UTILITIES INFRASTRUCTURE DESIGN - AIMS ISSUED FOR CONSTRUCTION CALCULATIONS

McMurdo Station, Antarctica

Submitted to:
United States Antarctic Program
Leidos Innovations - Antarctic Support Contract

Submitted by:

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July 2017

Project:	McMurdo Utilities					
Subject:	AIMS					
Project No.:	64017481-77		Calculation No.:	CALC-7481-77-S-001		
Status:			Rev	By	Date	Chk'd	Date
			Final	PIF	7/20/17	JW	7/20/17
Confirmation Required:	Yes	No	Preliminary		Final	Void
		X			X	

Technical Calculations

Structural Discipline

Calculation Title:
McMurdo Utilities
Final Structural Calculations

Prepared For:
Antarctic Support Contract

Prepared By:
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REGISTERED PROFESSIONAL ENGINEER
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No. S4594
Exp: 12/31/17
STRUCTURAL
STATE OF CALIFORNIA

07/24/17

Subject:	McMurdo Utilities				
Project No.:	64017481-77	Calculation No.:	CALC-7481-77-S-001	Rev:	Final

REVISION CONTROL

Revision Signatures			
Prepared by P Finley, PE, SE	7/20/17 Date	Reviewed by J Weaver, PE	7/24/17 Date
Reviewed/Checked by	Date	Approved by	Date

Interdisciplinary Coordination Review (ICR)			
ICR Complete?	❑ Yes X N/R	Affected Disciplines:	Structural

Revision History					
Status	Rev	Date	Prepared By	Affected Pages	Description of Changes

TABLE OF CONTENTS

1.0 INTRODUCTION

Analysis of Steel structures shall be performed in accordance with the provisions of the International Building Code IBC 2015 as well as all applicable codes associated with IBC 2015.

2.0 DESIGN INPUT

Load Combinations

Allowable Stress Design for Foundations and Deflections
1) 1.0 DL + 1.0 LL
2) 1.0 DL + SL
3) 1.0 DL + .75LL + 75 SL
4) 1.0 DL + 1.0 WL
5) 1.0 DL + 0.75 WL + 0.75 LL + .75 SL
6) 0.6 DL + 1.0 WL

Dead Loads
Dead Load .... 15 psf

Live Loads
Ground Snow Load.......... 40 psf
Floor Live Load Node Bld .... 50 psf
Floor Live Load Pump House .... 100 psf

Wind Loads
Basic Wind Speed .... 180 mph
Exposure .... D
Risk Category.......... IV

Earthquake Loads (E)
Short Period Spectral Accelerations (S_S) ....0.454 g
1 Second Spectral Accelerations (S_1) ....0.128 g
Site Classification ....B
Seismic Design Category C
Importance Factor- Contingency Ops 1.50

Foundations and Soils
Criteria as per Geotechnical Investigation Report by (Geotechnical Assessment Report – McMurdo Station, Ross Island, Antarctica, Dated May 2016).

	Allowable	Allowable including Increase for Wind or Seismic
Soil Bearing	2,100 psf	2,800 psf
Active Pressure	30 pcf	
Passive Pressure	200 pcf	267 pcf

3.0 MATERIALS OF CONSTRUCTION

Wood

Douglas Fir Larch No 1:	Fb = 1000 psi
Concrete	
Precast Foundations	f'c = 5000 psi
Reinforcing Steel	
Unless noted otherwise	ASTM - A615, Grade 60
Welded Rebar, Threaded Rebar	ASTM - A706, Grade 60
Smooth Welded Wire Fabric	ASTM - A185
Deformed Welded Wire Fabric	ASTM - A497
Deformed Bar Anchors	ASTM - A496
Structural Steel	
Wide Flange Beams	ASTM - A992, Grade 50
Wide Flange Columns	ASTM - A992, Grade 50
Tubes	ASTM - A500 - Grade B
Angles and Channels	ASTM - A36
Plates	ASTM - A36, or ASTM - A572, Grade 50
Base Plates	ASTM - A36
Connection Mat'l, Embedded Plates	ASTM - A36
Bolts	ASTM - A325
Anchor Bolts	ASTM - A1554 Gr 36
Welding Electrodes	ASTM - E70xx (U.N.O.)
Headed Shear Studs	ASTM - A108

4.0 METHODOLOGY

The utility structures will be designed to resist lateral loading from wind and seismic along with snow, dead, and live loads in the both directions. Beam elements will be provided at the foundation level to help stiffen the structure to control deflection and to help spread out the frame reactions to the precast concrete foundation.

Based upon site conditions, the foundations will be constructed of precast concrete foundations sized for both compression bearing and tension uplift forces. These foundations will bear on compacted grade and bear a min of 18 inches below grade.

Utility support bents will be provided where necessary to support above ground piping and cable trays.

Foundation for the water tank will use timber members with insulation and will incorporate thermosiphons located in the fill material below the tank.

For head walls at culverts, solider pile walls are being utilized to retain the soil.

5.0 REFERENCES

International Building Code, International Code Council, 2015.
American Society of Civil Engineers, ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, 2010.
American Institute of Steel Construction, AISC 14th Edition.
National Design Specification (NDS) for Wood Construction with 2012 Supplement

6.0 CONCLUSIONS

Based on the design inputs and stated assumptions, steel structures are being proposed for the required structures necessary for this utility project. See following calculations for supporting data and assumptions for each structure.

7.0 CALCULATIONS

Project Name: McMurdo Pump House

Location:

By:

Start Date: 12/2/2016

Comments:

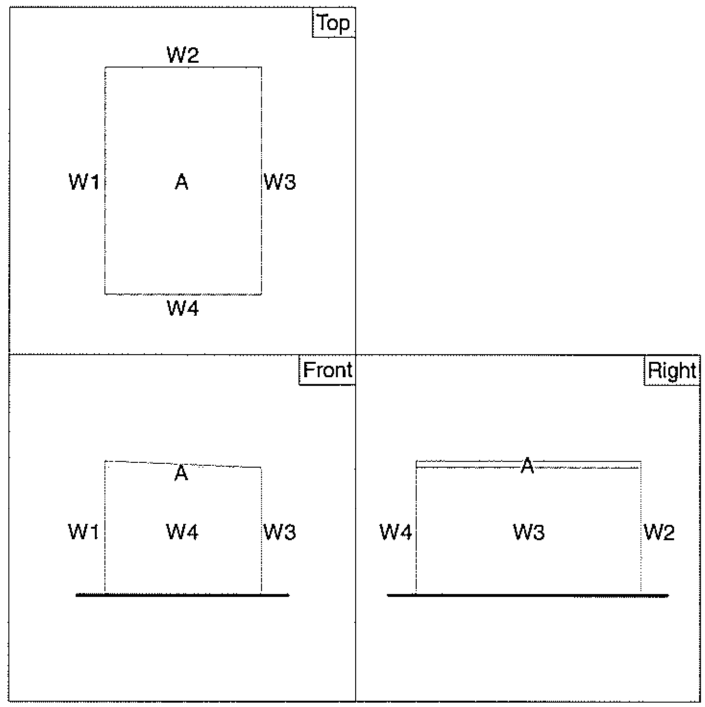
..\DESIGN - DATA\Calcs\Structural\Pump House.wls

ASCE7-10

Section - Main Section

Enclosure Classification: Enclosed

Wall	Length(ft)	Overhang(ft)
1	26.0	0.0
2	18.0	0.0
3	26.0	0.0
4	18.0	0.0



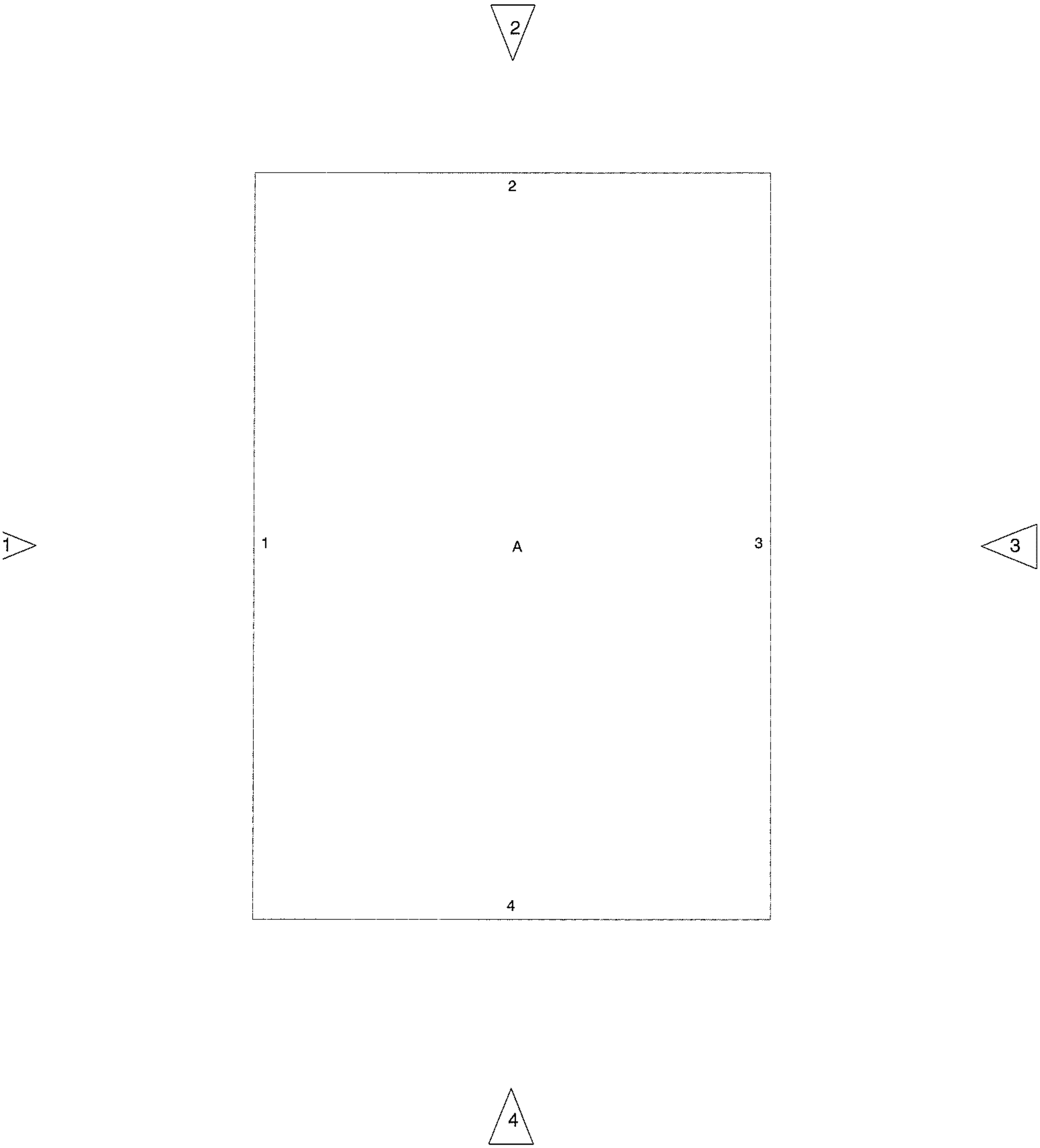
Eave Height: 14.66 ft
Parapet Height: 0 ft
Parapet Enclosure: Solid

Roof Shape: Monoslope

Roof	Slope(:12)
A	0.5

ASCE7-10

Composite Drawing



ASCE7-10

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 1

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Windward Wall	14.7	72.6	0.90	0.80	0.18	52.3	39.2	65.3
		15.4	73.0		0.80		52.6	39.5	65.6
2	Side Wall	14.7	72.6	0.90	-0.70	0.18	-45.7	-58.8	-32.7
3	Leeward Wall	14.7	72.6	0.90	-0.50	0.18	-32.7	-45.7	-19.6
4	Side Wall	14.7	72.6	0.90	-0.70	0.18	-45.7	-58.8	-32.7
A	Roof	0 to 7.3 *	72.6	0.90	-1.08	0.18	-70.6	-83.6	-57.5
		7.3 to 14.7 *	72.6		-0.77		-50.3	-63.4	-37.2
		14.7 to 18.0 *	72.6		-0.63		-41.2	-54.2	-28.1
		0 to 18.0 *	72.6		-0.18		-11.8	-24.8	1.3

