Allow. shear Capacity

$$= 2 \times 15 \times (1.10 + \frac{1.5}{2}) \times 7.2$$

$$= 39.9 \text{ k} > 21 \text{ k} \quad \text{OK}$$

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Rev. No. 0
By W. Kan Date 5/26/94
Chk'd mm Date 6/3/94

Subject

TEMP. PUMP 2 -
CONTAINER TEST WTS

Cross Section Area // Load Req'd

$$A = \frac{2}{3} \times 1.75 = 1.17''^2$$

$$\text{Edge Distance} = \frac{1.17}{1.5} = 0.78'' < 0.8 \times 1\frac{9}{16} = 1.25'' \quad \text{O.K.}$$

$$\text{FURNISHED} = 1.10'' < 1.25'' \quad \text{O.K.}$$

Sheet No. 4-16
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Rev. No. 0
By W. Kan Date 5/27/94
Chk'd mm Date 6/3/94

Subject TEMP. Pump 2 -
Horiz. Lifting Lug, Test (1)

Horizontal Lifting Lugs

Design Load = 21^k

RnD

$$A = \frac{21}{9.57} = 2.19 \text{ in}^2$$

use 3" ϕ Rod $A = \frac{\pi}{4} (3)^2 = 7.07 \text{ in}^2 > 2.19 \text{ in}^2$ OK

w/ 1/16" ϕ hole $A = 7.07 - 3 \times \frac{\pi}{4} \left(\frac{1}{16}\right)^2 = 5.01 \text{ in}^2 > 2.19 \text{ in}^2$ OK

PIN

Double Shear

$$A_v = \frac{21}{2} \times \frac{1}{7.2} = 1.46 \text{ in}^2$$

$$\frac{\pi}{4} d^2 = 1.46 \quad d = 1.36 \text{ in}$$

Use 1 1/2" ϕ

Lug GRIND END OF THE ROD TO BE USED AS A LIFTING LUG.

Bearing $f_p = 16.2 \text{ ksi}$

$$t_{\min} = \frac{21}{1.5 \times 16.2} = 0.86 \text{ in} \quad \text{use } 1 \frac{1}{2} \text{ in}$$

CHECK NET AREA @ CROSS SECTION THROUGH PIN-HOLE
AND $\perp$ LOAD

$$A_{\text{net}} = \frac{P}{F_t} = \frac{21}{12} = 1.75 \text{ in}^2$$

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By W. Kan Date 5/31/94
Chk'd MLW Date 6/2/94

Subject

TEMP. PUMP 2 -

Horizontal Lifting Lug, TEST WT

Check net area @ the end of 3" Rod

1) 1 1/2" Lifting Lug

$$\theta = \cos^{-1} \frac{0.75}{1.5} = \cos^{-1} \frac{1}{2} = 60^\circ$$

$$2\theta = 120^\circ = A^\circ$$

$$\text{arc } a = \frac{\pi r A^\circ}{180} = \frac{\pi (1.5) 120}{180} = 3.14$$

$$\begin{aligned} X = \text{Chord} &= 2\sqrt{2br - b^2} \\ &= 2\sqrt{2(0.75)(1.5) - (0.75)^2} \\ &= 2\sqrt{2.25 - 0.56} \\ &= 2.6" \end{aligned}$$

$$\begin{aligned} \text{Area } a_{\text{net}} &= \frac{(3.14 \times 1.5) - 2.6(1.5 - 0.75)}{2} \\ &= \frac{4.71 - 1.95}{2} \\ &= 1.38" \end{aligned}$$

$$\text{Area } B = \frac{\pi (3)^2}{4} - 2(1.38) = 4.31"$$

$$\text{Net Area} = 4.31 - 1.5(1\frac{1}{2} + \frac{1}{16}) = 1.97" \approx 1.75"$$

NEEDS ALLOWANCE FOR FABRICATING
TOLERANCES. TRY 2" LIFTING LUG

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Job/Calc. No. CA 4021-02-1
Rev. No. 0
By W. Kan Date 5/21/94
Chk'd M Date 6/2/94

Subject

TEMP. PUMP 2 -

CONTAINER TEST WT

ii) 2" Lifting Lug

$$\theta = \cos^{-1} \frac{1}{1.5} = \cos^{-1} \frac{2}{3} = \cos^{-1} 0.667 = 48.2^\circ$$

$$A = 2\theta = 96.4^\circ$$

$$\text{arc } a = \frac{\pi r A^\circ}{180} = \frac{\pi (1.5) 96.4}{180} = 2.52''$$

Area B

$$\text{Area nap} = \frac{(2.52 \times 1.5) - 2.24(1.5 - 0.5)}{2} = 0.77''$$

$$\begin{aligned} \text{Chord } X &= 2\sqrt{2br - b^2} \\ &= 2\sqrt{2(0.5)(1.5) - (0.5)^2} \\ &= 2\sqrt{1.5 - 0.25} \\ &= 2.24'' \end{aligned}$$

$$\text{Area B} = \frac{\pi}{4}(3)^2 - 2(0.77) = 5.53''^2$$

$$\text{Net Area} = 5.53 - 2 \times (1\frac{1}{2} \times \frac{1}{16}) = 2.40''^2 > 1.75''^2 \quad \text{O.K.}$$

Use 2" thick lifting Lug

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Subject

TEMP PUMP 2

HORIZ. LIFTING LIFT, TEST WT.

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 By W. Kau Date 5/27/94
 Chk'd ucm Date 6/2/94

EDGE DISTANCE || TO THE LOAD

$$\text{MAX ALLOW} = 0.8 \times \left(1\frac{1}{2} + \frac{1}{16}\right) = 1.25"$$

$$\text{FURNISHED} = 2 - \frac{1}{2} \left(1.5 + \frac{1}{16}\right) = 1.22" < 1.25" \text{ OK}$$

ALLOW. SHEAR CAPACITY

$$= 2 \times 1.5 \times \left(1.22 + \frac{1.5}{2}\right) \times 7.2 = 42.6^{\text{K}} > 21^{\text{K}} \text{ O.K.}$$

CROSS SECTIONAL AREA || LOAD REQ'D

$$A = \frac{2}{3} \times 1.75 = 1.17 \text{ in}^2$$

$$\text{EDGE DISTANCE} = \frac{1.17}{1.5} = 0.78" < 1.22" \text{ O.K.}$$

HITCH PIN ON 3" ϕ ROD

$$6 \text{ HS WT} = 12.2^{\text{K}}$$

$$\text{TOTAL HORIZ LOAD} = 12.2^{\text{K}} \times 1.25 \times \sin 8.88^\circ = 2.35^{\text{K}}$$

USE PLATED OVAL RING HITCH PIN, $\frac{3}{8}" \phi \times 4\frac{3}{8}"$ W/

4" GRIP

$$\text{SHEAR CAPACITY} = 9.74^{\text{K}} > 2.35^{\text{K}}$$

OK!

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Rev. No. 0
By W. K. M. Date 5/27/94
Chk'd M. L. M. Date 6/3/94

Subject

TEMP PUMP 2.

HORIZ LIFTING LUG, TEST NT

3" ϕ ROD WELDING TO PL

MIN EFFECTIVE THROAT $T = \frac{3}{8}"$

$$2 \times \frac{3}{8} \times 7.2 \times \frac{\pi}{4} (3)^2 = 38.2^k > 21^k \quad \text{O.K.}$$

USE $\frac{3}{8}"$ PARTIAL PENE WELDS AT BOTH ϕ

SHACKLE ON HORIZ. LUG.

$$T = 21^k$$

USE CROSBY FORGED SHACKLE

$$\text{WORKING LOAD LIMIT} = 13\frac{1}{2}^T$$

$$= 27^k > 21^k$$

O.K.

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Sheet No. 4-21
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Rev. No. 0
By MEW Date 5/27/94
Chk'd W Kam Date 6/3/94

Subject

TEMP PUMP 2 -
CONTAINER TEST WEIGHTS

SUPPORT LEGS

IMPACT.
$$\text{REMOVABLE WTS.} = \frac{12,250}{2} \times 1.25 = 7.66 \text{ K}$$

$$\text{BEAM INT} = \frac{107.4}{2} = 54 \text{ \#}$$

$$M_{\text{max}} = 7.66 \times (6 + 8.25)$$

$$+ 0.054 \times \frac{20.25}{2}$$

$$= 109.7 \text{ K-FT}$$

EXTREME
CONDITION

$$S_{\text{REQ'D}} = \frac{109.7}{12} = 9.1 \text{ IN}^3$$

$$V = 7.66 \text{ K}$$

REQ'D MIN. BEAM ELEMENTS $\approx 5/16$ "

TO MEET AISC REQUIREMENT TO
WELD THE BEAM TO 2" PLATE.

ASSUMED W 8 X 28 MEETS REQUIREMENTS

$$S = 24.3 \text{ IN}^3 >> 9.1$$

$$t_w = 5/16", \quad t_f = 3/16", \quad d = 8.06"$$

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

$$ALL V = \frac{5}{16} \times 8.06 \times 7.2 = 18.1^k \gg 7.6^k$$

OK!

BENDING ON PLATE (2")

$$18" \text{ EFFECTIVE WIDTH} = 9t$$

$$S = \frac{1}{6} \times 18 \times 2^2 = 12 \text{ in}^3$$

$$f_b = \frac{109.7}{12} = 9.1 \text{ ksi}$$

$$f_t = \frac{7.66}{18 \times 2} = 0.2 \text{ ksi}$$

$$f = f_b + f_t = 9.3 \text{ ksi} < 12 \text{ ksi} \quad \text{OK!}$$

WEB YIELDING

WIDTH OF WTS

$$ALL P = (12 + 2.5 \times k) \times 12 \text{ ksi}$$

$$= (12 + 2.5 \times \frac{15}{16}) \times 12 = 172^k \gg 7.68^k$$

NO STIFFENERS REQ'D.

TO INCREASE TORSIONAL RESISTANCE,

ADD ONE $\frac{1}{4}$ " END PLATE + TWO $\frac{1}{8}$ " STIFFENER

PLATES NEAR MID-SPAN, EACH LEG.

USE MIN. FILLET WELDS $\frac{3}{16}$ "

Subject

TEMP. PUMP 2 -

CONTAINER TEST WEIGHTS

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Date 5/27/94
By MCM
Chkd. MCM Date 6/3/94

VERTICAL LUG BENDING

$$\theta = \frac{f_{t-1}}{5.9} = \frac{0.78 + 3 + 4}{5.9}$$

$$= 8.88"$$

ECCENTRICITY @ 4"

Below $\bar{x}$ of LUG

$$e = 4 \times 8.88$$

$$= 0.62"$$

$$\textcircled{a} \quad 4 + 3 \frac{1}{16} = 7.81"$$

$$e = 7.81 \times 8.88 = 1.20"$$

LUG PLATE SUBJECTED TO

① 4" Below $\bar{x}$ of LUG

$$AXIAL = 21 \text{ K}$$

$$MOMENT = 21 \times 0.62 = 13.0$$

$$\textcircled{a} \quad 7.81"$$

$$AXIAL = 21 \text{ K}$$

$$MOMENT = 21 \times 1.20 = 25.2$$

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Sheet No. 4-24

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By mc Date 5/27/94

Chk'd mc Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

LUG PLATE

$1" \times 3\frac{3}{8}"$

$$A = 3.625 \text{ in}^2$$

$$S = \frac{1}{6} \times (3.625)^2 = 2.2 \text{ in}^3$$

$$f = \frac{21}{3.625} + \frac{25.2}{2.2} = 17.2 \text{ ksi}$$

NG

TRY

$1\frac{1}{2}" \times 3\frac{3}{4}"$

$$A = 5.63 \text{ in}^2$$

$$S = \frac{1}{6} \times 1.5 \times (3.75)^2 = 3.52 \text{ in}^3$$

$$f = \frac{21}{5.63} + \frac{25.2}{3.52} = 10.89 \text{ ksi} < 12 \text{ ksi}$$

OK

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Sheet No. 4-25

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By me Date 6/1/94

Chk'd W. K. Lee Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

HOIST RING BOLTS FOR REMOVABLE PLATES

EACH REMOVABLE WT. = 2042[#]

DESIGN LOAD = 2042 x 1.25 = 2553[#]

TENSION PER RING = 1277[#]

ALL $\sigma_t = \frac{19.1}{2}$ (A36)
= 9.6^{ksi}

$\frac{\pi}{4} \times d^2 \times 9.6 = 1.3$ ^K

$d = 0.42$ "
use $\frac{1}{2}$ " ϕ

USE AMERICAN SAFETY HOIST RINGS

ASSEMBLY PART # 23301, CAPACITY 2500[#] EACH

TOTAL CAPACITY 2 x 2500[#] > 2553[#]

OK

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Sheet No. 2-26

Job/Calc. No. CA-001-02-1

Rev. No. 0

By WCH Date 6/6/94

Chk'd WCH Date 6/6/94

Subject TEMP PUMP 2 -
TEST WEIGHTS

TIE-DOWN LUGS

TOTAL WEIGHTS =

HOLDER ASSEMBLY 2396.1 #

REMOVABLE WT. 11,250.2 #

TIE-DOWN LUGS

PLUS SHACKLES

(ESTIMATED)

150 #

16,796.3 #

USE CROSBY FORGED SHACKLES G-200

4 REQ'D, ORIENTED AT $< 5^\circ$ WITH

RESPECT TO SIDES OF REMOVABLE PLATE,

MIN. WORKING LOAD 17 TONS

ALLOWABLE CENTRIFUGAL FORCE OR FORCES

FROM ACCELERATING OR DECELERATING
(2 ACTIVE)

$$= 2 \times 17^T \times 2 \times \sin 36^\circ$$

$$= 38.0^K$$

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By MCM Date 6/6/94

Chk'd W/Kan Date 6/6/94

Subject TEMP PUMP 2 -
CONTAINER TEST WEIGHTS

OR NUMBERS OF GRAVITATIONAL ACCELERATION

$$= \frac{38.0}{16.8} = 2.26 \text{ g} > 1.5 \text{ g (PER TELECON 6/6/94 W/ RANDY JORISSEN)}$$

$$T = 2 \times 17^T = 34^K$$

NET AREA REQ'D $\perp$ FORCE

$$A_n = \frac{34}{12} = 2.83 \text{ "}$$

USE 1" PLATE & 1 1/16" ϕ HOLE

MIN. EDGE DISTANCE REQ'D

$$= \frac{2.83}{1} = 2.83 \text{ "}$$

MAX. ALLOWED EDGE DISTANCE = $8t = 8 \text{ "}$

USE 3" FROM CENTER LINE OF HOLE TO EDGES

$$\text{EDGE} = 6 - 1 \frac{1}{16} = 4.31 \text{ "} > 2.83 \text{ "}$$

$$< 8 \text{ "}$$

OK!

EDGE $\parallel$ FORCE

$$= \frac{3}{3} \times 2.83 \times \frac{1}{1} = 1.89 \text{ "} > 0.8 \times 1 \frac{5}{8} = 1.3 \text{ "}$$

FURNISHED 3" $\pm$

USE 1.3" TO CHECK SHEAR

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By mm Date 6/6/94

Chk'd W Kan Date 6/6/94

Subject TEMP. PUMP 2 -
TEST WEIGHTS

PIN ϕ

$$\text{ALLOWABLE SHEAR} = 2 \cdot t \cdot \left(1.3 + \frac{1\frac{5}{8}}{2} \right) \times 7.2$$

$$= 2 \times 1 \times (1.3 + 0.8125) \times 7.2$$

$$= 30.42 \text{ K} < 34 \text{ K}$$

INCREASE PLATE TO $t = \frac{34}{30.42} \times 1 = 1.12$ "
USE $1\frac{1}{8}$ "

CHECK BEARING ON PIN

$$f_p = \frac{34}{1.125 \times 1.625} = 18.6 \text{ KSI} > 16.2 \text{ KSI}$$

INCREASE THICKNESS TO $\frac{18.6}{16.2} \times 1.125 = 1.29$ "
USE $1\frac{3}{8}$ " PLATE

CHECK BENDING ON 12" BASE

$$S = \frac{1}{6} \times 1.375 \times 12^2 = 33 \text{ IN}^3$$

$$M = T \times 3 = 34 \times 3 = 102 \text{ K-IN}$$

$$f_b = \frac{102}{33} = 3.1 \text{ KSI} < 12 \text{ KSI}$$

OK!

SUMMARY: USE $1\frac{3}{8}$ " LUG PLATE, OTHER
DIMENSIONS SEE SKETCHES (ATTACHMENTS)
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By W. Kall Date 5/27/94
Chk'd W. Kall Date 6/3/94

Subject TEMP. PUMP 2.
CONTAINER TEST WEIGHTS

4.4 BOLT PATTERNS

CHECK BOLT CIRCLE, 1" ϕ BOLT, USE 14 BOLTS

$$M = 16,646.1 \times (2 + 5.90) = 131,504 \text{ #} - "$$

$$\begin{aligned} \text{WITH IMPACT} &= 131,504 \times 1.25 \\ &= 164,380 \text{ #} - " \end{aligned}$$

$$V = 16,646.1 \times 1.25 = 20,808 \text{ #}$$

21^k USED IN DESIGN

ASSUME NEUTRAL AXIS AT C.G. OF BOLT
PATTERN

$$\begin{aligned} I &= 4 \times (13.23^2 + 23.85^2 + 29.74^2) \frac{\pi}{4} \times 1^2 \\ &= 5116 \text{ IN}^4 \end{aligned}$$

$$S = \frac{I}{C} = \frac{5116}{29.74} = 172 \text{ IN}^3$$

USE HALF OF BOLTS FOR: SHEAR

$$A_v = 7 \times \frac{\pi}{4} \times (1)^2 = 5.50 \text{ IN}^2$$

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Sheet No. 1-30

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By ucom Date 5/27/94

Chk'd W Kan Date 6/3/17

Subject

TEMP. PUMP 2 -

CONTAINED TEST WEIGHTS

A325 BEARING TYPE

$$\frac{12}{9}$$

DETAIL

SCALE: 1 1/2" = 1'-0"

BOLT PATTERN

DETAIL

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Subject

TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

$$f_r = \frac{21}{5.5} = 3.82 \text{ ksi}$$

$$f_t = \frac{164}{172} = 0.95 \text{ ksi}$$

A 325 BEARING-TYPE CONNECTION, THREADS
INCLUDED IN SHEAR PLANE, ALL F_t :

$$F_t = (44^2 - 4.39 \times f_r^2)^{1/2}$$
$$= (44^2 - 4.39 \times 3.82^2)^{1/2} = 43.26 \text{ ksi}$$

USE HALF FOR $F_t = 21.63 \text{ ksi} >> 0.95 \text{ ksi}$

CHECK THE EFFECT OF $\frac{3}{8}$ " PLYWOOD CLIPS!
ON LOCAL BENDING OF THE BOLTS

$$M = \frac{21}{14} \times \frac{1}{2} \times \frac{3}{8} = 0.28 \text{ K-IN}$$

$$1" \phi$$
$$S = \frac{\pi d^3}{32} = 0.098 \text{ IN}^3$$

$$f_b = \frac{0.28}{0.098} = 2.86 \text{ ksi}$$

$$\text{MAX } f_t = 0.95 + 2.86 = 3.81 \text{ ksi} << 21.63 \text{ ksi}$$

OK!

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Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

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Rev. No. 0
By MEM Date 6/1/94
Chk'd W. Kim Date 6/3/94

4.5 WELDS:

1.) FILLER PLATE TO BULKHEAD PLATE

USE MIN $\frac{5}{16}$ " FILLET WELDS ALL
ROUND.

WELD CAPACITY:

$$A U V = \frac{1}{2} \times (\pi \times 58.375) \times \frac{5}{16} \times 7.2 \text{ ksi}$$

$$= 206.3 \text{ K}$$

DEMAND

$$V = \text{WEIGHT OF FILLER PLATE} \times 1.25$$

$$= 1.515 \text{ K} \times 1.25 << 206.3 \text{ K}$$

OK!

2.) SUPPORT LEGS.

WELD TO 2" PLATE, PER AISC

MIN. WELD $\frac{5}{16}$ ". USE ALL ROUND

THE $W 8 \times 28$ MEMBER.

