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Document Number: WHC-SD-SNF-DA-001, REV 0

Document Title: Calculations for Relocation of 105 KE Basin Seal Conveyor

Release Date: 9/20/94

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WHC Information Release Administration Specialist:

Kara Broz
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9/20/94
(Date)

SUPPORTING DOCUMENT

1. Total Pages **27**

2. Title

Calculations for Relocation of 105 KE Basin Seal Conveyor

3. Number

WHC-SD-SNF-DA-001

4. Rev No.

0

5. Key Words

K Basin
Seal Conveyor
Relocation
105 KE
Calculations

6. Author

Name: D. J. Tedeschi

Signature *[Handwritten Signature]*

Organization/Charge Code 8D320/EIC109

**APPROVED FOR
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KMB 9/20/94

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BY WHC

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9. Approval Designator **BS**

WHC-SD-SNF-DA-001, Revision 0

**CALCULATIONS FOR RELOCATION OF
105 KE BASIN
SEAL CONVEYOR**

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August 31, 1994

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Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

TABLE OF CONTENTS

	<u>Page</u>
Title Page	i
Table of Contents	ii
1.0 INTRODUCTION	1
2.0 DISCUSSION OF EQUIPMENT ACCIDENTS	1
<u>2.1 Equipment</u>	1
<u>2.2 Accidents And Their Analysis</u>	1
<u>2.2.1 Three Over One Analysis</u>	1
<u>2.2.2 Improper Sizing Of Weld Or Structural Support</u>	2
3.0 DISCUSSION OF ANALYSIS/RESULTS	2
<u>3.1 The Concrete Base</u>	2
<u>3.2 The Electrical Box</u>	3
<u>3.3 Static Loading of Winch Motor Assembly Supports</u>	3
4.0 CONCLUSIONS	4
APPENDICES	
APPENDIX A: GENERAL INFORMATION ON CALCULATIONS	5
APPENDIX B: CALCULATIONS ON CONCRETE BASE	6
APPENDIX C: CALCULATIONS ON ELECTRICAL BOX	7
APPENDIX D: CALCULATIONS ON WINCH MOTOR SUPPORT	8

Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

1.0 INTRODUCTION

The purpose of this paper is to document the relocation of 105 KE basin seal conveyor that has been designed to account for normal static loading and to show that a 3 over 1 safety analysis was performed. The seal conveyor relocation is per work plan WHC-SD-SNF-WP-002, Revision 0. Calculations performed are attached in the appendices as the basis for the analysis.

2.0 DISCUSSION OF EQUIPMENT ACCIDENTS

2.1 Equipment

The following is a list of equipment to be analyzed:

- A) Electrical box's fasteners.
- B) Winch motor assembly support frame.
- C) Concrete base.

See Engineering Change Notices (ECN) 607026, 607027, and drawing H-1-51844 for equipment description. See Appendix A for a general depiction. Note: all seal conveyor equipment is safety class 3 per Safety Equipment List, WHC-SD-NR-SEL-001, Revision 0.

2.2 Accidents And Their Analysis

2.2.1 Three Over One Analysis

2.2.1.1 Concrete Block The concrete basin floor is safety class 1 and the seal conveyor assembly is safety class 3. The 3 over 1 issue lies in the damage of the floor by the seal conveyor. The floor has the greatest potential to be damaged, not in an earthquake, but in the installation of the components. The accident causing potential damage is as follows:

When installing the concrete base, it is dropped from grating height through the water and damages the basin floor. The concrete base is the heaviest piece of the equipment and would have the greatest potential for damaging the floor. If this problem can be remedied to eliminate any structural damage, then there will not be a need to analyze other 3 over 1 postulations for other members failing due to an earthquake and falling through the water.

The analysis of this accident will be to compare the stress introduced by the concrete block hitting the floor to the allowable stress of the floor. The allowable stress of the concrete cannot be exceeded. The stress introduced by the block will be calculated at various positions of impact.

Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

2.2.1.2 Electrical Box A potential 3 over 1 issue is the failure of the electrical box attachments which could set other failures into motion and ultimately cause potential damage to the basin floor. The accident is as follows:

Under an earthquake load, the electrical box bolts shear off and the box falls on to the grating, (grating is safety class 3) and causes the grating to fail. Failure of the grating may result in it falling into the water and potentially causing damage to the concrete basin.

The analysis of this accident will be to ensure that fasteners attached to the unistrut won't fail in an earthquake. This is achieved by comparing the stress induced by the static and seismic loads to the allowable stress of the fasteners. The allowable stress cannot be exceeded.

2.2.2 Improper Sizing Of Weld Or Structural Support

Failure to size the structural supporting members or the welds will cause the failure of the support of the winch motor assembly. The accident is as follows:

Weight and operational loads cause the structural support for the winch motor assembly to fail and the assembly falls into the water basin water.

The analysis will compare the stresses on the structural supports, the support's welds and fastener attachments to the allowable stress for the materials. The allowable stress cannot be exceeded.

3.0 DISCUSSION OF ANALYSIS/RESULTS

3.1 The Concrete Base

The method used to do the calculations was to first assume that the concrete base falls through the water and conservatively reaches a terminal velocity. From there, the force due to impact is obtained and converted to stress using the area of initial impact. Next the compressive strength of the concrete basin floor is then compared to the stress of impact. The analysis took into consideration that the initial impact could happen at several locations on the block. For example, it could impact on the side versus a corner. See Appendix B for calculations.

The results of the calculations showed that the block could land on the floor at any location on the block except at the corners and not exceed the compressive strength of the concrete basin. To remedy the problem with the corners, the ECN that developed the block was revised to show that the all concrete corners will be cut back 1".

Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

These results led to the conclusion that the winch motor top assembly supports could be allowed to fail under accident conditions such as an earthquake, fall into the water and not damage the basin floor. Thus, in analyzing the top assembly, it would now only account for static loads and not seismic loading.

3.2 The Electrical Box

The method used to do the calculations on the electrical box was evaluated on a single screw using both seismic and static loads. The screw has the highest potential for failure and is the worst case versus failure of the Unistrut. The loading was based on the weight of the box and a seismic load for a safety class 3 piece of equipment. Seismic criteria was based on the requirements of Hanford Plant Standards SDC 4.1, Revision 12. Loads were developed then converted into stress using the area of the screw. A factor of safety was calculated using the overall stress evaluated against the manufacturer's loading requirements for the screws. See Appendix C for calculations

The results showed that there was no failure in the event of an earthquake nor under normal static conditions.

3.3 Static Loading of Winch Motor Assembly Supports

The process used to do the calculations was to develop the loads, calculate the stresses due to the various loading, then compare the calculated stresses to the allowable stress of the material being examined. The winch motor top assembly support was analyzed for failure of the supporting members and their connections. In developing the loads, a conservative assumption was made that the poles were not supported on the concrete base. This added an additional 200 lb load. The total load of the assembly and the supports were cut in half for evaluation. The center of gravity on the assembly was not known so, conservatively, the load was placed on the furthest end of the assembly plate away from the supports. The stress in the supporting member was first calculated then its attachment (weld) to another member. The calculated stress was then compared to the allowable stress of the material or weld material in terms of the "factor of safety". As long as the factor of safety was greater than 1, the design was considered adequate. See Appendix D for calculations.

The results showed that all members could withstand the static loading forced on them and that welded connections were adequately sized. The factor of safety for the members were all greater than 1 and the welds were at least 2.0. Bolted members also would withstand the loads and had a factor of safety of 1.9.

Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

4.0 CONCLUSIONS

Calculations have shown that the relocation of the safety class 3 seal conveyor will not cause any damage to the safety class 1 105 KE Basin floor during installation or failure of the supporting members. The new supports for the winch motor assemblies have not accounted for seismic loads since it is safety class 3 and is not required to operate after an earthquake. Failure of the supports will not damage the safety class 1 members of the facility. Calculations on the supports and associated attachments (welds, bolts) have shown that it will adequately sustain the weight of the winch motor assembly, poles, and conveyor with lids. Calculations showed that the electrical box fasteners (screws) under both static and seismic loading will adequately support the electrical box.

Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

APPENDIX A

GENERAL INFORMATION ON CALCULATIONS

ANALYTICAL CALCULATIONS

Page 1 of

Subject 105 KE BASIN 3 OVER 1 ANALYSIS FOR SEAL CONVEYOR
Originator DAVID TEDESCHI Date 8-29-94
Checker JEFF BURGESS Date 9/6/94

THESE CALCULATIONS ARE FOR THE PILOT SCALE

ENCAPSULATION AT 105 KE BASIN. THESE CALCS. SPECIFICALLY
APPLY TO THE RELOCATION OF THE SEAL CONVEYOR.

ANALYTICAL CALCULATIONS

Page _____ of _____

Subject 105KF BASIN SEAL CONVEYOR
Originator DAVID TEDESCHI Date 8-29-94
Checker JEFF BURGESS JS Burgess Date 9/6/94

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Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0

APPENDIX B

CALCULATIONS ON CONCRETE BASE

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN COVER ANALYSIS FOR SEAL CONVEYOR
Originator DAVID TEDESCHI Date 8-29-90
Checker JEFF BURGESS Date 9/6/91

GIVEN: FROM FIGURE 2.

CONNECTOR PLATE
PLATE: $22" \times 18" = \frac{396 \text{ in}^2 \cdot 5 \text{ lb/ft}^2}{144} = 13.75 \text{ lbs}$ 2 BARS: $(2 \times 6 \text{ in}) \cdot (6.08 \text{ lb/ft}) \cdot 3 \text{ ft} = 36.48 \text{ lbs}$
2 BARS: $(2 \times 6 \text{ in}) \cdot (6.08 \text{ lb/ft}) = 6.68 \text{ lbs}$ PLATE: $2 \text{ lbs} + \text{EQUIP} = 5 \text{ lbs}$
CONCRETE: $1.5 \text{ ft} \times 1.5 \text{ ft} \times 1.5 \text{ ft} \cdot (152.9 \text{ lb/ft}^3) = 514.35 \text{ lbs}$
Total weight: $\approx 574 \text{ lbs}$

* REFERENCES DENOTED BY, (#),
SEE PAGE A5-2

FIND: WHAT IS THE IMPACT ON THE BASIN FLOOR IF DROPPED?

① $F_B = \gamma_{\text{WATER OR AIR}} V$

① $F_D = \frac{C_D A \rho V^2}{2}$

① $W = \gamma V_{\text{OBJECT}}$

② $S' = S(1 + \sqrt{1 + \frac{V^2}{2g}})$

S' = STRESS DUE TO IMPACT

γ = SPECIFIC WEIGHT

V = VOLUME OF OBJECT

C_D = COEFFICIENT OF DRAG

A = AREA WATER IS DISPLACED

V = TERMINAL VELOCITY OF OBJECT

ρ = DENSITY OF FLUID MOVING THROUGH
 1.94 slugs/ft^3

S = STRESS UNDER STATIC LOADING

L = ELONGATION

g = GRAVITY

V = VELOCITY OF OBJECT BEFORE IMPACT

ANALYTICAL CALCULATIONS

Page _____ of _____

Subject 105KE BASIN '3 OVER 1 ANALYSIS FOR SEAL CONVEYOR

Originator DAVID TEDESCO Date 8-29-94

Checker JEFF BURGESS JB Burgess Date 9/1/94

$$\begin{aligned}\Sigma F_y &= 0 & F_D &= W - F_B \\ & & &= W - \gamma_{\text{WATER}} (\nabla) \\ & & &= 574 - (62.37 \frac{\text{lb}}{\text{ft}^3}) (3.375 \text{ ft}^3) \\ & & &= 363.5 \text{ lbf} \therefore \text{IT SINKS.}\end{aligned}$$

$$\begin{aligned}\nabla &= L \times W \times H \\ \nabla &= 1.5 \times 1.5 \times 1.5 \\ &= 3.375 \text{ ft}^3\end{aligned}$$

