MAR 15 1993

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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17

STA. 3

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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Impact Level	Reason for Transmittal	Originator Disposition	Receiver Disposition
1.	WHC-SD-WM-DA-123	NA	0	Lifting Beam Design/Analysis for the Data Acquisition and Control Systems Trailer	3SQ	2	1	

16. KEY		
Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)						(G)	(H)
Reason	Disposition	(J) Name	(K) Signature (M) MSIN	(L) Date	(J) Name	(K) Signature (M) MSIN	(L) Date	Reason	Disposition
1	1	Cog. Eng. C.E. Hanson	<i>C.E. Hanson</i>	3/11/93	H5-09				
1	1	Cog. Mgr. T.R. Benegas	<i>T.R. Benegas</i>	3/11/93	H5-09				
1	1	QA R.E. Lacey	<i>R.E. Lacey</i>	3/13/93	SI-54				
1	1	Safety G.E. McPherson	<i>G.E. McPherson</i>	3/10/93					
		Env.							
1	1	ESA Mgr. R.B. Pan	<i>R.B. Pan</i>	3/9/93					
1	1	Indep. Review D.E. Ryman	<i>D.E. Ryman</i>	3-2-93					

18. <i>T.C. Mackey</i> T.C. Mackey Signature of EDT Originator Date 3/24/93		19. <i>T.R. Benegas</i> T.R. Benegas Authorized Representative for Receiving Organization Date 3/14/93		20. <i>C.E. Hanson</i> C.E. Hanson Cognizant/Project Engineer's Manager Date 3/14/93		21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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SUPPORTING DOCUMENT		1. Total Pages 3031 ²⁰⁴ ₃₁₅₋₉₃
2. Title Lifting Beam Design/Analysis for the Data Acquisition and Control System Trailer	3. Number WHC-SD-WM-DA-123	4. Rev No. 0
5. Key Words Lifting Beam Analysis DACS Adjustable	6. Author Name: T.C. Mackey <i>T.C. Mackey</i> 2/24/93 Signature Organization/Charge Code 23480 / N23B1	
7. Abstract This supporting document details calculations completed to properly design an adjustable lifting beam. The main use of the lifting beam is to hoist the Data Acquisition and Controls Systems (DACS) trailer over a steam line. All design work was completed using the American Institute of Steel Construction, <i>Manual of Steel Construction</i> (AISC, 1989) and <i>Hanford Hoisting and Rigging Manual</i> (WHC, 1992).		
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J. D. Arndal 08/18/2010

Date Received: 2-25-93 <i>RMH 3-15-93</i>		INFORMATION RELEASE REQUEST		Reference: WHC-CM-3-4	
MAR 15 1993 Complete for all Types of Release					
Purpose ☐ Speech or Presentation ☐ Full Paper (Check only one suffix) ☐ Summary ☐ Abstract ☐ Visual Aid ☐ Speakers Bureau ☐ Poster Session ☐ Videotape			ID Number (include revision, volume, etc.) WHC-SD-WM-DA-123, Rev. 0 List attachments. Date Release Required		
☐ Reference ☒ Technical Report ☐ Thesis or Dissertation ☐ Manual ☐ Brochure/Flier ☐ Software/Database ☐ Controlled Document ☐ Other					
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New or novel (patentable) subject matter? ☒ No ☐ Yes If "Yes", has disclosure been submitted by WHC or other company? ☐ No ☐ Yes Disclosure No(s).			Information received from others in confidence, such as proprietary data, trade secrets, and/or inventions? ☒ No ☐ Yes (Identify)		
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R. B. Pan <i>R.B. Pan</i> 3/9/93					
		Date Cancelled		Date Disapproved	

WHC-SD-WM-DA-123
Rev. 0

**Lifting Beam Design/Analysis for the
Data Acquisition and Control System (DACS) Trailer**

February 1993

PREPARED BY: 2/24/93
T. C. Mackey, Principal Engineer
Equipment Stress Analysis

REVIEWED BY: 3/2/93
D. E. Ryman, Principal Engineer
Equipment Stress Analysis

APPROVED BY: 3/9/93
R. B. Pan, Manager
Equipment Stress Analysis

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

DESIGN VERIFICATION METHOD

The need for design verification has been reviewed with the method selected as indicated below: (ESR/Work Plan # NA / WP-23480-241).

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

R. B. Pan
Cognizant/Project/Design Manager

SD # WHC-SD-WM-DA-123

ECN # NA

DWG(S) # NA

INDEPENDENT REVIEW CHECKLIST

Document Reviewed Lifting Beam Design/Analysis for the Data Acquisition and Control System Trailer

Author T.C. Mackey

<u>Yes</u>	<u>No</u>	<u>N/A</u>	
(✓)	()	()	Problem completely defined.
()	()	(✓)	Are computer analysis applications documented in the report per EP 2.1? (code, version, hardware, input, output files)
()	()	(✓)	Is the software verification documentation either referenced or included in the report?
()	()	(✓)	Computer code error reports reviewed for impact if any.
(✓)	()	()	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.
(✓)	()	()	Acceptability limits on analytical results application and supported. Limits checked against sources.
(✓)	()	()	Safety margins consistent with good engineering practices.
(✓)	()	()	Conclusions consistent with analytical results and application limits.
(✓)	()	()	Results and conclusions address all points required in the problem statement.

D. E. Ryman
Reviewer

D. E. Ryman

3/2/93

Date

C O N T E N T S

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1.0 INTRODUCTION

This supporting document details the calculations for the design of an adjustable lifting beam. The lifting beam is to be used to hoist the Data Acquisition and Controls Systems (DACS) trailer over a steam line. All design work meets the standards of the American Institute of Steel Construction, *Manual of Steel Construction* (AISC 1989) and the *Hanford Hoisting and Rigging Manual* (WHC 1992).

2.0 SUMMARY OF RESULTS

The calculations in Appendix A show the design for an adjustable lifting beam that is adequate to support a 50,000-lb four-point hoist. The adjustable lifting beam can be disassembled and either of the shorter beams may be used for a 25,000-lb two-point hoist. The analysis is based on 125% of the rated load i.e. 62,500-lb.