PER UNIT 1" WELD

$$A = 4 \times 6.535 + 2 \times 7.13 = 40.4$$

$$I = \frac{1}{12} \times 7.13^3$$

$$+ 2 \times 6.535 \times (4.03^2 + 3.57^2) \text{ FLANGE}$$

$$= 409.05$$

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By W. K. R. L. Date 6/3/94
Chk'd W. K. R. L. Date 6/3/94

Subject TEMP PUMP 2 -
CONTAINER TEST WEIGHTS

$$M = 109.7 \text{ K-"} \quad V = 7.66 \text{ K}$$

$$f_t = \frac{109.7 \times 4.03}{409.05} = 1.08 \text{ K/"}$$

$$f_v = \frac{7.66}{40.4} = 0.19 \text{ K/"}.$$

$$f = (1.08^2 + 0.19^2)^{1/2} = 1.10 \text{ K/"}.$$

$$\text{ALL. WELD CAPACITY} = \frac{5}{16} \times 7.2 = 2.77 \text{ K/"} \gg 1.10 \text{ K/"}.$$

OK!

3. VERTICAL AND HORIZONTAL LIFTING

LUGS SEE LUG DESIGN

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By MLM Date 6/1/94
Chk'd W. Kane Date 6/3/94

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

4.6 CHICK BULKHEAD PLATE

BENDING STRESS

CONSERVATIVELY USE TOTAL WEIGHTS + IMPACT

$$WT./\text{in} = \frac{21,000}{\frac{\pi}{4} (61)^2} = 7.2 \text{ #/in}$$

USE CIRCULAR DISK, EDGES SUPPORTED

UNIFORM LOAD OVER ENTIRE SURFACE.

$$\text{AT CENTER } f_r = f_t = - \frac{3W}{8\pi m t^2} (3m + 1) \quad \left(\begin{array}{l} \text{FORMULAS} \\ \text{FOR} \\ \text{STRESS + STRAIN} \\ \text{BY ROARK} \end{array} \right)$$

$$\nu = \text{POISSON'S RATIO} = 0.26$$

$$m = \frac{1}{\nu} = 3.85, \quad t = 2"$$

$$f_r \text{ (RADIAL STRESS)} = f_t \text{ (TANGENTIAL STRESS)}$$

$$= \frac{3 \times 21,000}{8\pi \cdot 3.85 \cdot 2^2} (3 \times 3.85 + 1)$$

$$= 2,042 \text{ #/in} \ll 12,000 \text{ #/in}$$

OK!

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By W Date 6/8/94

Chk'd W/Kau Date 6/10/94

Subject TEMP PUMP 2
S.O DUMMY PUMP

5.1

GEOMETRY & EXISTING DUMMY PUMP WEIGHT

C.G.

-BASED ON 101 SY LOAD CHART
(ACTUAL PUMP)

W (#)	x (')	Wx (#-')
------------	------------	---------------

$210 \times 53.25'$		
$= 11,182.5$	26.625	$297,734$

150×12.75		
$= 1912.5$	59.625	$114,033$

$5000^\#$	52.42	$262,083$
-----------	---------	-----------

7000	29.08	$203,583$
--------	---------	-----------

$25,095^\#$	$877,433^{16-H}$	$= 10,529,196^{16-H}$
-------------	------------------	-----------------------

$\bar{x} = 34.96'$

(NOT USED IN THE CALCS)

SEE EXPLANATION P. 5-31 ~ 5-32

$W = 25,095^\#$

$\bar{y} = 53.25' - 34.96' = 18.29' = 18'-3\frac{1}{2}"$

$W\bar{y} = 25,095 \times 18.29 \times 12 = 5,507,851^{16-in}$

101 SY
LOAD CHART

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Subject TEMP PUMP 2
EXIST. DUMMY PUMP

REFERENCE DWG: SK-2-24006 RO

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By W. Kau Date 6/6/94

Chk'd M. L. Date 6/8/94

Subject TEMP PUMP 2
EXIST. DUMMY PUMP

① 20" ϕ Sch 20. w/concrete, $L = 19' - 11\frac{1}{2}"$
weight = 78.6 lb/ft inside area = 291 in²
Weight/FT w/concrete $78.6 + \frac{291 \times 145}{144} = 372$ lb/ft

WEIGHT = $372 \times 18.75 = 6975$ lbs

② 20" ϕ XS w/o concrete $L = 10' - 10"$

WT. /FT = 104 lb/ft

WEIGHT = $104 \times 10.83 = 1126$ lbs

③ 16" ϕ Sch 30 w/concrete $L = 4' - 4"$

Weight = 62.58 lb/ft inside area = 182.6 in²

Weight/FT w/concrete = $62.58 + \frac{182.6 \times 145}{144} = 246$ lb/ft

Weight = $246 \times 4.33 = 1065$ lbs

④ 16" ϕ Sch 30 w/o concrete $L = 4' - 11\frac{1}{2}"$

Weight = $62.58 \times 4.96 = 310$ lbs

⑤ 16" ϕ Sch 30 w/concrete $L = 3' - 8"$

Weight = $246 \times 3.67 = 903$ lbs

Subject TEMP PUMP 2
EXIST. DUMMY PUMP

⑥ 36" ϕ Sch 20 w/concrete $L = 5' - 8"$

$$\text{Weight} = 143 \text{ lb/ft}, \text{ inside area} = 975.8 \text{ in}^2$$

$$\text{Weight/Ft w/concrete} = 143 + \frac{975.8 \times 145}{144} = 1126 \text{ lb/ft}$$

$$\text{WEIGHT} = 1126 \times 5.67 = \underline{\underline{6384 \text{ lbs}}}$$

⑦ 16" ϕ Sch 30 w/o concrete $L = 14' - 2"$

$$\text{Weight} = 62.58 \times 14.17 = \underline{\underline{887 \text{ lbs}}}$$

SUMMARY: EXISTING DUMMY PUMP WITHOUT WT. OF ATTACH. & FLANGES

SECTION	LENGTH	WEIGHT (lbs)	REMARKS
①	18' - 9"	6975	w/concrete
②	10' - 10"	1,126	No concrete
③	4' - 4"	1,065	w/concrete
④	4' - 11 1/2"	310	No concrete
⑤	3' - 8"	903	w/concrete
⑥	5' - 8"	6384	w/concrete
⑦	14' - 2"	887	No concrete
	62' - 4 1/2"	17,165	

$$\text{Actual weight of Pump} = 25,095 \text{ lbs}$$

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Subject

TEMP PUMP 2
EXIST DUMMY PUMP

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By W. KAU

Date 6/7/94

Chk'd W. KAU

Date 6/7/94

BUMPER PLATE ASSEMBLY

(B1)

$$\frac{1}{2} \times (4\frac{5}{8} + 24) \times 9.75 \times \frac{1}{2} = 69.8 \text{ in}^3$$

$$+ \frac{1}{2} \times 1\frac{1}{4} \times 6 \times 4 = 15.0$$

$$\frac{1}{2} \times 1\frac{1}{4} \times 5 \times 2 = 6.3$$

$$\frac{\pi}{4} (4)^2 \times (4 - 0.5 - 2 \times 0.75) = 25.1$$

$$6 \times 6 \times \frac{3}{4} \times 2 = 54.0$$

$$170.2 \times \frac{490}{1728} = 48.3 \text{ lbs}$$

(B2)

$$\frac{1}{2} (4\frac{5}{8} + 21\frac{1}{2}) \times 9.69 \times \frac{1}{2} = 63.3 \text{ in}^3$$

$$+ \frac{1}{2} \times 1\frac{1}{4} \times 6 \times 4 = 15.0$$

$$\frac{1}{2} \times 1\frac{1}{4} \times 5 \times 2 = 6.3$$

$$\frac{\pi}{4} (4)^2 \times (4 - 0.5 - 1.5) = 25.1$$

$$6 \times 6 \times \frac{3}{4} \times 2 = 54.0$$

$$163.7 \times \frac{490}{1728} = 46.4 \text{ lbs}$$

(B3)

$$\frac{1}{2} (10 + 18) \times 5.375 \times \frac{1}{2} = 37.6$$

$$\frac{1}{2} \times 1\frac{1}{4} \times 10 \times 2 = 12.5$$

$$2 \times 2 \times \frac{1}{2} \times 2 = 4.0$$

$$54.1 \times \frac{490}{1728} = 15.3 \text{ lbs}$$

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Subject TEMP PUMP 2
EXIST DUMMY PUMP

(B4)

$$\frac{1}{5} \times (8+15) \times 12 \times \frac{1}{2} = 69.0$$

$$\frac{\pi}{4} (4)^2 \times (4-0.5-1.5) = 25.1$$

$$.6 \times 6 \times \frac{3}{4} \times 2 = 54.0$$

$$148.1 \times \frac{490}{1728} = 42.0 \text{ lbs}$$

SADDLE ASSY

(S1)

$$6" \phi \text{ pipe sch 80} \quad 32.71 \times 1.83 = 59.8 \text{ lbs}$$

$$1\frac{1}{8}" \text{ flange} \quad \frac{3}{8} \times \frac{1}{2} (6+14) \times 10 \times \frac{490}{1728} = 10.6$$

$$\text{End cap} \quad 3 \times 3 \times \frac{1}{2} \times \frac{490}{1728} = 1.3$$

$$71.7 \text{ lbs}$$

(S2)

$$6" \phi \text{ pipe sch 80} \quad 32.71 \times 1.83 = 59.8 \text{ lbs}$$

$$3/8" \text{ flange} \quad \frac{3}{8} \times \frac{\pi}{4} (6.19)^2 \times 2 \times \frac{490}{1728} = 6.4$$

$$\frac{3}{8} \times 6 \times 13.625 \times 2 \times \frac{490}{1728} = 17.4$$

$$\frac{3}{8} \times \frac{1}{2} (3.3+8) \times 13 \times \frac{490}{1728} \times 2 = 15.6$$

$$1/2" \text{ flange} \quad 1/2 \times 3 \times 3 \times \frac{490}{1728} = 1.3$$

$$100.5 \text{ lbs}$$

(S3)

$$6" \phi \text{ pipe sch 80} \quad 32.71 \times 1.83 = 59.8 \text{ lbs}$$

$$3/8" \text{ flange} \quad \frac{3}{8} \times \frac{1}{2} (8+13) \times 10 \times 2 \times \frac{490}{1728} = 22.3$$

$$1/2" \text{ flange} \quad 1/2 \times 3 \times 3 \times 2 \times \frac{490}{1728} = 2.6$$

$$84.7 \text{ lbs}$$

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By W. KAU Date 6/7/94

Chk'd mcm Date 6/8/94

Subject TEMP PUMP 2
EXIST DUMMY PUMP

16" ϕ Slip-on Flange

150^{lb} Flanges

$$\frac{\pi}{4} (23.5^2 - 16^2) \times \frac{(1.44 + 2.5)}{2} \times \frac{490}{1728} = 130^{lbs}$$

20" ϕ Slip-on Flange

150^{lb} Flanges

$$\frac{\pi}{4} (27.5^2 - 20^2) \times \frac{1.69 + 2.875}{2} \times \frac{490}{1728} = 181^{lbs}$$

300^{lb} Flanges reducer

$$\frac{\pi}{4} (30.5^2 - 16^2) \times \frac{2.5 + 3.75}{2} \times \frac{490}{1728} = 422^{lbs}$$

SEAL PLATE RINGS

2, 3, 8, 14, 15, 16, & 17 NO DETAILS & DIMENSIONS ON THE DWG.

PLATES ON SECTION (6)

Stiff.	$3 \times \frac{3}{8} \times 10 \times 10 = 112.5$	^{in³}
1/4" END PL	$\frac{\pi}{4} (36)^2 \times \frac{1}{4} = 254.5$	
3/4" END PL	$\frac{\pi}{4} (53)^2 \times \frac{3}{4} = 1,654.6$	
1" PL	$\pi \times \frac{53}{2} (1 \times 3.25 + 1 \times 8) = 936.6$	

$$2,958.2 \times 490/1728 = 839^{lbs}$$

END PL ON SECTION (7)

$$\frac{\pi}{4} (16)^2 \times \frac{3}{8} \times 490/1728 = 21.4^{lbs}$$

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Chk'd WTK Date 6/8/94

Subject TEMP PUMP 2
EXIST. DUMMY PUMP

CALCULATE C.G. OF EXIST. DUMMY PUMP

SECTION	WEIGHT (W)(lbs)	y (ins)	Wy
1	69.75	466	3,250,350
2	1.126	288.5	324,851
3	1.065	197.5	210,338
4	310	141.75	43,943
5	903	90.	81,270
6	6,384+839	34	245,582
7	887+21	- 85	- 77,180
B ₁	49	80.875	3,963
B ₂	47	427.5	20,093
B ₃	15	488.5	7,328
B ₃	15	541.5	8,123
B ₄	42	242.25	10,175
S ₁	72	212.5	15,300
S ₂	101	370.0	37,370
S ₃	85	488.0	41,480
1 @ 16" ϕ Flange	130	0	0
2 @ 16" ϕ F.	260	112	29,120
2 @ 16" ϕ F.	260	171.5	44,590
2 @ 20" ϕ Reducer	844	223.5	188,634
2 @ 20" ϕ F	362	353.5	127,967
Σ	20,792		4,613,297

$$\bar{y} = \frac{4,613,297}{20,792} = 221.9" \text{ OR } 18.5'$$

$$\text{OR } x = 356.6''$$

Subject Temp Pump 2
Dummy Pump

INCLUSION OF DISKS THAT ARE SHOWN IN THE SK-2-24086 RO.

AS # 2, 3, 8, 14, 15, 16 & 17, TO ADJUST FOR CG OF

THE EXISTING DUMMY PUMP PER AS-BUILT MARK-UPS.

WEIGHT OF DISK (38" OD, $\frac{1}{4}$ THICK PL)

20" OD PIPE

$$= \frac{\pi}{4} (38^2 - 20^2) \times \frac{1}{4} \times 0.283 = 58 \text{ \#}$$

16" OD PIPE

$$= \frac{\pi}{4} (38^2 - 16^2) \times \frac{1}{4} \times 0.283 = 66 \text{ \#}$$

$$\text{WT OF DISKS} = 5 \times 58 + 2 \times 66 = 422 \text{ \#}$$

$$58 \times (2 + 28.5 + 50.6 + 77.9 + 315.8) + 66 (458 + 483.5)$$

$$20,792 \times 356.6 = (20,792 + 422) \times$$

$$\times = 353.7' = 29.5'$$

$$\text{REVISED PUMP WT} = 21,214 \text{ \#}$$

Subject TEMP. PUMP 2-
DUMMY PUMP

5.2 REMOVABLE DISKS

4" DISK: $D = 1.6" \phi$ (CONTROLS)

UNSUPPORTED DISK HEIGHT

$$h = 20.5 - 8 - 0.375$$

$$= 12.125"$$

$$K = 2.1$$

TO LIMIT (AISC)

$$\frac{K L}{r} = 200$$

$$r = \frac{2.1 \times 12.13}{200} = 0.13"$$

$$r = \frac{t}{\sqrt{12}}$$

$$t = 0.13 \times (12)^{\frac{1}{2}} = 0.45" \text{ (MIN)}$$

USE $\frac{1}{2}"$

$$r = \frac{0.5}{\sqrt{12}} = 0.144"$$

$$C_c = 126.1 \text{ (A36)}$$

$$\frac{K L / r}{C_c} = \frac{2.1 \times 12.13}{0.144 \times 126.1} = 1.40 > 1.0$$

$$\therefore F_a = \frac{12 \pi^2 E}{23 (K L / r)^2} = \frac{12 \times \pi^2 \times 30 \times 10^3}{23 \left(\frac{2.1 \times 12.13}{0.144} \right)^2}$$

$$= 4.94 \text{ KSI}$$

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0

By

m

Date

6/9/94

Chk'd

u/Kan

Date

6/13/94

Subject

TEMP. PUMP 2 -

DUMMY PUMP

AREA BEARING ON THE DISK

$$= 2 \times 1.8 \times t$$

CONSERVATIVE TO USE ONLY HALF OF AREA

ALLOWABLE CAPACITY PER DISK

$$P = 8 \times \frac{1}{2} \times 4.94 = 19.8^k$$

$$\text{ESTIMATE MAX. REACTION} = \frac{25}{2} = 12.5^k < 19.8^k$$

OK!

Subject _____

Durham Pump

WEIGHT OF REMOVABLE DISK ASSEMBLY

$$l_1 = (41 - 16) / 2 - .375 = 12 \frac{1}{8}"$$

16" φ

20" φ

NOTES

1. UNLESS NOTED OTHERWISE, USE MIN. FILLET WELDS
2. BOLTS TO BE 5/8" φ W/ HEX. NUTS OR BETTER

Disk $A = \frac{\pi}{4} (41^2 - 16.75^2) \times \frac{1}{2} = 550 \text{ in}^3$

3/8" SLEEVE $\frac{3}{8} \times \pi (16.375) \times 10 = 193$

STIFF. PL. $\frac{1}{2} \times 4 \times 8 \times 10 = 160$

$$903 \times 440 / 1728 = 256 \text{ lbs.}$$

USE 265^{lbs} TO ACCOUNT FOR WELD & BOLTS

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Subject TEMP. PUMP 2 -
DUMMY PUMP

REMOVABLE DISKS FOR 16" ϕ (2" THICK DISK)

IN ORDER TO CUT DOWN NUMBERS OF DISKS
OF ONE TYPE, INTRODUCE ONE MORE TYPE

$$\text{NEW TYPE WEIGHT} = 3 \times 265 = 795 \text{ \#}$$

REFER TO $\frac{1}{2}$ " THICK DISK, MATERIAL TAKE-UP

$$\text{USE } \frac{5}{8}" \text{ SLEEVE} = \frac{193}{\frac{3}{8}} \times \frac{5}{8} = 322 \text{ IN}^3$$

$$\text{STIFF. PLS. } \frac{1}{2}" = 160 \text{ IN}^3$$

$$\text{REQ'D VOL OF STEEL} = \frac{795}{490} \times 1728 = 2804 \text{ IN}^3$$

$$\text{DISK VOL. REQ'D} = 2804 - 322 - 160 = 2322 \text{ IN}^3$$

$$\text{MIN. DISK THICKNESS} = \frac{\frac{1}{2}}{550} \times 2322 = 2.11"$$

INCREASE

STIFF. PL TO 1"

$$\text{VOL.} = \frac{160 \times 1}{\frac{1}{2}} = 320 \text{ IN}^3$$

MIN DISK THICKNESS

$$t = \frac{\frac{1}{2}}{550} \times (2322 - 160) = 1.965"$$

$$\text{ACTUAL WT.} = \left(322 + 320 + \frac{550}{\frac{1}{2}} \times 2 \right) \times \frac{490}{1728} = 806 \text{ \#}$$

use 2"

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Subject

Temp. pump 2 -
Dummy pump

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Chk'd W Kan Date 6/20/94

Less

$$(41 - 16.25) \times 2 \times 3 \times \frac{490}{1728} = - 41.3 \text{ \#}$$

Plus

$$\frac{5/8" \phi \text{ BOLTS } 4 \times 68.7}{100} = 3$$
$$\underline{768 \text{ \#}}$$

TOTAL WT., " Plus WELDS

$$\underline{775 \text{ \#}} \text{ (USED)}$$

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Chk'd W. Kan Date 6/20/94

Subject TEMP. PUMP 2~
Dummy Pump

REMOVE DISK FOR 20" ϕ (2"-THICK DISK)

COMBINE THREE 265[#] DISKS INTO ONE

WT. REQ'D = 795[#]

USE 2" DISK

5/8" SLEEVE

1" STIFF.

$$\text{Disk } A = \frac{\pi}{4} (41^2 - 21.25^2) \times 2 = 1931.2 \text{ IN}^3$$

$$\text{5/8" SLEEVE } \frac{5}{8} \times \pi \times (20.63) \times 10 = 405.1 \text{ IN}^3$$

$$\text{STIFF. } 1 \times 4 \times 8 \times 10 = 320 \text{ IN}^3$$

TOTAL 2656.3

$$\text{WT.} = 2656.3 \times \frac{490}{1728} = 753 \text{ #}$$

$$\text{LESS } (41 - 21.25) \times 2 \times 2 \times 1.5 \times \frac{490}{1728} = 34$$

$$\text{BOLT } \frac{5}{8} \phi \quad \frac{4 \times 68.7}{100}$$

719 #

$$+ \frac{3}{100} = 722 \text{ #}$$

INCLUDE WELDS,

$$\text{WAY } \underline{730 \text{ #}}$$

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By W. K. K. Date 6/10/94
Chk'd W. K. K. Date 6/10/94

