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Project Title/Work Order:

Stress Analysis for Portable Safety Platform (Core Sampler Truck)

EDT No.: 608361

ECN No.:

Name	MSIN	With Attachment	EDT/ECN & Comment	EDT/ECN Only
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O. M. Jaka	R3-08	X		
K. V. Scott	H5-52	X		
R. Y. Seda	R1-17	X		
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J. J. Verderber	S1-57	X		
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Page 1 of 1

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608361

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7. Abstract This document provides the stress analysis and evaluation of the portable platform of the rotary mode core sampler truck No. 2 (RMCST #2).		

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8. RELEASE STAMP

CONTENTS

	<u>PAGE</u>
1.0 INTRODUCTION	1
2.0 CONCLUSIONS AND RECOMMENDATIONS	1
3.0 CONFIGURATION AND LOADING	1
3.1 CONFIGURATION	1
3.2 LOADING	2
4.0 MATERIAL PROPERTIES AND ALLOWABLES	2
4.1 MATERIAL PROPERTIES	2
4.1.1 Aluminum Alloy 6061-T6	2
4.1.2 Aluminum Alloy 6063-T52	3
4.1.3 Weld Material	3
4.1.4 Structural Steel (ASTM A36)	4
4.2 ALLOWABLES	4
5.0 STRESS ANALYSIS	4
6.0 REFERENCES	8

STRESS ANALYSIS OF PORTABLE SAFETY PLATFORM (CORE SAMPLER TRUCK)

1.0 INTRODUCTION

This supporting document presents the stress analysis and evaluation of the portable platform of the rotary mode sampler truck. The portable platform comprises railing, railing posts, deck, legs, and a portable ladder. The portable platform is secured and restrained from lateral motion by means of two brackets added to the drill-head service platform.

Analysis results led to design modifications to some components. The results and conclusions appear in Section 2.0. The configuration and loading are presented in Section 3.0. The stress analysis is described in Section 4.0. The detailed stress analysis calculations are documented in the appendix.

2.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the evaluation indicate that all components of the modified portable platform assembly are adequate (WHC 1994a). The stresses in the components are within the stress limits specified in the Aluminum Construction Manual (ACM 1986) and satisfy the requirements of the *Code of Federal Regulations* (CFR 1990), Title 29, Occupational Safety and Health Administration (OSHA).

All posts, legs, and ladder railings should be fitted tightly into the corresponding sockets to reduce local stresses. All legs and ladder railings should be in contact with the truck floor and should touch the floor before the collars on the two 1-in.-diameter round tubes touch the supporting brackets on the truck platform. This installation requirement is necessary to prevent unsafe rocking motion of the platform and to eliminate high bending stresses in the support brackets.

3.0 CONFIGURATION AND LOADING

3.1 CONFIGURATION

The configuration and dimensions of the portable platform and the supporting brackets are documented in the following drawings:

- Drawing H-2-85358, Rev. 1 (WHC 1994a)
- ECN #610426 to drawing H-2-690067, Rev. 0 (WHC 1994b).

Figure 1 shows the general layout of the portable platform.

The portable platform consists of railing, deck, ladder, and legs. The railing consists of 1½-in. (outside diameter) by ¼-in.-thick aluminum tubes and five posts of 1½-in. diameter solid bars. The ladder consists of two square tube railings and four square tube rungs. The deck is made of fiberglass material laid on a platform constructed of square tubes. The platform stands on four square tube legs and the two ladder railings. The posts, legs, and ladder railings, assembled to the platform in sockets that are welded to the platform frame, are attached to the sockets by pin assemblies.

The portable platform is secured on the truck by two 1-in.-diameter round tubes inserted into two steel brackets welded to the truck platform. The brackets restrain the portable platform from lateral movement. The brackets do not carry any vertical or bending loads as long as the legs and the ladder railings touch the truck floor before the collars on the two round tubes (on the portable platform) touch the brackets in the vertical direction.

3.2 LOADING

The *Code of Federal Regulations* (CFR 1990) provides the load requirements for the railing and the portable ladder. For the railing, the requirement is that "the anchoring of posts and framing of members for railings of all types shall be of such construction that the completed structure shall be capable of withstanding 200 pounds applied in any direction at any point on the top rail." For portable metal ladders, CFR 1990 states that "portable ladders are designed as a one-man working ladder based on a 200 pound load." Accordingly, the 200 lbf is applied on the top railing in the direction that produces the largest stress in the railing structure and is applied on the lower rung of the portable ladder where a working person will step on first or step off last.

4.0 MATERIAL PROPERTIES AND ALLOWABLES

4.1 MATERIAL PROPERTIES

4.1.1 Aluminum Alloy 6061-T6

The materials used for round solid bars and round tubes are aluminum alloys 6061-T6 and T6511 (B211, B211, and B241). The minimum ultimate and yield strengths for these alloys are obtained from ASTM 1992 and ACM 1986:

Ultimate tensile strength (F_u)	= 38,000 lbf/in ²
Yield strength (F_y)	= 35,000 lbf/in ²
Shear yield strength (F_{sy})	= 20,000 lbf/in ² .

The strength properties of the aluminum alloys decrease when they are welded. The material within 1.0-in. of a weld should be evaluated for the reduced properties.

The reduced as-welded properties in the vicinity of a weld are obtained from ACM 1986:

$$\begin{aligned}\text{As welded ultimate tensile strength } (F_{uw}) &= 24,000 \text{ lbf/in}^2 \\ \text{As welded yield strength } (F_{yw}) &= 20,000 \text{ lbf/in}^2 \\ \text{As welded shear yield strength } (F_{syw}) &= 12,000 \text{ lbf/in}^2.\end{aligned}$$

4.1.2 Aluminum Alloy 6063-T52

The square tubes are made of aluminum alloy 6063-T52 (ASTM B241). ASTM 1992 gives a range of ultimate strengths from 22,000 to 30,000 lbf/in², and a range of yield strengths from 16,000 to 25,000 lbf/in². ASTM 1992 also shows that the minimum material properties of 6063-T52 are the same as those of 6063-T5. The manufacturers (See Kilsby 1994 and Ryerson 1994) provide material properties for 6063-T5 even though they specify 6063-T52 material for square tubing. This practice suggests that the manufacturers provide both materials with the same properties.

The tensile material properties for 6063-T5 as provided by Kilsby 1994 and Ryerson 1994 are listed below:

$$\begin{aligned}\text{Ultimate tensile strength } (F_u) &= 27,000 \text{ lbf/in}^2 \\ \text{Yield strength } (F_y) &= 21,000 \text{ lbf/in}^2 \\ \text{Shear yield strength } (F_{sy}) &= 0.577 \times F_y = 12,000 \text{ lbf/in}^2. \\ &\text{(Calculated)}\end{aligned}$$

These material properties are judged to be appropriate for the portable platform evaluation.

To obtain the as-welded material properties, the minimum as-welded properties in ACM 1986 are ratioed up by the ratio of the properties in Ryerson 1994 to the minimum properties in ASTM 1992 and ACM 1986:

$$\text{As-welded adjusted property} = \frac{F_{\text{min. ACM}} \times F_{\text{Ryerson}}}{F_{\text{min. ACM}}}$$

$$\text{As-welded ultimate tensile strength } (F_{uw}) = 17,000 \times \frac{27,000}{22,000} = 21,000 \text{ lbf/in}^2$$

$$\text{As-welded yield strength } (F_{yw}) = 11,000 \times \frac{21,000}{16,000} = 14,500 \text{ lbf/in}^2$$

$$\text{As-welded shear yield strength } (F_{syw}) = 6,500 \times \frac{12,000}{9,000} = 8,500 \text{ lbf/in}^2.$$

4.1.3 Weld Material

The welding wire used to weld these aluminum alloys is aluminum 4043 (WHC 1990 and ACM 1986). The ACM (1986) provides one value for the allowable shear stress of fillet welds ($F_{sw} = 5,000 \text{ lbf/in}^2$).

4.1.4 Structural Steel (ASTM A36)

The two steel brackets that secure the portable platform to the truck platform are made of structural steel ASTM A36:

Ultimate tensile strength = 58,000 lbf/in²
Yield strength = 36,000 lbf/in².