3.0 DISCUSSION

The adjustable lifting beam is designed specifically to hoist the DACS trailer from four attachment points, one at each corner of the trailer, without damaging the trailer. The total weight of the trailer is approximately 41,000-lb with a maximum weight of 11,000-lb at each corner (see Appendix B). Given these weights, the lifting beam was designed to support 50,000-lb. The adjustable lifting beam can be configured to hoist a maximum load of 50,000-lb with four attachment points provided the attachment points are in a rectangular pattern 4.33 to 12.08-ft wide and 17.75 to 38.42-ft long. The adjustable lifting beam may be configured for various lengths by changing the location of the bolts. There are nine bolt holes spaced 1.44-ft apart. The width of the adjustable lifting beam may be changed by using lifting lugs spaced 0.67-ft apart.

The adjustable lifting beam may be disassembled into four separate beams. The two shorter lifting beams (W12x72) may be used to hoist smaller items with a maximum load of 25,000-lb. The width of the shorter lifting beam may vary from 4.33-ft to 12.08-ft in 0.67-ft increments by using two of the lifting lugs that are located underneath the beam.

The lugs at each corner of the adjustable lifting beam are designed to rotate to ensure that, during a hoist, the chokers are lined up with the lugs.

Detailed drawings (WHC 1992) show the construction requirements, material specifications, and general notes.

4.0 CONCLUSIONS

The adjustable lifting beam is adequate for a four-point 50,000-lb hoist. When the adjustable lifting beam is disassembled, each shorter beam (W12x72) is capable of a 25,000-lb two-point hoist.

5.0 RECOMMENDATIONS

The following recommendations shall be followed to ensure that the adjustable lifting beam is used properly and safely:

- For a four point hoist, the maximum load is 50,000-lb
- For a two point hoist, the maximum load is 25,000-lb
- Only ASTM A-325 $\frac{1}{2}$ in. diameter by $2\frac{3}{4}$ in. bolts shall be used when the adjustable lifting beam is being reconfigured for increased or decreased length
- The $\frac{1}{2}$ in. ASTM A-325 bolts shall be torqued to 300-ft•lb
- The nuts, bolts, and washers shall be replaced annually
- The lugs at each corner of the adjustable lifting beam shall be checked to ensure that the chokers are lined up with the lugs during the hoist.

6.0 REFERENCES

- AISC, 1989, *Manual of Steel Construction*, 9th Edition, American Institute of Steel Construction, Chicago, Illinois.
- WHC, 1992, *Adjustable Lifting Beam*, Drawings H-2-83689 Sheets 1-4, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1992, *Hanford Hoisting and Rigging Manual*, WHC-CM-6-4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A
Calculations

DESIGN CALCULATION

WHC-SD-WM-DA-123

Rev. 0

(1) Drawing H-2-83689 (2) Doc. No. _____ (3) Page 1 of _____
 (4) Building 2006 (5) Rev. _____ (6) Job No. WUP-23480-241
 (7) Subject DACS LIFTING BEAM
 (8) Originator J. E. Macken Date 8/19/92
 (9) Checker D. E. Ryman Date 8/20/92

(10)

25 TON ADJUSTABLE SPREADER BEAM

PLAN VIEW

DESIGN CALCULATION

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 (4) Building 200 G (5) Rev. _____ (6) Job No. WP-23480-241
 (7) Subject DACS LIFTING BEAM
 (8) Originator J. E. Mueser Date 8/19/92
 (9) Checker D. B. Ryman Date 8/20/92

(10)

SECT. A-A

SECT. B-B

DESIGN CALCULATION

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 (4) Building 200 G (5) Rev. _____ (6) Job No. WP-23480-241
 (7) Subject DACS LIFTING BEAM
 (8) Originator J.C. Mackey Date 8/19/92
 (9) Checker D.F. Dugan Date 8/20/92

(10)

LOADS

WEIGHT OF DACS-1 TRAILER IS 41,000 #
 FOR FUTURE USE RATE LIFTING BEAM AT 25 TONS
 LOAD TEST REQUIRES 125% OF RATED LOAD
 25 TONS = 50,000 # X 1.25 = 62,500 #

LOAD AT EACH LUG = 62,500 / 4 = 15,625 #

CONSIDER 45° ANGLE FOR RIGGING

$$F_x = \tan 45^\circ \times F_y = F_y$$

$$F_y = 15.6 \text{ K}$$

12'-0" BEAM STRESS (USING 16A 40' BEAM)

$$M_x = PL/4 = 31,200 \times (12 \times 12) / 4$$

$$M = 1,123,200 \text{ IN-#}$$

BENDING MOMENT $M_y = M_x$ $\therefore S_x \text{ req'd} = S_y \text{ req'd}$

DUE TO COMBINED STRESSES FIND $S_x/2$

$$S_{\text{req'd}} = M/f_b = (1,123,200 / 11,600) \times 2$$

$$S_{\text{req'd}} = 193.6$$

DUE TO AXIAL LOAD INCREASE S_x BY 20%

$$193.6 \times 1.2 = 232 \text{ IN}^3$$

$$W14 \times 145 \quad S_x = 232 \text{ IN}^3$$

$$b_f = 15\frac{1}{2}" \quad T_f = 1\frac{1}{16}" \quad \therefore \text{INCREASE } S_y \text{ WITH 1" SIDE PLATE}$$

$$b_f > \text{depth} \therefore S_y > S_x \text{ WITH 1" SIDE PLATES.}$$

$$\text{Also } r_y > r_x \quad r_x = 6.33$$

$$KL/r = 1 \times 144 / 6.33 = 22.7 \therefore F_a = 20.48$$

$$f_a = P/A = 15.6 / 42.7 = .36 \text{ KSI} < 20.48 \text{ OK}$$

$$\text{AXIAL STRESS IS } .36 / 20.48 = .017 < 2\%$$

TRY W14 X 132

$$b_f = 14.725 \quad d = 14.6 \quad T_f = 1" \quad S_x = 209 > 193.6 \text{ OK}$$

$$r_x = 6.28 \therefore KL/r = 144 / 6.28 = 23$$

$$F_a = 20.41 \quad f_a = 15.6 / 39.8 = .4 < 20.4$$

$$f_y = M_y/S_y = 1,123,200 / 209 = 5374$$

$$f_x = M_x/S_x \quad M_x = P \times 4' = 15,600 \times 48 = 748,800$$

$$= 748,800 / 209 = 3582$$

$$\text{UNITY} = .4 / 20.4 + 5.4 / 11.6 + 3.6 / 11.6 = .8 < 1.0 \text{ OK}$$

$$\text{MIN. BEAM SIZE BASED ON } S_x = .8 \times 209 = 161.3$$

✓ W14 X 109 IS OK $S_x = 173 \quad T_f = 7/8"$ WITH 3/4 SIDE PL

$$\text{SIDE PL WT} \approx 860 \#$$

$$\text{BEAM WT} = \frac{1309}{2168} \#$$

$$\rightarrow \text{SEE W14 X 99 } t_f = 3/4" \quad d = 14"$$

SIDE VIEW

(PLAN VIEW SAME)