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

ASCE7-10

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 2

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Side Wall	14.7	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
2	Windward Wall	14.7	72.6		0.80		52.9	39.8	65.9
		15.4	73.0		0.80		53.1	40.1	66.2
3	Side Wall	14.7	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
4	Leeward Wall	14.7	72.6	0.91	-0.41	0.18	-27.1	-40.2	-14.0
A	Roof	0 to 7.3 *	72.6	0.91	-0.95	0.18	-62.8	-75.8	-49.7
		7.3 to 14.7 *	72.6		-0.87		-57.5	-70.5	-44.4
		14.7 to 26.0 *	72.6		-0.53		-35.0	-48.1	-21.9
		0 to 26.0 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

ASCE7-10

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 3

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Leeward Wall	14.7	72.6	0.90	-0.50	0.18	-32.7	-45.7	-19.6
2	Side Wall	14.7	72.6		-0.70		-45.7	-58.8	-32.7
3	Windward Wall	14.7	72.6	0.90	0.80	0.18	52.3	39.2	65.3
4	Side Wall	14.7	72.6	0.90	-0.70	0.18	-45.7	-58.8	-32.7
A	Roof	0 to 7.3 *	72.6	0.90	-1.08	0.18	-70.6	-83.6	-57.5
		7.3 to 14.7 *	72.6		-0.77		-50.3	-63.4	-37.2
		14.7 to 18.0 *	72.6		-0.63		-41.2	-54.2	-28.1
		0 to 18.0 *	72.6		-0.18		-11.8	-24.8	1.3

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

ASCE7-10

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 4

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Side Wall	14.7	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
2	Leeward Wall	14.7	72.6		-0.41		-27.1	-40.2	-14.0
3	Side Wall	14.7	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
4	Windward Wall	14.7	72.6	0.91	0.80	0.18	52.9	39.8	65.9
		15.4	73.0		0.80		53.1	40.1	66.2
A	Roof	0 to 7.3 *	72.6	0.91	-0.95	0.18	-62.8	-75.8	-49.7
		7.3 to 14.7 *	72.6		-0.87		-57.5	-70.5	-44.4
		14.7 to 26.0 *	72.6		-0.53		-35.0	-48.1	-21.9
		0 to 26.0 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

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Date:	10/31/16	Sheet	of
Project No.:		7481-77	
By:		PIF	

Component and Cladding Loads

Job Name:	McMurdo
Des:	C & C

Gcpi	0.18
qh	72.6 psf
qz	72.6 psf

	Wall GCp Values		
Area ft^2	Zone 4 & 5 Pos	Zone 4 Neg	Zone 5 Neg
= 20	1	-1.1	-1.4
= 50	0.95	-1.05	-1.3
= 100	0.9	-0.99	-1.15
= 200	0.81	-0.91	-1.05
= 500	0.79	-0.89	-0.93
> 500	0.7	-0.8	-0.8

	Wall Pressures Strength Level		
Area ft^2	Zone 4 & 5 Pos	Zone 4 Neg	Zone 5 Neg
= 20	85.7 psf	-93.0 psf	-114.7 psf
= 50	82.1 psf	-89.3 psf	-107.5 psf
= 100	78.4 psf	-85.0 psf	-96.6 psf
= 200	71.9 psf	-79.2 psf	-89.3 psf
= 500	70.4 psf	-77.7 psf	-80.6 psf
> 500	63.9 psf	-71.2 psf	-71.2 psf

	Wall Pressures Allowable		
Area ft^2	Zone 4 & 5 Pos	Zone 4 Neg	Zone 5 Neg
= 20	51.4 psf	-55.8 psf	-68.8 psf
= 50	49.2 psf	-53.6 psf	-64.5 psf
= 100	47.1 psf	-51.0 psf	-57.9 psf
= 200	43.1 psf	-47.5 psf	-53.6 psf
= 500	42.3 psf	-46.6 psf	-48.4 psf
> 500	38.3 psf	-42.7 psf	-42.7 psf

$q_z = .00256 K_z K_{zt} K_d V^2 I$

K_z	1.03	pg 317 Based on Height h or z
K_{zt}	1	
K_d	0.85	pg 250
V	180	
I	1	
q_z	72.62	psf } Strength Level

a = { .4(12) = 4.8' ; .1(18.0) = 1.8' ; .4(18.00) = 7.2' ; 3' } = 7.2'

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Date:	2/26/17	Sheet	of
Project No.:		7481-77	
By:		PIF	

Job Name:	McMurdo Utilities
Des:	C & C

Gcpi	0.18
qh	72.6 psf

	Roof GCp Values				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	0.3	-1.1	-1.3	-1.8	0	0
= 20	0.25	-1.1	-1.25	-1.62	0	0
= 50	0.22	-1.1	-1.22	-1.38	0	0
= 100	0.2	-1.1	-1.2	-1.2	0	0

	Roof Pressures Strength Level				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	34.9 psf	-93.0 psf	-107.5 psf	-143.8 psf	0.0 psf	0.0 psf
= 20	31.2 psf	-93.0 psf	-103.8 psf	-130.7 psf	0.0 psf	0.0 psf
= 50	29.0 psf	-93.0 psf	-101.7 psf	-113.3 psf	0.0 psf	0.0 psf
= 100	27.6 psf	-93.0 psf	-100.2 psf	-100.2 psf	0.0 psf	0.0 psf

	Roof Pressures Allowable				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	20.9 psf	-55.8 psf	-64.5 psf	-86.3 psf	0.0 psf	0.0 psf
= 20	18.7 psf	-55.8 psf	-62.3 psf	-78.4 psf	0.0 psf	0.0 psf
= 50	17.4 psf	-55.8 psf	-61.0 psf	-68.0 psf	0.0 psf	0.0 psf
= 100	16.6 psf	-55.8 psf	-60.1 psf	-60.1 psf	0.0 psf	0.0 psf

a = 7.2'

MERRICK & COMPANY

Date:	2/26/17	Sheet	of
Project No.:		7481-79	
By:		PIF	

Job Name:	McMurdo Utilities
Des:	C & C

Gcpi	0.18
qh	72.6 psf

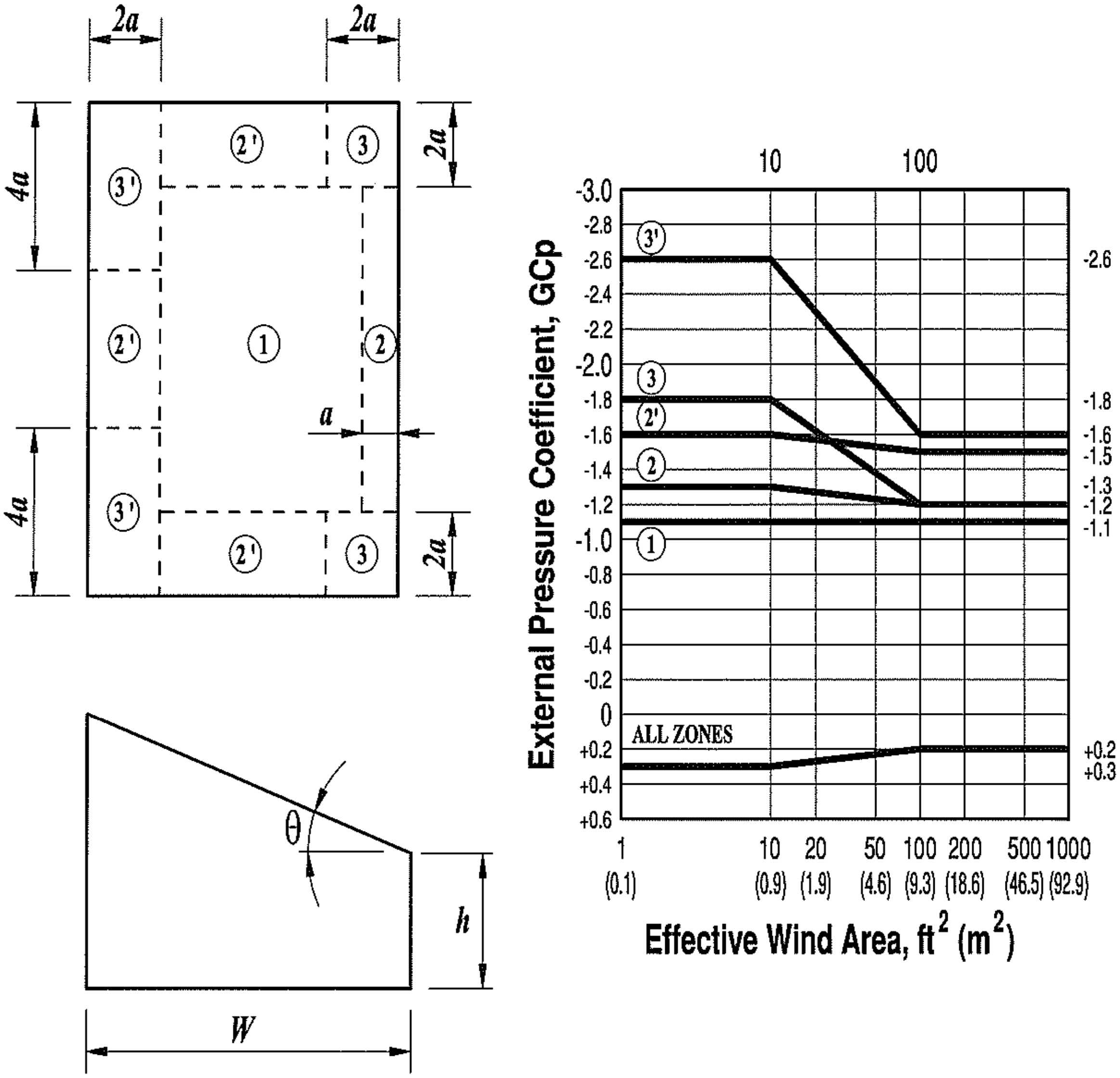
	Roof GCp Values				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	0.3	-1.1	-1.6	-2.6	0	0
= 20	0.25	-1.1	-1.58	-2.3	0	0
= 50	0.22	-1.1	-1.55	-1.9	0	0
= 100	0.2	-1.1	-1.5	-1.6	0	0

	Roof Pressures Strength Level				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	34.9 psf	-93.0 psf	-129.3 psf	-201.9 psf	0.0 psf	0.0 psf
= 20	31.2 psf	-93.0 psf	-127.8 psf	-180.1 psf	0.0 psf	0.0 psf
= 50	29.0 psf	-93.0 psf	-125.6 psf	-151.0 psf	0.0 psf	0.0 psf
= 100	27.6 psf	-93.0 psf	-122.0 psf	-129.3 psf	0.0 psf	0.0 psf

	Roof Pressures Allowable				Over Hang	
Area ft^2	Zone 1, 2 & 3 Pos	Zone 1 Neg	Zone 2	Zone 3 Neg	Zone 2	Zone 3
= 10	20.9 psf	-55.8 psf	-77.6 psf	-121.1 psf	0.0 psf	0.0 psf
= 20	18.7 psf	-55.8 psf	-76.7 psf	-108.1 psf	0.0 psf	0.0 psf
= 50	17.4 psf	-55.8 psf	-75.4 psf	-90.6 psf	0.0 psf	0.0 psf
= 100	16.6 psf	-55.8 psf	-73.2 psf	-77.6 psf	0.0 psf	0.0 psf

a = 7.2'

Components and Cladding		$h \le 60$ ft.
Figure 30.4-5A	External Pressure Coefficients, GC_p	**Monoslope Roofs**
Enclosed, Partially Enclosed Buildings		$3° < \theta \le 10°$



Notes:

1. Vertical scale denotes GC_p to be used with q_h.
2. Horizontal scale denotes effective wind area A, in square feet (square meters).
3. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
4. Each component shall be designed for maximum positive and negative pressures.
5. For $\theta \le 3°$, values of GC_p from Fig. 30.4-2A shall be used.
6. Notation:
   - a: 10 percent of least horizontal dimension or $0.4h$, whichever is smaller, but not less than either 4 percent of least horizontal dimension or 3 ft (0.9 m).
   - h: Eave height shall be used for $\theta \le 10°$.
   - W: Building width, in feet (meters).
   - θ: Angle of plane of roof from horizontal, in degrees.

