DISTRIBUTION SHEET

To PUREX/UO3 PLANT ENGINEERING W17140	From PUREX/UO3 PLANT ENGINEERING W17140	Page 1 of 1 Date 10/27/94
Project Title/Work Order SLUG BUCKET LIFTING YOKE DESIGN ANALYSIS		EDT No. 158175 ECN No. NONE

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J.S. HERTZEL	S5-66		X		
R.N. DALE	S5-51	X			
A.J. MCELFRESH	S5-51	X			
C.D. WOLLAM	S6-17				X
M.B. ENGHUSEN	S6-18		X		
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ENGINEERING DATA TRANSMITTAL

Page 1 of 2
1. EDT 158175

2. To: (Receiving Organization) PUREX/UO3 PLANT ENGINEERING W17510 W17140 AM		3. From: (Originating Organization) PUREX/UO3 PLANT ENGINEERING W17510 W17140 AM		4. Related EDT No.: NA	
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1	WHC-SD-CP-DA-093	1-13	0	SLUG BUCKET LIFTING YOKE DESIGN CALCULATIONS	XSQ AMM 10/27/94	2	1	1

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2	1	A.J. MCELFRESH Cog. Eng.	<i>[Signature]</i>	10/27/93	S5-51						
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1	1	R.A. KULICK Safety	<i>[Signature]</i>	10-27-93	S6-21						
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18. Signature of EDT Originator <i>[Signature]</i> 10/27/93		19. Authorized Representative Date for Receiving Organization 		20. Cognizant/Project Engineer's Manager <i>[Signature]</i> 10/27/93		21. DOE APPROVAL (if required) Ltr. No. NONE ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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RELEASE AUTHORIZATION

Document Number: WHC-SD-CP-DA-093, REV 0

Document Title: SLUG BUCKET LIFTING YOKE ANALYSIS

Release Date: 11/9/94

**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

November 9, 1994

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7. Abstract THE REDESIGNED SLUG BUCKET LIFTING YOKE IS ANALYZED IN ACCORDANCE WITH THE PROVISIONS OF THE WESTINGHOUSE HOISTING AND RIGGING MANUAL, AND OTHER NATIONALLY ACCEPTED DESIGN DOCUMENTS. THESE CALCULATIONS DEMONSTRATE THAT THE YOKE IS ADEQUATE TO BE USED FOR ITS INTENDED SERVICE IN THE 202-A BUILDING.		
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TITLE SHEET

WHC-SD-CP-DA-093

REV 0

SUPPORTING CALCULATIONS

TO

ANALYZE THE SLUG BUCKET LIFTING YOKE

FOR

CHEMICAL PROCESSING DEPARTMENT

(APPROVAL REQUIREMENTS--SQ)

BY

A.J. MCELFRISH

OCTOBER 4, 1994

PLANT ENGINEERING

PUREX

MASTER

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WHC-SD-CP-DA-093, REV. 0

DESIGN CALCULATION

(1) Drawing H-2-83605 (2) Doc. No. WHC-SD-CP-DA-093 (3) Page 3 of 13
 (4) Building MO-409 (5) Rev. 0 (6) Job No. KP
 (7) Subject SLUG BUCKET LIFTING YOKE DESIGN ANALYSIS
 (8) Originator A.J. MCELFRISH Date OCTOBER 19, 1993
 (9) Checker W.S. Smith Date 10/27/93

(10) INTRODUCTION: THERE ARE BASKETS OF FUEL IN THE STORAGE POOLS IN THE PUREX FACILITY (202-A). THESE BASKETS (CALLED SLUG BUCKETS) NEED TO BE REMOVED FROM PUREX AND TAKEN TO THE K-BASINS. THE CURRENT SLUG BUCKET LIFTING YOKE IS OF SUFFICIENT AGE TO BE IN QUESTION STRUCTURALLY. THEREFORE NEW YOKES NEED TO BE FABRICATED. PRIOR TO FABRICATING NEW YOKES THE SLUG BUCKET LIFTING YOKE DWG. NEEDS TO BE UPDATED FOR FABRICATION. HOWEVER, THE DESIGN NEEDS TO BE REFINED SO THAT THE YOKE WILL BE EASIER TO FABRICATE. THESE CALCS ARE PREPARED TO DEMONSTRATE THE ADEQUACY OF THE NEW DESIGN.