BASED ON THESE CALCS. TWO EA. 40' BEAMS ARE USED
SEE CALCS. ON FOLLOWING PAGES

DESIGN CALCULATION

WHC-SD-WM-DA-123

Rev. 0

(1) Drawing H-2-83689 (2) Doc. No. _____ (3) Page 4 of _____
 (4) Building 200 G (5) Rev. _____ (6) Job No. WP-23480-241
 (7) Subject DACS LIFTING BEAM
 (8) Originator J.C. Meehan Date 8/19/92
 (9) Checker D.E. Regan Date 8/20/92

(10) CONSIDER USING 2 EA. 40' BEAMS
12'-0" BEAM STRESS WITH 2 EA. 40' BEAMS

$$M_x = R \times a = 15.6 \times 4 = 62.4 \text{ K-FT}$$

$$\text{or } 748,800 \text{ IN-#}$$

USE PL 12" x 1/2"

$$M_y = 15.6 \times 12 = 187.2 \text{ K-IN}$$

$$\text{or } 187,200 \text{ IN-#}$$

$$S_x \text{ req'd} = 748,800 / 11,600 = 65$$

$$S_y \text{ req'd} = 187,200 / 11,600 = 16$$

INCREASE S_y BY ADDING SIDE PLATES

W12X65

W14X53 $b_f = 8$ $r_y = 1.92$ $S_x = 77.8$

$$f_{bx} = 748,800 / 77.8 = 9625$$

$$f_{bx} / F_{bx} = .8297$$

$$f_{by} = 187,200 / 77.8 = 2406$$

$$f_{by} / F_{by} = .2074$$

$$1.0371 > 1.0 \text{ + AXIAL N.G.}$$

TRY W12X65 $S_x = 87.9$ $A = 19.1$

$$f_{bx} = 748,800 / 87.9 = 8519$$

$$f_{bx} / F_{bx} = .734$$

$$f_{by} = 187,200 / 87.9 = 2130$$

$$f_{by} / F_{by} = .1836$$

$$.9180$$

$$KL/r = 12 \times 12 / 3.02 = 47.7$$

$$F_a = 18.61 \times 19.33 / 36 = 10$$

$$f_a = 15.6 / 19.1 = .8168$$

$$f_a / F_a = .0817$$

$$.9997$$

$$+ .11$$

FROM FOLLOWING PAGE - ADD TORSION $1.1 > 1.0 \text{ N.G.}$

TRY W12X72 $S_x = 97.4$ $S_y = 97.4$ w/A $\tau_f = 11/16$ USE $3/4$ SIDE PLATE

$$\frac{f_{bx}}{F_{bx}} = .734 \times \frac{87.9}{97.4} = .6624$$

$$\frac{f_{by}}{F_{by}} = .1836 \times \frac{87.9}{97.4} = .1657$$

$$\text{UNITY} = .6624 + .1657 + .0817 + .11 = 1.02 \text{ WITHIN } 5\% \text{ OK}$$

S_y IS CONS $\neq$ AXIAL IS CONS.

✓ USE W12X72 (FOR 12' BEAMS)

$$\text{STIFF PL WT} \approx 560 \text{ #}$$

$$\text{BEAM WT} \approx 564$$

$$1724 \text{ #}$$

DESIGN CALCULATION

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 (7) Subject DACS LIFTING BEAM
 (8) Originator J.C. Mackey Date 8/19/92
 (9) Checker D.E. Ryman Date 8/20/92

(10)

12' BEAM W12X65 (TORSION) ← SEE PREVIOUS PAGECHECK TORSION $L/a = 12/82.8 = .15$

TORSIONAL FUNCTION = 2.25

 $2.25/3.5$ $3.5 = \phi'' \left(\frac{65.5a}{M} \right) \therefore \phi'' = 2.25M/655a$

$$\sigma_{mo} = E w_{mo} \phi'' = 29 \times 10^3 \times 34.5 \times \frac{2.25M}{655a}$$

 $\frac{2.25}{3}$

$$M \approx (6+4) \times 15.6 = 156 \text{ k-in}$$

$$G = 11.2 \times 10^3$$

$$J = 2.19$$

$$\therefore \frac{2.25M}{655a} = \frac{2.25 \times 156}{11.2 \times 10^3 \times 2.19 \times 5 \times 82.8}$$

$$= 3.45 \times 10^{-5}$$

$$\sigma_{mo} = 29 \times 10^3 \times 34.5 \times 3.45 \times 10^{-5}$$

$$\sigma_{mo} = 34.5 \text{ KSI @ MIDSPAN w/o SIDE PLATE}$$

$$T_f = 5/8$$

ADD $5/8"$ or $1/2"$ SIDE PLATES $I_x \approx I_y = 533$

$$I_x + I_y = 1066$$

$$C = (6^2 + 6^2)^{1/2} = 8.5"$$

$$M C / J = 156 \times 8.5 / 1033 = 1.28 \text{ KSI}$$

$$1.28 / 11.6 = .11$$

DESIGN CALCULATION

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 (8) Originator D. E. Ryman Date 8-20-92
 (9) Checker INDEPENDANT REVIEW Date _____

(10)

FIND S_x AND S_y FOR W12x72
 W/ 2-PLATES $\frac{3}{4}$ " THICK

W12x72

$$I_{xx} = 597 \text{ in}^4$$

$$I_{yy} = 195 \text{ in}^4$$

PLATED BM

$$I_{xx} = 597 + \frac{0.75 \times 12.25^3 \times 2}{12} = 827 \text{ in}^4$$

$$S_x = \frac{827}{6.13} = 135 \text{ in}^3$$

$$I_{yy} = 195 + 2 \times 12.25 \times 0.75 \times 6.38^2 = 943 \text{ in}^4$$

$$S_y = \frac{943}{6.75} = 140 \text{ in}^3$$

$$I_{xx} + I_{yy} = 827 + 943 = 1770 \text{ in}^4 > 1066 \text{ in}^4$$

USED IN CALCS.