The criteria provided by AISC 1989 are applicable for the brackets. However, these brackets are stronger than the aluminum round tube supports fitted into the brackets. Accordingly, the brackets are acceptable as long as the aluminum tubes are acceptable.

4.2 ALLOWABLES

The CFR 1990 (see Section 3.2) does not provide specific design requirements or stress allowables for portable ladders. The word "withstand" in the reference to the 200-lb load can be interpreted as allowing the resulting stresses to be as high as the yield value for the material. However, to be on the conservative side, the ACM (1986) guidelines and stress limits are judged to be applicable.

The stress limits from ACM 1986 are listed below:

- Allowable bending stress for solid bars (F_b) = $1.3 F_y/1.65$
- Allowable bending stress for rectangular tubes (F_b) = $F_y/1.65$
- Allowable shear stress (F_s) = $F_{sy}/1.65$
- Allowable shear stress for fillet weld (4043 material) (F_{sw}) = 5,000 lbf/in².

Table 1 includes the allowable stress values of concern.

5.0 STRESS ANALYSIS

The stress analysis appears in the appendix to this report. The appendix also includes the evaluation of the calculated stresses against the ACM (1986) stress limits. Table 2 summarizes the stress results at the locations of interest. The evaluation of the stresses at the critical locations indicates a positive design margin. The steel brackets are not critical components.

The design margin (DM) used throughout the analysis is defined below:

$$DM = \frac{\sigma_{\text{allowable}}}{\sigma_{\text{calculated}}} - 1.0,$$

Where

$\sigma_{\text{allowable}}$ = maximum allowable stress value
 $\sigma_{\text{calculated}}$ = maximum calculated stress value.

Figure 1. Layout of Portable Platform.

Table 1. Summary of Allowable Stress Values.

Material	Component	Type of Stress	Yield Strength (lbf/in ²)	Allowable Stress Equ.	Allowable Stress ⁽¹⁾ (lbf/in ²)
6061-T6 or -T6511	Solid round bar (posts)	bending	35,000	$\frac{1.3 F_y}{1.65}$	28,000
	Round tubes (railing)	bending	35,000	$\frac{F_y}{1.65}$	21,000
6061-T6 within 1-in. of a weld	Round tubes (support tubes)	bending	20,000	$\frac{F_{yw}}{1.65}$	12,000
6063-T52	Square tubes (legs, platform, and ladder)	bending	21,000 ⁽²⁾	$\frac{F_y}{1.65}$	12,500
		shear	12,000 ⁽²⁾	$\frac{F_{sy}}{1.65}$	7,000
6063-T52 within 1-in. of a weld	square tubes (sockets)	bending	14,500 ⁽²⁾	$\frac{F_{yw}}{1.65}$	9,000
		shear	8,500 ⁽²⁾	$\frac{F_{syw}}{1.65}$	5,000
4043 weld wire	fillet weld	shear	----	----	5,000

⁽¹⁾The allowable stresses are rounded off according to the method of ACM 1986.

⁽²⁾See Section 4.1.2.

Table 2. Stress Results at Locations of Interest.

Component	Location	Tube or Weld Type (Material)	Stress Category	Calculated Stress, lbf/in ²	Allowable Stress ⁽¹⁾ , lbf/in ²	Design Margin ⁽²⁾ (DM)	Page Number ⁽³⁾
Railing	29.26 in. side	1.5 in. O.D. tube (6061-T6)	bending	8,525	21,000	1.46	11
	Weld	¼-in. fillet weld	shear	4,925	5,000	0.02	23
Posts	Single Post (solid bar)	1.5 in. solid bar (6061-T6)	bending	26,008	28,000	0.08	12
	Critical socket	1 3/4 x 1 3/4 x ¼-in. square tube (6063-T52 welded)	bending	8,454	9,000	0.06	19
	Welds at socket (worst case)	¼-in.-fillet weld (4043)	shear	4,177	5,000	0.20	30
Platform	long sides	1½ x 1½ x ¼-in. square tube (6063-T52)	bending	9,633	12,500	0.30	13
Legs	Top of the leg	1½ x 1½ x ¼-in. square tube (6063-T52)	bending	8,680	12,500	0.44	15
	Welds at socket	¼-in. fillet weld (4043)	shear	2,773	5,000	0.80	34
Ladder	Side railing	1½ x 1½ x ¼-in. square tube (6063-T52)	bending	10,417	12,500	0.20	16
	Weld at sockets (2 railings + 2 legs)	¼-in. fillet weld (4043)	shear	3,328	5,000	0.50	37
Support tubes	Welds at 1.0 in. O.D. tube	¼-in. fillet weld (4043)	shear	4,685	5,000	0.07	38

(1) The allowable stresses are listed in Table 1.

(2) $DM = \frac{\text{Allowable Stress}}{\text{Calculated Stress}} - 1.$

(3) Page number in the Appendix.

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APPENDIX

STRESS ANALYSIS AND EVALUATION OF PORTABLE
PLATFORM OF CORE SAMPLER TRUCK

ANALYTICAL CALCULATIONS

Page 6 of 42

Subject Portable Platform of Core Sampler Trucks #2 (CST #2)
Originator H. M. H. Zind Date 3-6-95
Checker Diane Kneble Date 3-9-95

TABLE OF CONTENTS

<u>SUBJECT</u>	<u>PAGE NO.</u>
1.0 INTRODUCTION	1
2.0 CONCLUSIONS	1
3.0 LOADS AND CRITERIA	1
3.1 LOADS	1
3.2 CRITERIA FOR ALUMINUM STRUCTURES	2
3.3 CRITERIA FOR WELDS	3
3.4 CRITERIA FOR STRUCTURAL STEEL	3
4.0 MATERIALS AND ALLOWABLES	4
4.1 ALUMINUM ALLOY 6061-T6	4
4.2 ALUMINUM ALLOY 6063-T52	5
4.3 STRUCTURAL STEEL	9
4.4 WELD MATERIAL, ALUMINUM 4043	9
5.0 ANALYSIS AND RESULTS	10
5.1 RAILING	10
5.2 POSTS	11
5.3 PLATFORM	12
5.4 LEGS	14
5.5 LADDER	15
5.6 SOCKETS	17
5.7 SUPPORT BRACKET	21
5.8 WELDS	23
5.9 PINS	39
6.0 SUMMARY OF RESULTS	40
7.0 REFERENCES	41

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing H-2-85358 (2) Doc. No. _____ (3) Page 1 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of Core Sampler Truck
(8) Originator Hassan H. Zuhm Date 11-30-94
(9) Checker Diana Koeller Date 3-9-95

(10).

PORTABLE PLATFORM OF CORE SAMPLER TRUCK

1.0 INTRODUCTION

This Appendix includes the analysis and evaluation of the ladder, hand rail and posts of the portable platform of the Core sampler truck and the two additional brackets to the drillhead service platform. The brackets are used to secure the portable platform on the truck.

2.0 CONCLUSIONS

All parts of the modified portable platform (WHC 1994a) are acceptable and satisfy the requirements of the Code of Federal Regulation (CFR 1990) and the stress limits of ACM 1986.

3.0 LOADS AND CRITERIA

3.1 LOADS

The CFR 1990 Code is used as a guide line for applied loads and configuration requirements. The ACM 1986 is used for design criteria and stress

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 2 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable platform of CST #2
(8) Originator Hassam H. Zaidi Date 11-30-94
(9) Checker Diana Koehler Date 3-9-95

(10) allowables.

The CFR 1990 states that "the anchoring of posts and framing of members for railings of all types shall be of such construction that the completed structure shall be capable of withstanding a load of at least 200-pounds applied in any direction at any point on the top rail", and that "portable ladders are designed as a one-man working ladder based on a 200-pound load." The CFR 1990 does not provide specific design requirements for portable metal ladders. However, it states that "the metal selected shall be of sufficient strength to meet the test requirements, and shall be protected against corrosion unless inherently corrosion-resistant."

3.2 CRITERIA FOR ALUMINUM STRUCTURES

The materials used for railing, posts, ladder and plates are Aluminum Alloy 6061-T6, 6061-T6511, and 6063-T52 (ASTM B211, B221, B241, B209, B210), see the drawing (WHC 1094a). To be on the conservative side, the ACM 1986 guidelines and stress limits are judged to be applicable for this evaluation.