MERRICK® & COMPANY | **Engineering Calculation Sheet** | 011-2010A

Date 11/15
Contract 7481-77
Calculation No.

Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	RF			

Pump House Loads

Roof DL

Beams & Girders	=	7 psf
Insulation	=	10 psf
Mech	=	10 psf
Mis	=	3 psf
		30 psf

Floor DL

Bms & Girders	=	10 psf
Floor	=	10 psf
Insulation	=	10 psf
Mech	=	10 psf
		40 psf

Wall Load = 15 psf

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	TB			

Roof Snow Load

P_g = 40 psf ground snow load

P_m = 20 (1.2) min Roof Snow load
= 24 psf

P_s = 30.2 psf see following Print out

Roof Snow load

McMurdo Utilities

pg =	40	psf	Ground Snow Load
Ce =	0.9		Exposure Factor
Ct =	1		Thermal Factor
I =	1.2		Importance Factor
W =	16	ft	Horiz Dist from eave to ridge
θ =	1.79	deg	Roof slope
Cs =	1		Roof slope factor

Basic Snow Loads

Flat Roof	**Low Slope Roofs Use pf**	**Sloped Roofs**
pf = .07*pg*Ce*Ct*I		ps = pf*Cs
pf = 30.2 psf	if θ > 38.00 deg	ps = 30.2 psf

Unbalanced Snow Loads for Hip and Gable Roofs

IF the slope is > 38 deg or less 2.38 deg then no unbalanced snow load

θ = 1.8 deg **unbalanced snow loading need NOT be considered**

For the Leeward Side of the Roof

For W <= 20 ft with rafter system

pub = I*pg

pub = 48 psf

For all other conditions

			γ =	19.2	pcf	"= .13pg+14"
			γ max =	30	pcf	
			use			
pub =	"ps"		**γ =**	**19.2**	**pcf**	
pub =	**30.24**	**psf**	hd =	1.84	ft	
hd*γ / sqrt(S) =			S =	31.998		
pub add =	**6.3**	**psf**	8*sqrt(S)*hd / 3 =	27.81	ft	

Snow load for Windward Side

For all other conditions

pub = ".3*ps"

pub = 9.07 psf

Subject McMurdo Utilities

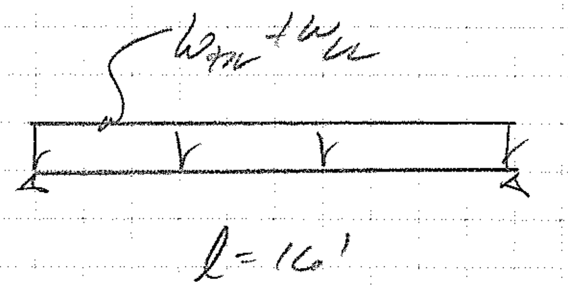
Pump House

Revision	By	Date	Chk'd	Date
	PF			

Check Floor Bms

$w_{DL} = 40(6)$
$= 240$ #/ft

$w_{LL} = 100(6)$
$= 600$ #/ft



$M_{TL} = \frac{(600+240)(16)^2}{8}$
$= 26,880$ #-ft
$= 26.9$ k-ft

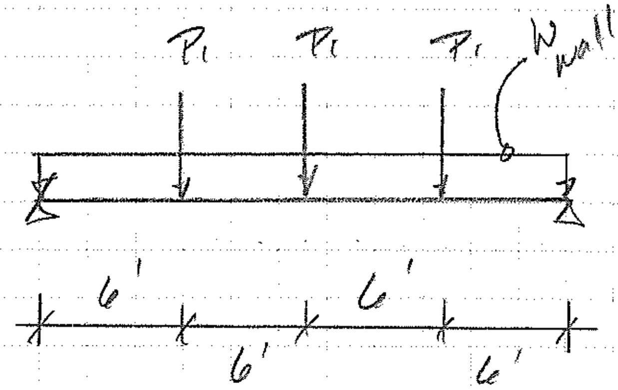
use W10X30 see following Print out

Check Floor Girder

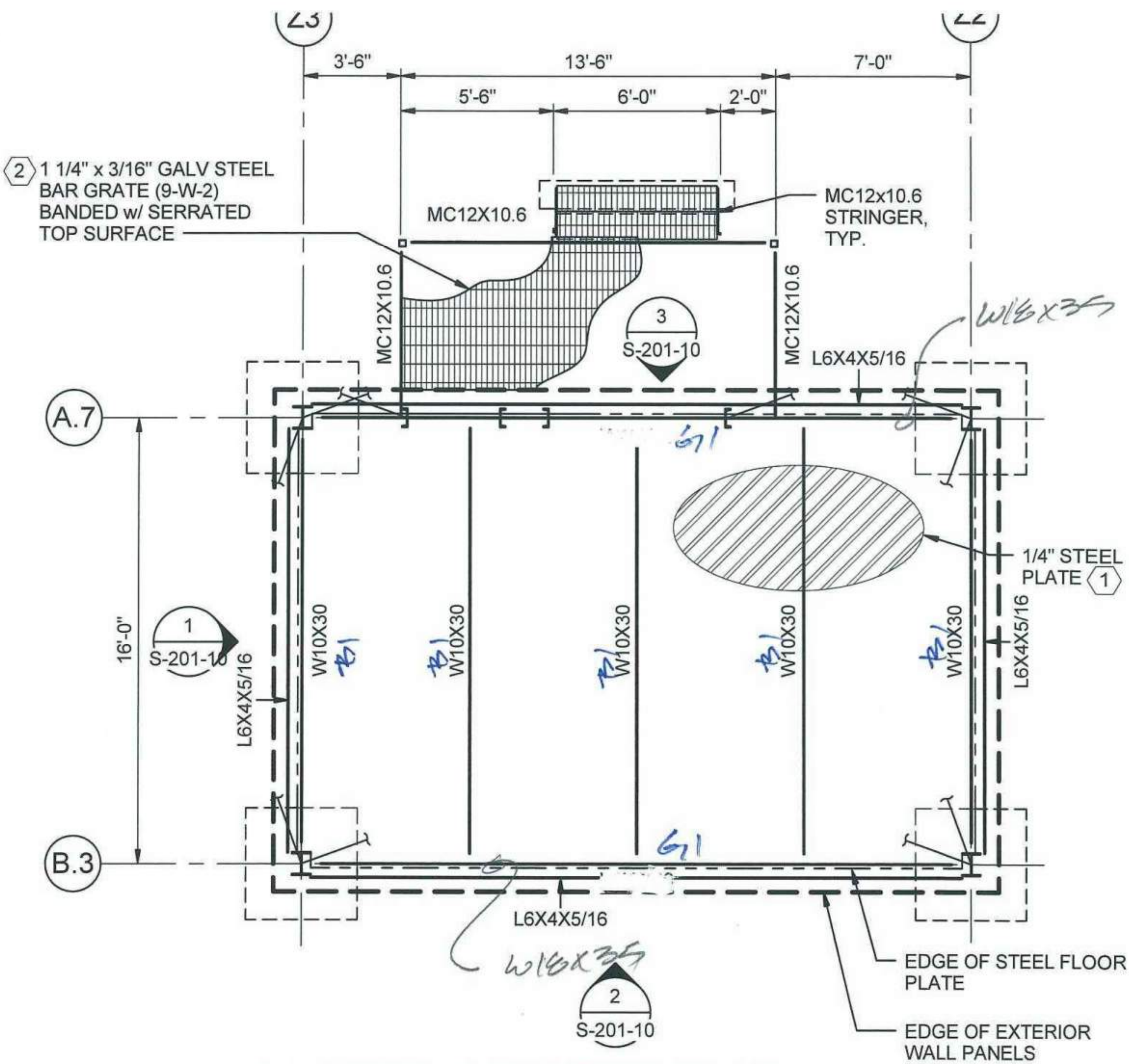
P1
$P_{DL} = 240(8)$
$= 1920$ #

$P_{LL} = 600(8)$
$= 4,800$ #

$P_{wall} = 15(16)$
$= 240$ #/ft



use W18X35 for Girder, see following Print out



1 LEVEL 1 FRAMING PLAN

1/4" = 1'-0"

MERRICK® & COMPANY

Date: 12/6/2016	Sheet of
Project No.:	7481-77
By:	PIF

BEAM LOADS AND ANALYSIS - STEEL WIDEFLANGE BEAMS

Job Name: McMurdo Utilities
Des: B1

Fy:	50 ksi	
E:	29000 ksi	
L:	16.0 ft	Beam Length
Lb:	0.0 ft	unbraced length

Applied Loads

Mappl =	26.9 k-ft	
Mu =	38 k-ft	
ϕ =	0.9	
D max =	0.5 in	
D est =	0.25 in	
Ireq =	85 in4	estimate

Member Properties

TRY:	W10X30
Sx=	32.4 in³
Ix=	170.0 in4
Iy=	16.7 in4
Zx=	36.6 in³
d=	10.47 in
h =	8.60 in
J	0.62 in
Cw	414.0 in
ry	1.374 in
ho	9.96 in
tf =	0.51 in
bf =	5.81 in
tw =	0.30 in
rts =	1.60

Check Flexural Compact Requirements

Flang

λ = b/(2*tf) =	5.70
λp = .38*sqrt(E/Fy) =	9.15
λr = 1*sqrt(E/Fy) =	24.08
b/t<=.38*sqrt(E/Fy) =	Member is Compact

Web

λ = h/tw =	28.7
λp = 3.76*sqrt(E/Fy) =	90.6
λr = 5.7*sqrt(E/Fy) =	137.3
h/t<=3.76*sqrt(E/Fy) =	Member is Compact

Lengths

Lp =	4.9 ft
Lr =	16.1 ft
Cb:	1
Fcr =	510092158311.5 ksi

STRENGTH DESIGN

Compact I Shapes

If Lb<=Lp

Mp = 152.5 k-ft	=Fy*Zx	(eq F2-1)
ϕMn = 137.3 k-ft		

If Lp < Lb <= Lr

Mn = 177.4 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((Lb-Lp)/(Lr-Lp))) <=Mp	(eq F2-2)
ϕMn = 159.7 k-ft		

If Lb > Lr

Mn = 1377248827441.0 k-ft	=Fcr*Sx <= Mp	(eq F2-3)
ϕMn = 1239523944696.9 k-ft		

Non-compact flanges

Mn = 165.9 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((λb-λp)/(λr-λp))) <=Mp	(eq F3-1)
ϕMn = 149.3 k-ft		

Slender Flanges

kc = 0.747		
Mn = 1623.1 k-ft	=.9*E*kc*Sx / λ^2	(eq F3-2)
ϕMn = 1460.8 k-ft		

Member is Compact

Lb<=Lp

USE (eq F2-1)

ϕMn =	**137.3 k-ft**	**DCR =**	**0.28**	OK	Strength Design
Mn/Ω =	**91.3 k-ft**	**DCR =**	**0.29**	OK	Allowable Stress Design

Gravity Beam Design

RAM SBeam v5.01

12/06/16 14:29:03

STEEL CODE: AISC 360-05 ASD G1

SPAN INFORMATION (ft): I-End (0.00,0.00) J-End (24.00,0.00)

Beam Size (User Selected) = W18X35 Fy = 50.0 ksi
Total Beam Length (ft) = 24.00
Mp (kip-ft) = 277.08
Top flange braced by decking.