DESIGN CALCULATION

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- (1) Drawing H-2-83689 (2) Doc. No. _____ (3) Page 7 of _____
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 (9) Checker D.K. Ryman Date 8/20/92

BASED ON PREVIOUS CALCS. TWO TO BEAMS ARE USED - SEE CALCS. ON NEXT PAGE

40'-0" BEAM (SINGLE BEAM)

AXIAL LOAD = $15,6 \times 2 = 31.2 \text{ K}$

$f_b = M/S$ $M = P \cdot e$ $e = \frac{14.66}{2} + \frac{\text{BEAM } d.}{2}$

CONSIDER BEAM $d/2 = 7"$

USE $7 + 7.33 = 15"$ $M = 31,200 \times 15 = 468,000 \text{ IN-#}$

CONSIDER AXIAL LOAD @ 80% STRESS

f_b @ 20% STRESS

$S_{req'd} = M/f_b = 468,000 \times 5 / 11,600 = 201 \text{ IN}^3$

USE r @ 200 MAX $\therefore KL/r = 200 \therefore r = KL/200 = 40 \times 12 / 200 = 2.4$

TRY W14X82 $r = 2.48$ $S_x = 123$

FOR ALLOWABLE AXIAL LOAD FIND RELATIVE F_y FOR

USE TO MODIFY F_a

$F_y/5 = 58/5 = 11.6 \text{ KSI}$ $F_T = 1.6 F_y \therefore F_y = F_T/1.6 = 11.6/1.6 = 19.33$

$KL/r = 1 \times 40 \times 12 / 2.48 = 194$ $F_a = 3.97$

MODIFIED $F_a = 3.97 \times 19.33 / 36 = 2.13 \text{ KSI}$

$P_a = 31.2 / 24.1 = 1.29 < 2.13 \text{ OK}$

$f_b = 15 \times 31.2 / 123 = 3.8 < 11.6 \text{ OK}$

CHECK FOR COMBINED AXIAL & BENDING

$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = \frac{1.29}{2.13} + \frac{3.8}{11.6} + \frac{0}{0} = .933 \leq 1.0 \text{ OK}$

TRY TO REDUCE BENDING BY REDUCING DEPTH & INCREASE r

TRY W12X65 $\therefore e = 14.66/2 + 12.12/2 = 13.4"$

$M = 31.2 \times 13.4 = 418 \text{ KIN}$

$f_b = 418 / 87.9 = 4.75 \text{ KSI}$

$KL/r = 40 \times 12 / 3.02 = 159 \therefore F_a = 5.91 \times 19.33 / 36 = 3.173$

$f_a = 31.2 / 19.1 = 1.63$

$1.63 / 3.173 + 4.75 / 11.6 = .924 < 1.0 \text{ OK}$

$b_f = 12 \therefore$ NO FURTHER SIZE REDUCTION IS POSSIBLE

✓ USE W12X65 BEAM

$WT = 2600 \#$

DESIGN CALCULATION

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 (7) Subject DACS LIFTING BEAM
 (8) Originator J.S. M...her Date 8/19/92
 (9) Checker D.K. Ryman Date 8/20/92

(10)

40' BEAM (TWO BEAMS)

AXIAL LOAD $> 15.6K$ CONSIDER $D=14"$ $C=7+7=14"$

$M = 14 \times 15600 = 218,400$ IN- $\#$

TRY W10X49 $r = 2.54$ $A = 14.4$ $S_x = 54.6$

$KL/r = 40 \times 12 / 2.54 = 189$ $F_c = 4.18 \times 19.33 / 36 = 2.244$ KSI

$f_a = 15600 / 14.4 = 1.08$ KSI

$f_b = M/S = 218,400 / 54.6 = 4.0$

ADDITIONAL M DUE TO DEAD WT.

$M = WL^2/8 = 49/2 \times (40 \times 12)^2 / 8 = 117,600$

$\Delta = 5WL^4 / 384EI$

$= 5 \times \frac{49}{12} \times (40 \times 12)^4 / 384 \times 29 \times 6 \times 272$

$= .357"$

ADDED M DUE TO ADDED $e = 15,600 \times .357 = 5581$ IN- $\#$

TOTAL $M = 218,400 + 117,600 + 5581 = 341,582$

$f_b = 341,582 / 54.6 = 6.256$ KSI

UNITY $= 6.256 / 11.6 + 1.08 / 2.244 = 1.02$ WITHIN 5% , OK

ACTUAL MOMENT IS LESS DUE TO e

$e_{ACTUAL} = \frac{14}{2} + \frac{10}{2} = 12" < 14"$

$M = 12 \times 15,600 = 187,200$

ACTUAL $M = 310,382$

$f_b = 310,382 / 54.6 = 5.684$

UNITY $\therefore = .97 < 1.0$

✓ USE 2EA W10X49

WT $= 3920$ $\#$

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 (7) Subject DACS LIFTING BEAM
 (8) Originator J. S. Alarcon Date 8/20/92
 (9) Checker D. E. Reynolds Date 8/20/92

(10)

LIFTING LUG LOADS (TOP)

TOP LUGS - CONSIDER SINGLE SHEAR

W = 15.6 + DW BEAMS

$$W10 \times 49 \text{ WT} = 3920 / 4 \text{ LUGS} = 980^{\#}$$

$$W12 \times 72 \text{ WT} = 1724 / 4 \text{ LUGS} = 431$$

1411

TOTAL LOAD = 15.6

$$+ 1.4$$

$$\hline 17.0 \text{ K}$$

CONSIDER CABLE @ 45°

$$\text{CABLE TENSION} = 17.0 / .707 = 24.0 \text{ K}$$

$$A_{req'd} = 24.0 / 11.6 = 2.073 \text{ IN}^2$$

$$24 / 2 = 12 \therefore \text{USE 12 TON SHACKLE}$$

$$\text{PIN } \phi = 1 \frac{3}{8}'' \text{ WIDTH @ PIN} = 2 \frac{1}{32}$$

TRY $1 \frac{1}{2}''$ THICK LUG @ 4" OD

$$- \frac{1 \frac{3}{8}}{2} + \frac{4}{2} = 1.3125 \therefore A = 1.3125 \times 1.5 = 1.9688 < 2.07$$

TRY $1 \frac{3}{4}''$ THICK LUG

$$A = 1.75 \times 1.3125 = 2.297 \text{ IN}^2 > 2.07 \text{ OK}$$

USE $1 \frac{3}{4}''$ THICK LUG @ 4" O.D.