WEIGHT OF REMOVABLE DISK ASSEMBLY (2" B)

NOTES

1. UNLESS NOTED OTHERWISE,
USE MIN. FILLET WELDS.
2. BOLTS TO BE $\frac{5}{8}$ " ϕ w/ HEX HD
A 307 OR BETTER

Subject TEMP PUMP 2 -
DUMMY PUMP

USE $5/8"$ ϕ BOLTS FOR REMOVABLE DISK ASSEMBLY

TIGHTEN TO 2^k EACH (A307) OR BETTER

$$\text{TORQUE REQ'D} = 0.2 \times 2 \times 5/8 \times \frac{1}{12} \times 10000 = 20.8 \#-1$$

USE $20 \#-1$

GAP BETWEEN HALF-DISK

TOLERANCE OF SLEEVE RADIIUS $+1/8"$

$$\text{ALONG ARC } \Delta S = \pi \times 1/8 = 3/8"$$

HOOP TENSION 12^k

ASSUME $8"$ EFFECTIVE $\times 3/8"$ THICK

$$f = \frac{12}{8 \times 3/8} = 4^k \pm 1$$

$$\text{STRAIN} = \frac{4}{30 \times 10^3}$$

$$\Delta S = \frac{\pi \cdot 20}{2} \times \frac{4}{30 \times 10^3} = 0.004" \text{ (NEGLECTABLE)}$$

$$\text{GAP} = 2 \left(\frac{3}{16} + \frac{1}{16} + \frac{1}{8} \right) + \frac{1}{4} \quad \text{ADDITIONAL MARGIN} \quad \text{USE } 1"$$

LUG PLATES

USE ALLOWABLE $12^k \pm 1$ FOR BENDING

SINCE THIS A TEMPORARY COMPONENT

$$M = 2^k - "$$

USE $4"$ EFF WIDTH

$$\frac{1}{2} \times \frac{1}{2}$$

$$S = \frac{2}{12} = \frac{1}{6} \times 4" \times t^2$$

$$t = 0.50" \quad \text{USE } 1/2"$$

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By mm Date 6/17/94
Chk'd W. Kaul Date 6/14/94

Subject

TEMP. PUMP 2 -

Dummy Pump

CHECK - FRICTION RESISTANCE RESULTING FROM 20" TIGHTENING

$$\text{SLIDING FORCE} = 775 \times 1.25 = 969 \text{ K}$$

$$\text{FRICTION COEFF STEEL TO STEEL} = 0.15$$

$$\begin{aligned}\text{AVAILABLE RESISTANCE} &= 4 \times 2 \times 0.15 \text{ K} \\ &= 1.2 \text{ K}\end{aligned}$$

$$\text{SF} = \frac{1.2}{10.97} = 1.2$$

TO INSURE NO SLIPPING OF DISKS, ADD

4- $\frac{3}{8}$ " ϕ SCREWS W/ SQUARE WASHERS TO

ASSEMBLY; WHERE TWO ASSEMBLIES ARE TOO

CLOSE, TWO ASSEMBLIES SHARE 4- $\frac{3}{8}$ " ϕ SCREWS

CHECK LOCAL STRESS IN 20" ϕ PIPE: STD. PIPE FILLED W/
CONCRETE IS NOT CRITICAL; CHECK XS W/O CONCRETE

$$t = 0.5" \quad r_c = 19/2 = 9.5"$$

$$e \text{ (WIDTH) EACH SIDE OF SLEEVE} = \frac{\sqrt{t r_c}}{2} = 1.09"$$

$$f_1 \text{ (COMPRESSION / IN)} = \frac{4 \times 2}{2(10 + e)} = 0.36 \text{ K/IN}$$

$$\text{MAX. MR} = 0.318 f_1 r_c$$

$$S = \frac{1}{6} \times 1 \times (0.5)^2 = 0.042 \text{ IN}^3$$

$$f_b = \frac{0.318 \times 0.36 \times 9.5}{0.042} = 26 \text{ KSI} < 36 \text{ KSI}$$

(DESIGN OF WELDED
STRUCTURE) f_1
By BLODGETT

OK!

Advanced
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WHC-SD-WM-DA-168

REV. 0

PAGE A-91

Sheet No.

5-19

Job/Calc. No. CA 4001-02-1

Rev. No.

0

By MCR Date 6/9/94

Chk'd WTK Date 6/13/94

Subject

TEMP PUMP 2

DUMMY PUMP

5.3. GEOMETRY AND MODIFICATION TO THE DUMMY PUMP

ACTUAL PUMP WEIGHT C.G. MEASURED FROM THE
END OF THE CANISTER

$$X = 34.96 - \frac{17''}{12} = 33.54' \quad (\text{REFERENCE ONLY NEVER USED IN CALC})$$

ACTUAL 31.1' USED

EXISTING DUMMY PUMP C.G. MEASURED FROM LEFT END

OF SECTION ①

$$X = 353.7'' \text{ OR } 29.51'$$

IN CRADLE TEST LOADS, THE DUMMY PUMP C.G. ≠

TOTAL WEIGHT MUST MATCH THOSE OF THE ACTUAL

PUMP, AND THE END OF SECTION ①, PTA, MATCHES THAT OF

THE ACTUAL PUMP. THE MATCHING WILL BE ACHIEVED BY

ATTACHING A SERIES OF REMOVABLE DISKS TO THE EXISTING

DUMMY PUMP.

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Sheet No. 5-20

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By mcw Date 6/16/94

Chk'd W. Kan Date 6/24/94

Subject Temp Pump 2 -
DUMMY Pump

PT. B, CG LOCATION OF DUMMY PUMP

PT. C, CG LOCATION OF ACTUAL PUMP

PER J.J. SISK CALLS. 3/7/94

$$\Delta W = 25,095 - 21,214 = 3881 \#$$

LOCATION OF ΔW FROM P.T.C.

$$X = \frac{21,214 (31.1 - 29.5)}{3881} = 8.75$$

THICKEN SECTION ⑥ END PLATE $53" \phi \times \frac{3}{4}"$
TO $53" \phi \times 2"$

$$\begin{aligned} \text{WT. ADDED} &= \frac{\pi}{4} (53)^2 \times 1.25 \times 0.283 \\ &= 780 \# \quad (\text{WHC TO VERIFY}) \end{aligned}$$

NO. DISKS REQ'D (DISKS, SEE P. 5-13)

$$N = \frac{3881 - 780}{265} = 11.7$$

SAY 12

Subject TEMP PUMP 2 -
DUMMY PUMP

By TRIAL & ERROR, ARRIVE A LAYOUT OF REMOVABLE
SETS OF WEIGHT.

CHECK THE MODIFIED DUMMY PUMP

$$\text{TOTAL WT.} = 21,214 + 12 \times 265 + 780 = 25,174 \quad \#$$

$$\begin{aligned} 25,174X &= 21,214 \times 29.5 &= 625,813 \\ &+ 265 \times 16 &= 4,240 \\ &+ 265 \times 21.5 &= 5,698 \\ &+ 265 \times (24 + 24.83 + 25.67 + 26.5) &= 26,765 \\ &+ 265 \times 36 &= 9,540 \\ &+ 780 \times 48.21 &= 37,604 \\ &+ 265 \times (51.88 + 52.71 + 53.55) &= 41,907 \\ &+ 265 \times 56.88 &= 15,073 \\ &+ 265 \times 61.38 &= 16,266 \\ &&= 782,906 \end{aligned}$$

$$X = 31.1' \quad \text{CHECK}$$

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Sheet No. 5-22
Job/Calc. No. CA4001-02-1
Rev. No. 0
By mm Date 6/16/94
Chk'd W. Kan Date 6/24/94

Subject Temp. Pump

ADJUSTMENT FOR COMBINING THREE DISKS INTO ONE

BALANCE MOMENT

MAX. ALLOWED PLACEMENT

$$= (18'-9'') + (10'-10'')$$

$$= (3'-3\frac{1}{2}'') - (5'')$$

$$= 25'-10\frac{3}{4}'' = 25.90'$$

$$3 \times 265 \times (25.66 + 52.71)$$

$$= 730 \times 25.90 + 775 \times x$$

$$x = 56.0'$$

APPROX.

TOTAL NEWLY MODIFIED DUMMY PUMP WEIGHT

$$= 21,214 + 6 \times 265 + 780 + 730 + 775$$

$$= \underline{\underline{25,089 \#}}$$

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Sheet No. 5-23'
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By mm Date 6/9/94
Chk'd U. Kan Date 6/13/94

Subject TEMP.
Dummy Pump

LOCATION OF ADDED DISKS = 3T.

SEE P. 5-21 & 5-22 &

A-95

Subject Temp Pump 2 -
Dummy Pump

5.4 STRUCTURAL INTEGRITY OF PUMP

CHECK SECTION (7)

WELDS, $\frac{1}{4}$ " FILLETS

$$S = \pi r^2$$

$$A_v = \frac{1}{2} (2\pi r) = \pi r$$

MOMENT:

$$\text{PIPE WT. } 62.6 \frac{\text{#}}{\text{ft}} \times 14.17 \times \frac{14.17}{2} \times \frac{1}{1000} = 6.3 \text{ K-1}$$

$$\text{WTS. } 265 (13.17 + 8.67) \times \frac{1}{1000} = 5.8$$

$$775 \times 7.79 \times \frac{1}{1000} = 6.0$$

$$18.1 \text{ K-1}$$

INCREASE FOR 25% IMPACT

$$M_{max} = 18.1 \times 1.25 = 22.6 \text{ K-1}$$

$$V = (62.6 \times 14.17 + 2 \times 265 + 775) \times 1.25 \times \frac{1}{1000} = 2.7 \text{ K}$$

CHECK $\frac{1}{4}$ " FILLET WELDS:

USE 16" ϕ ACTUAL FLANGE DIAMETER IS LARGER

$$f_v = \frac{2.7}{\pi \times 16} = 0.055 \text{ K/in}$$

$$f_b = \frac{22.6 \times 12}{\pi \times 16^2} = 0.34 \text{ K/in} \quad f = (f_v^2 + f_b^2)^{1/2} = 0.34 \text{ K/in}$$

$$\text{ALLOWABLE} = \frac{1}{4} \times 7.2 = 1.8 \text{ K/in} >> 0.34 \text{ K/in}$$

OK!

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REV. 0

PAGE A-97

Sheet No. 5-25

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By men Date 6/21/94

Chk'd Wkam Date 6/22/94

Subject TEMP PUMP 2 -
DUMMY PUMP

CHECK JOINT DETAIL PROPOSED BY WHC
@ SECTION (6) & (7)

STIFFENERS TREATED AS PIN-END CONDITION

MAX WIDTH OF STIFFENER PLATE (4 TOTAL)

EDGE OF FLANGE TO 36" OD

$$d = (36 - 23\frac{1}{2}) \frac{1}{2} = 6.25"$$

$$\text{MAX. WIDTH} = (6.25 - 1.44 \times \tan 30^\circ) \times \sin 60^\circ$$

$$= 4.69" \quad \text{USE } 4\frac{1}{2}"$$

LEVER ARM TO RESIST MOMENT

$$= (36 - 4.5) \times \sin 45^\circ = 22.3"$$

HORIZ. COMPONENT OF FORCE IN STIFFENER

$$H = \frac{1}{2} (22.6 \times 12) \times \frac{1}{22.3} = 6.1 \text{ K}$$

VERTICAL COMPONENT

$$V = 6.1 \times \tan 30^\circ = 3.5 \text{ K}$$

$$\text{FORCE IN THE STIFFENER} = \sqrt{6.1^2 + 3.5^2} = 7.0 \text{ K}$$

$$\text{STRESS} = \frac{7.0}{1 \times 4.5} = 1.6 \text{ KSI} \quad \text{NEGLECTABLE}$$

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Subject TEMP. PUMP 2 -
Dummy pump

16" ϕ , CHECK WALL FOR LOCAL BENDING

STIFFENER $\pm$ 16" ϕ CONTACT LENGTH

$$L = 4.5 \times \frac{1}{5.30} = 9"$$

EQUIV. EFFECTIVE WIDTH IN ADDITION TO L

$$e = \frac{\sqrt{tr_c}}{2} \quad t = 0.375", \quad r_c = \frac{15.25}{2} = 7.63"$$

$$= \frac{1}{2} (0.375 \times 7.63)^{1/2} = 0.85"$$

$$\therefore \text{TOTAL BEARING LENGTH} = 9 + 0.85 = 9.85"$$

$$f \text{ (BEARING PER LINEAL INCH)} = \frac{V}{9.85} = 0.36 \text{ K/IN}$$

ROUGH ESTIMATE LOCAL BENDING STRESS

$$M_R = K f r_c$$

$$= 0.136 \times 0.36 \times 7.63 = 0.37 \text{ K-IN}$$

$$S = \frac{1}{6} \times 1 \times (0.375)^2$$

$$f_b = \frac{M_R}{S} = \frac{0.37}{\frac{1}{6} \times (0.375)^2} = 15.9 \text{ KSI}$$

STRESS LEVEL IS OK!

SAME JOINT STRENGTHENING

APPLIES TO OTHER END OF 36" ϕ PIPE

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Sheet No. 5-27
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By W Date 6/10/94
Chk'd A/Kaw Date 6/13/94

Subject TEMPORARY PUMP 2.
Dummy Pump

CHECK BOLTS 16" ϕ PIPE, BOLT CONNECTION
BOLT CIRCLE 12 1/4" ϕ

8-1" ϕ , A325

$$I = 4 \times (4.07^2 + 9.82^2) A_{\text{bolt}}$$
$$= 452 \times \frac{\pi}{4} \times (1)^2$$
$$= 355 \text{ IN}^4$$

$$S = \frac{355}{h_1} = 36.1 \text{ IN}^3$$

SHEAR AREA

$$= \frac{1}{2} \times 8 \times \frac{\pi}{4} \times (1)^2$$
$$= 3.14 \text{ IN}^2$$

$$h_1 = 10.625 \times \sin 67.5 = 9.82$$

$$h_2 = 10.625 \times \sin 22.5 = 4.07$$

CRITICAL LIFTING CONDITION (ASSUME LIFTING @ CG)

APPROX.

$$V = \frac{25.1}{2} \times 1.25 = 16 \text{ K}$$

$$\text{MOMENT} = 16 \times \frac{31.3}{2} = 250 \text{ K-1}$$

Subject TEMPORARY Pump 2 -
Dummy Pump

$$f_v = \frac{16}{3.14} = 5.1 \text{ ksi}$$

$$f_t = \frac{250 \times 12}{36.1} = 83.1 \text{ ksi} > 44 \text{ ksi}$$

NG!

PROVIDE ADDITIONAL 8-1" ϕ BOLTS A325

$$I = 355 + (2 \times 10.625^2 + 4 \times 7.51^2) \times \frac{\pi}{4}$$

$$= 710 \text{ IN}^4$$

$$S = \frac{710}{10.625} = 66.8 \text{ IN}^3$$

$$f_t = \frac{250 \times 12}{66.8} = 44.9 \text{ ksi} > 44 \text{ ksi}$$

NG!

CHECK PIPE 16" ϕ ITSELF

$$S = 70.3 \text{ IN}^3, \quad A_v = \frac{1}{2} (18.41) = 9.21 \text{ IN}^2$$

$$f_b = \frac{250 \times 12}{70.3} = 42.7 \text{ ksi} \quad \text{TOO HIGH}$$

NG!

$$f_v = \frac{16}{9.21} = 1.7 \text{ ksi}$$

CONCLUSION: ONE-POINT LIFTING @ C.G. OF

THE NEWLY-MODIFIED DUMMY PUMP IS

UNACCEPTABLE.

Subject

TEMP. PUMP 2 -

Dummy Pump

CHECK CONNECTION &
PIPE W/ TWO

LIFTING PTS. (

LUGS 1 & 2, SEE

SK-2-24086 RO)

$$R_L = 25 \times 10.4 / 28.9 = 19.0 \text{ k}, \quad R_R = 25 - 9 = 16.0 \text{ k}$$

SHEAR & MOMENTS

② 20"φ & 16"φ FLANGE

$$V = 9.0 - 3 \times 2.3 - 0.7 - 7.0 - 1.1$$

$$= -0.7 \text{ k}$$

$$\text{OR } 0.7 \times 1.25 = 0.9 \text{ k (W/IMPACT)}$$

$$\begin{aligned} M &= 153.0 \\ &= R_L \times (29.6 - 12.6) = 121.6 \\ &\quad - 7.0 \times (29.6 - \frac{18.75}{2}) = 6.0 \\ &\quad - 1.1 \times (29.6 - 19.75 - \frac{10.8}{2}) = 3.6 \\ &\quad - 0.3 \times (29.6 - 16) = 2.4 \\ &\quad - 0.3 \times (29.6 - 21.5) = 2.0 \\ &\quad - 0.3 \times (29.6 - 24.0) = 2.6 \\ &\quad - 0.7 \times (29.6 - 25.9) = 5.2 \text{ k-1} \end{aligned}$$

$$\text{OR } 5.2 \times 1.25 = 6.5 \text{ k-1 (W/IMPACT)}$$

① 16"φ FLANGE OF SECTION ⑤

USE MOMENT @ RR SECTION ⑥ THICKENING PLATE

$$\begin{aligned} M &\approx 21.4 + 2.7 \times 5.7 + 1.1 \times \frac{5.7}{2} \times 1.25 + 0.8 \times 5.7 \times 1.25 \\ &= 46.4 \text{ k-1} \end{aligned}$$

Subject Temp. Pump 2 -
Dummy Pump

$$V = 16 \times 1.25 - 2.7 - (1.1 + 0.8) \times 1.25 = 14.9 \text{ K}$$

20" ϕ FLANGE - BOLT CONNECTION

SEE P. 5-24

$$M = 91 \text{ K-1} > 6.5 \text{ K-1}$$

$$V = 9.9 \text{ K} >> 0.9 \text{ K} \quad \text{OK BY COMPARISON}$$

16" ϕ FLANGE - BOLT CONNECTION

$$S = 36.1 \text{ IN}^3, \quad A_v = 3.14 \text{ IN}^2 \quad (\text{P. 5-21})$$

$$V = 14.9 \text{ K}, \quad M = 46.4 \text{ K-1}$$

$$f_v = \frac{14.9 \text{ K}}{3.14} = 4.7 \text{ KSI}$$

$$f_t = \frac{46.4 \times 12}{36.1} = 15.4 \text{ KSI}$$

$$ALL F_t = (44^2 - 4.39 \times f_v^2)^{1/2} = 42.9 \text{ KSI}$$

$$f_t = 15.4 \text{ KSI} < \frac{42.9 \text{ K}}{2} = 21.5 \text{ KSI} \quad \text{OK!}$$

16" ϕ PIPE ITSELF ($S = 70.3 \text{ IN}^3, \quad A_v = 9.21 \text{ IN}^2$)

$$f_b = \frac{46.4 \times 12}{70.3} = 7.9 \text{ KSI}, \quad f_v = \frac{14.9}{9.21} = 1.6 \text{ KSI}$$

Subject TEMPORARY PUMP 2 -
Dummy Pump

CHECK BOLTS @ 20" ϕ PIPE CONNECTION, A325 BOLTS

BOLT CIRCLE = 25" ϕ

o - HOLES
+ BOLTS

10 - 1 1/8" ϕ BOLT

$$I = 4 (11.89^2 + 7.35^2) < \frac{\pi}{4} \times (1.125)^2$$

$$= 776.9 \text{ IN}^4$$

$$S = \frac{776.9}{11.88} = 65.3 \text{ IN}^3$$

$$\text{SHEAR AREA } A_v = \frac{1}{2} \times 10 \times \frac{\pi}{4} \times (1.125)^2$$

$$= 4.97 \text{ IN}^2$$

W (PIPE & CONCRETE WT.)

$$= 372 \text{ #/ft}$$

Plus MISC ATTACHMENTS

10%

$$= 409 \text{ #/ft}$$

IMPACT

$$V = (409 \times 18.75 + 265) \times 1.25 \times \frac{1}{1000} = 9.9 \text{ K}$$

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REV. 0

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Sheet No. 5-32

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By W.K. Date 6/10/94

Chk'd W.Kan Date 6/24/94

Subject

TEMPORARY PUMP 2 -

DUMMY PUMP

$$M = (0.41 \times 18.75^2 \times \frac{1}{2} + 0.27 \times 2.75) \times 1.25$$

$$= 91.0 \text{ k-ft}$$

$$f_v = \frac{9.9}{4.97} = 2.0 \text{ ksi}$$

$$f_t = \frac{91.0 \times 12}{65.3} = 16.7 \text{ ksi}$$

$$AU F_t = (44^2 - 4.39 f_v^2)^{\frac{1}{2}} = 43.8 \text{ ksi}$$

$$\text{PER CRITERIA: } AU F_t = \frac{1}{2} \times 43.8 = 21.9 \text{ ksi} \\ > 16.7$$

OK!