ANALYTICAL CALCULATIONS

Page 3 of 42

Subject Portable Platform of CST #2
Originator Hagan H. Zaida Date 11-30-94
Checker Duane Koeller Date 3-9-95

The stress limits from ACM 1986 for buildings and similar type structures are given below.

$$\text{Allowable bending stress for solid bars} = \frac{1.3 F_y}{1.65}$$

$$\text{Allowable bending stress for rectangular tubes} = \frac{F_y}{1.65}$$

$$\text{Allowable shear stress} = \frac{F_{sy}}{1.65}$$

Where F_y is the tensile yield strength and F_{sy} is the shear yield strength of the material.

3.3 CRITERIA FOR WELDS

The fillet weld material is Aluminum Alloy 4043 and ACM 1986 provides one value for allowable shear stress.

The allowable shear stress for weld material (Aluminum Alloy 4043) $F_{sw} = 5,000 \text{ lb/in}^2$

3.4 CRITERIA FOR STRUCTURAL STEEL

AISC 1989 includes the stress limits for steel constructions.

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 4 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hassan H. Zieda Date 12-1-94
(9) Checker Shameh Kachle Date 3-8-95

(10)

4.0 MATERIALS AND ALLOWABLES

The dimensions and materials are obtained from WHC 1994a and 1994b. The platform is constructed from Aluminum Alloy 6061-T6 and 6063-T5 (ASTM B211, B221, and B241). The material properties are obtained from ASTM 1992, ACM 1986, Kilsby 1994, and Ryerson 1994. The bracket material is structural steel, ASTM A36. The weld material for 6061-T6 Aluminum is ER4043 Aluminum (WHC 1990).

4.1 ALUMINUM ALLOY 6061-T6

$$\text{ultimate strength } (F_u) = 38,000 \text{ lbf/in}^2$$

$$\text{yield strength } (F_y) = 35,000 \text{ lbf/in}^2$$

$$\text{Shear yield strength } (F_{sy}) = 20,000 \text{ lbf/in}^2$$

$$\text{Allowable bending stress for solid bars} = \frac{1.3 \times F_y}{1.65} = 28,000 \text{ lbf/in}^2$$

$$\text{Allowable bending stress for tubes} = \frac{F_y}{1.65} = 21,000 \text{ lbf/in}^2$$

$$\text{Allowable shear stress} = \frac{F_{sy}}{1.65} = 12,000 \text{ lbf/in}^2$$

ANALYTICAL CALCULATIONS

Page 5 of 42

Subject Portable Platform CST#7
Originator Hassan H. Zaidi Date 12-1-94
Checker Diane Koller Date 3-9-95

The strength properties of the welded aluminum decrease in the weld region (within 1.0-in. of a weld). The reduced as welded properties are obtained from ACM 1981, Table 3.3.2.

As welded ultimate strength (F_{uw}) = 24,000 lb_f/in²

As welded yield strength (F_{yw}) = 20,000 lb_f/in²

As welded shear yield strength (F_{syw}) = 12,000 lb_f/in²

Allowable as welded bending stress for solid bars = $\frac{1.3F_{yw}}{1.65} = 16,000 \text{ lb}_f/\text{in}^2$

Allowable as welded bending stress for tubes = $\frac{F_{yw}}{1.65} = 12,000 \text{ lb}_f/\text{in}^2$

Allowable as welded shear stress = $\frac{F_{syw}}{1.65} = 7,500 \text{ lb}_f/\text{in}^2$

NOTE: The allowable stresses are rounded off according to the method of ACM 1986.

4.2 ALUMINUM ALLOY 6063-T52

The square tubes are made of aluminum alloy 6063-T52 (ASTM B241). ASTM 1992 gives a range of ultimate strength from 22,000 to 30,000 lb_f/in², and a range of yield strength from 16,000 to 25,000 lb_f/in².

BD-6400-080.1 (07/93)

ANALYTICAL CALCULATIONS

Page 6 of 42

Subject Portable Platform CST #2
Originator Hassan H. Zaid Date 12-1-94
Checker Luane Koehl Date 3-9-95

ACM 1986 provides the minimum properties for 6063-T5 extrusion ($F_u = 22,000 \text{ lb/in}^2$, $F_y = 16,000 \text{ lb/in}^2$, and $F_{sy} = 9,000 \text{ lb/in}^2$). ASTM 1992 also shows that the minimum material properties of 6063-T52 are the same as those of 6063-T5. The manufacturers (Kilsby 1994 and Ryerson 1994) provide material properties for 6063-T5, even though they specify 6063-T52 material for square tubing. This ^{practice} suggests that the manufacturers provide both materials with the same properties.

The ^{tensile} material properties for 6063-T5 as provided by Ryerson 1994 are listed below.

Ultimate tensile strength (F_u) = $27,000 \text{ lb/in}^2$

Yield tensile strength (F_y) = $21,000 \text{ lb/in}^2$

shear yield strength (F_{sy}) = $0.577 F_y = 12,000 \text{ lb/in}^2$
(calculated)

These material properties are judged to be appropriate for the portable platform evaluation.

ANALYTICAL CALCULATIONS

Page 7 of 42

Subject Portable Platform of CST #12
Originator Hassan H. Zaid Date 2-21-95
Checker Rene Koehler Date 3-9-95

$$\text{Allowable bending stress} = \frac{F_y}{1.65} = 12,500 \text{ lbf/in}^2$$

$$\text{Allowable shear stress} = \frac{F_{sy}}{1.65} = 7,000 \text{ lbf/in}^2$$

To obtain the as welded material properties, the minimum as welded material provided by ACM 1986 (Table 3.3.2) are ratioed up by the ratio of the properties provided by Ryerson 1994 (page 6) to the minimum properties provided by ASTM 1992 and ACM 1986.

As welded minimum $F_{uw} = 17,000 \text{ lbf/in}^2$
As welded minimum $F_{yw} = 11,000 \text{ lbf/in}^2$
As welded minimum $F_{syw} = 6,500 \text{ lbf/in}^2$

} ACM 1986
(Table 3.3.2)

Adjusted properties $(F_{w \text{ min ACM}} \times \frac{F_{\text{Ryerson}}}{F_{\text{min}}})$:

$$\text{As welded ultimate Tensile strength } "F_{uw}" = 17,000 \times \frac{27,000}{22,000} = 21,000 \text{ lbf/in}^2$$

$$\sim \sim \text{yield strength } "F_{yw}" = 11,000 \times \frac{21,000}{16,000} = 14,500 \text{ lbf/in}^2$$

$$\sim \sim \text{shear yield strength } "F_{syw}" = 6,500 \times \frac{12,000}{9,000} = 8,500 \text{ lbf/in}^2$$

$$\text{Allowable as welded bending stress} = \frac{14,500}{1.65} = 9,000 \text{ lbf/in}^2$$

$$\text{Allowable as welded shear stress} = \frac{8,500}{1.65} = 5,000 \text{ lbf/in}^2$$

Table 1 tabulates a summary of the allowable stresses of concern.

ANALYTICAL CALCULATIONS

Page 8 of 42

Subject Portable Platform of CST #2
Originator Harold H. Zuck Date 12-1-94
Checker Dean Koelle Date 3-9-95

Table 1. Summary of Allowable Stress Values

Material	Component	Type of Stress	Yield Strength (lb/in ²)	Allowable Stress Eqn.	Allowable Stress ⁽¹⁾ (lb/in ²)
6061-T6 or -T6S11	Solid round bar (Posts)	Bending	35,000	$\frac{1.3 F_y}{1.65}$	28,000
	Round tubes (railing)	Bending	35,000	$\frac{F_y}{1.65}$	21,000
6061-T6 Within 1-in. of a weld	Round tubes (support tubes)	Bending	20,000	$\frac{F_{yw}}{1.65}$	12,000
6063-T52	Square tubes (legs, platform, and ladder)	Bending	21,000 ⁽²⁾	$\frac{F_y}{1.65}$	12,500
		Shear	12,000 ⁽²⁾	$\frac{F_{sy}}{1.65}$	7,000
6063-T52 Within 1-in. of a weld	Square tubes (sockets)	Bending	14,500 ⁽²⁾	$\frac{F_{yw}}{1.65}$	9,000
		Shear	8,500 ⁽²⁾	$\frac{F_{syw}}{1.65}$	5,000
4043 Weld wire	Fillet weld	Shear	—	—	5,000

(1) The allowable stresses are rounded off according to the method of ACM 1986.