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 (7) Subject DACS LIFTING BEAM
 (8) Originator J.C. Mackey Date 8/20/92
 (9) Checker D.E. Ryman Date 8/20/92

(10) LIFTING LUG (BOTTOM)

VERTICAL LOAD ONLY @ 15.6 K 15.6/2 = 7.8 TON
USE 8 1/2 TON SHACKLE

$A_{req'd} = 15.6/11.6 = 1.344$

PIN $\phi = 1 1/8"$

TRY 3" ϕ @ 1" THICK PL

$\frac{3}{2} - \frac{1 1/8}{2} = .9375$

$A = 1 \times .9375 = .9375 < 1.344$

TRY 4" ϕ @ 3/4" THICK PL

$\frac{4}{2} - \frac{1 1/8}{2} = 1.4375$ (RADIUS = 2")

$1.4375 \times .75 = 1.07 < 1.344$

USE 1" PL @ 4" ϕ $A = 1.4375 > 1.344$

SEE CALCS. AT THE BOTTOM OF THIS PAGE FOR LUG SHACKLE SIZE

CONSIDER POSSIBLE LATERAL LOAD @ LUG

USE 5' CHOKER AND $e = 8"$

$$LATERAL\ LOAD = \frac{15.6}{60} \times 8 = 2.08K$$

$$M = 2.5 \times 2.08 = 5.2\ K-IN$$

$$S = bh^2/6 = (2.5 \times 2) \times 1^2/6 = .83$$

$$f_b = 5.2/.83 = 6.27\ KSI$$

$$f_t = P/A = 15.6/(2.5 \times 2) \times 1 = 3.467$$

$$UNITY\ 6.27/11.6 + 3.467/11.6 = .94 \leq 1.0$$

FOR CONSISTENCY USE 12 TON SHACKLE BELOW

$$PIN\ \phi = 1 3/8" \quad A = 1.718\ IN^2 @ R = 2 1/2"$$

$$P_{allow} = 1.718 \times 11.6 = 19.94\ KIPS < 12\ TON$$

$$1 1/4" PL \quad A = 2.2656\ IN^2 \quad P_u = 2.2656 \times 11.6 = 26.3K > 24K\ OK$$

DESIGN CALCULATION

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(7) Subject DACS LIFTING BEAM
(8) Originator J.E. Ryznar Date 8/20/92
(9) Checker J.E. Ryznar Date 8/25/92

(10)

LIFTING LUG #2" Ø PIN.

TORSION @ LIFTING LUG

LOAD ON PIN (CONSIDER 2" Ø)

$$R = (15.6^2 + 15.6^2)^{1/2} = 22.1 \text{ K}$$

$$f_{\text{BEARING}} = P/A = 22.1 / (2 \times .75) = 14.67 > 11.6$$

CHECK SHEAR AT PIN $f_v = P/A$

$$A = \pi r^2 = 3.14 \times 1^2 = 3.14 \text{ IN}^2 \text{ (FOR 2" Ø PIN)}$$

$$\text{SHEAR STRESS} = P/A = 22.1 / 3.14 = 7.0 \text{ KSI} < 11.6 \text{ OK}$$

CHECK BENDING STRESS

$$f_b = M/S \quad M = 15.6 \text{ K} \times 2.5" = 39.0 \text{ K-IN}$$

$$S = .7854 R^3 = .7854$$

$$f_b = 39.0 / .7854 = 49.66 \text{ KSI} > 11.6 \text{ N.G.}$$

$$\text{TRY 4" Ø PIN} \quad S = .7854 R^3 = 6.2832 \text{ IN}^3$$

$$M = 39.0 \text{ K-IN}$$

$$f_b = M/S = 39.0 / 6.2832 = 6.21 < 11.6 \text{ KSI OK}$$

PER TELECON 8/20 3:15PM W/ JIM SIMMS & MIKE GRIMES
USE 4" Ø AND ALUMINUM LIFTING LUG IS OK/PREFERRED.

$$f_{\text{BEARING}} = P/A = 22.1 / (4 \times .75) = 7.367 < 11.6 \text{ OK}$$

VERT LOAD 15.6 K @ BOTTOM OF

$$\text{WELD AREA REQ'D} = 15.6 / 11.6 = 1.345 \text{ IN}^2$$

$$\text{LENGTH OF WELD} = 2 \pi r = 2 \times 3.14 \times 2 = 12.56"$$

$$A = .5 \times 12.56 = 6.28 \text{ IN}^2 > 1.345 \text{ OK}$$

CHECK BENDING @ LUG

$$S = bh^2/6 = 1.75 \times 4^2/6 = 4.667$$

$$\text{DUE TO THE } 3/4" \text{ RADIUS } M = 15.6 \times (2.5 - .75) = 27.3 \text{ K-IN}$$

$$f_b = M/S = 27.3 / 4.667 = 5.85 \text{ KSI} < 11.6 \text{ KSI OK}$$

$$T = 15.1 / (4 \times 1.75) = 2.16 \text{ KSI}$$

CHECK UNITY

$$\frac{5.85}{11.6} + \frac{2.16}{11.6} = 0.69 < 1 \text{ OK}$$

DESIGN CALCULATION

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 (7) Subject DACS LIFTING BEAM
 (8) Originator J. S. Mack Date 8/20/92
 (9) Checker D. E. Ryan Date _____

(10)