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PAGE A-105

Sheet No. 5-33

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By mm Date 6/24/94

Chk'd W Kan Date 6/24/94

Subject TEMP. PUMP 2 -
DUMMY PUMP

5.5 SUMMARY =

1. THE DUMMY PUMP MODIFICATION DESIGN IS BASED
and/or assumptions
ON THE FOLLOWING INFORMATION, FURNISHED TO
AEC FROM WHC.

A) EXISTING DUMMY PUMP

- A COPY OF SK-2-24086 RO;
- A COPY OF SAME DWG. WITH AS-BUILT MARK-UPS;
INCLUDE DIMENSIONS, LUGS & DISKS. (SEE 6-23)
- DISK DIMENSIONS GIVEN VERBALLY; AND
- ACTUAL TOTAL WEIGHT OF THE PUMP WAS
NOT GIVEN IN THE AS-BUILT MARK-UPS.

B) ACTUAL PUMP (TO BE SIMULATED BY MODIFYING THE EXISTING DUMMY PUMP)

- TOTAL WEIGHT OF PUMP IS GIVEN IN LOAD
CHART, 1015Y;
- ACTUAL LENGTH OF THE PUMP CAN BE
SCALE OFF THE LOAD CHART; ASSUMING IT
IS DRAWN TO SCALE.

Subject

Temp. Pump 2 -
Dummy Pump

[CONTINUATION OF (1), (2)]

- THE LOCATION OF THE PUMP C.G. WAS INSTRUCTED

By T.C. Mackey verbally TO USE THE VALUE

CALCULATED BY J.J. SISK ON 3/1/94

2. Dummy Pump Modification Design

- THE MODIFICATION SIMULATES TOTAL WEIGHT

AND LOCATION OF C.G. BUT NOT LENGTH

THAT WAS VERBALLY INSTRUCTED FROM RANDY

JORGENSEN; CONSEQUENTLY, THE LENGTH OF

THE MODIFIED PUMP REMAINS UNCHANGED;

- END PLATE OF SECTION (6), $53\phi \times \frac{3}{4}$ " IS

PROPOSED TO BE THICKENED TO $53\phi \times 1\frac{1}{4}$ " PER WHC

AEC REQUESTED THAT BE INCREASED TO 2"

THICK, WEIGH 780 LBS.

- ADDED WEIGHT (EXCEPT ITEM MENTIONED ABOVE)

IS SIMULATED WITH A SECT'S UNIFORM SIZE

OF DISKS - $50 \times 4\frac{1}{2}$ " $\frac{1}{2}$ "-THICK DISK PER RANDY'S

The dummy pump is to be used by WHC to simulate installation and removal of the actual pump. This requires that general dimensions, weight and C.G. of the dummy pump simulate those of the actual pump.

AEC started with a dummy pump designed by others, and was asked in this project to make the changes necessary such that the modified dummy pump will simulate the actual pump weight and C.G.

To accomplish this, AEC needed data on the actual pump, as well as the dummy pump design that is to be modified. The information received from WHC, both documented data and data passed to AEC verbally from WHC engineering staff, is documented on pages 5-33 through 5-35.

Based on the data received, AEC calculated the weight of the dummy pump design based on a materials take off from the design calcs/Dwgs. Actual as-built weights were not available. AEC designed and located eight disks to be added to the dummy pump (as shown in Sheet 6-13) to simulate the weight and C.G. of the actual pump, per data given to AEC.

AEC assumes:

1. The thickness of the end plate of Section 6 (sheet 5-2) will be increased from 3/4 in. to 2 in. such that the weight will be increased by 780 lb., and this change will be shown on Dwg. H-2-821397.

2. WHC will assess impact of any changes made to AEC designed dummy pump weights (disks) and/or their locations that might be required.
3. The dummy pump will be lifted at two points when the pump is in horizontal position.
4. 36 in. and 16 in. pipe diameter joints will be strengthened by WHC and modifications shown on Dwg. H-2-821397.

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Sheet No. 5-35
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By W.K. Date 6/20/94
Chk'd W.K. Date 6/20/94

Subject TEMP PUMP 2 -
DUMMY PUMP

REQUEST, AND THE DISKS ARE SO LOCATED
AND ATTACHED TO THE PUMP THAT THE MODIFIED
PUMP SIMULATES THE LOCATION OF C.G. OF THE
ACTUAL PUMP.

- REQUIRED NUMBERS OF DISKS (12) ARE
CONSIDERED TOO NUMEROUS BY WHC; DISKS
OF 2" THICK ARE USED TO SUBSTITUTE 6-1/2"
THICK DISKS.
- JOINT @ SECTIONS (6) + (7) IS BEING STRENGTHENING
BY WHC FOR LIFTING OPERATION REQUIREMENTS.

3. OPERATIONAL LIMITATION

- THE MODIFIED PUMP MUST NEVER BE LIFTED
UP AT ONE POINT AND STAYS IN THE HORIZONTAL
POSITION;
- LIFTING @ LUGS (1) & (2) SHOWN IN SK 2-24086.20
IS ACCEPTABLE FOR THE PUMP STRUCTURAL INTEGRITY.
HOWEVER, BOTH ENDS OF 36" ϕ SECTION JOINING WITH
16" PIPE MUST BE REINFORCED PER DETAILS ON PAGE S-25.

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PAGE A-110

Sheet No. 6-1
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By MLW Date 6/7/94
Chk'd WIK Date 6/7/94

Subject TEMPORARY PUMP 2-
ATTACHMENTS

6.0

ATTACHMENTS

- ATTACHMENT 6.1 : LIFTING BEAM ASSEMBLIES
SKETCHES (PAGES 6-1 THRU
6-3)
- ATTACHMENT 6.2 : SADDLES SKETCHES
(P. 6-4 THRU 6-6)
- ATTACHMENT 6.3 : CONTAINER TEST
WEIGHT SKETCHES
(P. 6-7 THRU 6-12)
- ATTACHMENT 6.4 : DUMMY PUMP
SKETCHES (P. 6-13)
- ATTACHMENT 6.5 : RELEVANT CORRESPONDENCES
TELECONS & AS-BUILT (P. 6-14 THRU
6-23)

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PAGE A-111

Sheet No. 6-1

Job/Calc. No. 04001-02-1

Rev. No. 0

By M. CHIAO Date 5/17/94

Chk'd W. KIM Date 5/25/94

Subject TEMP. PUMP 2

LIFTING BEAM ASSEMBLIES

6.1 LIFTING BEAM DESIGN SKETCHES

LIFTING BEAM

ELEVATION

Subject

TEMPORARY PUMP 2 -

LIFTING BEAM ASSEMBLIES

107

REMOVE WEB &
BOTTOM FLANGE IN
THIS PORTION OF
BEAM, TOP FLANGE,
TO STAY.

SECTION A AS SHOWN

5-25.

SECTIONS

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PAGE A-113

Sheet No. 6-3

Job/Calc. No. CA-001-02-1

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By Mc Date 5/17/94

Chk'd W. Kan Date 5/18/94

Subject

LIFTING BEAM ASSEMBLIES

DETAIL

1
6-1

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REV. 0

PAGE A-114

Sheet No. 6-4

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By Man Date 5/27/94

Chk'd W Kan Date 6/6/94

Subject TEMP. PUMP 2 -
SADDLES

6.2 SADDLE DESIGN SKETCHES

CANISTER REFERENCE DWGS: H-2-83734 SHTS. 1~3

NOTES:

1. ALL PLATES SHALL BE A 36 STEEL AND $\frac{1}{2}$ " THICK UNLESS NOTED OTHERWISE.
2. APPROX. WEIGHT PER SADDLE EQUAL $2\frac{3}{4}$ KIPS

Subject TEMP. PUMP 2 - REMOVAL & INSTALLATION
SADDLES

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PAGE A-116

Sheet No. 6-6

Job/Calc. No. CA 4001-02-1

Rev. No. 0

By MCW Date 6/2/04

Chk'd WKaw Date 6/2/04

Subject TEMP PUMP 2 - REMOVAL & INSTALLATION
SADDLES

WELDS & LUGS

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PAGE A-117

Sheet No. 6-7
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By M. CHIAO Date 5/27/94
Chk'd W. Kail Date 6/3/94

Subject TEMP PUMP 2
CONTAINER TEST WEIGHT HOLDER

6.3 CONTAINER TEST WEIGHTS

NOTES:

1. SOME OF DIMENSIONS
MAY BE ADJUSTED
IN FINAL DESIGN.
2. WELDS ARE
NOT SHOWN.
3. A36 STRUCTURAL
STEEL

SIDE ELEVATION
(HOLDER)

A-117

Subject TEMP. PUMP 2
CONTAINER TEST WEIGHT HOLDER

FRONT ELEVATION

* LINE UP W/ CG OF FULLY LOAD CONDITION

Subject TEMP. PUMP 2 -
Horizontal Lifting Lug, TEST WT

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Sheet No. 6-10
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By W. Kan Date 5/27/94
Chk'd MCW Date 6/3/94

Subject

TEMP. PUMP 2 -
CONTAINER TEST WTS.

DETAIL 2
6-7

Subject TEMP. PUMP 2 -
CONTAINER TEST WEIGHTS

DETAIL 3
A-121 6-7

Subject TEMP. 1 PAGE A-122

CONTAINER TEST WEIGHTS

SECTION

NTS

Advanced
Engineering
Consultants

WHC-SD-WM-DA-168
REV. 0

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Sheet No. 6-13
Job/Calc. No. CA 4001-02-1
Rev. No. 0
By ACM Date 6/8/94
Chk'd W Kan Date 6/8/94

Subject Temp. Pump 2 -
Dummy Pump

NOTE: 1. REMOVABLE DISKS

SEE CALC. P. 5-12 & 5-16
FOR SKETCHES

2. DUMMY PUMP IN HORIZONTAL

POSITION, IT MUST BE LIFTED
AT LEAST AT TWO POINTS
(PT. 1 & PT. 2)

ELEVATION
DATE 7/8/94

3. LOCATIONS OF DISKS CAN BE ADJUSTED AS LONG AS
LOCATION OF CC IS MAINTAINED, WHEN INTERFERENCE
WITH ATTACHMENTS ON THE EXISTING DUMMY PUMP OCCURS.

6.5 CORRESPONDENCE
1 TELECONS

DATE: May 9, 1994

6-14

WHC-SD-WM-DA-168
REV. 0

TO: Randy Jorissen (WHC)

PAGE A-124

FROM: Lincoln E. Malik *LEM*

SUBJECT: Tank 241 SY101 Mixer Pump Removal and Installation Project
BOA MJB-SMV-322666-002R, AEC Job No. 4001-02

6.5.1

Dear Randy:

This memo summarizes the data and clarifications AEC needs to proceed with the subject project:

Task 1 - Lifting Beam:

- 100 kips
1. The design loads for each of the two lifting beams is not clear for us. The scope of work calls for a canister plus pump design weight of 150 Kips. However the load chart we received from you adds up to approximately 70 Kips, which is supposed to include an impact factor of 1.25.

The loads are not uniformly distributed in the canister (the pump head is more heavy than the shaft). Design of the lifting beams requires that we have the maximum load on either lift beam. We can do this by having a load distribution of the canister and internals, as is given in the load chart, or a maximum lift load per lift beam defined by WHC.

Joint effort

In this regard, AEC also has a concern as to whether the design of the lift beams will be consistent with the design of the lifting lugs on the sides of the canister. The plates and welds now shown on the drawings may not be sufficient for the design load of the pin that will go in them. Also, will WHC or AEC take the responsibility for checking bearing and other associated loads on the canister lug plates. It does not make good sense to size a large pin for the design loads and factor of safety of 3, if the lug plates are designed for lower loads.

- NO
2. Should lift beam design loads include strongback, or will the strongback be left on the trailer?
 3. AEC needs the size of hook used with the lift beams to size the hole in the beam lug plate. Alternatively, we can design

Peter mine Clevins

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A-124

a pin to accommodate the hook. This might be a better overall detail both from a design and operations point of view.

4. Lift beam will be designed per AISC working stress design with allowable stresses per design criteria for C-106.

Task 2 - Saddles:

Our design to-date assumes the following. Please advise if this is to be different.

- will get loads from owner*
1. Saddles will be designed for load distribution shown on the load chart. Design will be based on AISC working stress design approach for gravity loads only. Seismic ~~and wind~~ loads have been eliminated from consideration by WHC (per phone conversation of 5/6/94). *Include wind.*
 2. Saddles will be placed on grout (for leveling) and the coefficient of friction used will be 0.2 (steel to concrete). Friction must still be used to resist initial lateral loads from laying the canister on the saddles at 15° with horizontal. *10°*
 - 3A. The saddles will be designed to be placed on the 8" slab-on-grade with soil bearing pressure of 2600 psf (ref. Dwg. STRL FDN PLAN & DETS).
 - 4B. Height at low point of saddle is assumed to be 4-3/4" (from t.o. base plate to b.o. radius plate). *OK*
 - 5B. AEC assumes that the container is designed to span the length between the two lifting lugs. Once the saddles are placed, WHC will check the container to span between the saddles, if necessary.

higher Bearing during lay down.

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Mackay

509-373-5262 FAX

6-16

WHC Response to AEC FAX (dated 5/10/94)
241SY101 Mixer Pump Project

WHC-SD-WM-DA-168
REV. 0

Respondent: Randy Jorissen

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6.5.2

Lincoln Malik,

This correspondence is a follow-up to our conversation on May 10, 1994, regarding the answers to your questions on the lifting beam and support saddles designs.

Response to Task 1 Questions/Comments - Lifting Beam

1. The 101SY load chart shows approximately 70 kip total load because it does not include the weight of the lead shot used for shielding, which will add an additional 66 kips. The lead shot must be included in the lifting beam design. As a design load, use 100 kips for each lifting beam (this includes an impact factor of 1.25).

AEC and WHC must jointly determine the size of the pin at the container/lifting beam interface. It is WHC's responsibility to determine structural adequacy of the container's lug plates; however, if AEC feels that the container lugs or welds are inadequate, AEC must discuss their concerns with WHC until all parties are satisfied that a workable solution has been reached.

2. Do not include strongback in lifting beam design loads: the strongback will be left on the trailer.
3. AEC will determine pin (or clevis) size for the lift beam lug plate. Provide WHC with the clevis/lug geometry and WHC will provide required lifting interface.
4. Correct.

Response to Task 2 Questions/Comments - Saddles

1. Do not design saddles for load distribution on load chart, as the loads do not include the lead shot used for shielding. WHC will FAX an updated load chart to AEC on 5/11/94 for use in saddle design. Do not design for seismic loads; however, the saddles must be designed for wind (with the weight of the container, wind loads should have minimal effect on saddle design). Use AISC working stress approach and AISC allowable stresses for saddles.
2. Per our conversation, your plan is to use 2 saddles, one located at each end of the container under the ribs that attach to the lifting lugs. WHC will check the container for the interface loads on the assumption that the saddles support the container over a 1/4 circle. This design will preclude the necessity of leveling multiple saddles. However, if

the container cannot withstand the interface loads with 2 saddles, you must go to a multi-saddle design. A steel/concrete friction coefficient of 0.2 is acceptable. I understand your concern that a 15 degree tilt angle from horizontal will put high loads in one saddle when the container first contacts the saddle - per our conversation, WHC will limit the horizontal tilt angle to 10 degrees. When the container first contacts a single saddle, the soil capacity allowable of 2600 psf may be exceeded - this is acceptable because it is a transient load and bearing capacity allowables are generally based on settlement. Provide conceptual design to WHC ASAP for checking interface loads.

4. Correct
5. Correct (this is the same as C-106).
6. Correct

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REV. 0

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ANALYTICAL CALCULATIC

Subject 101-SY CONTAINER/PUMP/LEAD SHOT LOAD DISTRIBUTION
 Originator CALCS. FOR INDEPENDENT REVIEW Date 5/10/94
 Checker Pandy J. Jansen Date _____

REVISED LOAD CHART - 101SY
- INCLUDES LEAD SHOT SHIELDING

DUMMY PUMP

6-19
FROM RANDY JORISSEN

CONCEPT FOR ADDING REMOVABLE WEIGHTS

WHC-SD-WM-DA-168
REV. 0
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NOTE -

- 1.) CONCEPT SHOWN USES BOLTED CONNECTIONS
 - FRICTION REQUIRED TO HOLD WEIGHT ON SHAFT OF DUMMY PUMP
 - MUST BE SLIGHT GAP BETWEEN TUBE SECTIONS TO ALLOW FOR CLAMPING ACTION
 - LUGS MUST BE SIZED FOR HIGH BOLT TORQUE
- 2.) MAX. DIAMETER = 41 in.
- 3.) PLATE MUST BE CHECKED FOR BUCKLING/BENDING WHEN PUMP TRANSITIONS FROM VERTICAL TO HORIZONTAL POSITION

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RECORD OF
MEETING ☐
TELECON ☒

6-20

6.5.3

DATE: 6/2/94

AEC PARTICIPANTS: Mike C.S. Chiao *Mcw*

WHC-SD-WM-DA-168
REV. 0
PAGE A- 130

OTHER PARTICIPANTS: Randy Jorissen (WHC)

PROJECT/SUBJECT: WHC Temporary Pump 2/Dummy Pump & Saddles
P.O. MJB-SWV-322666, Task 322666-002, AEC Job 4001-02

DISCUSSION NOTES:

Dummy Pump:

1. After Randy meets with Tom to discuss the subject matter tomorrow, he will then respond to AEC's previous request whether the dummy pump shown on Dwg. SK-2-24086, Rev. "0" reflects the as-built condition.
2. AEC is instructed to use the total length and limit a maximum cross sectional dimension of 36" as shown on Dwg. SK-2-24086 for designing and modifying the dummy pump.
3. Existing dummy pump weighs 19,435 lbs. per WHC calcs. on 11/28/92 by D.E. Ryman; new dummy pump after modifying will weigh 25,095 lbs. and the center of gravity to match that shown on 101SY load chart.
4. Randy did not object to AEC's proposal of increasing the new pump weights by filling the pipe sections with water.

Saddles:

WHC is still checking the canister rings for structural adequacy; however, he instructed AEC to go ahead to finalize the design AEC submitted earlier.

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WHC-SD-WM-DA-168

REV. 0

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DATE: 6/3/94

AEC PARTICIPANTS: Lincoln Malik, Mike C.S. Chiao

OTHER PARTICIPANTS: Randy Jorissen (WHC)

PROJECT/SUBJECT: WHC Temporary Pump 2/Dummy Pump

DISCUSSION NOTES:

Dummy Pump:

1. Randy will provide AEC a dimension - distance between the pump end and pivot point as shown on 101SY load chart.
2. AEC will locate center of gravity from the left end of the dummy pump that will match the end location of the actual pump on the cradle when tested; see SK-2-24086, Rev. 0 for dummy pump orientation.
3. Randy will provide actual weight of the concrete-filled pipe segments of the dummy pump to AEC.
4. AEC will check structural integrity of the dummy pump that will be supported by series of 41" O.D. disks when the pump lays inside the canister; AEC will detail the disks.
5. WHC decided using concrete instead of water to fill in the pipes for adding weights to the pump.