(2) See Section 4.2.

ANALYTICAL CALCULATIONS

Page 9 of 42

Subject Portable Platform of CST #2
Originator Hassan H. Zaid Date 12-1-94
Checker Shirane Kaeli Date 3-9-95

4.3 STRUCTURAL STEEL (ASTM A36)

The brackets on the truck rig are made of structural steel ASTM A36. These brackets are used as sockets for the support tubes on the platform. These brackets are not expected to be critical components.

$$\text{Ultimate strength } (F_u) = 58,000 \text{ lb/in}^2$$

$$\text{Yield strength } (F_y) = 36,000 \text{ lb/in}^2$$

The allowable stresses from AISC 1989 are calculated below.

$$\text{Allowable bending stress} = 0.6 F_y = 0.6 \times 36,000 = 21,600 \text{ lb/in}^2$$

$$\text{Allowable shear stress} = 0.4 F_y = 0.4 \times 36,000 = 14,400 \text{ lb/in}^2$$

4.4 WELD MATERIAL, ALUMINUM 4043

The allowable shear stress for fillet welds is obtained from ACI 1986.

$$\text{Allowable weld shear stress} = 5,000 \text{ lb/in}^2$$

Also, see Section 3.3.

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 10 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hess, H. J. Date 12-19-94
(9) Checker Diana Koebe Date 3-9-95

(10) 5.0 ANALYSIS AND RESULTS

Assume all fittings are tight fit and the legs are secured to the truck floor.
5.1 RAILING

The CFR calls for a minimum of 1.5 in.

diameter tube on a maximum of 8-ft post spacing and the top rail shall have a nominal height of 42 in. from the floor. The design satisfies these conditions.

Tube outside diameter = 1.5 in.

Wall thickness = 0.125 in.

Max. distance between posts = 29.26 in.

$$\text{Cross-section area} = \frac{\pi}{4} (d_o^2 - d_i^2) = 0.54 \text{ in}^2$$

$$I = \frac{\pi}{64} (d_o^4 - d_i^4) = 0.1287 \text{ in}^4$$

$$C = d_o/2 = 0.75 \text{ in.}$$

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 11 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST-#2
(8) Originator Hasan H. Zinda Date 12-19-94
(9) Checker Ryan Kachle Date 3-9-95

(10) The worst case is 200 lbf applied half way between the two posts with 29.26 in. spacing.

The most conservative case is a simply supported beam.

$$\text{Moment} = \frac{Pl}{4} = \frac{200 \times 29.26}{4} = 1,463 \text{ in-lbf}$$

$$\sigma = \frac{Mc}{I} = \frac{1463 \times 0.75}{0.1287} = 8,525 \text{ lbf/in}^2$$

Acceptable

$< 21,000 \text{ lbf/in}^2$
(Aluminum 6061-T6 round tube)

5.2 POSTS

All posts are solid Aluminum bars with
 $d_o = 1.5 \text{ in.}$

$$\text{Area} = \frac{\pi}{4} (1.5)^2 = 1.767 \text{ in}^2$$

$$I = \frac{\pi}{64} (1.5)^4 = 0.248 \text{ in}^4$$

$$c = 0.75 \text{ in.}$$

DESIGN CALCULATION

WHC-SD-WM-ANAL-029

Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 12 of 42
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject Portable Platform of CST#2
 (8) Originator Hassan H. Zaidi Date 12-19-94
 (9) Checker Deanne Koehler Date 3-9-95

(10) The worst case is 200 lbf applied at the top of the single post (43 in. high cantilever).

$$M = Pl = 200 \times 43 = 8,600 \text{ in-lbf}$$

$$\sigma = \frac{Mc}{I} = \frac{8,600 \times 0.75}{0.248} = 26,008 \text{ lbf/in}^2$$

Acceptable

$< 28,000 \text{ lbf/in}^2$
 (Alum. 6061-T6 solid bar)

5.3 PLATFORM

Assume platform without grating, and the 200 lbf is applied at the middle of the 4'-8" (56") span of the $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$ square tube.

Tube outside dimension = $1\frac{1}{2} \times 1\frac{1}{2}$

Tube thickness = 0.125 in.

$$\text{Area} = (1.5)^2 - (1.25)^2 = 0.687 \text{ in}^2$$

$$I_p = \frac{(1.5)^4}{12} - \frac{(1.25)^4}{12} = 0.218 \text{ in}^4$$

$$c = 0.75 \text{ in}$$

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 13 of 42
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject Portable Platform of CST #2
 (8) Originator Harsh H. Zia Date 12-19-94
 (9) Checker Diane Kaelin Date 2-9-95

Bending Stress

(10) Assume simply supported beam (conservative)

$$M = \frac{Pl}{4} = \frac{200 \times 56}{4} = 2,800 \text{ in-lb}$$

$$\sigma = \frac{Mc}{I} = \frac{2,800 \times 0.75}{0.218} = 9,633 \text{ lb/in}^2$$

Acceptable (6063-T52) < 12,500 lb/in²

The ASCE 7-88, 1988, Table 2 requires that an elevated platform be designed to carry a live load of 60 lb/ft² (alternate criterion).

Assume only the two long sides carry the load.

$$\text{Platform area} = 42 \times 28 + \frac{1}{2} \times 12 \times 28 = 1,344 \text{ in}^2 = 9.33 \text{ ft}^2$$

$$\text{Total load} = \frac{60}{(12)^2} \times 1,344 = 560 \text{ lb}$$

$$\text{load per linear inch (on two sides only)} = \frac{560}{(56+42)} = 5.71 \text{ lb/in}$$

$$\text{Moment} = \frac{wl^2}{8} = \frac{5.71(56)^2}{8} = 2,240 \text{ in-lb}$$

$$\sigma = \frac{Mc}{I} = \frac{2,240 \times 0.75}{0.218} = 7,706 \text{ lb/in}^2$$

Acceptable (6063-T52) < 12,500 lb/in²

ANALYTICAL CALCULATIONS

Page 14 of 42

Subject Portable Platform of CST #2
Originator Hassan H. Zaid Date 2-21-95
Checker Diane Kibbler Date 3-9-95

5.4 LEGS

Assume a horizontal load of 200 lbf at the platform is reacted by the four legs and the two ladder rails (neglect the two supports locating the portable platform to the truck platform).

Legs:

Tube outside dimension = $1\frac{1}{4}$ " x $1\frac{1}{4}$ " square tube.

Tube thickness = 0.125 in.

$$\text{Area} = (1.25)^2 - (1.0)^2 = 0.562 \text{ in}^2$$

$$I = \frac{(1.25)^4}{12} - \frac{(1)^4}{12} = 0.12 \text{ in}^4$$

$$C = 0.625 \text{ in.}$$

Assume the ladder rails ($1\frac{1}{2}$ " square tube) are the same size of the legs, conservative.

Assume the six legs are cantilever beams with 50-in. length (actual length $48\frac{1}{4}$ -in.), conservative.

$$\text{Moment} = P \times l = 200 \times 50 = 10,000 \text{ in-lbf}$$

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 15 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hassen H. Zied Date _____
(9) Checker Duane Koelle Date 3-9-95

- (10) Assume the ladder rails have the same properties as the legs (conservative).

$$\sigma = \frac{MC}{I} = \frac{10,000 \times 0.625}{6 \times 0.12} = 8,680 \text{ lb/in}^2$$

Acceptable (6063-T52) < 12,500 lb/in²

The vertical load on the legs (including platform weight) produces negligible stresses.

When the two truck supports share the load, the stresses in the legs will be less than 8,680 lb/in².

5.5. LADDER

The ladder railing and rungs are constructed from $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ square tube.

Side Railing

The ladder railings are attached to the two legs on the side. Assume the 200 lb person load is applied horizontally on the lower rung (i.e. 40-in. distance from the upper support in the platform). For conservatism, assume the ladder railings have the same tube size as the legs (i.e. $1\frac{1}{4}'' \times 1\frac{1}{4}''$ tube).