Solve for Terminal Velocity of Block Falling Through Water

$$\textcircled{1} \quad F_D = \frac{C_D A_p V^2}{2} \Rightarrow V = \left(\frac{2 F_D}{C_D A_p} \right)^{1/2} = \text{Terminal Velocity (Worst Case)}$$

① From Table 11-1 Assume $C_D = 1.10$ for a cube. $V \rightarrow \square$ ($C_D = 1.10$) for $Re > 10^4$

$$V = \left(\frac{2 (363.5 \text{ lbf})}{(1.10) (1.5 \text{ ft}) (1.5 \text{ ft}) (1.94 \frac{\text{slugs}}{\text{ft}^3})} \right)^{1/2} = 12.3 \text{ ft/sec}$$

CHECK Reynolds # Re AND VERIFY C_D OF 1.10

$$\textcircled{1} \quad Re = \frac{V L \rho_{\text{WATER}}}{\mu_{\text{WATER}}} = \frac{(12.3 \text{ ft/sec}) (1.5 \text{ ft}) (1.94 \frac{\text{slugs}}{\text{ft}^3})}{2.36 \times 10^{-5}} = 1.5 \times 10^6$$

Type Reynolds # of 1.5×10^6 IS GREATER THAN 10^4 $\therefore$ C_D OF 1.10 IS ACCEPTABLE AND THE

Terminal Velocity of the Block is 12.3 ft/sec.

Assume Terminal Velocity is Achieved For Impact Loading (Worst Case).

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN 3 OVER 1 ANALYSIS FOR SEAL CONEYOR
 Originator DAVID TEDESCHI Date 8-29-99
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STRESS DUE TO IMPACT ON BASIN FLOOR.

U_{AL} for BASIN = 3000 PSI (COMPRESSION)

$$(2) \quad S' = S \left(1 + \sqrt{1 + \frac{V^2}{2g}} \right) \quad \text{LET } C = 1 \text{ FOR RIGID STRUCTURES.}$$

$$S = \frac{W - F_B}{A} \quad \begin{array}{l} F_B = \text{BOYANCE FORCE} \\ W = \text{WEIGHT of OBJECT} \\ A = \text{AREA of OBJECT.} \end{array}$$

$$1. \quad S = \frac{F_D}{A} \quad F_D = \text{FORCE DUE TO DRAG.}$$

$$= \frac{363.5 \text{ lbf}}{(1.5 \text{ ft})^2} = 161.5 \text{ lb/ft}^2$$

$$= 161.5 \left(1 + \sqrt{1 + \frac{(12.06)^2}{(1)(32.2)}} \right) = 161.5 (3.35)$$

$$= 541.0 \frac{\text{lb}}{\text{ft}^2} \cdot \frac{1 \text{ ft}^2}{144 \text{ IN}^2} = 3.75 \text{ PSI}$$

3.75 PSI IS LESS THAN 3000 PSI WHICH IS ACCEPTABLE

ASSUME IT WERE TO FALL ON A POINT SUCH AS A EDGE $\approx 16''$ LONG $\times \frac{1}{8}''$ THICK

$$S = \frac{363.5}{\left(\frac{16}{12} \right) \left(\frac{1}{8} \right)} = 26,172 \text{ PSF}$$

$$S' = \frac{26172 (3.35)}{144} = 608 \text{ PSI}$$

608 < 3000 $\therefore$ OK

ASSUME IT WERE TO FALL ON A POLE GUIDE WITH A DIA. OF $1\frac{1}{16}''$

$$S = \frac{363.5}{\pi \left(\frac{1\frac{1}{16}}{2} \right)^2} = 59,036 \text{ PSF}$$

$$S' = \frac{59,036 (3.35)}{144} = 1373 \text{ PSI}$$

1373 < 3000 $\therefore$ OK

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105KE BASIN 3 OVER 1 ANALYSIS FOR SEAL CONVEYOR
Originator DAVID FEDERICH Date 8-29-94
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ASSUME LOAD IS CONCENTRATED

AT A CORNER OR TIP WITH A CROSS SECTIONAL
AREA OF $\frac{1}{8}" \times \frac{1}{8}"$.