OBJECTIVE: THE OBJECTIVE OF THESE CALCULATIONS IS TO SELECT APPROPRIATELY SIZED STRUCTURAL MEMBERS AND WELD SIZES TO SERVE AS COMPONENTS IN THE SLUG BUCKET LIFTING YOKE WHICH WILL ADEQUATELY SUPPORT THE EXISTING SLUG BUCKETS TO BE REMOVED FROM THE 202-A BLDG.

CRITERIA: ACCORDING TO MR. TIM HUBER THERE ARE APPROXIMATELY 2.8 METRIC TONS OF FUEL STORED IN THE BASINS. THE FUEL IS SPLIT RELATIVELY EVENLY BETWEEN FOUR (*) BASKETS, SO THE WEIGHT OF EACH BASKET IS:

$$WT = \frac{1}{4} (2.8)(2204.62125) = 1543\#$$

↳ NO. OF # IN METRIC TON

DESIGN CALCULATION

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 (9) Checker WMS Date 10/27/93

PER DWG HD-6154, A SLUG-BUCKET (BUCKET WEIGHT 150 #. THEREFORE THE TOTAL WEIGHT OF A LOAD BUCKET IS:

$$W = 1543 + 150 = 1693, \text{ OR } 5 \text{ MY } 1800 \#$$

THE YOKE NEEDS TO BE DESIGNED TO SUPPORT THIS AMOUNT OF WEIGHT + WEIGHT OF YOKE.

THE HOISTING RIGGING MANUAL REQUIRES THAT THE ALLOWABLE STRESS USED IN DESIGN (ALLOW-

LATIONS BE THE LESSOR OF A FACTOR OF 3

BASED ON YIELD, OR A FACTOR OF 5 BASED ON ULTIMATE. FOR A 36 STEEL THESE VALUES ARE AS FOLLOWS:

$$\text{YIELD} - 35,000 \text{ PSI} \times [35000/3] = 11,667$$

$$\text{ULTIMATE} - (\text{TENSILE}) 60,000 \text{ PSI} \times [60,000/3] = 12,000$$

THEREFORE USE $T_A = 11,667 \text{ PSI}$

$$T_A = 0.7 \times 11,667 = 8166 \text{ PSI}$$

WMS #4

DESIGN CALCULATION

(1) Drawing H-2-83605 (2) Doc. No. WHC-SD-CP-DA-0923 Page 5 of 13
(4) Building MO-409 (5) Rev. 0 (6) Job No. KP
(7) Subject SLUG BUCKET LIFTING YOKE DESIGN ANALYSIS
(8) Originator A. J. MCFRESH Date OCTOBER 19, 1993
(9) Checker WULT Date 10/27/93

(10) REFERENCES:

- 1) ASSEMBLY & DETAILS - BUCKET LIFTING YOKE - H-2-59729
- 2) SLUG BUCKET - HD-61514
- 3) TELEPHONE CONVERSATION W/ TIM HUBER - 373-1503
- 4) ASME BOILER & PRESSURE VESSELS CODE - TABLE UCS-23
SECTION VIII - DIVISION 1 - 1992
- 5) CRANE TECH PAPER #410 - FLOW OF FLUIDS... (CRANE CO. 1976)
- 6) AISC HANDBOOK - MANUAL OF STEEL CONSTRUCTION, NEW YORK, SIXTH EDITION
- 7) HANFORD SITE HOISTING & RIGGING MANUAL DOE-RL-92-36
SECTION II, P. 3/16.