DESIGN CALCULATION

WHC-SD-WM-ANAL-029

Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 16 of 42
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject Portable Platform M.C.S.T. #2
 (8) Originator Hassan H. Zaidi Date 12-13-94
 (9) Checker Duan Kachle Date 3-7-95

(10) See section properties in Section 5.4.

$$M = 200 \times 40 = 8,000 \text{ in-lb}$$

$$\sigma = \frac{M C}{4 I} = \frac{8,000 \times 0.625}{4 \times 0.121} = 10,417 \text{ lb/in}^2$$

$$(6063-T52) < 12,500 \text{ lb/in}^2$$

Acceptable

Rungs

Assume simply supported beam with 200 lb at the middle of the rung. See section properties in Section 5.3.

$$\text{Rung span} = 19 - 3 = 16 \text{ in.}$$

$$M = \frac{Pl}{4} = \frac{200 \times 16}{4} = 800 \text{ in-lb}$$

$$\sigma = \frac{M C}{I} = \frac{800 \times 0.75}{0.218} = 2,752 \text{ lb/in}^2$$

$$(6063-T52) < 12,500 \text{ lb/in}^2$$

Acceptable.

ANALYTICAL CALCULATIONS

Page 17 of 42

Subject Portable Platform of CST #2
Originator Hazen H. Zinda Date 2-17-95
Checker Duane Kachler Date 3-9-95

5.6 SOCKETS

The sockets of the railings are more critical than the sockets of the legs and ladder. The sockets are stiffened by plates or angles welded on the sides of the sockets and on the platform tubes. Each socket has a different stiffener arrangement as provided in WHC 1994a and shown on page 13.

The sockets are all within 1-in of welds. Therefore, the reduced allowable stresses are applicable.

5.6.1 Post Sockets

The moment on the railing sockets is 8,600 in-lbf, see section 5.2. The sockets are made of $1\frac{3}{4}$ -in. by $1\frac{3}{4}$ -in. by $\frac{1}{8}$ -in. square tube

$$\text{Area} = (1.75)^2 - (1.5)^2 = 0.8125 \text{ in}^2$$

$$I = \frac{(1.75)^4}{12} - \frac{(1.5)^4}{12} = 0.36 \text{ in}^4$$

$$C = 0.875 \text{ in}$$

The socket of the single post is critical because it has to withstand the 200 lbf by itself.

ANALYTICAL CALCULATIONS

WHC-SD-WM-ANAL-029
Rev. 0

Page 18 of 42

Subject Portable Platform of CST #2
 Originator Hazen H. Zrada Date 12-20-94
 Checker Dwaine Koehler Date 3-9-95

5.6.1.1 Single Post With Stiffeners

The socket of the single post is surrounded by 4 stiffeners with $\frac{1}{4}$ -in. thickness.

The moment of inertia is composed of the tube and the four stiffeners.

$$I_{\text{tube}} = 0.36 \text{ in}^4$$

$$\begin{aligned}
 I_{x-x} &= 2 \frac{0.25 \times (1.25)^3}{12} + 2 \frac{1.25 \times (0.25)^3}{12} \\
 &\quad + 2 (1.25 \times 0.25) (1.0)^2 + I_{\text{tube}} \\
 &= 0.0813 + 0.0033 + 0.625 + 0.36 \\
 &= 1.07 \text{ in}^4
 \end{aligned}$$

$$C = \frac{1.75}{2} = 0.875 \text{ in. (socket wall)}$$

$$\sigma = \frac{M C}{I} = \frac{8,600 \times 0.875}{1.07} = 7,033 \text{ lb/in}^2$$

$$(\text{welded 6063-T52}) < 9,000 \text{ lb/in}^2$$

Acceptable

ANALYTICAL CALCULATIONS

Page 19 of 42

Subject Portable Platform of CST #2
Originator H.H. Zinda Date 2-21-95
Checker Ruane Koble Date 3-9-95

5.6.1.2 Posts 1 & 4 (See page 13)

These poles are at the ends of the railing. Each one will carry not more than 60% of the load applied in the plane of the railing and not more than 90% of the load applied perpendicular to the plane of the railing.

These poles have 3 stiffeners.

$$A_{\text{tube}} = 0.8125 \text{ in}^2$$

$$I_{\text{tube}} = 0.36 \text{ in}^4$$

$$C_x = \frac{2.25}{2} = 1.125 \text{ in}$$

Centroid Calculations (About Base)

$$C_{y1} = \frac{0.8125 \times 1.125 + (1.25 \times 0.25) \times 0.125 + 2(1.25 \times 0.25) \times 1.125}{0.8125 + 3(1.25 \times 0.25)} = 0.946 \text{ in.}$$

$$C_{y2} = 2.0 - 0.946 = 1.054 \text{ in.}$$

$$I_{x-x} = 0.36 + 0.8125(0.179)^2 + 2 \frac{0.25(1.25)^3}{12} + 2(0.25 \times 1.25)(0.179)^2 + \frac{1.25(0.25)^3}{12} + (1.25 \times 0.25)(0.946 - 0.125)^2 = 0.7 \text{ in}^4$$

$$I_{y-y} = 0.36 + \frac{0.25 \times (1.25)^3}{12} + 2 \left(\frac{1.25 \times (0.25)^3}{12} \right) + 2(1.25 \times 0.25)(1)^2 = 1.03 \text{ in}^4$$

$$\sigma_x \text{ (parallel to rail)} = \frac{0.6 \times 8,600 \times 1.054}{0.7} = 7,770 \text{ lb}_f/\text{in}^2$$

$$\sigma_y \text{ (perpendicular to rail)} = \frac{0.9 \times 8,600 \times 1.125}{1.03} = 8,454 \text{ lb}_f/\text{in}^2$$

Acceptable

$$< 9,000 \text{ lb}_f/\text{in}^2$$

BD-6400-060.1 (07/93)

ANALYTICAL CALCULATIONS

Page 20 of 42

Subject Portable Platform of CST #2
 Originator H. H. Zaida Date 12-20-94
 Checker D. K. Koller Date 3-9-95

5.6.1.3 Posts 2 And 3

These posts are in the middle of the railing (see page 13).

Each post has only one stiffener and will not carry more than 40% of the load at any direction (engineering judgement).

From page 17;

$$A_{\text{tube}} = 0.8125 \text{ in}^2$$

$$I_{\text{tube}} = 0.36 \text{ in}^4$$

$$C_{y_1} = \frac{0.8125 \times \left(\frac{1.75}{2} + 0.25 \right) + (1.25 \times 0.25) \times 1.25}{0.8125 + (1.25 \times 0.25)} = 0.847 \text{ in}$$

$$I_{x-x} = 0.36 + 0.8125(0.278)^2 + \frac{1.25(0.25)^3}{12} + (1.25 \times 0.25)(0.847 - 1.25)^2 = 0.587 \text{ in}^4$$

$$I_{y-y} = 0.36 + \frac{0.25(1.25)^3}{12} = 0.4 \text{ in}^4$$

$$\sigma_x (\text{perpendicular to rail}) = \frac{0.4 \times 8,600 \times 1.153}{0.587} = 6,757 \text{ lbf/in}^2$$

$$\sigma_y (\text{parallel to rail}) = \frac{0.4 \times 8,600 \times 0.875}{0.4} = 7,525 \text{ lbf/in}^2 < 9,000 \text{ lbf/in}^2$$

5.6.2 Ladder And Legs Sockets

The results in Sections 5.4 and 5.5 show that the ladder rails are stressed more than the legs. Assume the four ladder sockets are all $1\frac{1}{2}$ -in. by $1\frac{1}{2}$ in. square tube (see page 12). Assume no stiffeners.

$$\sigma = \frac{8,000 \times 0.175}{4 \times 0.218} = 6,880 \text{ lbf/in}^2 < 9,000 \text{ lbf/in}^2$$

BD-6400-080.1 (07/93)

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 21 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Haseen H. Zaidi Date 12-20-94
(9) Checker Dean Kach Date 3-9-95

(10) 5.7 SUPPORT BRACKET

The platform is secured on the truck by two brackets. The brackets restrain the platform from moving horizontally. The two round tubes (1.0 in. O.D. x 0.188 in. Wall) take only horizontal load; they are not touching the brackets in the vertical direction. The legs and ladder should touch the truck floor before the collar of the two tubes touch the brackets otherwise the platform will be hanging on the brackets and cause unsafe rocking motion (unstable condition).