POINT LOADS (kips):

Dist (ft)	DL	LL	Flange Bracing Top	Flange Bracing Bottom
6.000	1.92	4.80	Yes	No
12.000	1.92	4.80	Yes	No
18.000	1.92	4.80	Yes	No

LINE LOADS (k/ft):

Load	Dist (ft)	DL	LL
1	0.000	0.035	0.000
	24.000	0.035	0.000
2	0.000	0.240	0.000
	24.000	0.240	0.000

SHEAR: Max Va (DL+LL) = 13.38 kips Vn/1.50 = 106.20 kips

MOMENTS:

Span	Cond	LoadCombo	Ma	@	Lb	Cb	Ω	Mn / Ω
			kip-ft	ft	ft			kip-ft
Center	Max +	DL+LL	100.4	12.0	0.0	1.00	1.67	165.92
Controlling		DL+LL	100.4	12.0	0.0	1.00	1.67	165.92

REACTIONS (kips):

	Left	**Right**
DL reaction	6.18	6.18
Max +LL reaction	7.20	7.20
Max +total reaction	13.38	13.38

DEFLECTIONS:

Dead load (in)	at	12.00 ft	=	-0.292	L/D	=	985
Live load (in)	at	12.00 ft	=	-0.384	L/D	=	751
Net Total load (in)	at	12.00 ft	=	-0.676	L/D	=	426

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 3/1 Sheet 26 of 178

Contract 7481-77

Calculation No.

Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	RF			

Check Floor Plate

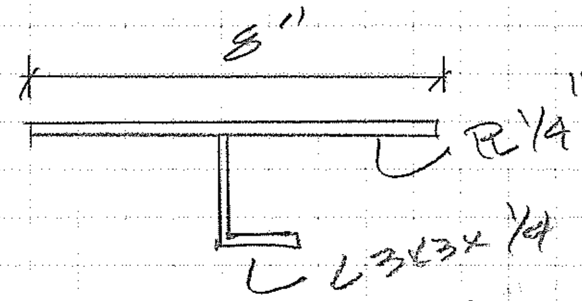
$k = 1.15$ $S_y = 1.7$

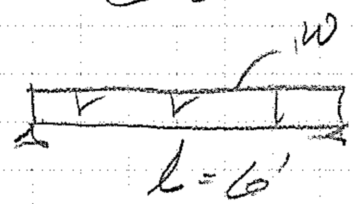
$\lambda = 16$

$\lambda_{pg} = 10.78$

$k_c = .76$

$\lambda_{rg} = 23.50$





$F_{cr} = 36 - .3(36)\left(\frac{16-10.78}{23.5-10.78}\right)$

$w = 130(1.5) = 195$ #/ft

$M_n = 31.6(1.7) = 53.72$ k-in

$M = \frac{195(6)^2}{8} = 877.5$ #-ft $= 10.5$ k-in

$\frac{M_n}{\Omega} = \frac{53.72}{1.67} = 32.17$ k-in

$M_{all} = 32.17 > M_{app} = 10.5$ ok

DCR = .33

use 1/4" floor plate w/ L3x3x1/4 Angle stiffeners

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 3/11 Sheet of

Contract 7481-77

Calculation No.

Subject McMurdo

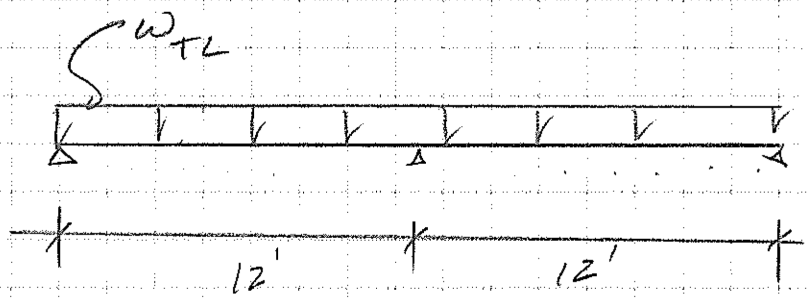
utilities

Pump House

Revision	By	Date	Chk'd	Date
	PF			

* Check Roof Framing for Cladding

* Based on Roof Pressures use 2' spacing of support structure



$w_{WL} = 2(121)$

$= 242$ #/ft

$w_{DL} = 23(2)$

$= 46$ #

$.6DL = .6(46)$

$= 27$ #/ft

$w_{TL} = 242 - 27$

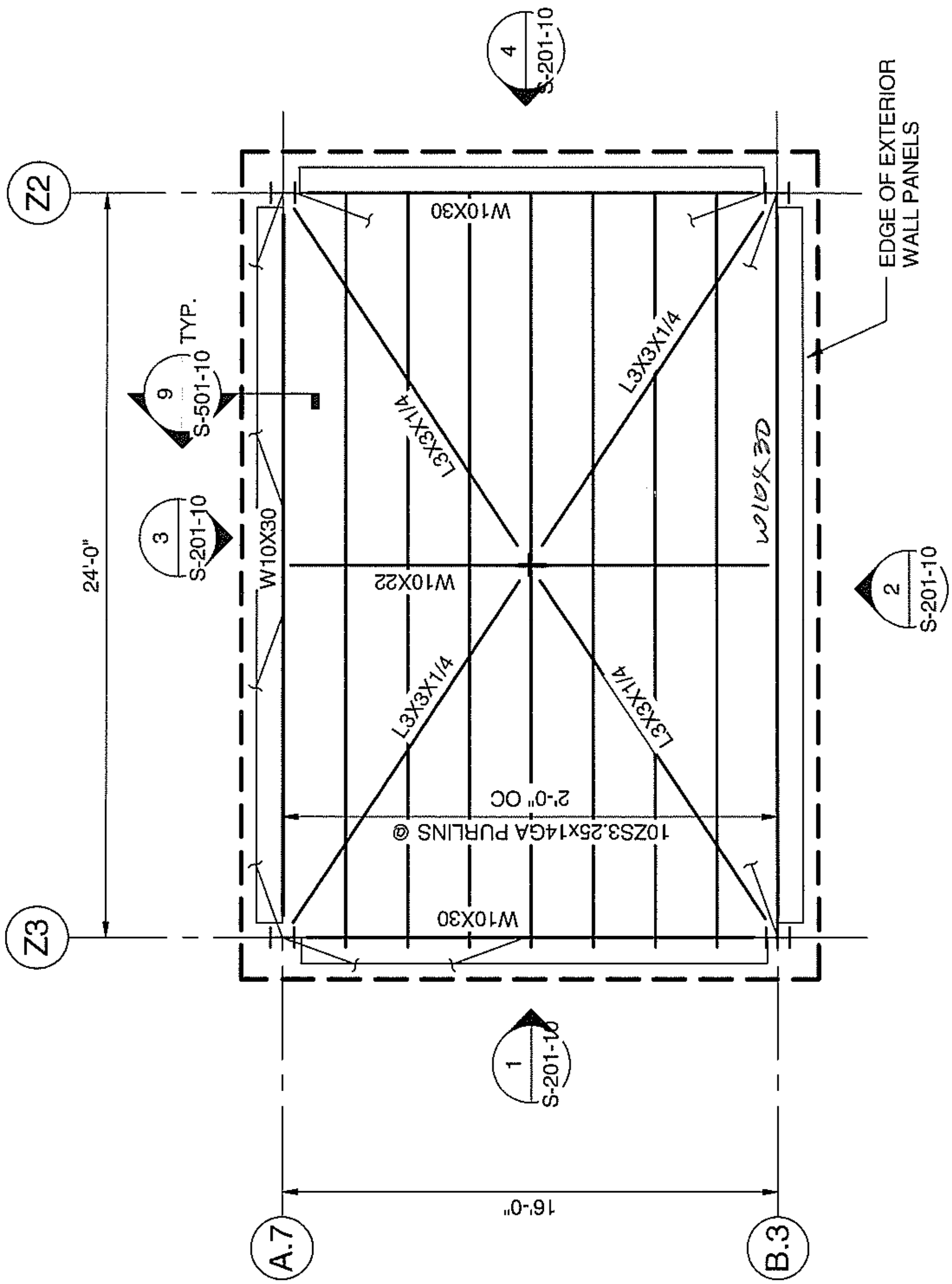
$= 215$ #/ft

use 10Z3.25X070 (14ga min)

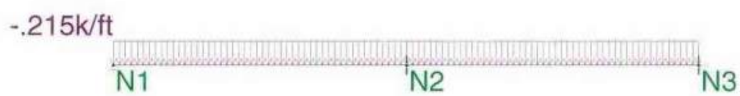
Zee purlins at

2' OC

Roof



Z2
Z3
A.7
B.3
24'-0"
16'-0"
4 S-201-10
3 S-201-10
9 S-501-10 TYP.
2 S-201-10
1 S-201-10
W10X30
W10X30
W10X30
W10X22
W10X30
L3X3X1/4
L3X3X1/4
L3X3X1/4
L3X3X1/4
10ZS3.25x14GA PURLINS @ 2'-0" OC
EDGE OF EXTERIOR WALL PANELS