BOLTS

TRY USING $\frac{3}{4}"$ ϕ BOLTS A-325 W/SLOTTED HOLES

$$F_t = 19.4 \text{ K/BOLT}$$

$$\text{CONSIDER LSL @ } F_s = 5.5 \text{ K}$$

$$\text{RESISTING TORSION } M = 144.3 \text{ K-IN}$$

$$\text{MOMENT ARM} = 12" + 1.75 + 1.75 = 15.5" \text{ (C.M.S.)}$$

$$\text{TENSION} = 144.3 / 15.5 = 9.3 \text{ KIPS/2} = 4.65 \text{ K/BOLT}$$

$$\text{SHEAR} = 15.6 / 4 \text{ BOLTS} = 3.9 \text{ K/BOLT}$$

$$\text{UNITY } 3.9 / 5.5 + 4.65 / 19.4 = .9488 < 1.0 \text{ OK}$$

CONSIDER LOAD ON $\frac{3}{4}"$ ϕ STIFF. ON 3 SIDES

TREAT AS BEAM W/2 LOAD EACH SIDE OF SLOT.

$$\text{BEAM WIDTH} = \frac{1\frac{3}{4} - (\frac{3}{4} + \frac{1}{16})}{2} = 1.3438"$$

$$\text{LOAD} = 4.65 / 2 = 2.325$$

$$S = bh^2/6 = 1.3438 \times .75^2 / 6 = .126$$

$$f_b = M/S \quad M = PL/8 = 4.65 \times 5/8 = 2.9063 < 11.6 \text{ OK}$$

✓ $\frac{7}{8}"$ ϕ BOLTS ARE OK

STIFF ϕ CHECK

COMPRESSION ON $\frac{1}{2}"$ STIFF. ϕ

$$L = 12 \quad r = .57735 d / 2 \quad c d = \frac{1}{2}" \quad r = .1443$$

$$L/r = 12 / .1443 = 83.13$$

$$F_c = 15.02 \times 19.33 / 36 = 8.06 \text{ KSI}$$

$$\text{COMPRESSION} \approx 4.65 \text{ K}$$

$$A_{req'd} = 4.65 / 8.06 = .5766 \text{ in}^2$$

$$2" \times \frac{1}{2}" \text{ STIFF. } A = 2 \times \frac{1}{2} = 1.0 \text{ in}^2 \text{ OK}$$

DESIGN CALCULATION

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(4) Building 200 G (5) Rev. _____ (6) Job No. WP-23480-241
(7) Subject DACS LIFTING BEAM
(8) Originator D. E. Ryman Date 8-25-92
(9) Checker J. C. Mackey Date 8/31/92

- (10) DETERMINE TORQUE VALUE FOR ASTM A-325 HIGH STRENGTH BOLTS FOR 50% YIELD OF BOLT (REUSABLE BOLTS)

A-325 BOLT $\frac{7}{8}$ " ϕ

$$F_u = 120,000 \text{ lb/in}^2 \text{ MIN.}$$

$$F_y = 92,000 \text{ lb/in}^2 \text{ MIN}$$

50% YIELD BASED ON NET AREA

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

D = NOMINAL DIAMETER OF BOLT

A_s = STRESS AREA

n = THREADS / INCH

$\frac{7}{8}$ " ϕ BOLT, n = 9 THREADS / INCH.

$$A_s = 0.7854 [0.875 - (0.9743/9)]^2$$

$$= 0.462 \text{ in}^2$$

FOR 50% OF YIELD

$$\text{TENSION} = 0.5 \times 92000 \times 0.462$$

$$= 21252 \text{ lbs}$$

$$T = 0.2 \times P \times \frac{d}{12}$$

T = TORQUE, FT. LBS

P = TENSION

d = NOMINAL DIAMETER OF BOLT

$$T = 0.2 \times 21252 \times \frac{0.875}{12} = 310 \text{ FT. LBS}$$

USE 300 FT. LBS INSTALLATION TORQUE FOR REUSABLE $\frac{7}{8}$ " ϕ A-325 BOLTS

DESIGN CALCULATION

WHC-SD-WM-DA-123

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 (4) Building N/A 2006 (5) Rev. 0 (6) Job No. WP-23480-165
 (7) Subject 192A GANTRY CRANE MODIFICATION DHCS 241
 (8) Originator D.E. Ryan Date 12-5-91
 (9) Checker C.E. Mackay Date 12-6-91

(10)

DETERMINE TORQUE VALUE FOR
 ASTM A-325 HIGH STRENGTH BOLT
 FOR 50% YIELD OF BOLT (REUSING BOLTS)

A-325 BOLT $5/8"$ ϕ BOLT

$$F_u = 120,000 \text{ lb/in}^2 \text{ MIN}$$

$$F_y = 92,000 \text{ lb/in}^2 \text{ MIN}$$

50% YIELD BASED ON NET AREA

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

D = NOMINAL DIAMETER OF BOLT

A_s = STRESS AREA

n = THREADS / INCH

$5/8"$ ϕ BOLT, n = 11 THREADS / INCH

$$A_s = 0.7854 [0.625 - (0.9743/11)]^2$$

$$= 0.226 \text{ in}^2$$

FOR 50% OF YIELD

$$\text{TENSION} = 0.5 \times 92000 \times 0.226$$

$$= 10,400 \text{ lb}$$

$$T = 0.2 \times P \times d / 12$$

T = TORQUE, FT LBS

P = TENSION

d = NOMINAL BOLT DIAMETER

$$T = 0.2 \times 10,400 \times \frac{0.625}{12} = 108 \text{ FT. LBS}$$

BOLT MANUFACTURER RECOMMENDED

150 FT. LB FOR NORMAL INSTALLATION

OF $5/8"$ ϕ A-325 BOLTS

$$P (\text{TENSION}) = \frac{T \times 12}{0.2 \times d} = \frac{150 \times 12}{0.2 \times 0.625} = 14,400 \text{ lbs}$$

DESIGN CALCULATION

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 (4) Building N/A 2006 (5) Rev. 0 (6) Job No. WP-23480-168
 (7) Subject 193A GANTRY CRANE MODIFICATION DACS 241
 (8) Originator D.E. Ryman Date 12-5-91
 (9) Checker C.S. Mackey Date 12-6-91