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WHC-SD-WM-DA-168
REV. 0

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MEETING
TELECON

PAGE A-132

DATE: 5/26/94

AEC PARTICIPANTS: Mike C.S. Chiao *WCC*

OTHER PARTICIPANTS: Randy Jorissen (WHC)

PROJECT/SUBJECT: WHC Temporary Pump 2/Lifting Beams, Saddles
P.O. MJB-SWV-322666, Task 322666-002, AEC Job 4001-02

DISCUSSION NOTES:

Lifting Beams: Randy received lifting beam sketches AEC faxed to him yesterday; agreed to single-plate (1-3/4" thick) extension to the underside of top flange of the beam; approved 12" clearance between the bottom of the beam and top of canister rings; AEC requested WHC to verify this dimension on the sketch.

Saddles: Randy asked how much of the container being supported in the AEC design; responded that the support is over a 1/4 circle.

Test Weights: Test weights include the weight of the holder; design two lifting lugs on the holder - one vertical, other horizontal; the center of the vertical lug is lined up with center of gravity of the holder itself, the horizontal lug is lined up with center of gravity of the holder plus all the weights. However, the vertical lug is still designed for full weights.

Dummy Pump: Randy will verify if the dummy pump shown on WHC sketch reflects as-built condition; WHC calcs. showed a conflicting dimension; use dimensions & load shown on 101SY load chart to check and modify the dummy pump.

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**Advanced
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Consultants**

180 Montgomery Street, Suite 850 San Francisco, CA 94104
Telephone: (415) 291-9600 Fax: (415) 291-9696

August 17, 1994

FAXED
8/17/94

Ms. Theresa Peterson
Westinghouse Hanford Company
P.O. Box 1970, H5-53
Richland, WA 99352

Subject: Hydrogen Mitigation in Tank SY101 - Dummy Pump Weights

Dear Ms. Peterson;

This letter is to confirm our telephone conversation earlier this afternoon. We understand that WHC wishes to replace the $\frac{3}{8}$ in 16 UNC2A x $\frac{1}{2}$ in, A354 Grade BD Hex Cap Screws for the MPA Dummy Pump Removable Discs, shown in drawing H-2-834749, Sh. 1, with Same screws made of A307 Grade material. AEC finds this replacement to be acceptable for this case.

Please call me if you have any questions.

Very truly yours,

Lincoln E. Malik
President

LEM:rm

Appendix B

Additional Analysis of Container Test Weight for Tank 241SY101

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

PAGE B-2 OF B-6

(1) Drawing	H-283943, Rev. 0	(2) Doc. No.	
(4) Building		(5) Rev.	(1)
(7) Subject	Test weight for 1015Y container		
(8) Originator	F.H. Hwang	Date	7-7-94
(9) Checker	J.M. Koz	Date	7-11-94

(10)

WEIGHT OF TEST WEIGHT for 1015Y CONTAINER

* Uniform dead load = 92.8 lb/ft of container
Uniform live load = 210 lb/ft of pump

Purpose: Determine the weight of test weight assembly that simulate the pump. Also check the reactions of the hydraulic system.

Total wt. of pump (live loads)

$$= 7000 + 5000 + 3000 + 210 \times 53.25 + 150 \times (12 \times 12 + 9) / 12$$

$$= 28096.06$$

Calculate the weight of test weight assembly (Wt)

$$W_t (53 \times 12 + 9) = 210 \times 53.25 \times (53 \times 12 + 3) / 2 + 7000 \times (29 \times 12 + 1) + 5000 \times (52 \times 12 + 5) + 3000 \times (53 \times 12 + 3) + 150 \times (12 \times 12 + 9) \times (59 \times 12 + 7.5) / 12$$

B-2

BD-6400-060 1 (12/87)

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0(1) Drawing H-2-A3743, Rev. 0 (2) Doc. No. _____

(4) Building _____ (5) Rev. _____

PAGE B-3 OF B-6

(7) Subject Test weight for 101 sy Containers(8) Originator F.H. HuangDate 7-11-94(9) Checker B.M. K...Date 7-11-94

(10)

$$645 W_t = 3,445,929 + 2,443,000 + 3,145,000 + \\ 1,917,000 + 1,368,394$$

$$W_t = \underline{19,296 \text{ lb.}}$$

Vertical Reaction at Jack joint

$$F_c (232 \sin 42^\circ + 19.44 \cos 42^\circ) = 19296 \times 645 + 1000 \times 53.25 \times \frac{(53 \times 12 + 3)}{2} \\ + 4084 \times 9 + 30,000 \times 15 \times 12$$

$$= 34,896,060 \text{ lb-in}$$

$$F_c = \frac{34,896,060}{169.68}$$

$$= 205.6 \text{ Kips}$$

1% within computer calcs.

Use $F_{cy} = 203.6 \text{ kips}$; $W_u = 928 \text{ lb/ft}$ to calculate the weight of Test Weight Assembly (W_t):

$$203614 \times 169.68 = W_t \times 645 + 928 \times 53.25 \times 319.5 \\ + 4084 \times 9 + 30,000 \times 15 \times 12$$

$$645 W_t = 13,324,055$$

$$W_t = \underline{20657 \text{ lb.}}$$

Test weight increase is

$$20657 - 16770 = 3887 \text{ lb.}$$

ANALYTICAL CALCULATIONS

PAGE B-4 OF B-6

Subject H-2-83743, Rem. 0, Test Weight

Originator F.H. Huang

Date 7-11-94

Checker I.M. Koo

Date 7-11-94

changes for test weight Design:

(1) 6 filler plates (5' x 5' x 2")

→ 4 filler plates with a thickness of 3"

Total weight of new filler plates

$$(5 \times 12)(5 \times 12) 2 \times 0.284 \times 6 + 3887$$

$$= 12268.8 + 3887 = 16156 \text{ lb.}$$

Weight of each new plate

$$W = 16156 / 4 = 4039 \text{ lb.}$$

The length of 5' x 3" plate

$$= \frac{4039}{0.284 \times 3 \times 60} = 79" \text{ or } 6'-7"$$

Size of each new filler plate

$$\underline{6'-7" \times 5' \times 3"}$$

$$\underline{\text{Weight: } 4039 \text{ lb}}$$

Hoist ring (part 23301, rate 4000 lb each)

4 rings on each plate, 2 each side O.K.

(2) or USE 8 filler plates of 5' x 5' x 2"

Total weight of Test Weight Assembly

$$W_T = 16770 + 60 \times 60 \times 2 \times 0.284 \times 2$$

$$= 20,860 \text{ lb.}$$

Within 1% of 20657 lb. O.K.

(1) Drawing 14-2-83743, RAYO (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) PAGE B-5 OF B-6
 (7) Subject Test weight for 101 sy Condenser
 (8) Originator FH Huang Date 7-11-94.
 (9) Checker JL B... Date 7/20/94

(10)

CHECK W8X28 CANTILEVER BEAM

Design Criteria: Bending and tension stress = 12 ksi
 Weld: 7.2 ksi on effective area

Max Moment, (8 Filler plates of 5x5x2",
 7 each weights 2045 lb, one 2175 lb)

$$M = 2045(5+7+9+11+13+15+17) + 2175(19) = 198790 \text{ in-lb}$$

Bending stress:

$$\sigma = \frac{198790}{2 \times 24.3} = 4090 \text{ psi}$$

With impact add 25% load

$$\sigma = 4090 \times 1.25 = 5113 \text{ psi} < 12,000 \text{ psi OK}$$

WELD STRENGTH, $b = 6.5"$; $d = 8"$

$$S_w = 2bd + \frac{d^3}{3} = 125.33 \text{ in}^2$$

$$f_b = \frac{M}{S_w} = \frac{198790 \times 1.25}{2 \times 125.33}$$

$$= 991.3 \text{ lb/in}$$

$$A_w = [4(6.5) - 2(0.313) + 2(6.125)]$$

$$= 37.624 \text{ in}$$

shear

$$V = (2045 \times 7 + 2175) \times 1.25 / 2$$

$$= 10306 \text{ lb}$$

$$f_v = \frac{10306}{37.624} = 274 \text{ lb/in}$$

$$f_r = \sqrt{991.3^2 + 274^2} = 1028.5 \text{ lb/in}$$

$$\text{weld size} = \frac{1028.5}{7200} = 0.143 \text{ in} < 3/16 \text{ in OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83743, Rev. 2 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____
(7) Subject Test Weight for 101 Sy Container
(8) Originator FH Huang Date 7-12-94
(9) Checker [Signature] Date 7/20/94

PAGE B-6 OF B-6

(10)

HORIZONTAL LIFTING LUG

Total Weight of Test Weight
= 20860 lb

Tearing strength

$$a = 2 - (1 \frac{9}{16}) \frac{1}{2} = 1.219''$$

$$Area = at = 1.219 \times 2 = 2.438 \text{ in}^2$$

$$\sigma = \frac{20860}{2.438} = 8558 \text{ psi} < 12,000 \text{ psi}$$

also check,

Allowable load for tear-out based on the
Equation derived by D.T. Ricker, Eng. Journal
of AISC.

The allowable load is

$$P = \frac{1.67 F_b t a^2}{d}$$

where

t is lug plate thickness

F_b allowable bending
stress of lug

$F_b = 12 \text{ ksi}$ design criteria

d is hole diameter

a is edge distance

$$P = \frac{1.67 (12000) (2) (2 - \frac{25}{16})^2}{25/16}$$

$$= 38,100 \text{ lb} > 20,860 \text{ lb} \quad \text{o.k.}$$

tear-out allowable load is larger
than the weight of Test Weight Assembly.

Appendix C

Additional Analysis of Mock-up Pump Modification for Tank 241SY101

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83 749, Rev. 0 (2) Doc. No. _____
(4) Building SK-2-24088, Rev. 0 (5) Rev. _____ (6) _____
(7) Subject Sy101 Mockup pump Assembly
(8) Originator F.H. Higgins Date 7-19-94
(9) Checker J.V. Eger Date 7/22/94

(10)

BENDING OF Mock-up pump

WEIGHT for PIPES

$\phi 36''$: 142.68 #/ft STD

$\phi 20''$: 78.64/ft STD, 104.13 #/ft XS

$\phi 16''$: 62.58 # STD from CRANE, CO

REACTIONS + MOMENTS FROM UNIFORM + POINT LOADS

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing 14-2-d3749, Rev. 0 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____
(7) Subject Sy 101 Mockup pump Assembly
(8) Originator FH Huang Date 7-19-94
(9) Checker J. V. Egger Date 7/22/94

PAGE C-3 OF C-12

(10)

Section length and weight

$$a = 5.667'$$

$$W_1 = [142.68 \times 5.667 + \frac{\pi}{4} (3)^2 (5.667) 145] / 5.667$$

$$= 6617 / 5.667 = 1167.6 \text{ \#/ft}$$

$$b = 3.667'$$

Wt of Bumper plate

$$= [(4.625 + 24) 9.75 / 2 \times \frac{1}{2} + 6 \times 6 \times \frac{3}{4} \times 2$$

$$+ \frac{\pi (4)^2}{4} \times 4 + \frac{2}{2} (1.25) (6 + 6 + 5.875)] \times 0.284$$

$$= 55.8 \text{ \#}$$

$$W_2 = [62.58 \times 3.667 + \frac{\pi}{4} (1.333)^2 (3.667) 145 +$$

$$55.8 + 106] / 3.667$$

$$= 1133.3 / 3.667$$

$$= 309.05 \text{ \#/ft}$$

* Flange wt:
106 \# for 150 \# slip on.
Ladish Cataly ss.

$$c = 4.958'$$

$$\text{Two Flanges wt} = (106)(2) = 212 \text{ \#}$$

$$W_3 = (62.58 \times 4.958 + 212) / 4.958$$

$$= 522.27 / 4.958 = 105.34 \text{ \#/ft}$$

$$d = 4.333' ; \text{Two Flanges: } 106 \text{ \#} + 185 \text{ \#}$$

$$\text{Saddle wt} = 1.833 \times 18.57 \times 2$$

$$= 105 \text{ \#}$$

$$W_4 = (62.58 \times 4.333 + \frac{\pi}{3} (1.333)^2 (4.333) 145 +$$

$$106 + 185 + 105) / 4.333$$

$$= 1540 / 4.333 = 356.3 \text{ \#/ft}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83749, Rev. 0 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject S-101 Mock up pump Assembly
(8) Originator FH Huang Date 7-19-94
(9) Checker J. Y. Eggert Date 7/22/94

PAGE C-4 OF C-12

(10)

$$e = 10.833'$$

$$\text{Two Flange wt} = 296 \#$$

$$W_5 = (104.13 \times 10.833 + 296) / 10.833$$

$$= 1424 / 10.833 = 131.5 \#/\text{ft}$$

Locate Lifting Point at 4'-9" From $\phi 20"$ STD Joint with $\phi 20"$ X S PIPE
 $f = 4.75'$ filled with CONCRETE, $\phi 20"$ STD PIPE

$$\text{one Flange wt} = 148 \#$$

$$\text{Saddle wt} = 105 \#$$

$$W_6 = \left\{ \left[78.6 + \frac{\pi}{4} \left(\frac{20}{12} \right)^2 \times 145 \right] \times 4.75 + 148 + 105 \right\} / 4.75$$

$$= 2129 / 4.75 = 448.2 \#/\text{ft}$$

Length of $\phi 20"$ STD PIPE Field Measured as 18'-9"

$$g = 14' \text{ filled with concrete}$$

$$\text{Saddle wt. } 2 \times 7 \times \frac{22}{12} \times 1.05 = 55 \# \text{ add 5\%}$$

$$\text{Bumper plate: } (10 + 18) (5 \frac{5}{16}) \times \frac{1}{2} \times \frac{1}{2} \times 2$$

$$\times 0.284 \times 1.05 = 22 \#$$

$$W_7 = \left\{ \left[78.6 + \frac{\pi}{4} \left(\frac{20}{12} \right)^2 \times 145 \right] \times 14 + 55 + 22 \right\} / 14$$

$$= 5606.2 / 14 = 400.5 \#/\text{ft}$$

$$h = 14.167', \text{ one flange} = 106 \#; \frac{3}{8}" \text{ plate} = 21 \#$$

$$W_8 = (62.58 \times 14.167 + 106 + 21) / 14.167 = 74.58 \#/\text{ft}$$

Calculate R_1 at A

$$\begin{aligned} R_1 l = & W_1 a [2(l-a) - a] / 2 + W_2 b [2(l-a) - b] / 2 + W_3 c [2(l-a-b) - c] / 2 \\ & + W_4 d [2(l-a-b-c) - d] / 2 + W_5 e [2(l-a-f) - e] / 2 + W_6 f^2 / 2 \\ & - W_7 g^2 / 2 + W_8 h (l + h + l) / 2 + P_3 (U_1 + U_2 + U_3) \\ & + P_4 U_4 + P_2 U_6 + P_1 (U_5 + U_7 + U_8) \end{aligned}$$

C-4

C-5

$$P_4 = \left\{ \pi (20.5^2 - 10^2) \times 2 - 10.5 \times 5 \times 2 \times 2 + \frac{1}{2} \times 8 \times 8 \times 4 + 1 \times 4 \times 8 \times 2 + \frac{1}{2} (20^2 - 18.75^2) \times 10 \right\} \times 10^3$$

$$\phi 20", 2" \text{ thick}$$

$$P_3 = \left\{ \pi (20.5^2 - 10^2) \times \frac{1}{2} - 10.5 \times 4 \times \frac{1}{2} \times 2 + \frac{1}{2} \times 8 \times 8 \times 4 + \frac{1}{2} \times 4 \times 8 \times 2 + \frac{1}{2} (20^2 - 19.25^2) \times 10 \right\} \times 10^3 \times 0.284 = 242 \#$$

$$\phi 20", \frac{1}{2}" \text{ thick}$$

$$P_2 = \left\{ \pi (20.5^2 - 8^2) \times 2 - 5 \times 12.5 \times 2 \times 2 + 1 \times 8 \times 8 \times 4 + 1 \times 4 \times 8 \times 2 + \frac{1}{2} (16^2 - 14.75^2) \times 10 \right\} \times 10^3 \times 0.284 = 741.3 \#$$

$$\phi 16", 2" \text{ thick}$$

$$P_1 = \left\{ \pi (20.5^2 - 8^2) \times \frac{1}{2} - 4 \times 12.5 \times 2 \times \frac{1}{2} + \frac{1}{2} \times 8 \times 8 \times 4 + \frac{1}{2} \times 4 \times 8 \times 2 + \frac{1}{2} (16^2 - 15.25^2) \times 10 \right\} \times 10^3 \times 0.284 = 242.5 \#$$

$$\phi 16", \frac{1}{2}" \text{ thick}$$

disk weight

$$l = a + b + c + d + e + f = 34.21'$$

where

(10)

(1) Drawing	H-2-B3749, Rev (2)	Doc. No.
(4) Building	(5) Rev.	
(7) Subject	SY 101 Mockup Pump Assembly	
(8) Originator	FH Huang	
(9) Checker	L. Y. Egan	
	Date	7-19-94
	Date	7-22-94

PAGE C-5 OF C-12

WMC-SD-WM-DA-168
REV. 0

DESIGN CALCULATION

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83749, Rev. 0 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject Sy 101 Mockup pump assembly
 (8) Originator F.H. Huang Date 7-19-94
 (9) Checker J. V. Gagliardi Date 7/25/94

(10)

point load distances

$$U_1 = 2'; U_2 = 7.5'; U_3 = 10'; U_4 = 11.875'$$

$$U_5 = 22; U_6 = 42; U_7 = 42.875'; U_8 = 47.375'$$

$$\begin{aligned} R_1(34.21) &= 661.7(2 \times 34.21 - 5.667)/2 + 1133.3[2(34.21 - 5.667) \\ &\quad - 3.667]/2 + 522.27[2(34.21 - 5.667 - 3.667) - \\ &\quad 4.958]/2 + 1544[2(34.21 - 5.667 - 3.667 - 4.958) - \\ &\quad 4.333]/2 + 1424[2(10.833 + 4.75) - 10.83]/2 \\ &\quad + 448.2(4.75)^2/2 - 400.5(14)^2/2 \\ &\quad + 71.58 \times 14.167(34.21 \times 2 + 14.167)/2 \\ &\quad + 242(2 + 7.5 + 10) + 710.8(11.875) + \\ &\quad 741.3 \times 42 + 242.5(42.875 + 47.375 + 22) \\ &= 207,618.3 + 30,269.9 + 11,697.3 \\ &\quad + 27,408.3 + 14,477 + 5,056.3 - \\ &\quad 39,249 + 4,187.5 + 7,223.1 \end{aligned}$$

$$R_1 = \frac{37140}{34.21} = 10856 \#$$

Total weight of Mockup Pump

$$\begin{aligned} &= 661.7 + 1133.3 + 522.27 + 1544 + \\ &\quad 1424 + 2129 + 5606.2 + 71.58 \times 14.167 \\ &\quad + 242 \times 3 + 710.8 + 741.3 + 242.5 \times 3 \\ &= 22895 \# \end{aligned}$$

$$R_2 = 22895 - 10856 = 12039 \#$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83749, Kav. 0 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) Job _____
 (7) Subject SV101 Mock up pump Assembly
 (8) Originator F.H. Helling Date 7-21-94
 (9) Checker J.W. Goff Date 7/25/94

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(10)

Determine the maximum moment, assuming
 X is in the section "d".

$$\begin{aligned}
 M_x = & R_1 x - w_1 a (2x - a)/2 - w_2 b [2(x - a) - b]/2 \\
 & - w_3 c [2(x - a - b) - c]/2 - w_4 (x - a - b - c)^2/2 \\
 & - P_2 (42 - 34.21 + x) - P_1 [(47.37 - 34.21 + x) \\
 & + (42.875 - 34.21 + x) + (x - (34.21 - 22))]
 \end{aligned}$$

$$\frac{\partial M_x}{\partial x} = 0 \Rightarrow$$

$$\begin{aligned}
 X = & [R_1 - w_1 a - w_2 b - w_3 c + w_4 (a + b + c) - \\
 & P_2 - 3P_1] / w_4 \\
 = & \{10856 - 6617 - 1133.3 - 522.3 + \\
 & 356.3(5.667 + 3.667 + 4.958) - \\
 & 741.3 - 777.5\} / 356.3 \\
 = & 17.42'
 \end{aligned}$$

Max Moment at $x = 17.42'$ in Sect. d

$$\begin{aligned}
 M_{max} = & 10856(17.42) - 6617(2 \times 17.42 - 5.667)/2 \\
 & - 1133.3[2(17.42 - 5.667) - 3.667]/2 - \\
 & 522.3[2(17.42 - 5.667 - 3.667) - 4.958]/2 \\
 & - 356.3(17.42 - 5.667 - 3.667 - 4.958)^2/2 \\
 & - 741.3(42 - 34.21 + 17.42) - 242.5[(47.37 - 34.21 + \\
 & 17.42) + (42.875 - 34.21 + 17.42) + (17.42 - (34.21 - 22))]
 \end{aligned}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83749, Rev. 0 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____
(7) Subject Sy 101 Mock up pump Assembly
(8) Originator FH Huang Date 7-21-94
(9) Checker J. V. Elgin Date 7/25/94

PAGE C-8 OF C-12

(10)

$$\begin{aligned} M_{max} &= 18911.5 - 96518.9 - 11241.8 - \\ &\quad 2928.5 - 1743.1 - 18688.2 - 15004.7 \\ &= 42986 \text{ ft-lb} \end{aligned}$$

$$S = 70.3 \text{ in}^3 \text{ for } \phi 16" \text{ STD pipe}$$

Bending stress

$$\begin{aligned} \sigma_b &= \frac{42986 \times 12}{70.3} \\ &= 7337 \text{ psi} \end{aligned}$$

With impact

$$M = 42986 \times 1.25 = 53,732 \text{ ft-lb}$$

$$\sigma_b = \frac{53732 \times 12}{70.3}$$

$$= 9,172 \text{ psi} < 12,000 \text{ psi O.K.}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-23749.R-1.2 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject Lifting Lug For Mock up pump
(8) Originator Fit Engineering Date 7-21-96
(9) Checker J.V. Egger Date 7/21/00

PAGE C-9 OF C-12

(10)

Lifting Lug For mock up pump used
in two load cases:

Load case 1:

Eight disks of test weight are attached
to the mock up pump. The assembly
is lifted horizontally for load testing cradle.