Loads: BLC 1, TL

		SK - 1
		Feb 27, 2017 at 9:30 AM
		Z Roof Purlin.r3d

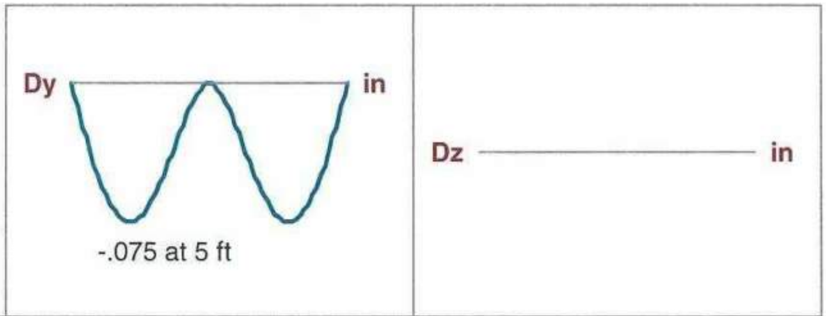
Beam: *M1*

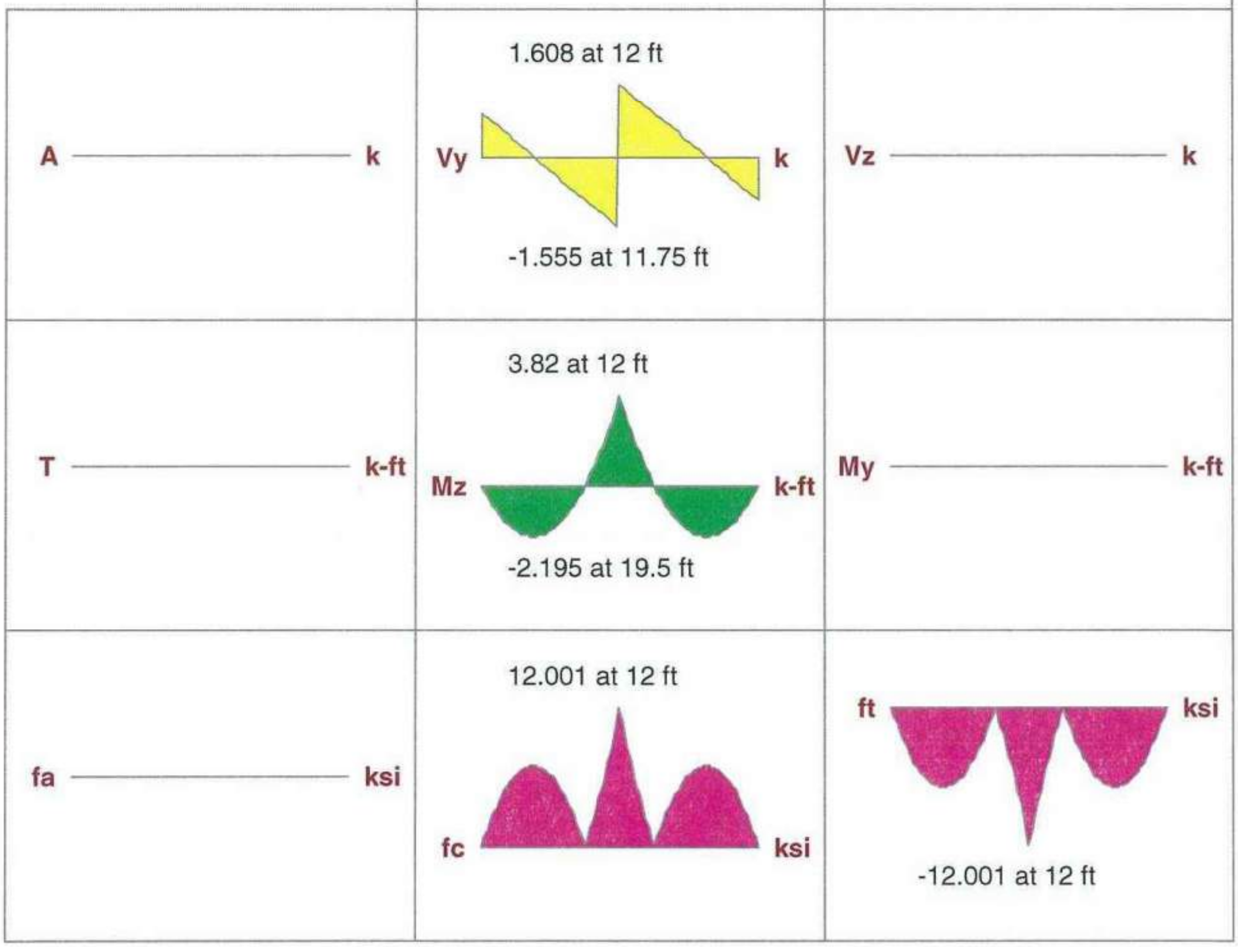
Shape:	**10ZS3.25x070**
Material:	**A570 Gr.33**
Length:	**24 ft**
I Joint:	**N1**
J Joint:	**N3**

LC 1:

Code Check: **0.884 (bending)**

Report Based On 97 Sections





AISI S100-10: ASD Code Check

Max Bending Check	**0.884**	Max Shear Check	**0.500 (y)**
Location	**12 ft**	Location	**12 ft**
Equation	**C5.2.1-2**	Max Defl Ratio	**L/3825**

R (D6.1.1) **Not Used**

Fy	**33 ksi**		y-y	z-z	A eff. (Fy)	**.76 in^2**
Pn/Ω	**13.939 k**	Cm	**.6**	**.85**	A eff. (Fn)	**1.048 in^2**
Tn/Ω	**24.898 k**	Lb	**12 ft**	**12 ft**	Iy eff.	**2.829 in^4**
Mny/Ω	**1.204 k-ft**	KL/r	**141.176**	**141.176**	Sy eff. (L)	**.753 in^3**
Mnz/Ω	**4.321 k-ft**	L Comp Flange	**12 ft**		Sy eff. (R)	**.731 in^3**
Vny/Ω	**3.218 k**	L-torque	**24 ft**		Iz eff.	**19.096 in^4**
Vnz/Ω	**4.975 k**				Sz eff. (T)	**3.819 in^3**
Cb	**1**				Sz eff. (B)	**3.819 in^3**

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date Sheet of

Contract

Calculation No.

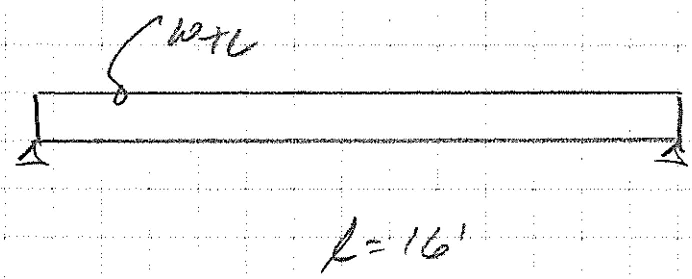
Subject

Revision	By	Date	Chk'd	Date

Check Lanfuer Support Girder

Trib Area

$216\ ft^2$



$w_{WL} = 78(12)$

$= 936\ \#/ft$

$w_{DL} = 30(12)$

$= 360\ \#/ft$

$.6 w_{DL} = .6(360)$

$= 216\ \#/ft$

$w_{TL} = 936 - 216$

$= 720\ \#/ft$ up

$M_{TL} = \frac{720(16)^2}{8}$

$= 23{,}040\ \#\text{-}ft$

Use W10x22 see following printout.

MERRICK & COMPANY

Date: 2/27/2017	Sheet	of
Project No.:	7481-77	
By:	PIF	

BEAM LOADS AND ANALYSIS - STEEL WIDEFLANGE BEAMS

Job Name: McMurdo Utilities
Des: Pump House roof beam

Fy: 50 ksi
E: 29000 ksi
L: 16.0 ft — Beam Length
Lb: 16.0 ft — unbraced length

Applied Loads

Mappl = 23 k-ft
Mu = 32.2 k-ft
ϕ = 0.9
D max = 1 in
D est = 0.31 in
Ireq = 37 in4 — estimate

Member Properties

TRY: W10X22
Sx= 23.2 in³
Ix= 118.0 in4
Iy= 11.4 in4
Zx= 26.0 in³
d= 10.17 in
h = 8.67 in
J 0.24 in
Cw 275.0 in
ry 1.325 in
ho 9.81 in
tf = 0.36 in
bf = 5.75 in
tw = 0.24 in
rts = 1.55

Check Flexural Compact Requirements

Flang

λ = b/(2*tf) = 7.99
λp = .38*sqrt(E/Fy) = 9.15
λr = 1*sqrt(E/Fy) = 24.08
b/t<=.38*sqrt(E/Fy) = Member is Compact

Web

λ = h/tw = 36.1
λp = 3.76*sqrt(E/Fy) = 90.6
λr = 5.7*sqrt(E/Fy) = 137.3
h/t<=3.76*sqrt(E/Fy) = Member is Compact

Lengths

Lp = 4.7 ft
Lr = 13.8 ft
Cb: 1
Fcr = 28.1 ksi

STRENGTH DESIGN

Compact I Shapes

If Lb<=Lp

Mp = 108.3 k-ft	=Fy*Zx	(eq F2-1)
ϕMn = 97.5 k-ft		

If Lp < Lb <= Lr

Mn = 58.0 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((Lb-Lp)/(Lr-Lp))) <=Mp	(eq F2-2)
ϕMn = 52.2 k-ft		

If Lb > Lr

Mn = 54.4 k-ft	=Fcr*Sx <= Mp	(eq F2-3)
ϕMn = 49.0 k-ft		

Non-compact flanges

Mn = 111.5 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((λb-λp)/(λr-λp))) <=Mp	(eq F3-1)
ϕMn = 100.4 k-ft		

Slender Flanges

kc = 0.666		
Mn = 526.5 k-ft	=.9*E*kc*Sx / λ^2	(eq F3-2)
ϕMn = 473.9 k-ft		

Member is Compact

Lb > Lr

USE (eq F2-3)

ϕMn =	**49.0 k-ft**	**DCR =**	**0.66**	OK	Strength Design
Mn/Ω =	**32.6 k-ft**	**DCR =**	**0.71**	OK	Allowable Stress Design

Subject: Mc Murdo

Utilities

Pump House

Revision	By	Date	Chk'd	Date

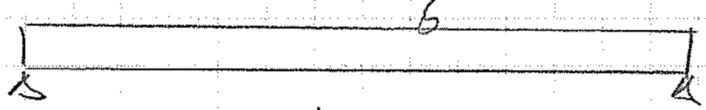
* Exterior Cladding

4" insulated Panel for wall

use 4' spacing for wind girt support
see following printout

* Size Horiz Girt

4(54.5) = 218 #/ft



l = 24'

M = 15,696 #-ft
= 15.7 k-ft
= 188.4 k-in

use MC 9 x 23.9
Mn/Ω = 21 k-ft < 15.7k-ft
OK

Load Span Tables

using 4" Panel

For FM Global Requirements, Click Here

To View Fastening Patterns, Click Here

The Load Span Table below is based on Allowable Stress Design (ASD). For loads calculated based on ASCE 7-10 (LRFD), please refer to section 2.4.1 of ASCE 7-10 for the applicable load combinations using Allowable Stress Design.

Metl-Span Architectural Flat Wall Panels

22 Ga. Exterior / 26 Ga. Interior Facings

Allowable Connection Load[1,6,7,8] (psf) for Two or More Equal Spans

use 4' supports

Panel Type[2]	Fastener[3,4,5]	Thickness	Support Span 4'	5'	6'	7'	8'	9'	10'	11'	12'
CF-36 Architectural Flat	FP1	2"	54.8	42.8	35.0	29.5	25.4	22.4	20.0	18.0	16.4
		2.5"	56.7	44.3	36.2	30.5	26.3	23.1	20.6	18.6	16.9
		3"	58.4	45.7	37.4	31.5	27.1	23.8	21.2	19.1	17.4
		4"	61.5	48.4	39.6	33.4	28.8	25.3	22.5	20.2	18.4
	FP2	2"	66.0	51.5	42.1	35.5	30.6	26.9	24.0	21.7	19.7
		2.5"	71.4	55.8	45.6	38.4	33.1	29.1	25.9	23.4	21.3
		3"	76.6	60.0	49.1	41.3	35.6	31.3	27.8	25.1	22.8
		4"	86.9	68.4	56.0	47.2	40.7	35.7	31.8	28.6	26.0
	FP3	2"	88.3	69.0	56.3	47.0	38.9	32.4	27.2	23.1	19.7
		2.5"	90.0	70.4	57.5	48.4	41.8	36.7	32.7	29.5	26.3
		3"	91.4	71.6	58.5	49.3	42.5	37.3	33.2	29.9	27.2
		4"	93.7	73.7	60.4	50.9	43.9	38.5	34.3	30.8	28.0
	FP1	2"	72.1	56.3	45.9	38.7	33.4	29.4	26.3	23.1	19.7

| Need Help?
LIVE CHAT
Weekdays 8am - 5pm CST

		2.5"	74.3	58.1	47.4	40.0	34.5	30.3	27.0	24.3	22.2
		3"	76.3	59.8	48.9	41.2	35.5	31.1	27.7	25.0	22.7
		4"	80.0	62.9	51.5	43.5	37.5	32.9	29.2	26.3	23.9
CF-30 Architectural Flat	FP2	2"	90.8	70.9	57.9	47.0	38.9	32.4	27.2	23.1	19.7
		2.5"	95.5	74.7	61.0	51.4	44.3	38.9	34.7	30.5	26.3
		3"	100.0	78.3	64.0	53.9	46.5	40.8	36.3	32.7	29.8
		4"	108.5	85.3	69.9	59.0	50.8	44.6	39.7	35.7	32.4
	FP3	2"	90.8	71.3	57.9	47.0	38.9	32.4	27.2	23.1	19.7
		2.5"	103.5	81.2	66.7	56.5	49.1	41.7	35.5	30.5	26.3
		3"	109.7	86.0	70.2	59.2	51.0	44.8	39.9	35.9	32.4
		4"	112.4	88.4	72.5	61.1	52.7	46.2	41.1	37.0	33.6
CF-24 Architectural Flat	FP1	2"	89.3	69.7	56.9	47.0	38.9	32.4	27.2	23.1	19.7
		2.5"	91.9	71.9	58.7	49.5	42.7	37.5	33.4	30.1	26.3
		3"	94.3	73.9	60.4	50.9	43.8	38.5	34.3	30.9	28.1
		4"	98.5	77.5	63.5	53.5	46.2	40.5	36.0	32.4	29.4
	FP2	2"	90.8	71.3	57.9	47.0	38.9	32.4	27.2	23.1	19.7
		2.5"	103.5	81.2	66.7	56.5	49.1	41.7	35.5	30.5	26.3
		3"	115.2	90.3	74.1	62.7	54.4	48.0	42.9	37.2	32.4
		4"	121.9	95.6	78.4	66.2	57.3	50.5	45.1	40.8	37.2