(10)

$$\text{TENSION OF } 14,400 \text{ lbs} = \frac{14,400 \times 100\%}{92,000 \times 0.226} \text{ OF YIELD}$$

$$= 69\% \text{ OF YIELD}$$

A-325 $\frac{3}{4}$ " ϕ BOLT

TORQUE FOR 50% YIELD OF BOLT

$\frac{3}{4}$ " ϕ BOLT, $n=10$

$$A_s = 0.7854 \left[0.75 - \left(0.9743 / 10 \right) \right]^2$$

$$= 0.334 \text{ in}^2$$

FOR 50% OF YIELD

$$\text{TENSION} = 0.5 \times 92,000 \times 0.334$$

$$= 15,364 \text{ lb}$$

$$\text{TORQUE } T = 0.2 \times 15,364 \times \frac{0.75}{12} = 192 \text{ FT. LBS}$$

BOLT MANUFACTURING RECOMMENDED

270 FT. LB FOR NORMAL INSTALLATION

OF $\frac{3}{4}$ " ϕ

$$P(\text{TENSION}) = \frac{T \times 12}{0.2 \times d} = \frac{270 \times 12}{0.2 \times 0.75} = 21,600 \text{ lb}$$

$$\text{TENSION OF } 21,600 \text{ lbs} = \frac{21,600 \times 100}{92,000 \times 0.334} \text{ OF YIELD}$$

$$= 70\% \text{ OF YIELD}$$

FOR REUSABLE $\frac{5}{8}$ " & $\frac{3}{4}$ " ϕ A325 BOLTS
 USE THE FOLLOWING INSTALLATION
 TORQUES

$\frac{5}{8}$ " ϕ - 100 FT. LBS

$\frac{3}{4}$ " ϕ - 150 FT. LBS

DESIGN CALCULATION

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 (8) Originator D.E. Ryan Date 8/26/92
 (9) Checker INDEPENDANT REVIEW Date _____

(10)

BOLTS

P (INTO PAPER)

ELEVATION
END

PLAN

SECTION

1-1

$$P = 15.6 \times 0.7071 = 11.03 \text{ K}$$

$$\begin{aligned} \text{TENSION ON BOLTS} &= \frac{11.03 \times 8.5}{15.5 \times 2} \\ &= 3.02 \text{ K} \end{aligned}$$

DESIGN CALCULATION

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(7) Subject DALS LIFTING BEAM
(8) Originator D.L. Ryman Date 8/26/92
(9) Checker INDEPENDANT REVIEW Date _____

(10) CHECK PRYING
FLG OF W10X49

$$d' = 15/16" = 0.938 \text{ in} \quad d'/2 = 0.469 \text{ in}$$

$$b = 2.455" \quad t_w = 0.34 \text{ in}$$

$$a = 2.545" \quad p = 5.25 \text{ in}$$

$$b' = 1.986 \text{ in}$$

$$a' = 3.014 \text{ in}$$

$$\begin{aligned} e_{READ} &= \sqrt{\frac{8 T b'}{p F_y}} \\ &= \sqrt{\frac{8 \times 4.65 \times 1.986}{5.25 \times 36 \text{ K}}} \\ &= 0.63 \text{ in} \quad \text{N.G.} \end{aligned}$$

$$T = 4.65 \text{ K}$$

$$b' = 1.986 \text{ in}$$

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

$$p = 5.25 \text{ in}$$

$$\text{FIND } \delta = 1 - d'/p$$

$$= 1 - \frac{0.938}{5.25} = 0.82$$

DESIGN CALCULATION

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(8) Originator D.E. Rymer Date 8/26/92
(9) Checker INDEPENDENT REVIEW Date _____

(10) FIND $\beta = \frac{1}{\rho} \left(\frac{B}{T} - 1 \right)$ $B = 19.4 \text{ K}$
 $\rho = \frac{b'}{a'} = \frac{1.986}{3.014} = 0.659$
 $\beta = \frac{1}{0.659} \left(\frac{19.4}{4.65} - 1 \right)$
 $= 4.81 > 1$ SET $\alpha' = 1$

$$t_{reqd} = \sqrt{\frac{8 T b'}{\rho F_y (1 + 5 \alpha')}} \\ = \sqrt{\frac{8 T \times 1.986}{5.25 F_y (1 + 1 \times 0.82)}} \\ = \sqrt{\frac{1.66 T}{F_y}}$$

$T = 4.65 \text{ K}$	$F_y = 19.8 \text{ KSI}$	$t_{reqd} = 0.62 \text{ in}$
$T = 4.65 \text{ K}$	$F_y = 36.0 \text{ KSI}$	$t_{reqd} = 0.46 \text{ in}$
$T = 1.25 \text{ K}$	$F_y = 19.8 \text{ KSI}$	$t_{reqd} = 0.32 \text{ in}$
$T = 1.25 \text{ K}$	$F_y = 36.0 \text{ KSI}$	$t_{reqd} = 0.24 \text{ in}$

$T = 4.65 \text{ K}$ IS CONSERVATIVE

T IS REALISTICALLY CLOSER TO
1.25 K. FLANGE BENDING O.K

$T_{ACTUAL} = 3.02 \text{ K}$

$t_{reqd} = 0.50 \text{ in} < 0.52 \text{ in O.K}$

APPENDIX B
Vendor Data Sheets

NUCLEAR TEST ENGINEERING

WEIGHT AND CENTER OF GRAVITY — DATA SHEET

Form EJ-18(Rov 4-80) Trailer No. 040-1

Name: _____

Date & Location: 8/11/92

I. CONFIGURATION:

L = 49 ft 10 in

= 299 in

N = 10 ft 00 in

= 60 in

* Reference ATSI drawing number _____

Show major items affecting weight.

PLAN VIEW

SIDE ELEVATION

Weighed with:

ATSI Modules _____

FRC Crib _____

UGC Beam _____

Road Gear _____

No. Batteries _____

Fuel _____

No. Scopes _____

As trailer was configured 8/11/92

User contacted? ☒

II. MEASUREMENTS & LOAD CELL LOCATIONS:

R = RED = 8800 lb

Y = YELLOW = 10700 lb

W = WHITE = 10800 lb

G = GREEN = 10700 lb

T = TOTAL = _____ lb

*A = 23 in

B = 114 in

C = 570.5 in

D = 108 in

E = 23 in

F = 6 in

H = 570.5 in

K = 12 in

III. CALCULATIONS:

Q OF TRAILER

$$\bar{Z} = (R.B + Y.D + W.F + G.K)/T = \underline{\hspace{2cm}} \text{ in}$$

$$N/2 = \underline{\hspace{2cm}} \text{ in}$$

File: DACS-1.WGT

11-Aug-92, 08:36 AM

TRAILER DACS-1 WEIGHT AND CENTER-OF-GRAVITY REPORT

Name: LANCE GROFT

Weighed At: ATLAS

Hole Number: 0

=====

TRAILER CONFIGURATION:

WEIGHED WITH:

Length (L)	= 49 feet, 10 inches.	A.T.S.I. Modules:	NO
Length (L)	= 49.8333 feet.	F.R.C. Crib:	NO
Length (L)	= 598 inches	U.G.C. Beam:	NO
Center-line (L/2)	= 299 inches.	Road Gear:	YES
Width (N)	= 10 feet, 0 inches.	Number of batteries:	
Width (N)	= 10 feet.	Pounds of fuel:	
Width (N)	= 120 inches	Number of scopes:	
Center-line (N/2)	= 60 inches.		