Total weight is about 23 kips; reaction
 $R_2 \sim 13$ kips

Load case 2:

The mock up pump is in the vertical position
for container and bag system testing. One
crane hold the upper lug, the 2nd crane
lift the pump through the lower lug. The
Test Weight Disks are taken off from the
pump. Total weight: 19 kips

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83749, Rev. 2 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____
(7) Subject Lifting Lug for Mock-up Pump
(8) Originator FH Huang Date 7-21-94
(9) Checker J.V. Eager Date 7/21/94

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(10) Load Case 1:
Horizontal Lift:

$$P = 13,000 \text{ lb.}$$

with a s.f. of 1.25

$$P = 13,000 \times 1.25$$

$$= 16.3 \text{ kips}$$

Assume

$$P = 17 \text{ kips}$$

Tension tear-out strength:

$$A = t a = 1.5 \left(2.5 - \frac{1.5}{2} \right)$$

$$= 2.625 \text{ in}^2$$

$$\sigma_t = \frac{17}{2.625}$$

$$= 6.5 \text{ ksi} < 12 \text{ ksi}$$

O.K.

The allowable load
based on DT Rickle's eq.

$$P = \frac{1.67(12)(1.5)(2.5 - 1.5/2)^2}{1.5}$$

$$= 61 \text{ kips} > 17 \text{ kips} \quad \text{OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing U-2-2374-9, Rev. 2 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject Lifting Lug for Mock up pump
(8) Originator Fit Huang Date 7-21-94
(9) Checker J. V. Egan Date 7/21/94

PAGE C-11 OF C-12

(10)

Check weld strength

* Lug lifts 17,000 lb;

design criteria: 7200 psi

(1) Weld at the root of the lug

minimum weld size:

$$t = \frac{17,000}{10 \times 2 \times 7200}$$

$$= 0.12" < 0.75"$$

OK

Full penetration

(2) Weld at the ends of the sleeve

$$t = \frac{17,000}{20\pi \times 2 \times 7200}$$

$$= 0.019" < 1/4" \quad \text{OK}$$

(3) Weld at the joints of the two half cylinders.

$$t = \frac{17,000}{2 \times 12 \times 7200} = 0.10" < 1/2" \quad \text{OK}$$

* Use Crosby Forged Shackle
9 1/2 ton

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing 17-2-83749, Rev. 0 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____
(7) Subject Lifting Lug for Mock up pump
(8) Originator Elt. Thucanh Date 7-21-94
(9) Checker J.V. Eager Date 7/21/98

PAGE C-12 OF C-12

(10)

Load case 2:

Vertical Lifting

Assume the lower lug carries one half of the total weight:

$$P = \frac{23}{2} = 11.5 \text{ kips}$$

With impact

$$P = 11.5 \times 1.25 \sim 15 \text{ kips}$$

Bending stress:

Moment

$$M = 15 \times 3 = 45 \text{ kip-in}$$

$$S = (1.5 \times 10^2) / 6 = 25 \text{ in}^3$$

$$\sigma_b = \frac{45}{25} = 1.8 \text{ ksi} < 12 \text{ ksi} \quad \text{O.K.}$$

Compressive stress on concrete inside pipe

Reaction

$$R_1 = \frac{15 \times 3}{10} = 4.5 \text{ kip}$$

Compression area

$$A = \left(\frac{1}{2} + \frac{1}{2}\right) \left(1\frac{1}{2} + \frac{1}{2} + \frac{1}{2}\right) = 2.5 \text{ in}^2$$

$$\sigma_c = \frac{4.5}{2.5} = 1800 \text{ PSI}$$

< 2000 PSI for concrete
O.K.

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Appendix D

Analysis of Removable Support for the Transport Assembly

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing 14-2-83755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) PAGE D-2
(7) Subject TRUSSPORT TEMPORARY REMOVABLE SUPPORT
(8) Originator J. V. EGGERT Date 11/30/94
(9) Checker W. M. H. Tuck Date 5 DEC. 94

(10) OBJECTIVE

DESIGN TEMPORARY SUPPORT FOR CONTAINER
ON 1015Y TRAILER. SUPPORT WILL ELEVATE
THE OPEN END OF THE CONTAINER DURING
REMOVAL OF THE TOP END OF THE 1015Y
PUMP. CONTAINER IS BEING ELEVATED
TO PREVENT FLUIDS, WHICH MAY DRAIN
THE PUMP, FROM DRAINING FROM THE
CONTAINER

REFERENCES

1. MANUAL OF STEEL CONSTRUCTION ALLOWABLE
STRESS DESIGN NINTH EDITION. (AISC)
2. MINIMUM DESIGN LOADS FOR BUILDINGS
AND OTHER STRUCTURES (ANSI/ASCE ~~7-88~~)

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____

(4) Building _____ (5) Rev. _____

PAGE D-3

(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT

(8) Originator L.V. ELLER Date 9/29/94

(9) Checker WANDA TUCK Date 5 Dec. 94

(10)

KAMP TRAILER DWG.

REF. DWG.

H-2-83736

STRONG BACK

H-2-83734

COUNTERWEIGHT

$$l = \sqrt{(623.813)^2 + 36^2} = 624.85 \text{ IN}$$

$$\tan^{-1} \left(\frac{36}{623.813} \right) = 3.303^\circ$$

MAXIMUM GRADE OF ROAD - 4%

MINIMUM SLOPE TO PREVENT DRAINAGE - $\frac{1}{4}$ " / FT

$$\text{SLOPE } \angle \text{ OF CONTAINER } \frac{4}{100} + \frac{1/4}{12} = 0.06093$$

$$\frac{36}{623.813} + 0.06093 = 0.119$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J. V. EIGER Date 9/28/94
 (9) Checker James A. Trick Date 6 Dec. 94

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(10)

ROTATION of ϕ OF CONTAINER @ COL. LINE 24
 AROUND ASSEMBLY PIN.

$$\tan^{-1}(0.119) = 6.76^\circ$$

Vertical offset of ϕ OF CONTAINER

$$y = 623.913 \cdot \tan(6.76^\circ) - 36 = 37.95''$$

HORIZONTAL offset of ϕ OF CONTAINER

$$y = 624.85(\cos 6.76^\circ) - 623.913 = -3.307''$$

ROTATION OF CONTAINER RING @ COL. LINE 24
 $5' - 11\frac{5}{8}''$ DIA OF CONTAINER RING

$$y = 35.8125(\cos 3.302^\circ) = 35.753''$$

$$x = 35.8125(\sin 3.302^\circ) = 2.062''$$

LOCATION OF SUPPORT POINT FROM TOP OF
 TRAILER

$$\begin{aligned} \text{VERTICAL} &= 24.35 + 36 + 37.95 - 35.753 \\ &= 62.547'' \end{aligned}$$

$$\begin{aligned} \text{HORIZONTAL} &= -3.307 + 2.062 \\ &= -1.245'' \end{aligned}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-33755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) J. _____
 (7) Subject TRANSPORT ASSIGNMENT REMOVABLE SUPPORT
 (8) Originator J. V. EGGER Date 9/29/94
 (9) Checker JANIS A. TUCK Date 5 Dec. '94

PAGE D-5

(10)

WEIGHT OF CONTAINER AND PUMP 66400 #

ASSUME 25% INCREASE FOR IMPACT $W = 83,000 \#$

$$W = \frac{83000}{623.813} = 133 \text{ #/in}$$

$$\sum V = V_A + V_B - 83000 \#$$

$$\sum H = H_A + H_B = 0$$

$$\sum M_A = V_B (623.813) + H_B (38) - 83000 \left(\frac{623.813}{2} \right) = 0$$

ASSUME REACTION AT B IS NORMAL TO ϕ OF CONTAINER

$$\frac{H_B}{V_B} = \frac{38}{623.813}$$

$$H_B = \frac{38}{623.813} V_B$$

$$V_B (623.813) + \left(\frac{38}{623.813} V_B \right) (38) = 83000 \left(\frac{623.813}{2} \right) = 0$$

$$V_B = \frac{83000 \left(\frac{623.813}{2} \right)}{623.813 + \frac{38^2}{623.813}}$$

$$= 41347 \#$$

$$H_B = \frac{38}{623.813} (41347) = 2518 \#$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject TRANSPORT ASSEMBLY: PRIMARY AIR SUPPORT
 (8) Originator J. V. EGGER Date 9/14/94
 (9) Checker JAMES A. TUCK Date 5 Dec. 94

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(10) WIND LOADS. (ANSI/ASCE 7-88)

$$q_z = 0.00256 K_z (I V)^2$$

$$V = 70 \text{ MI/HR.}$$

$$I = 1.07$$

CATEGORY III

$$K_z = 0.87$$

EXPOSURE C $z = 20 \text{ FT}$

$$q_z = 0.00256 (0.87) [(1.07)(70)]^2$$

$$= 12.5 \text{ #/FT}^2$$

$$F = q_z G_z C_f A_f$$

$$G_z = 1.29 \quad \text{TABLE 5} \quad z = 20 \text{ FT}$$

$$M = 11 \text{ FT} \quad N = 11 \text{ FT}$$

$$M/N = \frac{11}{11} = 1.00 \leq 6$$

$$C_f = 1.2$$

$$F/A_f = 12.5 (1.29) (1.2) = 19.35 \text{ #/FT}^2$$

$$F = 19.35 (11) (11) = 2341.35 \text{ #}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-33755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) PAGE D-7
(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
(8) Originator J. V. ETGER Date 9/23/94
(9) Checker James A. Tucker Date 5 Dec 94

(10)

REQ'D BEARING AREA ON SHIELDING PLATE

$$A = \frac{P}{F_b} = \frac{\sqrt{41347^2 + 2519^2}}{12,000 \#/IN^2}$$

$$= 3.45 IN^2$$

CHECK HORIZONTAL BRACE.

$$P = 4150 \#$$

$$W = 19.35 (11)$$

$$= 212.85 \#/FT$$

REACTION AT A DUE TO W

$$R_A = \frac{W}{2l} (l+a)^2 \quad (\text{AISC pg 2-304})$$

$$R_A = \frac{212.85}{2(5)} (5+5)^2$$

$$= 2575.5 \#$$

TOTAL AXIAL LOAD IN BRACE

$$P = \frac{(2575.5 + 2519)}{\cos 45^\circ} = 7203 \#$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-93-755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) PAGE D-8
(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
(8) Originator L. V. ELLIOTT Date 9/29/94
(9) Checker VA Tuck Date 5 Dec. 94

(10)

CHECK $L3 \times 3 + 5/16"$

$$A = 1.78 \text{ in}^2 \quad r_z = 6.599 \text{ in}$$

$$\frac{KL}{r} = \frac{(1)(5/\cos 45)(12)}{6.599} = 144$$

FOR A36 STEEL $F_y = 36$ (AISC E.2)

$C_c = 126.1$ (AISC pg 5-120)

$F_A = 7.2 \text{ ksi}$ (AISC pg 5-122)

$$f_a = \frac{7203}{1.73} = 40.47 \text{ ksi} \leq 7200 \text{ ksi OK}$$

BOLT SIZE REQUIRED

$$P_H = P_V = 2575.5 + 2518 = 5094$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject TRANSPORT ASSEMBLY REMEDIATION SUPPORT
(8) Originator J. V. ELLER Date 9/29/04
(9) Checker JAMES A. TUCK Date 5 DEC. 94

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(10)

CHECK $\frac{3}{4}"$ A325 BOLT $A = 0.4418 \text{ in}^2$

$$f_v = \frac{5.094}{0.4418} = 11.53 \text{ K/in}^2$$

$$F_t = \sqrt{(44)^2 - 4.39(11.53)^2}$$

$$= 36.78 \text{ K/in}^2$$

$$f_t = \frac{5.094}{0.4418} = 11.53 \text{ K/in}^2 < 30.36 \text{ K/in}^2 \text{ OK}$$

CHECK BENDING STRESS IN $L 4 \times 3 \times \frac{5}{16}$

$$W = \frac{2576}{11}$$

$$= 234.2 \text{ \#/ft}$$

$$P = 2518 \text{ \#}$$

$$R_A = R_B = \frac{2518}{2} + \frac{234.2(11)}{2} = 2547 \text{ \#}$$

$$M_A = \frac{(234.2/12)(45.5)^2}{2} = 22,954 \text{ \#-IN}$$

MOMENT AT LOAD P

$$M = \frac{(234.2/12)(66)^2}{2} - 2547(17.5) = -2065 \text{ \#-IN}$$

SECTION PROPERTIES $L 4 \times 3 \times \frac{5}{16}$ $A = 2.09 \text{ in}^2$

$$I_x = 3.38 \text{ in}^4 \quad \bar{y} = 1.26 \text{ in}$$

$$I_y = 1.65 \text{ in}^4 \quad \bar{x} = 0.759 \text{ in}$$

$$r_z = 0.647 \text{ in} \quad \tan \alpha = 0.554$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) PAGE D-10
(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
(8) Originator J.V. EGER Date 9/28/94
(9) Checker James A. Tuck Date 5 Dec. 94

(10)

$$\alpha = \tan^{-1}(0.554) \\ = 28.997^\circ$$

$$I_z = A r^2 = 2.09 (0.647)^2 = 0.875 \text{ in}^4$$

$$I_w = I_x + I_y - I_z = 3.38 + 1.65 - 0.875 = 4.16 \text{ in}^4$$

$$z_A = (3 - \bar{x}) \sin \alpha + \bar{y} \cos \alpha \\ = (3 - 0.759) (\sin 28.997) + 1.26 (\cos 28.997) \\ = 2.188 \text{ in}$$

$$w_A = (3 - \bar{x}) \cos \alpha - 1.26 \sin \alpha \\ = 1.350 \text{ in}$$

$$z_B = \bar{y} \cos \alpha - \bar{x} \sin \alpha \\ = 0.734 \text{ in}$$

$$w_B = \bar{y} \sin \alpha + \bar{x} \cos \alpha \\ = 1.275 \text{ in}$$

$$z_C = (4 - \bar{y}) \cos \alpha + \bar{x} \sin \alpha \\ = 2.765$$

$$w_C = (4 - \bar{y}) \sin \alpha - \bar{x} \cos \alpha \\ = 0.664 \text{ in}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (PAGE D-11)
 (7) Subject TRANS PORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J.V. ELGER Date 9/29/91
 (9) Checker Vanna A. Tach Date 5 Dec. 94

(10)

$$M_w = 22,954 \cos \alpha$$

$$= 20,080 \#-in$$

$$M_z = 22,954 \sin \alpha$$

$$= 11,120 \#-in$$

STRESS AT A

$$f_{ba} = \frac{20,080 (2.139)}{4.16} - \frac{11,120 (1.35)}{0.975}$$

$$= -6,595 \# / in^2$$

STRESS AT B

$$f_{bb} = \frac{20,080 (0.734)}{4.16} + \frac{11,120 (1.275)}{0.975}$$

$$= 19,750 \# / in^2$$

$$f_{bc} = \frac{-20,080 (2.765)}{4.16} - \frac{11,120 (0.664)}{0.975}$$

$$= -21,780 \# / in^2$$

$$b/e = \frac{4}{(5/16)} = 12.8 \quad \frac{76}{\sigma F_y} = 12.7$$

$b/e \leq 76/\sigma F_y$ (AISC TABLE B5.1)

OK LESS THAN 1% $(\frac{12.8}{12.7} = 1.008)$

LATERALLY UNBRACED LENGTH 48.5"

$$l_b < \frac{76 b_f}{\sqrt{F_y}} \quad (\text{AISC F1.2})$$

$$48.5 < 50.7 \quad \text{OK} \quad F_b = 0.6 F_y = 21.6 \text{ ksi OK.}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-B3755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____
 (7) Subject TRANSPORT ASSEMBLY REMOVEABLE SUPPORT
 (8) Originator J.V. ELLER Date 9/20/94
 (9) Checker James A. Tude Date 5. Dec. 94

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(10)

CHECK BENDING STRESS IN 4" LEG OF L4x3x5/16

$$M = 6726 (2.5 - \frac{3}{4}) = 11770 \text{ #-IN}$$

ASSUME 5" WIDTH OF LEG.

$$S = \frac{bd^2}{6} = \frac{5 (5/16)^2}{6} = 0.0814 \text{ IN}^3$$

$$f_b = \frac{11770}{0.0814} = 144635 \text{ #/IN}^2 \text{ N.G.}$$

ADD STIFFENERS ON EA. SIDE OF BOLT.