$$\frac{0.125}{12} \times \frac{0.125}{12} = 1.31 \times 10^{-4} \text{ ft}^2$$

$$S' = \frac{\frac{363.5}{1.1 \times 10^{-4}} (3.35)}{144} = 76,876.6 \text{ PSI} \quad \underline{\text{NOT OK}}$$

$76 \times 10^3 > 36000 \therefore$ THIS WILL CAUSE LOCAL DESTRUCTION IN THE
BLOCK AND THE CONCRETE BASIN FLOOR. TO AVOID THIS
THE CORNERS OF THE BLOCK WILL CUT BACK 1".

THE CONCRETE BLOCK IS THE HEAVIEST OBJECT OF THE
SEAL CONVEYOR AND WILL NOT DAMAGE THE
SAFETY CLASS 1 BASIN FLOOR IF DROPPED.

THEREFORE, THIS WILL PRECLUDE ANALYZING
THE REST OF THE SEAL CONVEYOR FOR A
SEISMIC EVENT. THE REST OF THE ANALYSIS
WILL BE STATIC LOADING.

**Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0**

APPENDIX C

CALCULATIONS ON ELECTRICAL BOX

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject IOS KE PASIN SEAL Conveyor ELECTRICAL BOX
 Originator DAVID TEDESCHI Date 8-30-94
 Checker JEFF BURGESS -JS Burgess Date 9/6/94

SEISMIC ANALYSIS of ELECTRICAL BOX:

GIVEN: FROM FIGURE 1:

* REFERENCES DENOTED BY
 A (#). SEE PAGE A5-2

SEISMIC: $F_s = Wg$

VERIFY 3/8" SCREWS WILL HOLD THE BOX DURING
 A SEISMIC EVENT. (7) ASSUME FOR SAFETY CLASS 3.

PER REFERENCE (7):

AT SCREW A:

$g = ZC$. FOR SF 3 $Z = 0.12g$
 $C = 2.12$

ASSUME A SEISMIC

$g = (0.12)(2.12) = 0.25g$

EVENT IN THE X DIRECTION.

$$F_s = (150 \text{ lbs}) \frac{1}{4} \text{ SCREWS} + \frac{1}{4} (150 \cdot 0.12)$$

$$= \frac{(150 \text{ lbs}) \frac{1}{4} + \frac{1}{4} (150 \cdot 0.12)}{\left(\frac{3}{8}\right)^2} = 380.3 \text{ PSI}$$

ANALYTICAL CALCULATIONS

Page _____ of _____

Subject 105 KE BASIN SEAL CONVEYOR ELECTRICAL BOX
Originator DAVID TEDESCHI Date 8-30-94
Checker JEFF BURGESS Date 9/6/94

SOLVE FOR LOADS IN TENSION

WEIGHT:

$$+ (\sum M_D = 0)$$

$$F_A(19'') + W(3'') = 0$$

$$F_A = \frac{W(3)}{19} = \frac{150 \times 3}{19} = 23.7 \text{ lb}$$

SINCE THERE ARE 2 MEMBERS AD AND DC THEN: $23.7/2 = 11.85 \text{ lb}$

SEISMIC:

$$+ (\sum M_B = 0)$$

$$F_A(13'') + F_s(3'') = 0$$

$$F_A = \frac{F_s(3)}{13} = \frac{(150)(0.25)(3)}{13} = 8.65 \text{ lb}$$

SINCE THERE ARE 2 MEMBERS AB AND DC THEN: $\frac{8.65}{2} = 4.33 \text{ lb}$

$\sum F_A$

$$F_{Aw} + F_{As} = F_A$$

$$11.85 + 4.33 = 16.17 \text{ lb}$$

$$\sigma = \frac{F_A}{A_{\text{screw}}} = \frac{16.17 \text{ lb}(4)}{\pi \left(\frac{3}{8}\right)^2} = 146.4 \text{ PSI}$$