4 5 6 7 8 9 10 11 12

Notes:

1. *The Load Span Table above is based on Allowable Stress Design (ASD). For loads calculated based on ASCE 7-10 (LRFD), please refer to section 2.4.1 of ASCE 7-10 for the applicable load combinations using Allowable Stress Design.*
2. *Based on CF-panel with 22 ga. Architecturally Flat exterior and 26 ga. Light Mesa interior face (min Fy = 33 ksi).*
3. *Fastener pattern FP1 is based on CF panel clips fastened to min. 14 ga. steel. Fastener options will be (2) ¼" -14 SDS Type 3, (2) ¼" -14 Self-Tapping, (2) ¼" -14 Type 5 SDS, or ¼" -20 Type 5 SDS. Fastener selection will be based on fastener pullout capacity from support steel members.*
4. *For CF-30, FP2 is based on FP1 along with (1) blind rivet at 10" o.c. from female panel sidelap. For CF-24 and CF-36, FP2 is based on FP1 along with (1) blind rivet at 12" o.c from female panel sidelap.*
5. *For CF-30, FP3 is based on FP1 along with (2) blind rivets at 10" o.c. from female panel sidelap. For CF-36, FP3 is based on FP1 along with (2) blind rivets at 12" o.c from female panel sidelap.*
6. *Allowable loads based on panel stress, connection strength and deflection design criteria are derived from ASTM E72 and E1592 structural testing.*
7. *The allowable inward or outward loads is the smallest load calculated with a factor of safety of 2.5 for bending stress, 3.0 for shear stresses, 2.0 for connection and deflection limitation of L/180.*
8. *The structural capacity of the supports are not considered and must be examined independently.*

Metl-Span Architectural Flat Wall Panels[7]

22 Ga. Exterior / 26 Ga. Interior Facings

Allowable Positive Load[1,4,5,6,] (psf) for Two or More Equal Spans

Panel Type[2]	Design Criteria[3]	Support Span								
		4'	5'	6'	7'	8'	9'	10'	11'	12'
2"		90.8	71.3	58.6	49.8	43.2	38.0	33.9	28.5	23.2

	Bending & Shear									
	Deflection (L/180)	96.1	73.1	57.9	47.0	38.9	32.4	27.2	23.1	19.7
2.5"	Bending & Shear	106.3	83.1	67.9	57.2	49.3	43.3	38.6	34.8	28.3
	Deflection (L/180)	117.1	89.9	71.7	58.8	49.1	41.7	35.7	30.9	27.0
3"	Bending & Shear	118.2	92.6	75.7	63.8	55.0	48.3	43.0	38.7	33.5
	Deflection (L/180)	135.2	104.4	83.8	69.2	58.2	49.7	42.9	37.4	32.8
4"	Bending & Shear	124.8	98.1	80.4	67.8	58.5	51.3	45.6	41.1	37.3
	Deflection (L/180)	162.2	126.5	102.5	85.3	72.4	62.4	54.4	47.9	42.5
		4	5	6	7	8	9	10	11	12

Notes:

1. *The Load Span Table above is based on Allowable Stress Design (ASD). For loads calculated based on ASCE 7-10 (LRFD), please refer to section 2.4.1 of ASCE 7-10 for the applicable load combinations using Allowable Stress Design.*
2. *Based on CF-panel with 22 ga. Architectural Flat exterior and 26 ga. Light Mesa interior face (min Fy = 33 ksi).*
3. *Refer to the allowable connection load chart, for suction loads.*
4. *Allowable positive or suction load is the lowest value of panel bending strength, shear strength, deflection limit and connection strength for each fastener pattern.*
5. *Allowable loads based on panel stress and deflection design criteria are derived from ASTM E72 structural testing and calculated with factor of safety of 2.5 for bending stress, 3.0 for shear stresses and deflection limitation of L/180.*
6. *The structural capacity of the purlins are not considered and must be examined independently.*
7. *Consult Metl-Span for recommendations on panel profile and gauge suitable for thermal stresses.*

Toll Free 877 585 9969
Phone 972 221 6656
Fax 972 420 9382
1720 Lakepointe Dr. Ste #101
Lewisville TX 75057

MERRICK & COMPANY — **Engineering Calculation Sheet**

011-2010A

Date 3/1 Sheet of

Contract 7481-77

Calculation No.

Subject McMurdo

Pump House

Revision	By	Date	Chk'd	Date
	BF			

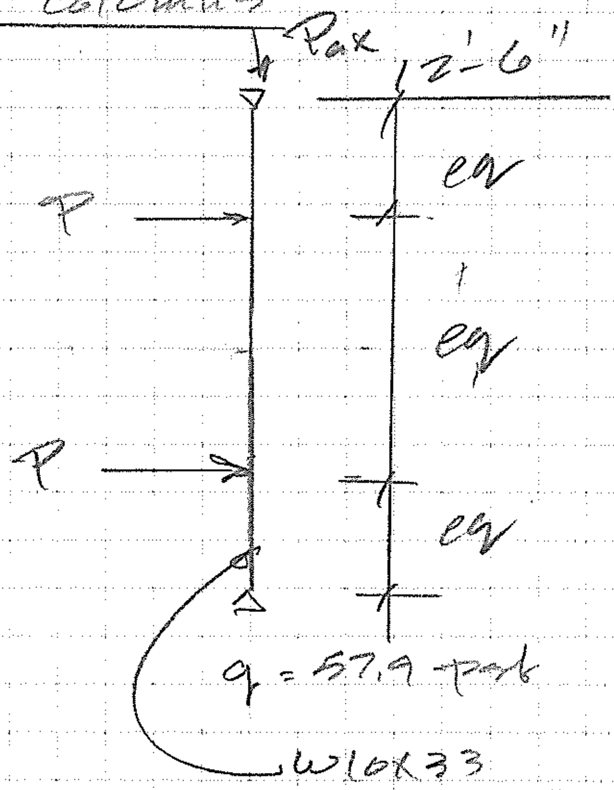
* Check vertical wall wind Girts

* Check Corner Columns

$A = 113\ ft^2$

$P = (58)(4.25)(9)$

$= 2219\ \#$



$M_{max} = 2219\,(4.25)$

$= 9431\ \#\text{-ft}$

$= 113\ \text{k-in}$

$M_{all} = .9 F_y S_x$

$= .9(50)(9.2)$

$= 414\ \text{k-in}$

$P_{ax} = 11.4$ kips
DL+SL

$P_{all} = 181$ kips
W10X33

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}}\right) \leq 1.0$$

$$\frac{11.4}{181} + 113/414 = .34 < 1.0 \quad \text{OK}$$

W10X30 Column
OK

MERRICK® & COMPANY

Engineering Calculation Sheet

011-2010A

Date 3/1 Sheet of

Contract 7481-77

Calculation No.

Subject Mc Murdo

Pump House

Revision	By	Date	Chk'd	Date
	BF			

* check vertical channel Girts

P = 58 (8)(4.25)

= 1972 #

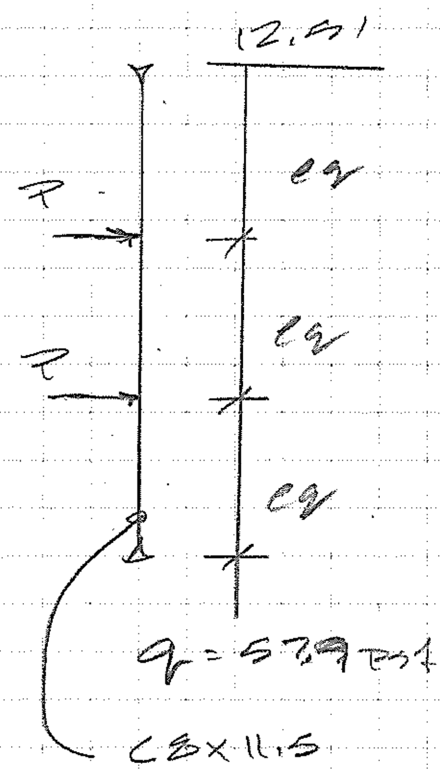
M = 1972 (4.25)

= 8381 #-ft

= 8.4 k-ft

Mall ≈ 8.4 k-ft OK

use C8x11.5



Subject McMurdo

utilities

Pump House

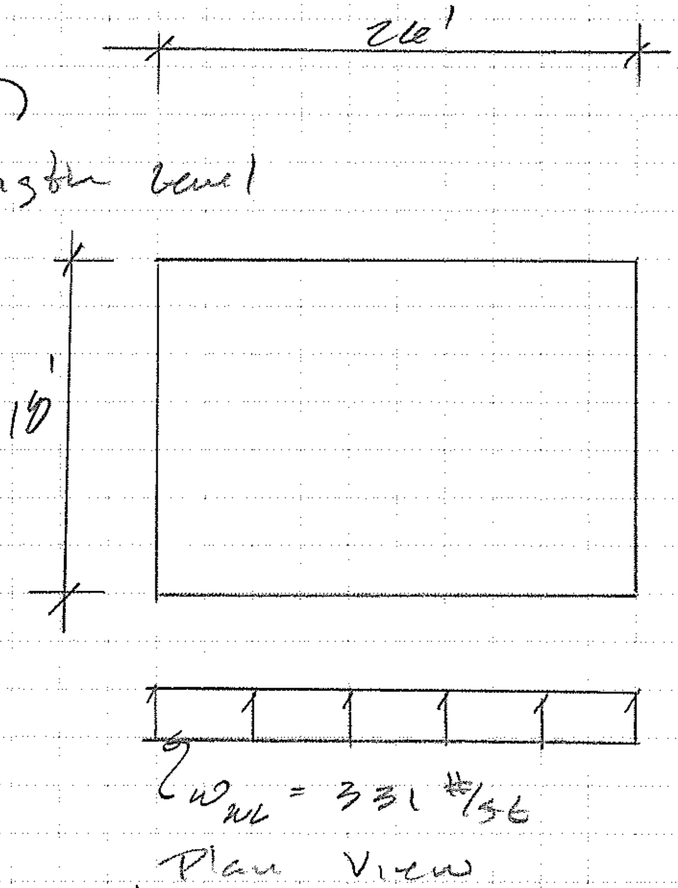
Revision	By	Date	Chk'd	Date
	PF			

Pump House wind load

$w_{WL} = (39.2 + 45.7)(13/2)$

$= 552$ #/ft strength level

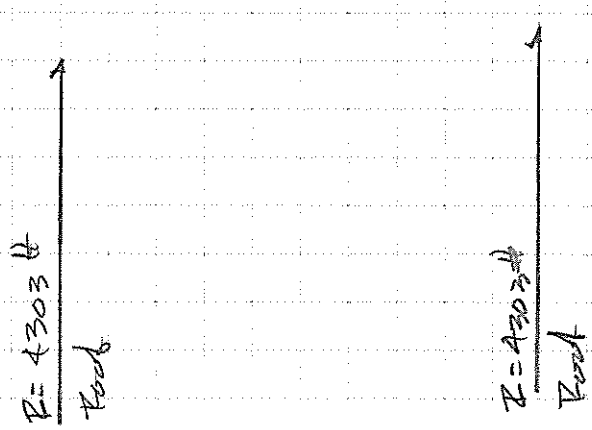
$w_{WL} = .6(552)$
allow
$= 331$ #/ft



@ Floor level

$w_{WL} = .6(552 + 2(39.2+45.7))$ Roof
allowable
$= 433$ #/ft

$R_{Floor} = 433(13)$
$= 5629$ #



MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 3/2 Sheet 41 of 178 of

Contract 7981-77

Calculation No.