RD 6400 060 1 (12/87)

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 22 of 42
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject Portable Plot Arm M CST #2
 (8) Originator Hassan H. Zaidi Date 12-20-94
 (9) Checker Russell Roehle Date 3-9-95

(10) The tube is the critical component, if it passes then the steel bracket passes.

$$\text{Tube O.D.} = 1.00 \text{ in.}$$

$$\text{Wall thickness} = 0.188 \text{ in. } (3/16)$$

$$\text{Tube I.D.} = 0.625 \text{ in}$$

$$\text{Area} = \frac{\pi}{4} (1.0^2 - (0.625)^2) = 0.48 \text{ in}^2$$

$$I = \frac{\pi}{64} [(1.0)^4 - (0.625)^4] = 0.0416 \text{ in}^4$$

Assume the 200 lbf load is carried by the two brackets only (neglect the Legs).

$$M = \frac{3 \times 200}{2} = 300 \text{ in-lbf per bracket}$$

$$\sigma = \frac{300 \times 0.5}{0.0416} = 3,606 \text{ lbf/in}^2$$

$$(\text{welded 6061-T6}) < 12,000 \text{ lbf/in}^2$$

Acceptable

DESIGN CALCULATION

WHC-SD-WM-ANAL.-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 23 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform CST #2
(8) Originator Hansen H. Zick Date 12-20-94
(9) Checker Norm Koehl Date 3-9-95

(10) 5.8 WELDS

The weld analysis procedure of Blodgett 1982 is used in this evaluation.

5.8.1 Railing Welds

The worst case is the $\frac{1}{8}$ in. fillet weld on the $1\frac{1}{2}$ in. tube analyzed in Section 5.1.

$$\text{Moment} = \frac{Pl}{8} \quad (\text{Fixed ends})$$

$$M = \frac{200 \times 29.26}{8} = 731.5 \text{ in-lbf}$$

$$A_w = \pi D = 4.71 \text{ in}$$

$$S_w = \frac{\pi D^2}{4} = 1.767 \text{ in}^2$$

$$f = \frac{M}{S_w} + \frac{P}{A_w} = \frac{731.5}{1.767} + \frac{100}{4.71} = 414 + 21.2 = 435.2 \text{ lbf/in}$$

$$\text{shear stress } f_{sw} = \frac{435.2}{0.707 \times 0.125} = 4,925 \text{ lbf/in}^2$$

Acceptable

$$< 5,000 \text{ lbf/in}^2$$

ANALYTICAL CALCULATIONS

Page 24 of 42

Subject Portable Platform of CST #2
Originator Hassam H. Fieda Date 2-22-95
Checker James J. Miller Date 3-9-95

5.8.2 Welds of Sockets of Posts

The layout of the posts is shown on page 13.

The single post is surrounded by four stiffeners; two plates and two angles. Posts 1 and 4 are stiffened by three stiffeners, two plates and one angle. Posts 2 and 3 have only one plate stiffener each. Assume the welds deposited on each socket are carrying the load applied on that socket and that the welds joining the stiffener to the other parts of the structure do not share in carrying the load on that socket.

In section 5.6, the load on each socket was defined according to the arrangement of the posts and engineering judgement. The single post carries the full load. Posts 1 and 4 each carries ^{not more than} 60% of the load in the plane of the railing and 90% of the load perpendicular to the railing. Posts 2 and 3 do not carry more than 40% of the load in any direction.

The section properties and the weld analysis follow the methods of Blodgett, 1982.

ANALYTICAL CALCULATIONS

Page 25 of 42

Subject Portable Plot Form M CST #2
Originator Hassan H. Zaid Date 2-17-95
Checker Diana Kach Date 3-9-95

5.8.2.1 Single Post

Iny (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A \cdot y^2 = M \cdot y$	$I_y = \frac{1 \cdot x d^3}{12}$
1	1.25	0.0	1.25	—	—	—
2	1.25	0.875	1.25	1.09375	0.957	0.163
3	1.25	1.75	1.25	2.1875	3.828	—
4	1.25	0.875	1.25	1.09375	0.957	0.163
5 #5'	2(2.5)	0.0	5.0	—	—	—
6 #6'	2(2.5)	0.0	5.0	—	—	—
7 #7'	2(2.5)	1.5	5.0	7.5	11.25	—
8 #8'	2(2.5)	1.5	5.0	7.5	11.25	—
9	1.75	0.0	1.75	—	—	—
10	1.75	1.75	1.75	3.0625	5.359	—
11	1.75	0.875	1.75	1.53125	1.34	0.446
12	1.75	0.875	1.75	1.53125	1.34	0.446
Total			32	25.5	36.281	1.218

Assume →
7 #8' at same
location as 7 #8'
(1.5 in.)

$$I_{ny} = I_y + I_9 - \frac{M^2}{A}$$

$$I_{ny} = 36.281 + 1.218 - \frac{(25.5)^2}{32} = 17.18 \text{ in}^3$$

$$n_{ay} = \frac{M}{A} = 0.8 \text{ in. (0.875" actual)}$$

ANALYTICAL CALCULATIONS

Page 26 of 42

Subject Portable Platform of CST #2
Originator Hassan H. Zaidi Date 2-17-95
Checker James Hebl Date 3-9-95

In x (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A \cdot y^2$ = M · y	$I_z = \frac{1 \times d^3}{12}$
1	1.25	2.5	1.25	3.125	7.8125	—
2	1.25	2.5	1.25	3.125	7.8125	—
3	1.25	2.5	1.25	3.125	7.8125	—
4	1.25	2.5	1.25	3.125	7.8125	—
5 & 5'	2(2.5)	1.25	5.0	6.25	7.8125	2(1.302)
6 & 6'	2(2.5)	1.25	5.0	6.25	7.8125	2(1.302)
7 & 7'	2(2.5)	1.25	5.0	6.25	7.8125	2(1.302)
8 & 8'	2(2.5)	1.25	5.0	6.25	7.8125	2(1.302)
9	1.75	0.0	1.75	—	—	—
10	1.75	0.0	1.75	—	—	—
11	1.75	0.0	1.75	—	—	—
12	1.75	0.0	1.75	—	—	—
Total			32.00	37.50	62.5	10.416

Assume
5'-8' at same
location as 5-8.

$$I_{n_x} = 62.5 + 10.416 - \frac{(37.5)^2}{32} = 28.97 \text{ in}^3$$

$$Max = \frac{37.5}{32} = 1.17$$

ANALYTICAL CALCULATIONS

Page 27 of 42

Subject Portable Platform of CST #2
Originator Hassan H. Zaidi Date 2-17-95
Checker Norma Kelle Date 3-9-95

$$C = \sqrt{(2.5 - 1.17)^2 + (0.875)^2} = 1.592 \text{ in.}$$

$$J_w = I_{nx} + I_{ny} = 28.97 + 17.18 = 46.15 \text{ in}^3$$

$$Z_w = \frac{J_w}{C} = \frac{46.15}{1.592} = 29.0 \text{ in}^2$$

$$\text{Shear force } f = \frac{T}{Z_w} = \frac{8,600}{29.0} = 296.5 \text{ lb}_f/\text{in}$$

$$\text{Shear stress } (f_{sw}) = \frac{296.6}{0.707 \times 0.125} = 3,356 \text{ lb}_f/\text{in}^2$$

Acceptable

$$< 5,000 \text{ lb}_f/\text{in}^2$$

5.8.2.2 Posts 1 And 4

These two posts are not expected to carry more than 90% of the load in a direction perpendicular to the plane of the railing and not more than 40% in the plane of the railing. For weld analysis, the 90% of the load is used because the welds are evaluated for the torsional shear capacity. The 90% load bounds the 40% load. The orientation of the lowest torsional sectional property is used.