SELECTED DATA FROM REFERENCES APPEAR IN APPENDIX
ASSUMPTIONS:

- 1) ALL PARTS OF THE LIFTING YOKE NOT CHANGED ARE ADEQUATE.
- 2) THE WEIGHT OF A LOADED BASKET IS AS PRESENTED BY REF. #3.
- 3) THE STRENGTH OF THE PIPING MEMBERS IS AS LISTED IN REFERENCE 4 ABOVE

SUMMARY & CONCLUSIONS

THE RESULTS OF THIS ANALYSIS INDICATE THAT ALL CALCULATED STRESSES IN THE NEWLY DESIGNED SLUG BUCKET LIFTING YOKE COMPONENTS ARE BELOW THE ALLOWABLE ACCORDING TO THE HOISTING & RIGGING MANUAL. THE STRENGTH OF THE NEWLY DESIGNED YOKE IS ESSENTIALLY THE SAME AS BEFORE, BUT IS LIGHTER & EASIER TO FABRICATE. ALSO APPROVED COMMERCIAL HOOKS ARE BEING USED INSTEAD OF FABRICATED UNITS. THE COMMERCIAL HOOKS ARE INHERENTLY BETTER THAN THOSE FABRICATED. THEREFORE WE MAY CONCLUDE THAT THE NEW DESIGN IS BETTER THAN THE ORIGINAL & WILL ADEQUATELY SERVE AS REQUIRED.

DESIGN CALCULATION

(1) Drawing H-2-83605 (2) Doc. No. WHC-SD-CP-DA-093 (3) Page 6 of 13
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 (8) Originator A. J. MCELFRESH Date OCTOBER 19, 1993
 (9) Checker *Wm Smith* Date 10/27/93

(10) CALCULATIONS-

A) REDESIGN OF SHANK--

THE TOTAL SUSPENDED LOAD IS 1800# OR 900# PER SHANK

THE EQ'N FOR STRESS IN TENSION IS $\sigma = \frac{P}{A}$

WHERE:

σ = STRESS LEVEL, PSI

P = APPLIED LOAD, POUNDS

A = AREA OF MEMBER, IN²

WE ARE LOOKING FOR A_{REQUIRED} OR A_R, SO

$$A = \frac{P}{\sigma} = \frac{900}{11,667} = 0.077 \text{ IN}^2$$

THIS AREA REPRESENTS A VERY SMALL MEMBER. HOWEVER, THERE ARE OTHER CONSIDERATIONS SUCH AS MEMBER RESISTANCE TO BENDING OR DEFLECTING. THE MAIN CONSIDERATION IS DIMENSIONAL RIGIDITY SO THAT THE HOOKS WILL ALWAYS BE CORRECTLY POSITIONED TO CONTACT THE LIFTING PINS IN THE BASKET OR BUCKET. THEREFORE, SELECT A SCH 40 1 1/4" DIAMETER PIPE WHICH HAS A AREA OF 0.6455 IN². PIPE DATA OBTAINED FROM REFS. COMPARE NOW THE STRENGTH OF EXISTING 1 1/4" SQ BAR VERSUS THE 1 1/4" PIPE

$$I_{BAR} = \frac{bh^3}{12} \text{ WHERE } b = \text{BASE DIM} \neq h = \text{HEIGHT}$$

$$b = 1 \frac{1}{4} \quad h = 1 \frac{1}{4} \quad I_{xx} = \frac{(1.25)(1.25)^3}{12} = 0.203 \text{ IN}^4$$

$$\text{FROM REF 5 } I_{xx-PIPE} = 0.1947 \text{ IN}^4$$

$$\% \text{ DIFFERENCE CHANGE } = \frac{0.1947 - 0.203}{0.1947} = -0.043 = -4.3\%$$