ANALYTICAL CALCULATIONS

Page _____ of _____

Subject 105KE BASIN SEAL CONVEYOR ELECTRICAL BOX

Originator DAVID TEBESCHI Date 8-30-94

Checker JEFF BURGESS ~~to Burgess~~ Date 9/6/94

FROM THE UNISTRUT MFG SCREWS

ARE: 5750 PSI TENSILE = S_y

TAKING THE RESULTANT STRESS:

$$\sigma_{ACT} = \sqrt{\tau^2 + \sigma^2} = \sqrt{(380)^2 + (146)^2} = \underline{407 \text{ PSI}}$$

SINCE MOST OF THE STRESS IS DUE TO
SHEAR, THEN:

$$S_{ALLOWABLE} = \frac{S_y}{2} = \frac{5750 \text{ PSI}}{2} = \underline{2875 \text{ PSI}}$$

$$F.S. = \frac{S_y}{\sigma_{ACT}} = \frac{2875}{407} = \underline{7.1} \quad \underline{OK}$$

∴ THE SCREWS WILL NOT FAIL IN
A SEISMIC EVENT.

**Calculations for Relocation of Seal Conveyor
WHC-SD-SNF-DA-001, Revision 0**

APPENDIX D

CALCULATIONS ON WINCH MOTOR SUPPORTS

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN SEAL CONVEYOR
Originator DAVID TEDESCHI Date 8-29-94
Checker JEFF BURGESS Date 9/6/94

GIVEN:

FROM FIGURE 2:

0.560 IN
FLANGE WID X 49
//// = WELD

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

* ASSUME BASE DOES NOT
SUPPORT POLES.

SINCE CENTER OF GRAVITY IS
NOT KNOWN ON SEAL CONVEYOR ASSEMBLY
A CONSERVATIVE ASSUMPTION IS TO
DIVIDE THE TOTAL WEIGHT BY
2 AND PLACE AT THE FURTHEST END.
ALSO ASSUME BEAM GOES ALL 40".

WEIGHT OF CONVEYOR ASSEM.

WEIGHT OF BEAMS NEGLECTED.

TOP ASSEM: 120 lbs

* 2 POLES: 200 lbs (4)

CONVEYOR + LIDS: 100 lbs

TOTAL: 420 lbs OR

210 lbs PER SUPPORT

1. VERIFY BEAM # 1 OR 2 WON'T FALL DUE TO BENDING

ASSUME CANTILEVER BEAM FREE END.

$$\sigma_b = \frac{M c}{I}$$

$$M_{max} = (210 \text{ lbs})(40 \text{ in}) = 8400 \text{ lbs-in}$$

$$I = I_{outer} - I_{inner} = \frac{b d^3}{12} - \frac{b d^3}{12}$$

$$= \frac{(2)(2)^3}{12} - \frac{(2-0.25)(2-0.25)^3}{12}$$

$$= 1.33 \text{ in}^4 - 0.782 \text{ in}^4 = 0.548 \text{ in}^4$$

** REFERENCES DENOTED BY (#)
SEE PAGE A5-Z

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI

Date 8-29-94

Checker JEFF BURGESS

Date 9/1/94

$$C = \frac{2}{2} = 1 \text{ IN.}$$

$$\sigma_B = \frac{(18400 \text{ lb-IN})(1 \text{ IN})}{0.548 \text{ IN}^4}$$

$$= 15,328.4 \text{ PSI}$$

$$\tau_B = \frac{F}{A} = \frac{210 \text{ lbs}}{1.59 \text{ IN}^2} = 132 \text{ PSI} - \text{Neglect}$$

⑤ $\sigma_A = \text{Allowable stress for BENDING} = \sigma_y (.6) = (46)(.6)$
 $\sigma_A = 27.6 \text{ KSI}$

$$F.S. = \frac{\sigma_A}{\sigma_B} = \frac{27.6}{15.3} = 1.8$$

∴ MATERIAL IS OK AND SHOULD NOT FAIL DUE TO BENDING.