BD-6400-080.1 (07/93)

ANALYTICAL CALCULATIONS

Page 28 of 42

Subject Portable Platform of EST #2
Originator H. H. Zaidi Date 2-21-95
Checker Diane Koller Date 3-9-95

Posts 1 & 4

Iny (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A · y^2 = M · y$	$I_y = \frac{1}{12} L^3$
2	1.25	0.875	1.25	1.09375	0.957	0.163
3	1.25	1.75	1.25	2.1875	3.828	—
4	1.25	0.875	1.25	1.09375	0.957	0.163
5	2.5	0.0	2.5	—	—	—
6	2.5	0.0	2.5	—	—	—
7 & 7'	2(2.5)	1.5	5.0	7.5	11.25	—
8 & 8'	2(2.5)	1.5	5.0	7.5	11.25	—
9	1.75	0.0	1.75	—	—	—
10	1.75	1.75	1.75	3.0625	5.359	—
11	1.75	0.875	1.75	1.53125	1.34	0.446
12	1.75	0.875	1.75	1.53125	1.34	0.446
Total			25.75	25.5	36.281	1.218

Assume {
5'-8' at same
location as 5-8.
(1.5 in.)

$$I_{ny} = 36.281 + 1.218 - \frac{(25.5)^2}{25.75} = 12.25 \text{ in}^3$$

$$n_{ay} = \frac{25.5}{25.75} \approx 1.0 \text{ in}$$

ANALYTICAL CALCULATIONS

Page 29 of 42

Subject Portable Plot Form of Truck #2
Originator H. H. Zick Date 2-21-95
Checker Duane Koehn Date 3-9-95

Inx (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A · y^2$ = M · y	$I_y = \frac{1}{12} L d^3$
2	1.25	2.5	1.25	3.125	7.8125	—
3	1.25	2.5	1.25	3.125	7.8125	—
4	1.25	2.5	1.25	3.125	7.8125	—
5	2.5	1.25	2.5	3.125	3.90625	1.302
6	2.5	1.25	2.5	3.125	3.90625	1.302
7 & 7'	2(2.5)	1.25	5.0	6.25	7.8125	2.604
8 & 8'	2(2.5)	1.25	5.0	6.25	7.8125	2.604
9	1.75	0.0	1.75	—	—	—
10	1.75	0.0	1.75	—	—	—
11	1.75	0.0	1.75	—	—	—
12	1.75	0.0	1.75	—	—	—
Total			25.75	28.125	46.875	7.812

Assume
5'-8' at same
location as 5-8.

$$I_{nx} = 46.875 + 7.812 - \frac{(28.125)^2}{25.75} = 23.97 \text{ in}^4 \quad n_{ax} = \frac{28.125}{25.75} = 1.092 \text{ in.}$$

ANALYTICAL CALCULATIONS

Page 30 of 42

Subject Portable Platform of CST #2
Originator H.H. Tada Date 2-21-85
Checker James Koehler Date 3-9-85

$$C = \sqrt{(1.0)^2 + (2.5 - 1.092)^2} = 1.727 \text{ in.}$$

$$J_w = I_{nx} + I_{ny} = 12.25 + 23.97 = 36.22 \text{ in}^3$$

$$Z_w = \frac{36.22}{1.727} = 20.97 \text{ in}^2$$

$$\text{Shear force} = \frac{0.9 \times 8,600}{20.97} = 369 \text{ lb}_f/\text{in}$$

$$\text{Shear stress} = \frac{369}{0.707 \times 0.125} = 4,177 \text{ lb}_f/\text{in}^2$$

Acceptable $< 5,000 \text{ lb}_f/\text{in}^2$

Posts 2 & 3

These posts are in the middle of the railing. Each one will not carry more than 40 % of the applied load in any direction (engineering judgement). The orientation of the lowest torsional sectional property is used.

ANALYTICAL CALCULATIONS

Page 31 of 42

Subject Portable Plot form of CST #2
Originator H. H. Zink Date 2-21-95
Checker Diane Koehler Date 3-9-95

Posts 2 & 3

I_{ny} (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	$M = A \cdot y$	$I_y = A \cdot y^2$ $= M \cdot y$	$I_z = \frac{1 \times d^3}{12}$
4	1.25	0.875	1.25	1.09375	0.957	0.163
6	2.5	—	2.5	—	—	—
8	2.5	1.5	2.5	3.75	5.625	—
9	1.75	—	1.75	—	—	—
10	1.75	1.75	1.75	3.0625	5.359	—
11	1.75	0.875	1.75	1.53125	1.34	0.446
12	1.75	0.875	1.75	1.53125	1.34	0.446
Total			13.25	10.96875	14.621	1.055

$$I_{ny} = 14.621 + 1.055 - \frac{(10.97)^2}{13.25} = 6.59 \text{ in}^3 \quad n_{ay} = 0.875 \text{ in.}$$

ANALYTICAL CALCULATIONS

Page 32 of 42

Subject Portable Platform M CST #2
Originator Hasan H. Zaid Date 2-21-95
Checker Dane Kachik Date 3-9-95

Inx (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A \cdot y^2$ = M · y	$I_x = \frac{1 \cdot x^3}{12}$
4	1.25	2.5	1.25	3.125	7.8125	—
6	2.5	1.25	2.5	3.125	3.90625	1.302
8	2.5	1.25	2.5	3.125	3.90625	1.302
9	1.75	—	1.75	—	—	—
10	1.75	—	1.75	—	—	—
11	1.75	—	1.75	—	—	—
12	1.75	—	1.75	—	—	—
Total			13.25	9.375	15.625	2.604

$$I_{nx} = 15.625 + 2.604 - \frac{(9.375)^2}{13.25} = 11.6 \text{ in}^3$$

$$r_{nx} = \frac{9.375}{13.25} = 0.707 \text{ in.}$$

ANALYTICAL CALCULATIONS

Page 33 of 42

Subject Portable Platform of CST #2
Originator H.H. Zide Date 2-21-95
Checker Duane Koehler Date 3-9-95

$$C = \sqrt{(0.875)^2 + (2.5 - .707)^2} \cong 2.0 \text{ in.}$$

$$J_w = I_{nx} + I_{ny} = 11.6 + 6.59 = 18.19 \text{ in}^3$$

$$Z_w = \frac{18.19}{2} \cong 9.1 \text{ in}^2$$

$$\text{Shear force} = \frac{0.4 \times 8,600}{9.1} = 378 \text{ lb/in}$$

$$\text{shear stress} = \frac{378}{0.707 \times 0.125} = 4,277 \text{ lb/in}^2$$

Acceptable $< 5,000 \text{ lb/in}^2$

5.8.3 Platform Welds

The welds of the platform frame carry very small loads because they are at the corners (where the legs are) and the fiberglass grated platform will distribute the load along the four sides of the platform. In addition, the welds are full penetration welds. Therefore, the welds are not critical.

ANALYTICAL CALCULATIONS

Page 34 of 42

Subject Portable Platform of CST #2
Originator H. H. Zisch Date 2-23-95
Checker James Koelke Date 3-9-95

5.8.4 Welds For Leg Sockets

See Section 5.4 for load details. There are four leg sockets (1 1/2-in. by 1 1/2-in. by 1/8-in. tube) and two ladder sockets (1 3/4-in. by 1 3/4-in. by 1/8-in. tube) carrying the horizontal load. Assume all 6 socket's are 1 1/2-in. tube with only one stiffener.

$$P = 200 \text{ lbf} \quad l = 50 \text{ in.}$$

$$M = 10,000 \text{ in-lbf}$$

From pages 35 & 36 (next two pages)

$$J_w = I_{nx} + I_{ny} = 6.57 + 4.31 = 10.88 \text{ in}^3$$

$$C = \sqrt{(0.75)^2 + (2 - 0.578)^2} = 1.61 \text{ in.}$$

$$Z_w = \frac{10.88}{1.61} = 6.8 \text{ in}^2$$

$$\text{Shear Force} = \frac{10,000}{6 \times 6.8} = 245 \text{ lbf/in}$$

$$\text{shear stress} = \frac{245}{0.707 \times 0.125} = 2,773 \text{ lbf/in}^2$$

Acceptable. $< 5,000 \text{ lbf/in}^2$

ANALYTICAL CALCULATIONS

Page 35 of 42

Subject Portable Plot Form of Trucks # 2
Originator Hassan Ha Zinda Date 2-23-95
Checker James Ladd Date 3-9-95