A WEIGHT DIFFERENCE

$$\text{WEIGHT OF } 1 \frac{1}{4} \text{ BAR } W = [1.25] \times 12 \times 0.284 = 5.3 \text{ LBS}$$

DESIGN CALCULATION

(1) Drawing H-2-83605 (2) Doc. No. WHC-SD-CP-DA-083 Page 7 of 13
 (4) Building MO-409 (5) Rev. 0 (6) Job No. KP
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 (8) Originator A.J. MCELFRISH Date OCTOBER 19, 1993
 (9) Checker WHL Date 10/27/93

(10)

THE WEIGHT OF $1\frac{1}{4}$ " PIPE PER FOOT IS 2.27 #/FT. THE TOTAL LENGTH OF $1\frac{1}{4}$ " BARS IS ABOUT 21 FT. SO THE ΔW IS:

$$\Delta W = 21(5.3 - 2.27) = 63.63 \text{ POUNDS (SAVING!)}$$

MEANWHILE THE STRENGTH IS ESSENTIALLY THE SAME.

B) REDESIGN OF THE CROSS-BRACES

EXISTING BRACES ARE $2 \times 2 \times \frac{3}{8}$ " L.

$$I_{xx} = 0.48 \text{ in}^4 \text{ (REF 6, PAGE 1-29)}$$

$$I_{xx \text{ PIPE}} = 0.195 \text{ in}^4$$

EVEN THOUGH THE STRENGTH OF THE SINGLE PIPE IS LESS THAN THE 2" L, IT IS SUFFICIENT TO MAINTAIN THE DIMENSIONAL RELATIONSHIP OF THE SHANKS. THIS IS CERTAIN BY OBSERVATION.

C) CALCULATION OF WELD SIZES

THE FOLLOWING SKETCH REPRESENTS THE CONFIGURATION OF THE LOAD PLATE AND SHANK:

LENGTH OF WELD IS:

$$L = \pi D = \pi(1.66) = 5.21"$$

$$A = 5.21 \times 1.1875 \times 0.707 = 0.691 \text{ in}^2$$

ASSUME WE USE

A $\frac{3}{16}$ " WELD

$$P = T A = 8166 \times 0.691 = 5645 \text{ #/OK.}$$

BECAUSE $5645 \gg 900 \text{ #}$.

$$\text{FOR THE } \frac{3}{4}" \text{ BAIL: } L = \pi(1.75) = 2.356 \text{ in } A = 0.707 \times 1.1875 \times 2.356 = 0.312, P_A = T A = 8166 \times 0.312 = 2550 > 900, \therefore \text{OK.}$$

THEREFORE WE CAN SPECIFY $\frac{3}{16}$ " WELDS.

DESIGN CALCULATION

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 (8) Originator A.J. MCELRESH Date OCTOBER 19, 1993
 (9) Checker Will Smith Date 10/27/93

(10) FIND WELD SIZE FOR HOOK SLEEVE TO SHAFT.
 THE ID OF 1 1/4" PIPE IS 1.38 (REF 5) THE PIPE
 OD IS 1.66, SO THE PIPE WALL IS 0.140".

TRY A 1/8" WELD: WELD AREA IS:

$$C = \pi D \times .125 \times .707 = \pi (1.38) (.125) (.707) = 0.383$$

$$P = T A = 8166 \times .383 = 3128 > 900, \therefore \text{OK} \rightarrow 1/8" \text{ WELD}$$

D) CHECK BEARING STRESS ON PN 6

ASSUME EFFECTIVE BEARING AREA (ONLY)
 IS WIDTH OF PIPE, THEN BEARING AREA IS:

$$0.5 \times 1.66 \times 2 = 1.66 \text{ in}^2$$

$$T = P/A = 900 / 1.66 = 542.2 \text{ PSI} < 11,667 \text{ PSI}, \therefore \text{OK}$$

E) HOOK SELECTION:

THE HOOK IS BEING CHANGED. IT IS A STANDARD
 HOOK FROM THE CROSBY CO. & IS RATED FOR 3
 METRIC TONS, WHICH IS MORE THAN THE 1/4 TON
 (METRIC) WE ARE DESIGNING FOR. (SEE P. 13 OF 13)

WHC-SD-CP-DA-093, REV. 0

APPENDIX

HANFORD SITE HOISTING AND RIGGING MANUAL	Manual	DOE-RL-92-36
	Section	11.0
BELOW-THE-HOOK LIFTING DEVICES	Page	3 of 16
	Effective Date	January 15, 1993

vacuum or magnetic lifting devices is required, a qualified engineer must be consulted. Only the marking requirements for magnetic lifters are included in this section. 36
37
38

11.2 GENERAL FEATURES 39

Structural and mechanical lifting devices are often one-of-a-kind designs. Typical devices are shown in Attachment 11.1. 40
41

11.3 DESIGN AND FABRICATION 42

11.3.1 Design Factor 43

Structural and mechanical lift devices shall be designed with a minimum design factor of 3, based on the yield strength, for load-bearing structural components. 44
45
46

11.3.2 Welding 47

Welding shall be in accordance with the requirements of ANSI/AWS D1.1, ANSI/AWS D1.2, Section IX, of the Boiler and Pressure Vessel Code, or other national welding standard. 48
49
50

NOTE: Requirements for weld nondestructive testing shall be determined by the applicable welding standard or fabrication specification. 51
52

11.3.3 Guarding 53

Guards will be provided for all moving parts or pinch points that may be a hazard to the operator if the operator is near the device during lift. 54
55

11.3.4 Electrical 56

Wiring and electrical equipment shall comply with the requirements of article 610 of ANSI/NFPA 70 (NEC). 57
58

11.3.5 Analysis 59

Site-fabricated, below-the-hook lifting devices shall be analyzed by the design engineer to verify that they conform to the required design factor. 60
61

11.4 MARKING 62

Structural and mechanical below-the-hook lifting devices shall be provided with identification displaying the following data, as a minimum: 63
64
65

1. Rated load 66
2. Manufacturer's name (contractor's name if fabricated onsite) 67
3. Lifting device weight (if over 100 pounds) 68
4. Drawing number (if applicable) 69
5. Serial number (if applicable). 70

REFERENCE NUMBER FOUR (4)

According to the American Society of Mechanical Engineer's Code, Section VIII, Division number 1, Table UCS-23, Page 286, the Specified Min Yield Stress for Electric Resistance Welded Carbon Steel Pipe made according to SA-53, which is equivalent to ASTM A-53, is 35 ksi. The Specified Minimum Tensile Stress is 60 ksi. (One ksi is 1000 psi).

Based on the Specified Min Yield Stress, and according to reference number seven (7), (see page 10 of 13), the Allowable Stress is the yield stress divided by the number 3, or $35,000/3 = 11,667$ psi (11.7 ksi).

REFERENCE NUMBER 5

The following data was taken from Crane Technical Manual Number 410, and is listed as follows:

Nominal Pipe Size:	1 1/4"
Outside Diameter:	1.66 inches
Identification:	STD, Sch. 40
Wall Thickness:	0.140"
Inside Diameter:	1.38"
Area of Metal:	.6685 square inches
Moment of Inertia:	.1974 inches ⁴
Section Modulus:	0.2346 inches ³

RELEVANT DATA FROM CROSBY MANUAL FOR UTILIZED HOOK

Item: Crosby Shank Hook
Working Limit: 3 Tons (Made from Carbon Steel)
Hook Opening: 1.5 inches (Will fit a 1 1/4 inch shaft, or pin.)

The above data was taken from the "The Crosby Group Inc.", GENERAL CATALOGUE, COPYRIGHT 1992, PAGE 56. The Crosby company makes all types of lifting devices for industry.