ASSUME UNIFORM LOAD ON PLATE WITH 3 EDGES FIXED AND 1 EDGE FREE (REMARK TABLE 26 CASE 10a, pg. 469)

$$q = \frac{6726}{(3)(4)} = 560 \text{ #/IN}^2$$

$$a = 3 \quad b = 4 \quad a/b = 0.75$$

MAXIMUM STRESS $\beta_3 = 0.286$

$$T = \frac{\beta_3 q b^2}{t^2} = \frac{0.286 (560) (4)^2}{(5/16)^2} = 26240 \text{ #/IN}^2$$

$$F_b = 0.75 F_y \quad F_b = 27,000 \text{ #/IN}^2 \text{ (AISC F2.1)}$$

D-12

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing 14-2-93755 (2) Doc. No. _____ PAGE D-13
 (4) Building _____ (5) Rev. _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J. V. EAGEN Date 10/13/94
 (9) Checker James A. Tuck Date 6 Dec. 1994

(10) DETERMINE SIZE OF WELD ON STIFFENER.

$$P_V = P_H = \frac{6726}{4} = 1682 \#$$

$$A_w = 4 \text{ in}$$

$$S_w = \frac{d^2}{6} = \frac{4^2}{6} = 2.67 \text{ in}^2$$

$$f_H = \frac{P_H}{4} + \frac{P_H(2)}{S_w} + \frac{P_V(2.5)}{S_w}$$

$$= \frac{1682}{4} + \frac{1682(2)}{2.67} + \frac{1682(2.5)}{2.67}$$

$$= 3255 \#/\text{in}$$

$$f_V = \frac{P_V}{4} = \frac{1682}{4} = 421 \#/\text{in}$$

$$f_w = \sqrt{3255^2 + 421^2} = 3282 \#/\text{in}$$

$$w = \frac{f_w}{928 \#/\text{in} / 1/16} = \frac{3282}{928} = 3.5/16 \text{ in} \approx \underline{\underline{3/16 \text{ in}}}$$

USE 1/4" FILLET WELD

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____ PAGE D-14
 (4) Building _____ (5) Rev. _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator L.V. EGGER Date 9/29/99
 (9) Checker James H. Tucker Date 6 Dec. 1999

(10)

CHECK BENDING STRESS IN 1" PL

$$M = (19.35 \text{ #/FT}^2) (6 \text{ FT}) (1 \text{ FT}) = 116.1 \text{ #-FT/FT}$$

$$S = \frac{bt^2}{6} = \frac{(12)(1)^2}{6} = 2.00 \text{ IN}^3/\text{FT}$$

$$f_b = \frac{116.1 \text{ #-FT/FT} (12 \text{ IN/FT})}{2.00 \text{ IN}^3/\text{FT}} = 696.6 \text{ #/IN}^2$$

$$F_b = 6.75 F_y = 27 \text{ K/IN}^2 > 6.697 \text{ K/IN}^2 \text{ OK.}$$

WEIGHT OF 1" PLATE

$$(11 \text{ FT}) (11 \text{ FT}) \left(\frac{1}{12} \text{ FT}\right) (490 \text{ #/FT}^3) = 4940 \text{ #}$$

CHECK CONNECTION TO EXISTING SUPPORT

$$V = 413.47 + 4940 \\ = 46287 \text{ #}$$

SHEAR PER BOLT

$$P_v = \frac{46287}{8} = 5786 \text{ #/BOLT}$$

SINGLE SHEAR 1" ϕ A325 BOLTS

$$F_y = 16.5 \text{ K/BOLT} > 5.786 \text{ K/BOLT OK}$$

MINIMUM BOLT SPACING (AISC J3.3)

$$S_{\min} = 3d = 3(1) = 3"$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing 11-2-93 755 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J. J. V. ELLER Date 9/22/94
 (9) Checker JANNA A. TUCK Date 6 Dec. '94

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(10)

MINIMUM BOLT SPACING (AISC J3.9)

$$S \geq \frac{2P}{F_u t} + \frac{d}{2}$$

$$S \geq \frac{2(5.752)}{(58)(1)} + \frac{(3/4)}{2}$$

$$S \geq 0.573"$$

MINIMUM EDGE DISTANCE

$$L_e = 1.5d = 1.5(3/4) = 1.125" \text{ (AISC J3.4)}$$

$$L_e \geq \frac{2P}{F_u t}$$

$$L_e \geq \frac{2(5.752)}{58(1)}$$

$$L_e \geq 0.198"$$

BEARING STRESS

$$F = \frac{P}{dt} = \frac{5.752}{(1)(1)} = 5.752 \text{ k/in}^2$$

$$1.0 F_u = 1.0(58) = 58 \text{ k/in}^2 \text{ OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing 14-2-93755 (2) Doc. No. _____ PAGE D-16
 (4) Building _____ (5) Rev. _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J. V. EGGER Date 12/28/94
 (9) Checker JAMONA TRICK Date 6 Dec. 1994

(10)

CHECK BEARING ON W30X191

$$\frac{R}{t_w(N+5K)} \leq 0.66 F_y \quad (\text{AISC K1.3})$$

$$R = 46287^\#$$

$$t_w = 0.710 \text{ IN}$$

$$N = 1 \text{ IN}$$

$$K = 1.15/16 \text{ IN}$$

$$\frac{46,287}{0.71(1 + 5(1.15/16))} = 6.1 \text{ K/IN}^2 \leq 24 \text{ K/IN}^2 \text{ OK}$$

CHECK WEB CRIPPLING

$$R = 67.5 t_w^2 \left[1 + 3 \left(\frac{N}{d} \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{F_{yw} \left(\frac{t_f}{t_w} \right)} \quad (\text{AISC K1.4})$$

$$t_w = 0.710 \text{ IN}$$

$$t_f = 1.195 \text{ IN}$$

$$d = 30.68 \text{ IN}$$

$$F_{yw} = 36 \text{ K/IN}^2$$

$$N = 1 \text{ IN}$$

$$R = 67.5 (0.71)^2 \left[1 + 3 \left(\frac{1}{30.68} \right) \left(\frac{0.71}{1.195} \right)^{1.5} \right] \sqrt{36 \left(\frac{1.195}{0.71} \right)}$$

$$R = 275.72^\# > 46,287 \text{ OK.}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83755 (2) Doc. No. _____ PAGE D-17
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
(8) Originator J.V. EGGER Date 10/16/99
(9) Checker JANIEA TUCK Date 6 Dec. 99

(10)

CHECK BENDING IN 1" PLATE DUE TO
ECCENTRIC CONTAINER REACTIONS.

$$\sum M_B = 41287(10) - 2518(60) + V_A(60) = 0$$

$$V_A = \frac{261790}{60} = 4363\#$$

MOMENT ON 1" PLATE

$$M = 41287(10) = 412,870 \#-IN.$$

$$F_b = 0.75 F_y = 24 \text{ K/IN}^2$$

$$S = \frac{bd^2}{6}$$

$$\frac{M}{S} \leq F_b$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-93755 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject TRANSPORT ASSEMBLY REMOVAL SUPPORT
(8) Originator J. V. EGGER Date 10/18/94
(9) Checker JAMES A. TUCK Date 6 DEC. 1994

PAGE D-18

(10)

$$\frac{412.87}{\frac{b(1)^2}{2}} \leq 24$$

$$b \geq \frac{412.87(6)}{24(1)^2} = 103.22" - 8' 7"$$

8'-7" IS TOO WIDE TO ASSUME REASONABLE DISTRIBUTION OF THE LOADS AND STIFFNESS TO REINFORCE PLATE

ASSUME ONLY 3 TEE 5 3/8" WIDE RESIST THE MOMENT.

$$\bar{x} = \frac{\sum A \bar{x}}{\sum A} = \frac{3(5\frac{3}{8})(1)(\frac{1}{2}) + 3(\frac{3}{4})(5)(1 + \frac{5}{8})}{3(5\frac{3}{8})(1) + 3(\frac{3}{4})(5)}$$

$$= 1.733 \text{ in}$$

$$I_{\bar{x}} = \sum (I_o + A \bar{x}^2)$$

$$= \frac{3(5\frac{3}{8})(1)^3}{12} + 3(5\frac{3}{8})(1.733 - \frac{1}{2})^2 +$$

$$\frac{3(\frac{3}{4})(5)^3}{12} + 3(\frac{3}{4})(5)(1 + \frac{5}{8} - 1.733)^2$$

$$= 84.422 \text{ in}^4$$

D-18

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-33755 (2) Doc. No. _____ PAGE D-19
 (4) Building _____ (5) Rev. _____
 (7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT
 (8) Originator J. V. Fagga Date 10/19/94
 (9) Checker James A. Trice Date 6 Dec. 1994

(10)

$$S_{x1} = \frac{I_x}{c_{x1}} = \frac{84.422}{1.733} = 48.718 \text{ in}^3$$

$$S_{x2} = \frac{I_x}{c_{x2}} = \frac{84.422}{(5 + (-1.733))} = 19.784 \text{ in}^3$$

BENDING STRESS IN PLATE

$$f_b = \frac{412.87}{19.784} = 20.87 \text{ K/in}^2$$

$$d/e \leq \frac{127}{\sqrt{F_y}} \quad (\text{AISC TABLE B5.1})$$

$$d/e = \frac{5}{3/4} = 6.67$$

$$\frac{127}{\sqrt{36}} = 21.17 \quad \text{OK.}$$

$$F_b = 0.6 F_y \quad \text{AISC SECTION F1.2}$$

$$F_b = 0.6(36) = 21.6 \text{ K/in}^2 > 20.87 \text{ K/in}^2 \text{ OK}$$

$$\Sigma V = V_A + V_B - 41.287 \text{ K} = 0$$

$$-2700 + V_B - 41.287 =$$

$$V_B = 43.987 \text{ K}$$

AXIAL STRESS

$$f_a = \frac{43.987}{(3)(5\frac{3}{8})(1) + 3(\frac{3}{4})(5)} = \frac{43.987}{27.375} = 1.61 \text{ K/in}^2$$

$$r_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{84.422}{27.375}} = 1.756 \text{ in}$$

$$\frac{KL}{r} = \frac{(1)(60)}{1.756} = 34.17$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-33755 (2) Doc. No. _____ PAGE D-20
(4) Building _____ (5) Rev. _____
(7) Subject TRANSPORT ASSEMBLY REMOVAL SUPPORT
(8) Originator J. H. Egger Date 10/18/94
(9) Checker VONNIE A. Tuck Date 6 DEC. 1994

(10)

$$\frac{Kk}{r} = \frac{34.17}{127.9} = 0.267$$

$$C_a = 0.547 \quad (\text{AISC TABLE 3})$$

$$F_a = C_a F_y = 0.547(36) = 19.7 \text{ K/in}^2$$

$$\frac{f_a}{F_a} = \frac{1.61}{19.7} = 0.082 \leq 0.15$$

COMBINED STRESS

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1 \quad (\text{AISC H1})$$

$$0.082 + \frac{20.87}{21.6} = 1.05 \text{ OK}$$

LOAD DISTRIBUTED OVER A LARGER
AREA OF THE 1" PLATE. AND
WEIGHT OF CONTAINER USED

CHECK SHEAR STRESS

$$\sum H = H_A + H_B - 2.518 \text{ K} = 0$$

$$H_A - V_A = -4.36 \text{ K}$$

$$H_B = -1.85 \text{ K}$$

$$f_v = \frac{-1.851}{3(5)(3/4)} = 0.164 \text{ K/in}^2 \leq 0.4 F_y \text{ OK} \quad (\text{AISC F4})$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-B 3755 (2) Doc. No. _____

PAGE D-21

(4) Building _____ (5) Rev. _____

(7) Subject TRANSPORT ASSEMBLY REMOVABLE SUPPORT(8) Originator J.V. Egger Date 10/12/94(9) Checker Jamela Tuck Date 6 DEC. 1994

(10)

CHECK WELD STRESS (HORIZONTAL SHEAR STRESS)

$$f_v = \frac{VQ}{I}$$

$$V = 6.847^k$$

$$Q = 3(5\frac{3}{8})(1)(1.733 - \frac{1}{2})$$

$$= 19.882$$

$$I = 84.422$$

$$f_v = \frac{6.847(19.882)}{84.422} = 1.613^k/in$$

MINIMUM FILLET WELD - $\frac{1}{4}$ " (AISC
TABLE J2.4)

ALLOWABLE WELD STRESS

$$0.3 F_T - F_T = 70^k/in^2$$

STRESS PER IN OF $\frac{1}{4}$ " FILLET

$$F_v = (\frac{1}{4})(\frac{1}{\sqrt{2}})(0.3)(70) = 3.712^k/in$$

MAX SPACING FOR Z" OF WELD ON EACH SIDE

$$\frac{(Z) 2 (3.712)}{1.613} = 9.205 in.$$

USE $\frac{1}{4}$ " 2-6
 $\frac{1}{4}$ " 2-6

Appendix E

Analysis of Saddle Modification for Air Pallets

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-93763 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) PAGE E-2
(7) Subject SADDLE MODIFICATIONS FOR AIR PALLETS
(8) Originator J.V. EGGER Date 11/20/94
(9) Checker James A. Tuck Date 6 Dec. 1994

- (10) MODIFICATION OF SADDLE DESIGN TO ALLOW
AIR PALLETS TO BE INSTALLED FOR LIFTING
AND MOVING CONTAINERS.

MAXIMUM ALLOWABLE SLAB LOADING LIMITED
TO ALLOWABLE SOIL BEARING PRESSURE OF
 $= 2600 \text{ #/FT}^2$. (18.056 #/m^2)

REACTIONS AT CONTAINER SUPPORT POINTS

UNIFORM PUMP LOADS - 210 #/FT
UNIFORM CONTAINER - 1000 #/FT
UNIFORM SHIELDING - 1245 #/FT

FOR CONTAINER DIMENSIONS
SEE H-2-83734

FOR LOADS SEE
LOAD CHART 10154

$$\sum Y = R_A + R_B - 5000 - 7000 - \frac{210 (654.875)}{12} - \frac{1000 (654.875)}{12} - \frac{1245 (623.75)}{12} = 0$$

$$R_A + R_B = 142,747 \text{ #}$$

$$\begin{aligned} \sum M_A = & -5000 (29.75) + 7000 (250.25) \\ & + \left(\frac{210}{12} \right) (654.875) \left(\frac{654.875}{2} - 67.975 \right) \\ & + \left(\frac{1000}{12} \right) (654.875) \left(\frac{654.875}{2} - 67.975 \right) \\ & + \left(\frac{1245}{12} \right) (623.75) \left(\frac{623.75}{2} - 39.75 \right) \\ & - R_B (523) = 0 \end{aligned}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) J _____
 (7) Subject SADDLE MODIFICATION FOR AIR PALLETS
 (8) Originator J. V. EGGER Date 11/29/94
 (9) Checker VANDIA A. TUCK Date 6 Dec. 1994

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(10)

$$\Sigma M_A = -148,750 + 1,752,000 + 2,975,000 \\ + 14,165,000 + 17,707,000 - R_B(523)$$

$$R_B = \frac{36,450,000}{523} = 69,694 \#$$

$$R_A = 142,747 - 69,694 = 73,053 \#$$

MINIMUM AREA OF AIR PALLET

$$A = \frac{73,053 \# + 8000 \#}{18.056 \#/\text{sq ft}}$$

$$A = 4489 \text{ sq ft TOTAL}$$

$$\frac{4489}{2} = 2245 \text{ sq ft / PALLET FOR 2.}$$

BOB JEFFERS, WESTERN REGIONAL
 MANAGER OF AERO-GO (206) 293-6904
 MURIEL KLOTZ WITH 2700 sq ft / PALLET
 SIZE 60" x 60" x 2 3/4"

USE 2 5' x 5' AIR PALLETS UNDER
 EXISTING DESIGN. EXISTING DESIGN USED
 4' x 8' BASE. (AEC CALCULATION PG 3-4)
 CHECK MAXIMUM MOMENT FOR 5' x 10'
 BASE (AEC CALCULATION PG. 3-7)

$$M = \frac{77}{2} \left(\frac{5}{2}(12) - \frac{50.65}{2} \times \frac{1}{2} \right) = 667.5 \text{ K-FT}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____ PAGE E-4
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject SADDLE MODIFICATION FOR AIR PALLETS
 (8) Originator J.W. EGGER Date 11/29/94
 (9) Checker James A. Tuck Date 6 DEC 1994

(10)

DETERMINING MOMENT FOR 80" LOAD
 AT CENTER OF 62" SPAN.

$$M = \frac{80(62)}{4} = 1240 \text{ K-IN.}$$

ALLOWABLE BENDING STRESS

$$F_b = 12 \text{ K/IN}^2$$

REQUIRED SECTION MODULUS

$$\frac{1240}{12} = 103 \text{ IN}^3$$

TRY 5 W12 X 19 $S = 21.3 \text{ IN}^3$

$$5(21.3) = 106.5 \text{ IN}^3 \text{ OK.}$$

CHECK WEB CRIPPLING (AISC K1.4.a)

$$R = 67.5 t_w^2 \left[1 + 3 \left(\frac{N}{d} \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{F_{yw} \left(\frac{t_f}{t_w} \right)}$$

$$R = 80/5 = 16 \text{ K} \quad F_{yw} = 36 \text{ K/IN}^2$$

$$t_w = 0.235 \quad t_f = 0.350 \quad d = 12.16$$

$$16 = 67.5 (0.235)^2 \left[1 + 3 \left(\frac{N}{12.16} \right) \left(\frac{0.235}{0.350} \right)^{1.5} \right] \sqrt{36 \left(\frac{0.235}{0.350} \right)}$$

$$16 = 18.327 [1 + 0.136 N]$$

$$\left(\frac{16}{18.327} - 1 \right) \left(\frac{1}{0.136} \right) = N$$

$$N = -0.934 < 0 \text{ WEB CRIPPLING OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing 14-2-837123 (2) Doc. No. _____ (6) PAGE E-5
 (4) Building _____ (5) Rev. _____ (6)
 (7) Subject SADDLE MODIFICATION FOR AIR PALLETS
 (8) Originator J. V. EGGER Date 11/29/94
 (9) Checker James A. Tuck Date 6 Dec. 1994

(10)

CHECK LOCAL WEB YIELDING

LOAD AT E OF W12X19 (AISC K1.3.a)

$$\frac{R}{t_w(N+5K)} \leq 0.66 F_y$$

$$R = 16^K \quad t_w = 0.235 \quad K = \frac{13}{16} \quad F_y = 36$$

$$\frac{16}{(0.235)(N + 5(\frac{13}{16}))} \leq 0.66(36)$$

$$\frac{16}{0.235(0.66)(36)} \leq (N + 5(\frac{13}{16}))$$

$$2.866 \leq N + 4.063$$

$$N \geq -1.197 < 0 \text{ LOCAL WEB YIELDING OK}$$

LOAD AT END OF W12X19 (AISC K1.3.b)

$$\frac{R}{t_w(N+2.5K)} \leq 0.66 F_y$$

$$R = 16/2 = 8^K$$

$$\frac{8}{(0.235)(N + 2.5(\frac{13}{16}))} \leq 0.66(36)$$

$$\frac{8}{0.235(0.66)(36)} \leq (N + 2.5(\frac{13}{16}))$$

$$1.433 \leq N + 2.031$$

$$N \geq -0.598 < 0 \text{ LOCAL WEB YIELDING OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject SADDLE MODIFICATION FOR AIR PALLETS
 (8) Originator J. V. EGGER Date 11/23/94
 (9) Checker James A. Tuck Date 6 Dec. 1994

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(10)

CHECK SHEAR STRESS (AISC F4)

$$\frac{h}{t_w} \leq \frac{380}{\sqrt{F_y}}$$

$$h = 12.16 - 2(0.35) = 11.46$$

$$h/t_w = 11.46 / 0.235 = 48.77$$

$$\frac{380}{\sqrt{36}} = 63.33 \geq 48.77 \text{ OK.}$$

$$F_v = 0.4 F_y$$

$$= 0.4 (36) = 14.4 \text{ K/in}^2$$

$$f_v = \frac{8}{12.16(0.235)} = 2.8 \text{ K/in}^2 \leq 14.4 \text{ K/in}^2 \text{ OK.}$$

CHECK BENDING STRESS (AISC F1.3)

$$l/r_t = 62 / 1.00 = 62$$

$$\sqrt{\frac{102 \times 10^3 C_b}{36}} \leq l/r_t \leq \sqrt{\frac{510 \times 10^3 C_b}{F_y}}$$

$$53 C_b \leq 62 \leq 119 C_b$$

$$F_b = \left[\frac{2}{3} - \frac{F_y (l/r_t)^2}{1530 \times 10^3 C_b} \right] F_y \leq 0.6 F_y$$

$$= \left[\frac{2}{3} - \frac{36 (62)^2}{1530 \times 10^3 (1)} \right] 36 = 20.74 \text{ K/in}^2$$

$$f_b = \frac{1240/5}{21.3} = 11.64 \text{ K/in}^2 < 20.74 \text{ K/in}^2 \text{ OK.}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____ PAGE E-7
 (4) Building _____ (5) Rev. _____ (6) _____
 (7) Subject SADDLE MODIFICATION FOR AIR PALLET S
 (8) Originator J.V. EGGER Date 11/29/94
 (9) Checker James A. Tuck Date 6 Dec. 1994

(10)

ALLOWABLE BEARING PRESSURE 2.6 K/FT^2

BEAM REACTION LOAD $80 \text{ K} / 2 = 40 \text{ K}$

REQUIRED AREA $A = \frac{40}{2.6} = 15.39 \text{ FT}^2$

LENGTH OF PLATE - $10'$

WIDTH REQ'D = $\frac{15.39}{10} = 1.539 \text{ FT}$
 18.462 IN

USE $20''$

PLAN VIEW

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____
(4) Building _____ (5) Rev. _____ (6) _____
(7) Subject SADDLE MODIFICATION FOR AIR PALLETS
(8) Originator J.V. EGGER Date 11/29/94
(9) Checker James A. Tuck Date 6 Dec. 1994

PAGE E-8

(10)