2. CHECK SIZE OF WELDS AT FREE END:

Weld IS AS FOLLOWS:

Weld IS IN BENDING STRESS

$$\sigma_w = \frac{M C}{I}$$

$$I = (0.707)(h) I_0 \quad \text{WHERE } h = \text{WELD THICKNESS}$$

$$I_0 = \frac{2d^3}{3} - 2d^2 \bar{y} + (b + 2d) \bar{y}^2$$

$$\bar{y} = \frac{d^2}{b + 2d} = \frac{(2'')^2}{2'' + 2(2'')} = .5 \text{ IN}$$

$$I_0 = \frac{2(2'')^3}{3} - 2(2'')^2(.5'') + (2'' + 2(2''))(.5'')^2$$

$$I_0 = 2.833 \text{ IN}^3 \quad C = \frac{d^2}{b + 2d} = \bar{y} = .5 \text{ IN.}$$

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI

Date 8-29-94

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JB Burgess

Date 9/6/94

$$\sigma_w = \frac{(8400 \text{ lbf/in}) (.5 \text{ in})}{(2.83 \text{ in}^3) (.707) (.25 \text{ in})}$$

$$= 8,387.7 \text{ psi}$$

SHEAR IS MINIMAL COMPARED TO BENDING AND
WILL BE ACCOUNTED FOR.

BENDING WILL PUT WELD IN TENSION.

⑤

FOR FILLET WELD IN TENSION:

ALLOWABLE STRESS IS SAME AS BASE METAL

REQUIRED WELD STRENGTH: EQUAL OR LESS THAN
"MATCHING" WELD METAL. ASSUME WELDING STICK OF
E70.XX $\sigma_y = 36 \text{ KSI}$

$$\sigma_y = 36 \text{ KSI}$$

$$\sigma_w = 21 \text{ KSI}$$

$$\text{F.S.} = \frac{\sigma_y}{\sigma_w} = \frac{36 \text{ KSI}}{8 \text{ KSI}} = 4.5$$

$\therefore \underline{\underline{1/4'' \text{ weld will be acceptable}}}$

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI Date 8-29-94

Checker JEFF BURGESS *JB* Date 9/6/94

IN ^(BEAM) MEMBER 3, CHECK THE TORSIONAL STRESS:
DUE TO ^(BEAM) MEMBER 1, AND 2 IN BENDING. SPICE THE
BEAM IN HALF AND ANALYZE. BEAM #1 CONNECTION
IS WORST CASE SINCE BEAM #3 EXTENDS THE
MOST FROM THE I BEAM AT THIS POINT.

CHECK BEAM #3 FOR FAILURE DUE TO TORSION (SHEAR)

⑤ τ_{MAX} for thin walls $\rightarrow \tau_{MAX} = \frac{T}{2tQ}$
 $T = \text{TORQUE}$
 $t = \text{THICKNESS of MAT.}$
 $Q = \text{CROSS SECTIONAL AREA.}$

$$\tau = \frac{8400 \text{ lb-in}}{2(0.25 \text{ in})(1.75 \text{ in})(1.75 \text{ in})}$$

$$\tau_{MAX ACTUAL} = 5.4857 \text{ PSI}$$

⑤ MAXIMUM SHEAR ALLOWABLE: $\tau_{MAX} = \frac{S_y}{2} = \frac{46}{2} = 23 \text{ KSI}$

$$F.S. = \frac{\tau_{MAX ALLOWABLE}}{\tau_{MAX ACTUAL}} = \frac{23 \text{ KSI}}{5.4 \text{ KSI}} = 4.25$$

$\rightarrow$ BEAM CAN HANDLE LOAD.

BENDING WILL NOT BE AS MUCH OF A PROBLEM AS
TORSION BENDING WAS SOLVED IN MEMBER #1

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI

Date 8-29-94

Checker JEFF BURGESS

Date 9/6/94

CHECK WELD SIZE OF 1/4"

PRIMARY SHEAR AT C.G. OF WELD:

$$\tau_y = \frac{V}{A}$$

V = WEIGHT of OBJECT / SHEAR FORCE

A = THROAT AREA of WELD.