=====

MEASUREMENTS AND LOAD CELL LOCATIONS:

Red Weight	= 8800	Dimension A = 23"
Yellow Weight	= 10700	Dimension B = 114
White Weight	= 10800	Dimension C = 570.5
Green Weight	= 10700	Dimension D = 108
		Dimension E = 23
		Dimension F = 6
		Dimension H = 570.5
		Dimension K = 12
Total Weight	= 41000 pounds.	

(Deviation) = -2.63415 inches.

(Deviation) = 9.76928 inches.

Dimension Z = 57.3659 inches.

Dimension X = 308.768 inches.

=====

CHECK PRINT

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WHC-SD
Rev 1

REVISIONS		DATE	BY	APP'D
1	INITIALS			
2	INITIALS			
3	INITIALS			
4	INITIALS			
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CELLS AND PLATING WILL BE COMPLY
TO CODE OF FEDERAL REGULATIONS
TITLE 29, SECTION 1910.101, 101.2

SCALE
1" = 4'

NOTES
A. 100% ON-ONE
A. 100% ON-ONE

BACK
8'-2"

FRONT
10'-4"

LOOKS LIKE 10'-4"
(SCALES SAME)

FILE
INITIALS
FOR 1 - 100%
FOR 2 - 100%
FOR 3 - 100%
FOR 4 - 100%
FOR 5 - 100%

HAND TIED
PANEL

HAND TIED
PANEL

POWER
PANEL

3" BELLO
PANEL

POWER
PANEL

TIE DOWN
EACH SIDE

FRONT

FORGED SHACKLES

WHC-SD-WM-DA-123 R.O

G-209 S-209

Screw pin anchor shackles meet Federal Specification RR-C-271b Type IV Class 1.

Load Rated

- Working Load Limit permanently shown on every shackle.
- Forged, Quenched and Tempered, with alloy pins.
- Capacities 1/3 thru 150 tons.
- Look for the red color . . . mark of genuine Crosby-Laughlin quality.
- Shackles can be furnished proof tested with certificates to designated standards (i.e., ABS, Lloyds, etc.). Charges for proof testing and certification available upon request.
- Hot Dip Galvanized or Self Colored

G-213 S-213

Round pin anchor shackles meet Federal Specification RR-C-271b Type IV Class 4.

ANCHOR SHACKLES

Working Load Limit (tons)	Nominal Shackle Size (in)	DIMENSIONS (in)							Weight (lbs) 213 209	
		Inside Length	Inside Width		Diameter		Tolerance Plus or Minus			
			at Pin	at Bow	Pin	Outside of Eye	Length	Width		
† 1/3	3/16	7/8	3/8	1 1/16	1/4	9/16	1/16	1/16	—	.05
1/2	1/4	1 1/8	1/2	25/32	5/16	1 1/16	1/16	1/16	.13	.12
3/4	5/16	1 7/32	17/32	27/32	3/8	1 3/16	1/16	1/16	.17	.19
1	3/8	1 7/16	2 1/32	1 1/32	7/16	3 1/32	1/8	1/16	.25	.31
1 1/2	7/16	1 11/16	23/32	1 5/32	1/2	1 1/16	1/8	1/16	.38	.38
2	1/2	1 7/8	13/16	1 5/16	5/8	1 3/16	1/8	1/16	.70	.63
3 1/4	5/8	2 3/8	1 1/16	1 11/16	3/4	1 9/16	1/8	1/16	1.50	1.38
4 3/4	3/4	2 13/16	1 1/4	2	7/8	1 7/8	1/4	1/16	2.32	2.25
6 1/2	7/8	3 5/16	1 7/16	2 9/32	1	2 1/8	1/4	1/16	3.40	3.38
8 1/2	1	3 3/4	1 11/16	2 11/16	1 1/8	2 3/8	1/4	1/16	5.00	5.32
9 1/2	1 1/8	4 1/4	1 13/16	2 29/32	1 1/4	2 5/8	1/4	1/16	6.97	6.81
12	1 1/4	4 11/16	2 1/32	3 1/4	1 3/8	3	1/4	1/16	9.75	9.50
13 1/2	1 3/8	5 3/16	2 1/4	3 1/2	1 1/2	3 5/16	1/4	1/8	13.25	13.25
17	1 1/2	5 3/4	2 3/8	3 7/8	1 5/8	3 5/8	1/4	1/8	17.25	17.70
25	1 3/4	7	2 7/8	5	2	4 5/16	3/4	1/8	29.46	30.38
35	2	7 3/4	3 1/4	5 3/4	2 1/4	5	3/4	1/8	45.75	45.00
†55	2 1/2	10 1/2	4 1/8	7 1/4	2 3/4	6	3/4	1/4	—	85.75

†Furnished in screw pin only.

S-2131

Trawling shackle with thin square head screw pin.

TRAWLING SHACKLES

Self Colored only

Working Load Limit (tons)	Nominal Shackle Size (in)	DIMENSIONS (in)						Weight (lbs)
		Inside Length	Inside Width at Pin	Diameter		Tolerances Plus or Minus		
				Pin	Outside of Eye	Length	Width	
2	½	1⅝	1⅜	⅝	1⅜	⅛	⅛	.75
3¼	⅝	2	1⅞	¾	1⅞	⅛	⅛	1.24
4¾	¾	2⅜	1¼	⅞	1⅞	¼	⅛	2.18
6½	⅞	2⅜	1⅞	1	2⅞	¼	⅛	3.28