Subject McMurdo utilities

Pumphouse

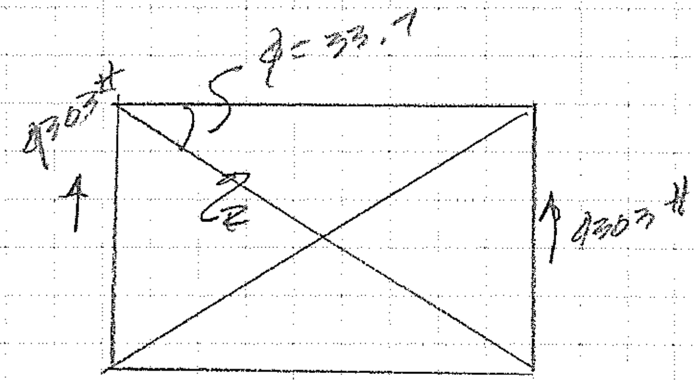
Revision	By	Date	Chk'd	Date
	BG			

Check Roof Angle Bracing

V = 4303 #

$P = \frac{4303}{\sin(33.7)}$

= 7759 #



$A = 1.44\ in^2$

$F_y = 36$ ksi

$F_u = 58$ ksi

U = .6

tensile yielding

$P_{all} = \frac{F_y A_g}{1.67}$ $\Omega = 1.67$

$P_{all} = 31k > 7.8k$ ‖ ok

tensile Rupture

$P_a = \frac{F_u A_e}{2.0}$ $\Omega = 2.0$

$= 25k > 7.8k$ ‖ ok

$A_e = .6(1.44)$

= .864

use L3x3x1/4" tension only brace

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 12/15 Sheet 42 of 178 of

Contract 7481-77

Calculation No.

Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	BF			

Load at Roof transV

$R_{R_1} = .6(24/2)\left[54.2(3.3^2/2) +\right.$
wL

$63.4(7.4)(7.4/2 + 3.3) +$

$\left.83.6(7.4)(7.4/2 + 7.4 + 3.3)\right]$

$\div 16$

$= 7239\#$

$R_{R2} = 2641\#$
wL

$R_{1DL} = R_{2DL}$ (Roof

$R_{DL} = 30(18)(16/2)\,1/2$

$= 2160\#$

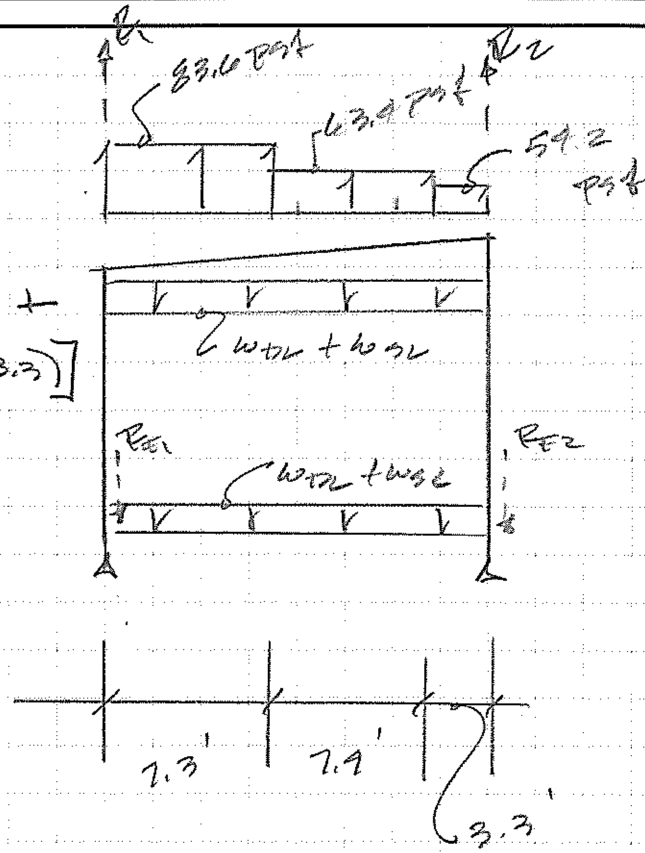
$R_{SL} = 30.2/30\ (2160)$

$= 2174\#$

$w_{DL} = 30(3)$

$= 90\ \#/sf$

$w_{SL} = 91\ \#/sf$



Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	PF			

$R_{F1} = R_{F2}$ (Floor)

$R_{FDL} = 40/30\,(2160)$

$= 2880\ \#$

$R_{FLL} = 100/40\,(2880)$

$= 7200\ \#$

$w_{FDL} = 40(3) + 15(15)$

$= \underbrace{\quad}_{\text{Floor}} \qquad \underbrace{\quad}_{\text{wall}}$

$= 345\ \#/ft$

$w_{FLL} = 100(3)$

$= 300\ \#/ft$

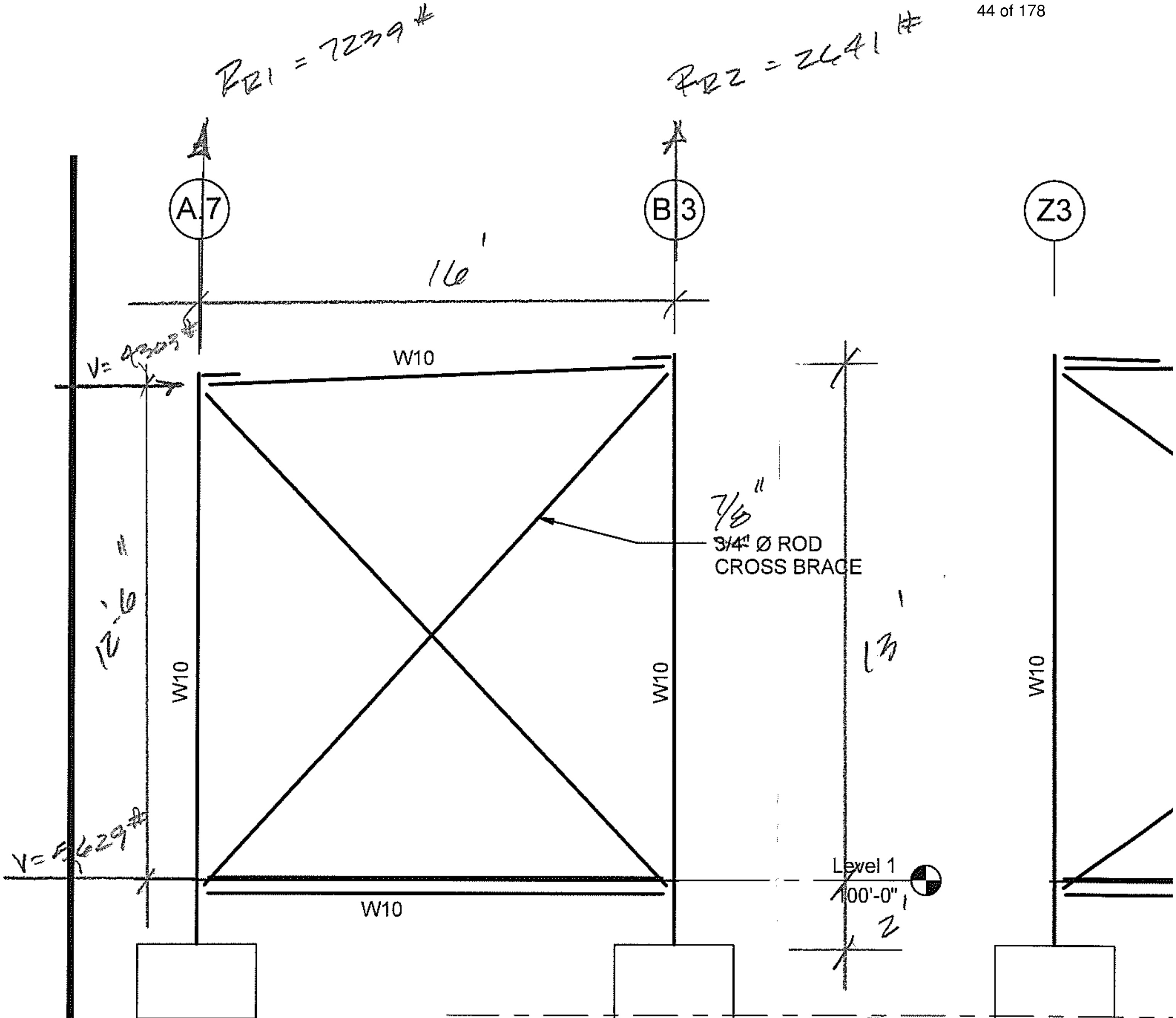
see following print out for Frame Design

Columns will be W10x33

Floor Bm = W10x30

Roof Bm = W10x30

Bracing = 7/8" φ Rod

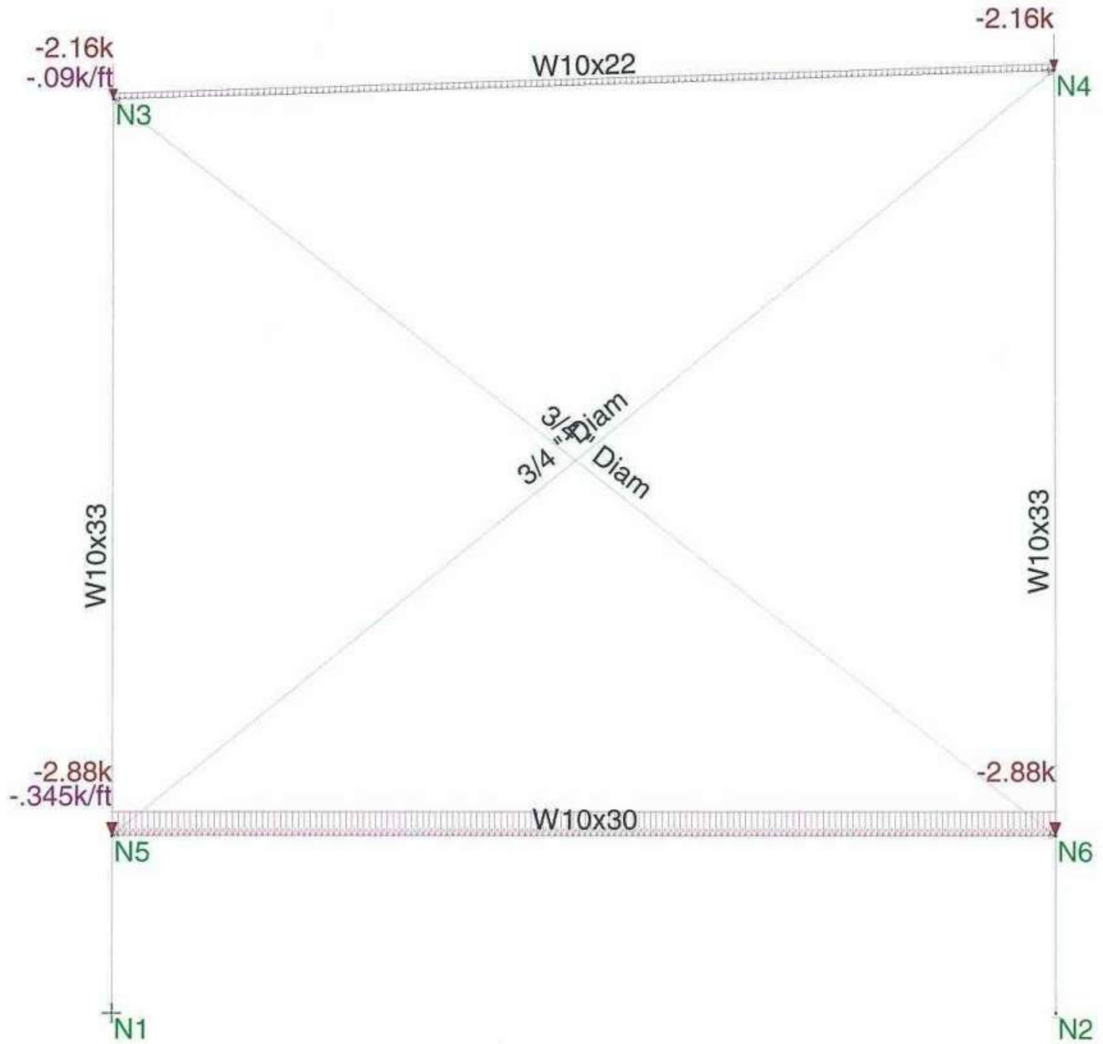


1 ELEVATION

1/4" = 1'-0"