$$A = 1.414 h d$$

$$\tau_y = \frac{V}{(0.707 h d) 2_{\text{welds}}}$$

$$= \frac{210 \text{ lb}}{(0.707) (\frac{1}{4}) (2) (2)} = 297 \text{ PSI}$$

SECONDARY SHEAR DUE TO TORSION:

$$\tau_z = \frac{T R}{J}$$

T = Torque = 1962 lb-in

R = DISTANCE BETWEEN CGs

J = POLAR MOMENT OF INERTIA

$$R = \frac{b}{2} + \frac{h}{2} = \frac{1.5}{2} + \frac{.25}{2}$$

$$R = 1.125 \text{ IN}$$

$$J = J_0 (0.707) h$$

$$J_0 = \frac{d (3 b^2 + d^2)}{6} = \frac{2 (3 (1.5)^2 + (2)^2)}{6} = 5.33 \text{ IN}^3$$

$$J = (5.33 \text{ IN}^3) (0.707) (1.25 \text{ IN}) = .9427 \text{ IN}^3$$

$$\tau_y = \frac{(1680 \text{ lb-in}) (1.125 \text{ IN})}{0.943 \text{ IN}^3} = 2,004.2 \text{ PSI}$$

ANALYTICAL CALCULATIONS

Page _____ of _____

Subject 105 KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI

Date 8-29-99

Checker JEFF BURGESS

Date 9/6/99

WELD IN BENDING:

$$\textcircled{3} \sigma_x = \sigma_y = \frac{M c}{I}$$

M = MOMENT ABOUT CG
 I = MOMENT OF INERTIA
 c = DISTANCES BETWEEN CG.

$$I = I_o (0.707)(h)$$

$$I_o = \frac{b d^3}{2} = \frac{2 (2)^3}{2} = 4 \text{ IN}^3$$

$$I = (4 \text{ IN}^3) (0.707) (1.25 \text{ IN}) = 0.707 \text{ IN}^4$$

$$c = \frac{d}{2} = \bar{y} = \frac{2"}{2} = 1"$$

$$\sigma_x = \frac{(8400 \text{ lb-in})(1 \text{ IN})}{0.707 \text{ IN}^4} = 11,881.2 \text{ PSI}$$

CHECK FACTOR OF SAFETY for Weld:

$$\begin{aligned}
 \tau_{\text{ACTUAL}} &= \sqrt{\sigma_x^2 + \tau_z^2 + \tau_y^2} \\
 &= \sqrt{(11,881)^2 + (2,004)^2 + (297)^2} \\
 &= 12,052 \text{ PSI}
 \end{aligned}$$

98% of τ STRESS IS DUE TO BENDING

$\textcircled{5} \therefore S_y = 46 \text{ KSI}$ Allowable SAME AS BASE METAL
 HOWEVER USE E70 WELD STICK
 AND IT HAS $\tau_y = 36 \text{ KSI}$

$$F.S. = \frac{S_y}{\tau_{\text{ACT}}} = \frac{36}{12} = 3$$

$\therefore 1/4"$ WELDS ARE ACCEPTABLE.

ANALYTICAL CALCULATIONS

Page ____ of ____

Subject 105 KE BASIN SEAL CONVEYOR

Originator DAVID TEDESCHI

Date 8-30-94

Checker JEFF BURGESS

Date 9/6/94

Solve For Failure of Bolts:

Assume NO PRELOAD ON BOLTS. $\rightarrow$ + WASHERS

$$\sum M_B = 0$$

$$F_A(4") = 210 \text{ lb} (14.62")$$

$$F_A = \frac{(210)(14.62)}{4} = 767.5 \text{ lbs}$$

$$\sigma_{Bolt} = \frac{F}{A} = \frac{767.5(4)}{\pi(\frac{1}{4})^2} = 15,635.4 \text{ PSI}$$

⑤ Allowable stress is $\sigma_A = \sigma_{ULT}(.33) = (95)(.33) = 31.15 \text{ PSI}$
(FOR TENSION)

$$F.S. = \frac{\sigma_A}{\sigma_D} = \frac{31.15}{15.6} = 2.0 \text{ ok}$$

- BOLTS ARE SIZED ADEQUATELY FAILURE
WILL NOT OCCUR DUE TO STATIC LOADING.