UNIFORM PRESSURE UNDER PLATE

$$\frac{40,000}{20(120)} = 16.7 \text{ #/in}^2$$

SHEAR DIAGRAM

CHECK MOMENT @ 47"

$$M = 0.334 \frac{(47)^2}{2} - 8(13) = 264.2 \text{ K-in}$$

CHECK MOMENT @ 60"

$$M = 0.334 \frac{(60)^2}{2} - 8(13) - 8(26) = 288 \text{ K-in}$$

E-8

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____
 (4) Building _____ (5) Rev. _____ (6) PAGE E-9
 (7) Subject SADDLE MODIFICATION FOR AIR PALLETS
 (8) Originator J.V. EGGER Date 11/29/94
 (9) Checker James H. Fick Date 6 Dec. 1994

(10)

DETERMINE SECTION MODULUS. (ASSUME 20"
WIDE TUBE

$$S = \frac{20(6)^2}{6} - \frac{19.5(4)^2}{6} = 68 \text{ in}^3$$

$$f_b = \frac{288}{68} = 4.235 \text{ k/in}^2$$

AISC TABLE B5.1

$$\frac{b}{t} \leq \frac{170}{\sqrt{F_y}} \quad \text{FLANGE}$$

$$\frac{b}{t} = \frac{20}{1} = 20 \quad \frac{170}{\sqrt{36}} = 31.67 \quad \text{OK}$$

$$\frac{d}{t} \leq \frac{640}{\sqrt{F_y}} \quad \text{WEB}$$

$$\frac{d}{t} = \frac{6}{0.25} = 24 \quad \frac{640}{\sqrt{36}} = 106.7 \quad \text{OK}$$

CHECK HORIZONTAL SHEAR IN WEBS

$$f_v = \frac{VQ}{It}$$

$$Q = 1(20)(3 - \frac{1}{2}) = 50 \text{ in}^3$$

$$I = \frac{20(6)^3}{12} - \frac{19.5(4)^3}{12} = 256 \text{ in}^4$$

$$V = 11.34 \text{ k} \quad t = (\frac{1}{4} \text{ in})(2) = 0.5 \text{ in}$$

$$f_v = \frac{50(11.34)}{256(0.5)} = 4.43 \text{ k/in}^2 < 14.4 \text{ k/in}^2 \quad \text{OK}$$

DESIGN CALCULATION

WHC-SD-WM-DA-168
REV. 0

(1) Drawing H-2-83763 (2) Doc. No. _____ PAGE E-10
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(10)

WELD REQ'D BETWEEN WEB & FLANGE.

$$f_v = 4.34 \text{ K/IN}^2 (0.5) = 2.215 \text{ K/IN OF WELD}$$

$$F_v = 0.3 (70) = 21 \text{ K/IN}^2$$

$$= \text{EFFECTIVE THROAT} = \frac{2.215}{21} = 0.105 \text{ IN}$$

$$w = \sqrt{2} (0.105) = 0.149 \text{ IN}$$

USE $\frac{3}{16}$ FILLET WELD

$$\frac{\frac{1}{4}}{0.149} (3) = 5.034$$

OR USE $\frac{1}{4} \sqrt{3-5}$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

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 (8) Originator J.V. EGGER Date 11/29/94
 (9) Checker W. M. A. Tuck Date 6 Dec 1994

(10)

BENDING IN 1" PLATE

$$M = \frac{w l^2}{2}$$

$$w = 16.7 \text{ #/in/in}$$

$$l = 20 \text{ in}$$

$$M = \frac{16.7 (20)^2}{2} = 835 \text{ #-in/in}$$

$$S = \frac{b d^2}{6} = \frac{1 (1)^2}{6} = 0.167 \text{ in}^3$$

$$f_b = \frac{M}{S} = \frac{835}{0.167} = 5010 \text{ #/in}^2$$

ALLOWABLE STRESS

$$F_b = 0.75 F_y \text{ (AISC F2.1)}$$

$$F_b = 0.75 (36) = 27 \text{ #/in}^2 \text{ OK}$$

CHECK SHEAR STRESS IN 1" PLATE

$$V = \frac{w l}{2} = \frac{16.7 (20)}{2} = 167 \text{ #/in}$$

$$f_v = \frac{167}{(\frac{1}{4})(1)} = 668 \text{ #/in}^2$$

$$F_v = 0.4 F_y \text{ (AISC F4)}$$

$$F_v = 0.4 (36) = 14.4 \text{ #/in}^2 > 668 \text{ #/in}^2 \text{ CR.}$$

CHECK AXIAL LOAD IN 1/4" PLATE

$$f_a = \frac{167}{0.25 (1)} = 668 \text{ #/in}^2$$

DESIGN CALCULATION

WHC-SD-WM-DA-168

REV. 0

(1) Drawing H-2-33763 (2) Doc. No. _____
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 (9) Checker James A. Tuck Date 6 Dec. 1994

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(10)

$$r = \frac{d}{\sqrt{12}} = \frac{(1/4)}{\sqrt{12}} = 0.072$$

$$\frac{Kd}{r} = \frac{2(5)}{0.072} = 138.6$$

$$C_c = 126.1 \quad (\text{AISC TABLE 4})$$

$$F_a = \frac{12\pi^2 E}{23 (Kd/r)^2} \quad (\text{AISC E2})$$

$$F_a = 7.73 \text{ ksi} > 6.69 \text{ ksi OK}$$

DESIGN CALCULATION

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(10)

DETERMINING WEIGHT OF SUPPORT

1" PLATE 120" X 102"

$$\frac{(120)(102)(1)}{1728} (490) = 3471 \#$$

24 1/2" PLATE 13 X 12

$$\frac{(24)(13)(12)(1/2)}{1728} (490) = 531 \#$$

12 1/2" PLATE 34 X 12

$$\frac{(12)(1/2)(34)(12)(1/2)}{1728} (490) = 347 \#$$

5 W12 X 19 102" LONG

$$5(19)(\frac{102}{12}) = 808 \#$$

1" PLATE ROLLEN TO 2'-11 3/8" RADIUS

$$\frac{\frac{\pi}{2} (35.625)(22)(1)}{1728} (490) = 349 \#$$

2 1" PLATES 120" X 20"

$$2 \frac{(1)(120)(20)}{1728} (490) = 1361 \#$$

4 1/2" PLATES 5" X 120"

$$4 \frac{(1/2)(5)(120)}{1728} (490) = 340 \#$$

TOTAL = 7207 #

SAY 8000 #

DESIGN CALCULATION

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(10)

USE 3/4 TON SHACKLES AT 4 PLACES (3/4" pin)

$$\frac{8000}{2} = 4000 \text{ \# / SHACKLE}$$

ASSUME 45° PULL ANGLE

$$P = \frac{4000}{\sin 45^\circ} = 5657 \text{ \#} < 6,500 \text{ \# OK}$$

BEAM LOAD ON 1/2" PLATE

$$f_p = \frac{6500}{0.75 (1/2)} = 17,330 \text{ \#/in.}$$

$$F_p = \frac{L_e F_u}{2d} \leq 1.2 F_u \quad (\text{AISC J3.7})$$

$$L_e = 1" \quad F_u = 58 \text{ K/in.} \quad d = 0.75"$$

REF 1 - DESIGN AND
CONSTRUCTION OF
LIFTING BEAMS
4th QTR 1991
ENGINEERING
JOURNAL AISC

$$F_p = \frac{1(58)}{2(0.75)} = 38.7 \text{ K/in.}^2 > 17,330 \text{ \#/in.}^2 \text{ OK}$$

$$P_u = 2at F_u \quad (\text{REF 1 pg. 151})$$

$$a = 4t \quad t = 1/2"$$

$$P_u = 2(4(1/2))(1/2)(58) = 116 \text{ K} \quad 0.2 P_u = 23.2 \text{ K} \rightarrow 6500 \text{ \# OK}$$

$$P_p = 0.9 F_y t d \quad (\text{REF 1 pg. 152})$$

$$= 0.9(36)(1/2)(0.75) = 12.15 \text{ K} > 6500 \text{ \# OK}$$

$$e_{min} = \sqrt{\frac{Pd}{1.67 F_b t}} \quad (\text{REF 1 pg. 152})$$

$$P = 6500 \text{ \#} \quad d = 0.75 \quad F_b = 0.6(36) = 21.6 \text{ K/in.}^2 \quad t = 1/2"$$

$$e_{min} = \sqrt{\frac{6.5(0.75)}{1.67(21.6)(1/2)}} = 0.52 \text{ in.} < 0.625" \text{ OK}$$

DESIGN CALCULATION

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REV. 0

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$$P_u = 2(0.4)(F_y)et \quad (\text{REF 1 pg. 152})$$

$$P_u = 2(0.4)(36)(0.625)(\frac{1}{2}) = 9.0^K$$

$$0.2 P_u = 1.8^K < 2830^{\#} \text{ N.G.}$$

INCREASE EDGE DISTANCE

$$e = \frac{2.83}{1.8} (0.625) = 0.983$$

USE $1\frac{3}{8}''$

DESIGN CALCULATION

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DESIGN CALCULATION

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(10)

HEIGHT OF FORK LIFT CORRECT FROM GROUND IS BETWEEN 18" & 24"

HEIGHT OF TOWER PIV ON STAPLE SUPPORT FROM GROUND $5" + 1" + 12\frac{1}{3}" / 2 = 12\frac{1}{6}"$

DISTANCE FROM FORK LIFT TO TOWER PIV $12\frac{3}{4}" - 3\frac{7}{8}" + 13" + 13" + 6\frac{3}{8}" = 41\frac{1}{4}"$

ANGLE BETWEEN TOWER & GROUND

0" GROUND

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(8) Originator J.V. EGGER Date 11/29/94
(9) Checker JANNA F. TUCK Date 6 Dec. 1994

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(10)

MAXIMUM LOAD ON TOWBAR EYE.

$$t = 1\frac{1}{2}''$$

$$a = e = 1\frac{3}{8}'' - \frac{1}{2}(1\frac{1}{2}'') = 0.625''$$

$$d = 1\frac{1}{2}''$$

$$F_u = 58 \text{ ksi}$$

$$P_u = 2at F_u$$

$$= 2(0.625)(1.5)(58) = 109 \text{ k}$$

$$P = 0.2 P_u = (0.2)(109) = 21.75 \text{ k}$$

BEARING

$$P_p = 6.9 F_y t d$$

$$= 6.9(36)(1.5)(1.5) = 72.9 \text{ k}$$

TENSION TEAR OUT

$$P = \frac{1.67 F_y t e^2}{d}$$

$$= \frac{1.67[(0.75)(36)](1.5)(0.625)^2}{1.5} = 17.6 \text{ k}$$

SHEAR

$$P_u = 2(0.4)(F_y) e t$$

$$= 2(0.4)(36)(0.625)(1.5) = 27 \text{ k}$$

MAXIMUM LOAD = 17.6 k

DESIGN CALCULATION

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(10)

ASSUME MAXIMUM FORCE IN TOW BAR

IS 18 K

CHECK TS 5x5 x 1/4

LENGTH OF TS 5x5 x 1/4

$$(13 + 13)\sqrt{2} = 36.77 \text{ IN}$$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{16.4}{4.59}} = 1.92 \text{ IN}$$

$$\frac{KL}{r} = \frac{36.77}{1.92} = 19.15 \quad C_c = 126.1 \text{ (AISC TABLE 4)}$$

$$\frac{KL/r}{C_c} = \frac{19.15}{126.1} = 0.152$$

$$C_a = 0.574$$

$$F_a = 0.574(36) = 20.66 \text{ K/IN}^2 \text{ (AISC TABLE 3)}$$

$$f_a = \frac{18}{4.59} = 3.922 \text{ K/IN}^2 < 20.66 \text{ K/IN}^2 \text{ OK}$$

CHECK 1 3/8" x 10" PLATE

$$f_a = \frac{P}{A} = \frac{18 \text{ K} \cos 45^\circ}{(1.375)(10)} = 0.926 \text{ K/IN}^2$$

$$M = (18 \text{ K})(\sin 45^\circ)(7.375) = 100.2 \text{ K-IN}$$

$$f_b = \frac{M}{S} = \frac{100.2 \text{ K-IN}}{\frac{10(1.375)^2}{6}} = 31.31 \text{ K/IN}^2 \text{ N.G.}$$

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(10)

MOMENT OF INERTIA OF TS 5x5x1/4

$$I = 16.9 \text{ in}^4$$

$$I/L = 16.9/36.77 = 0.46$$

MOMENT OF INERTIA OF 1 3/8 x 10" PLATE

$$I = \frac{10(1.375)^3}{12} = 2.166 \text{ in}^4 \quad F/L = \frac{2.166}{13.875} = 0.16$$

$$L = 3.536 + 4.589 + 6 - 1/4 = 13.875"$$

THE TS 5x5x1/4 IS $0.46/0.16 = 2.9$ TIMES
STIFFER THAN THE 1 3/8" PLATE. ASSUME
THE TS 5x5x1/4 RESTRAINS THE ROTATION ~~OF~~
THE 1 3/8" PLATE (SEE MARK TABLE 3
CASE 1F)

DESIGN CALCULATION

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(10)

Roark's Formulas for Stress and Strain, Sixth Edition

Table 3

Notation:

$W := 18000 \cdot \cos\left(\frac{45}{180} \cdot \pi\right)$	$W = \text{load}$
$w := 0$	$w = \text{load per unit length}$
$M_o := 0$	$M_o = \text{applied couple}$
$\theta_o := 0$	$q_o = \text{angular displacement}$
$\Delta_o := 0$	$\Delta_o = \text{lateral displacement}$
$T_1 := 0$	$T_1 = \text{temperature on top surface}$
$T_2 := 0$	$T_2 = \text{temperature on bottom surface}$
$R_a := 0$	$R_a = \text{left vertical reaction}$
$R_b := 0$	$R_b = \text{right vertical reaction}$
$M_a := 0$	$M_a = \text{left end moment}$
$M_b := 0$	$M_b = \text{right end moment}$
$V := 0$	$V = \text{shear}$
$E := 29000000$	$E = \text{modulus of elasticity}$
$I := \frac{10 \cdot 1.375^3}{12}$	$I = \text{moment of inertia}$
$\gamma := 0$	$\gamma = \text{temperature coefficient of expansion}$
$l := 12.75 + 5.25 - .25 - 3.875$	$l = \text{length of beam}$
$x := l + .25 - 6$	$x = \text{length from left end of beam}$
$a := 0$	$a = x \text{ distance from left end}$
	$\langle x-a \rangle^n = \Phi(x-a) \cdot (x-a)^n$

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$$W_1 := 18000 \cdot \cos\left(\frac{45}{180} \cdot \pi\right) \quad a_1 := 0$$

1.f Left end guided, right end simply supported

$$R_{a1} := 0 \quad M_{a1}(x) := W_1 \cdot (l - a_1) \quad \theta_{a1} := 0$$

$$y_{a1}(x) := \frac{-W_1 \cdot (l - a_1)}{6 \cdot E \cdot I} \cdot (2 \cdot l^2 + 2 \cdot a_1 \cdot l - a_1^2)$$

$$R_{b1}(x) := W_1 \quad M_{b1} := 0$$

$$\theta_{b1}(x) := \frac{W_1}{2 \cdot E \cdot I} \cdot (l^2 - a_1^2) \quad y_{b1} := 0$$

1. Concentrated load

Transverse Shear

$$V_1(x) := R_{a1} - W_1 \cdot \Phi(x - a_1) \quad V_1(x) = -1.273 \cdot 10^4$$

Bending Moment

$$M_1(x) := M_{a1}(x) + R_{a1} \cdot x - W_1 \cdot \Phi(x - a_1) \cdot (x - a_1) \quad M_1(x) = 7.319 \cdot 10^4$$

Slope

$$\theta_1(x) := \theta_{a1} + \frac{M_{a1}(x) \cdot x}{E \cdot I} + \frac{R_{a1} \cdot x^2}{2 \cdot E \cdot I} - \frac{W_1 \cdot \Phi(x - a_1) \cdot (x - a_1)^2}{2 \cdot E \cdot I} \quad \theta_1(x) = 0.016$$

Deflection

$$y_1(x) := y_{a1}(x) + \theta_{a1} \cdot x + \frac{M_{a1}(x) \cdot x^2}{2 \cdot E \cdot I} + \frac{R_{a1} \cdot x^3}{6 \cdot E \cdot I} - \frac{W_1 \cdot \Phi(x - a_1) \cdot (x - a_1)^3}{6 \cdot E \cdot I} \quad y_1(x) = -0.106$$

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(10)

$$W_2 := -28050 \quad a_2 := 1 + .25 - 6$$

1.f Left end guided, right end simply supported

$$R_{a2} := 0 \quad M_{a2}(W_2) := W_2 \cdot (1 - a_2) \quad \theta_{a2} := 0$$

$$y_{a2}(W_2) := \frac{-W_2 \cdot (1 - a_2)}{6 \cdot E \cdot I} \cdot (2 \cdot l^2 + 2 \cdot a_2 \cdot l - a_2^2)$$

$$R_{b2}(W_2) := W_2 \quad M_{b2} := 0$$

$$\theta_{b2}(W_2) := \frac{W_2}{2 \cdot E \cdot I} \cdot (l^2 - a_2^2) \quad y_{b2} := 0$$

1. Concentrated load

Transverse Shear

$$V_2(x, W_2) := R_{a2} - W_2 \cdot \Phi(x - a_2) \quad V_2(x, W_2) = 2.805 \cdot 10^4$$

Bending Moment

$$M_2(x, W_2) := M_{a2}(W_2) + R_{a2} \cdot x - W_2 \cdot \Phi(x - a_2) \cdot (x - a_2)$$

$$M_2(x, W_2) = -1.613 \cdot 10^5$$

Slope

$$\theta_2(x, W_2) := \theta_{a2} + \frac{M_{a2}(W_2) \cdot x}{E \cdot I} + \frac{R_{a2} \cdot x^2}{2 \cdot E \cdot I} - \frac{W_2 \cdot \Phi(x - a_2) \cdot (x - a_2)^2}{2 \cdot E \cdot I}$$

$$\theta_2(x, W_2) = -0.021$$

Deflection

$$y_2(x, W_2) := y_{a2}(W_2) + \theta_{a2} \cdot x + \frac{M_{a2}(W_2) \cdot x^2}{2 \cdot E \cdot I} + \frac{R_{a2} \cdot x^3}{6 \cdot E \cdot I} - \frac{W_2 \cdot \Phi(x - a_2) \cdot (x - a_2)^3}{6 \cdot E \cdot I}$$

$$y_2(x, W_2) = 0.148$$

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(10)

$x := 1 + .25 - 6$ $W_2 := -30000, -29000 \dots 20000$

$x := 0, .1 \dots 1$ $W_2 := -20000$

DESIGN CALCULATION

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(1) Drawing H-2-8371.3 (2) Doc. No. _____ PAGE E-27
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(9) Checker Monna A. Tuck Date 6 Dec. 1994

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$$V_1(1 + .25 - 6) + V_2(1 + .25 - 6, W_2) = 7.272 \cdot 10^3 \quad V_1(0) + V_2(0, W_2) = -1.273 \cdot 10^4$$

$$M_1(1 + .25 - 6) + M_2(1 + .25 - 6, W_2) = -4.181 \cdot 10^4 \quad M_1(0) + M_2(0, W_2) = 6.16 \cdot 10^4$$

DESIGN CALCULATION

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(10)

MAXIMUM MOMENT IN PLATE 61.4 K-IN

$$f_b = \frac{61.4}{\frac{10(1.375)^2}{6}} = 19.5 \text{ K/IN}^2$$

$$F_b = 0.75 F_y \quad (\text{AISC F2.1})$$

$$F_b = 0.75(36) = 27 \text{ K/IN}^2$$

COMBINED STRESSES (AISC H1)

$$\frac{f_a}{F_a} = \frac{0.926}{20.66} = 0.045$$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{7.166}{13.75}} = 0.397$$

$$KL/r = \frac{2(13.875)}{0.397} = 69.9$$

$$F_{ex} = 30.48$$

$$\frac{f_a}{F_a} + \frac{C_{mx} f_{bx}}{\left(1 - \frac{f_a}{F_{ex}}\right) F_{bx}} = 0.045 + \frac{0.85(19.5)}{\left(1 - \frac{0.926}{30.48}\right) 27}$$

$$= 0.677 \leq 1.0 \text{ OK}$$