I_{ny}

(Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A · y^2$ = M · y	$I_y = \frac{1}{12} x d^3$
4	1.25	0.75	1.25	0.9375	0.7031	0.163
6	2.0	—	2.00	—	—	—
8	2.0	1.375	2.00	2.75	3.7810	—
9	1.5	—	1.50	—	—	—
10	1.5	1.5	1.50	2.25	3.3750	—
11	1.5	0.75	1.50	1.125	0.8437	0.28125
12	1.5	0.75	1.50	1.125	0.8437	0.28125
Total			11.25	8.187	9.545	0.7255

$$I_{ny} = 9.545 + 0.725 - \frac{(8.187)^2}{11.25} = 4.31 \text{ in}^2$$

$nay = 0.75 \text{ in.}$

BD-6400-060.1 (07/93)

ANALYTICAL CALCULATIONS

Page 36 of 42

Subject Portable Platform of Truck #2
 Originator Harold H. Tichler Date 2-23-95
 Checker Barbara Kuchler Date 3-9-95

I_{ny} (Unit Weld Size)

Member	Size L	Distance y	Area A = L x 1	M = A · y	$I_y = A · y^2$ = M · y	$I_y = \frac{1 \times d^3}{12}$
4	1.25	2.0	1.25	2.5	5.0	—
6	2.0	1.0	2.00	2.0	2.0	0.667
8	2.0	1.0	2.00	2.0	2.0	0.667
9	1.5	—	1.50	—	—	—
10	1.5	—	1.50	—	—	—
11	1.5	—	1.50	—	—	—
12	1.5	—	1.50	—	—	—
Total			11.25	6.5	9.0	1.33

$$I_{nx} = 9.0 + 1.33 - \frac{(6.5)^2}{11.25} = 6.57 \text{ in}^3$$

$$n_{AX} = \frac{6.5}{11.25} = 0.578$$

ANALYTICAL CALCULATIONS

WHC-SD-WM-ANAL-029
Rev. 0

Page 37 of 42

Subject Portable Platform of Truck #2
 Originator Harrison H. Zinda Date 2-23-95
 Checker Dennis Koebe Date 3-9-95

5.8.5 Welds For Ladder Sockets

See Section 5.5 for loads. The ladder load is carried by two leg sockets and two ladder rail sockets. Assume all 4 sockets are $1\frac{1}{2}$ -in. tube with only one stiffener.

$$Z_W = 6.8 \text{ in}^2 \quad (\text{see page 34})$$

$$M = 8,000 \text{ in-lb}$$

$$\text{shear force} = \frac{8,000}{4 \times 6.8} = 294 \text{ lb}_f / \text{in}$$

$$\text{shear stress} = \frac{294}{0.707 \times 0.125} = 3,328 \text{ lb}_f / \text{in}^2$$

$$\text{Acceptable} < 5,000 \text{ lb}_f / \text{in}^2$$

5.8.6 Welds For Ladder Rung

Assume fixed supported beam and all welds are fillet.

$$A_W = 2(1.5 \times 4) = 12 \text{ in. (two sides)}$$

$$S_W = bd + \frac{d^2}{3} = \frac{4}{3}(1.5)^2 = 3 \text{ in}^2$$

$$\text{shear force} = \frac{M}{S_W} + \frac{P}{A_W} = \frac{400}{3} + \frac{200}{12} = 150 \text{ lb}_f / \text{in}$$

$$\text{shear stress} = \frac{150}{0.707 \times 0.125} = 1,697 \text{ lb}_f / \text{in}^2$$

$$\text{Acceptable} < 5,000 \text{ lb}_f / \text{in}^2$$

BD-6400-080.1 (07/93)

DESIGN CALCULATION

WHC-SD-WM-ANAL-029

Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 38 of 42
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject Portable Platform of CST #2
 (8) Originator HASSAN H. ZIDA Date 12-21-94
 (9) Checker Amr Kalle Date 3-9-95

5.8.7⁽¹⁰⁾ Support Tubes

The bracket assembly is given in section 5.7.
 The weld of 1" O.D. tube to square tube is critical.

$$A_w = \pi D = 3.14 \text{ in}$$

$$S_w = \frac{\pi D^2}{4} = 0.785 \text{ in}^2$$

$$M = 300 \text{ in-lbf}$$

$$f = \frac{M}{S_w} + \frac{P}{A_w} = \frac{300}{0.785} + \frac{100}{3.14} = 414 \text{ lbf/in}^2$$

$$\text{shear stress } f_{sw} = \frac{414}{0.707 \times 0.125} = 4,685 \text{ lbf/in}^2$$

Acceptable

$$< 5,000 \text{ lbf/in}^2$$

The welds of the steel brackets have larger section properties and weld allowables. Therefore, they are acceptable by comparison.

DESIGN CALCULATION

WHC-SD-WM-ANAL-029

Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 39 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hassan H. Zaidi Date 12-21-94
(9) Checker Duane Koehler Date 3-9-95

(10) S.9 PINS

All pins, clevises and bolts are 0.25-in. diameter. The bolts are made of steel ASTM A-307.

Assume the pins are made of Aluminum 6061 (conservative).

$$\text{Shear area} = \frac{\pi d^2}{4} = \frac{\pi (0.25)^2}{4} = .049 \text{ in}^2$$

Maximum Load on any pin will never exceed 400 lbf (200 lbf man + 200 lbf assembly).

The worst pin is subjected to double shear.

$$\tau = \frac{400}{2 \times 0.049} = 4,082 \text{ lbf/in}^2$$

$$< 12,000 \text{ lbf/in}^2 \text{ (Section 4.1)}$$

Acceptable

ANALYTICAL CALCULATIONS

Page 40 of 42

Subject Portable Platform of CST #2
Originator Hazen H. Zisch Date 2-23-95
Checker Duan Kelle Date 3-9-95

6.0 SUMMARY OF RESULTS

The critical results at locations of interest are tabulated below.

Table 2. Stress Results at Locations of Interest.

Component	Location	Tube or Weld Type (Material)	Stress Category	Calculated Stress lbf/in ²	Allowable Stress ⁽¹⁾ lbf/in ²	Design Margin ⁽²⁾ (DM)	Page Number ⁽³⁾
Railing	29.26 in. side	1.5 in. O.D. tube (6061-T6)	bending	8,525	21,000	1.46	11
	Weld	1/4-in. fillet weld	shear	4,925	5,000	0.02	23
Posts	Single Post (solid bar)	1.5 in. solid bar (6061-T6)	bending	26,008	28,000	0.08	12
	Critical socket	1 3/4 x 1 3/4 x 1/4-in. square tube (6063-T52 welded)	bending	8,454	9,000	0.06	19
	Welds at socket (worst case)	1/4-in. fillet weld (4043)	shear	4,177	5,000	0.20	30
Platform	long sides	1 1/2 x 1 1/2 x 1/4-in. square tube (6063-T52)	bending	9,633	12,500	0.30	13
Legs	Top of the leg	1 1/2 x 1 1/2 x 1/4-in. square tube (6063-T52)	bending	8,680	12,500	0.44	15
	Welds at socket	1/4-in. fillet weld (4043)	shear	2,773	5,000	0.80	34
Ladder	Side railing	1 1/2 x 1 1/2 x 1/4-in. square tube (6063-T52)	bending	10,417	12,500	0.20	16
	Weld at sockets (2 railings + 2 legs)	1/4-in. fillet weld (4043)	shear	3,328	5,000	0.50	37
Support tubes	Welds at 1.0 in. O.D. tube	1/4-in. fillet weld (4043)	shear	4,685	5,000	0.07	38

(1) The allowable stresses are listed in Table 1.

(2) DM = $\frac{\text{Allowable Stress}}{\text{Calculated Stress}} - 1$.

(3) Page number in the Appendix.

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 41 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hassan H. Zick Date 12-1-94
(9) Checker Russell Kroll Date 3-9-95

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BD-6400-060 1 (12/87)

DESIGN CALCULATION

WHC-SD-WM-ANAL-029
Rev. 0

(1) Drawing _____ (2) Doc. No. _____ (3) Page 42 of 42
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject Portable Platform of CST #2
(8) Originator Hassan H. Zaid Date 12-1-94
(9) Checker Duane Kohler Date 3-9-95

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