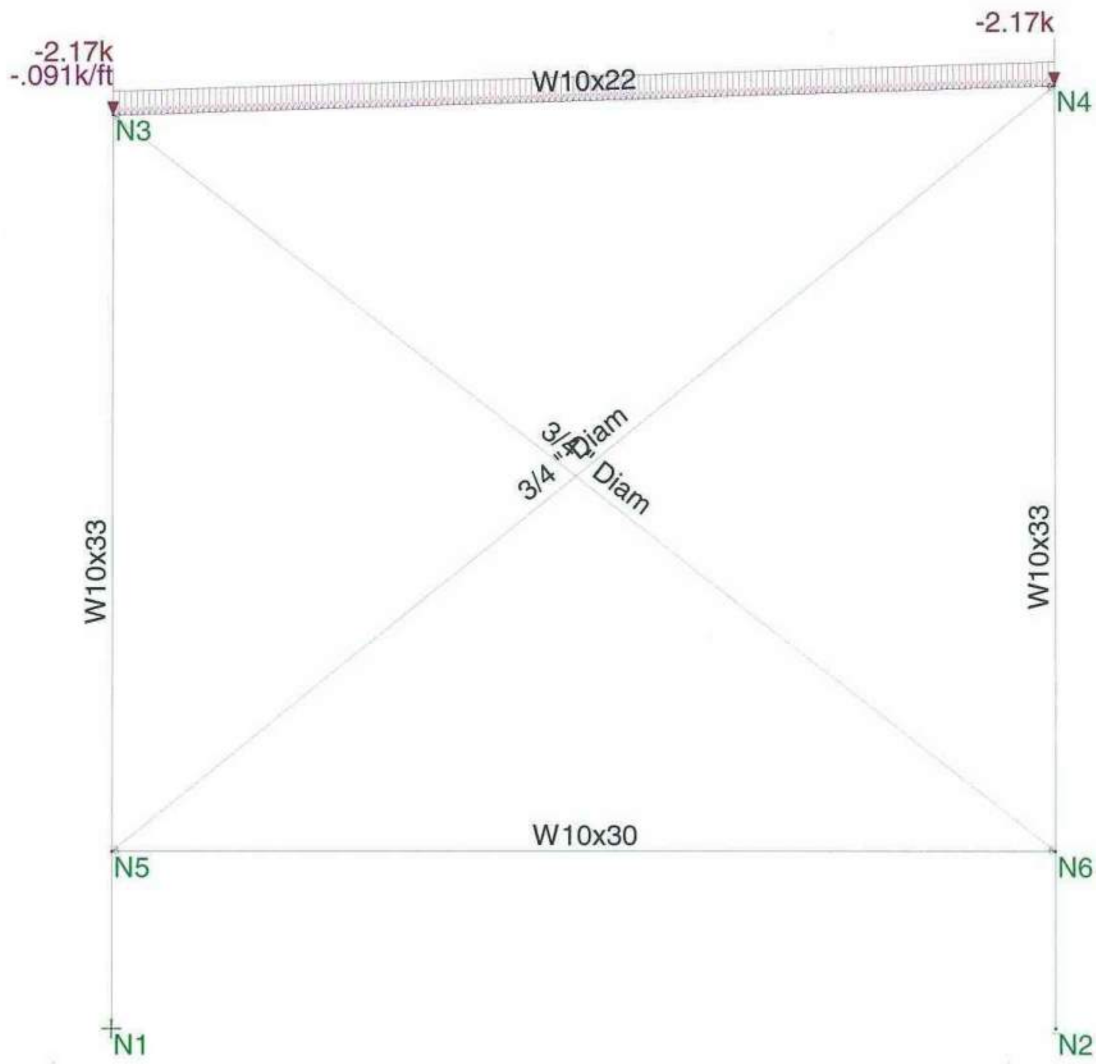
Z2

Z3



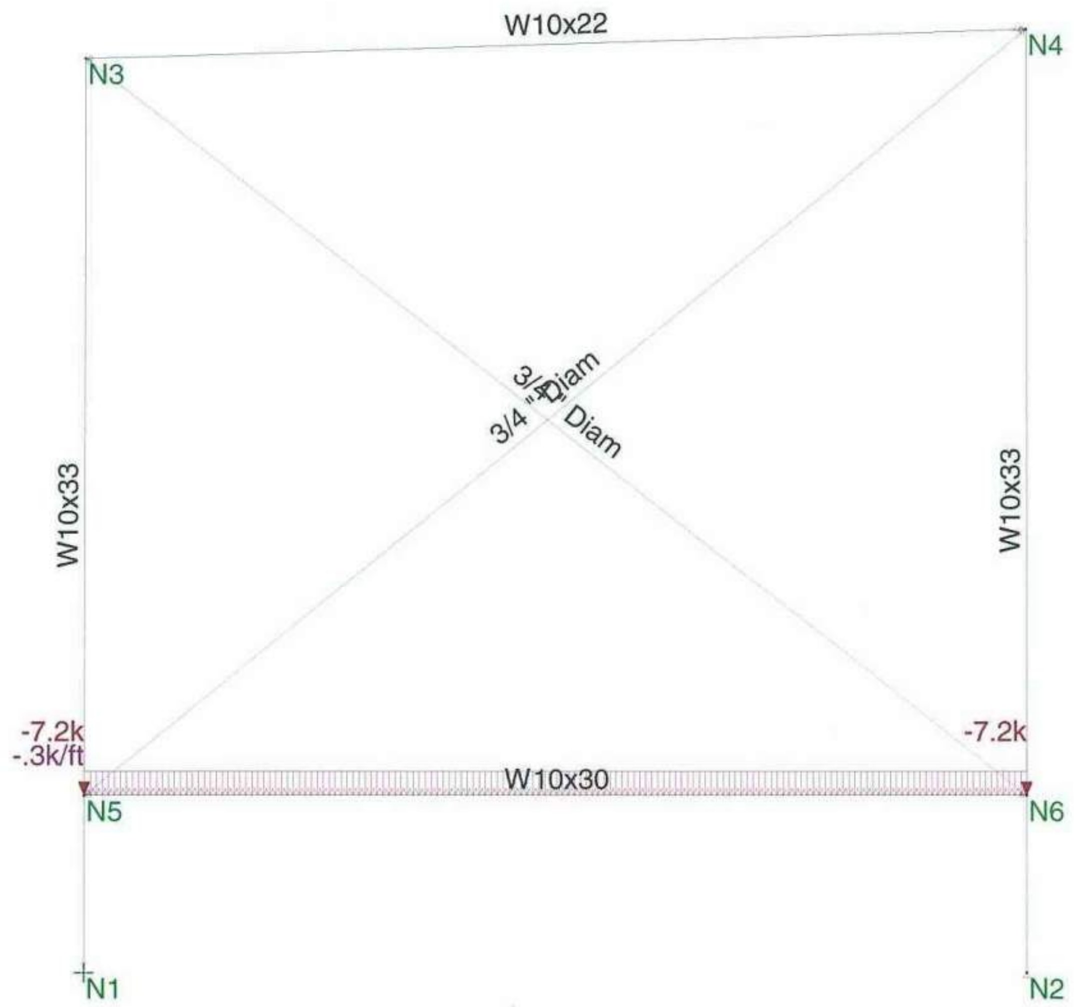
Loads: BLC 1, DL
Results for LC 1, DL+WL

Merrick	Pump House	SK - 1
PIF		Dec 7, 2016 at 2:23 PM
7481-77		Pump House Building Trans Frame...



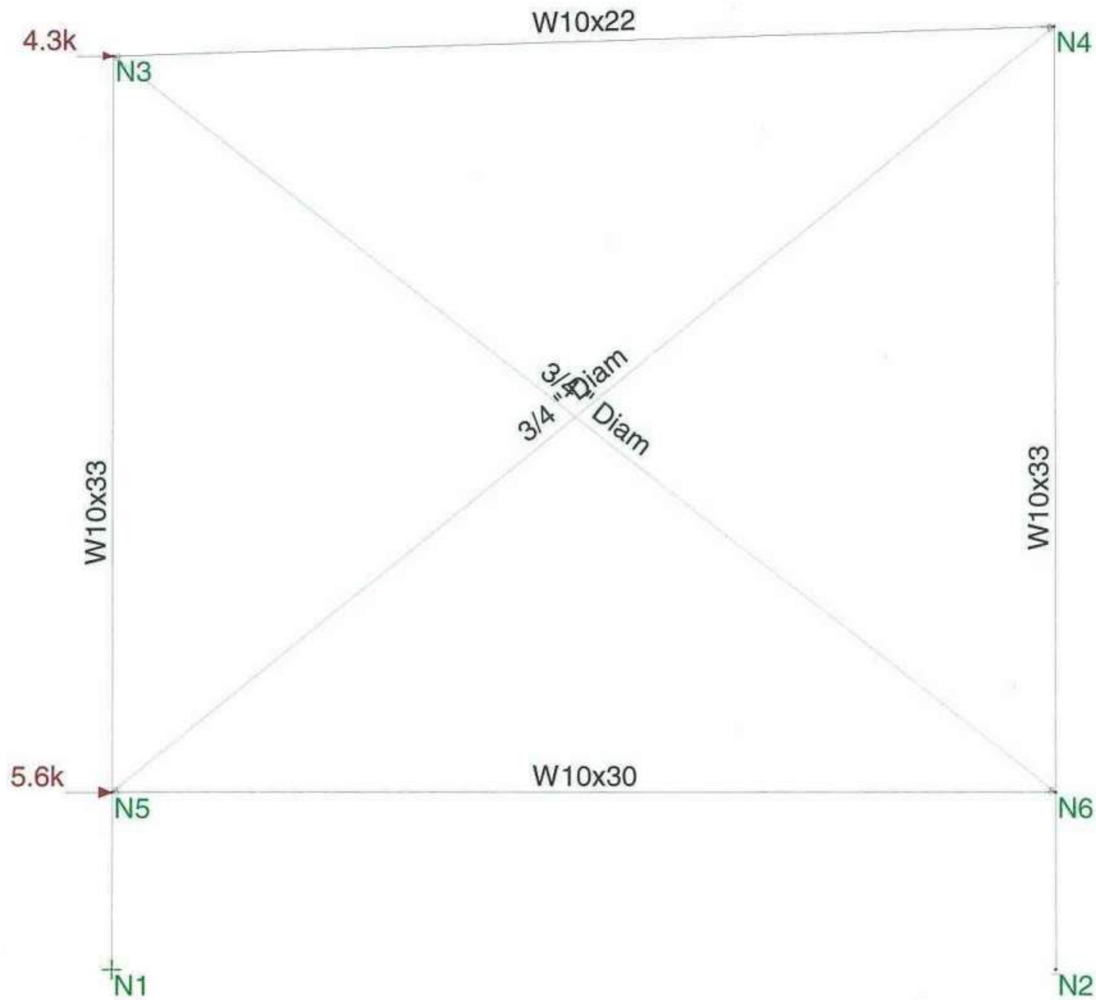
Loads: BLC 3, SL
Results for LC 1, DL+WL

Merrick	Pump House	SK - 3
PIF		Dec 7, 2016 at 2:24 PM
7481-77		Pump House Building Trans Frame...



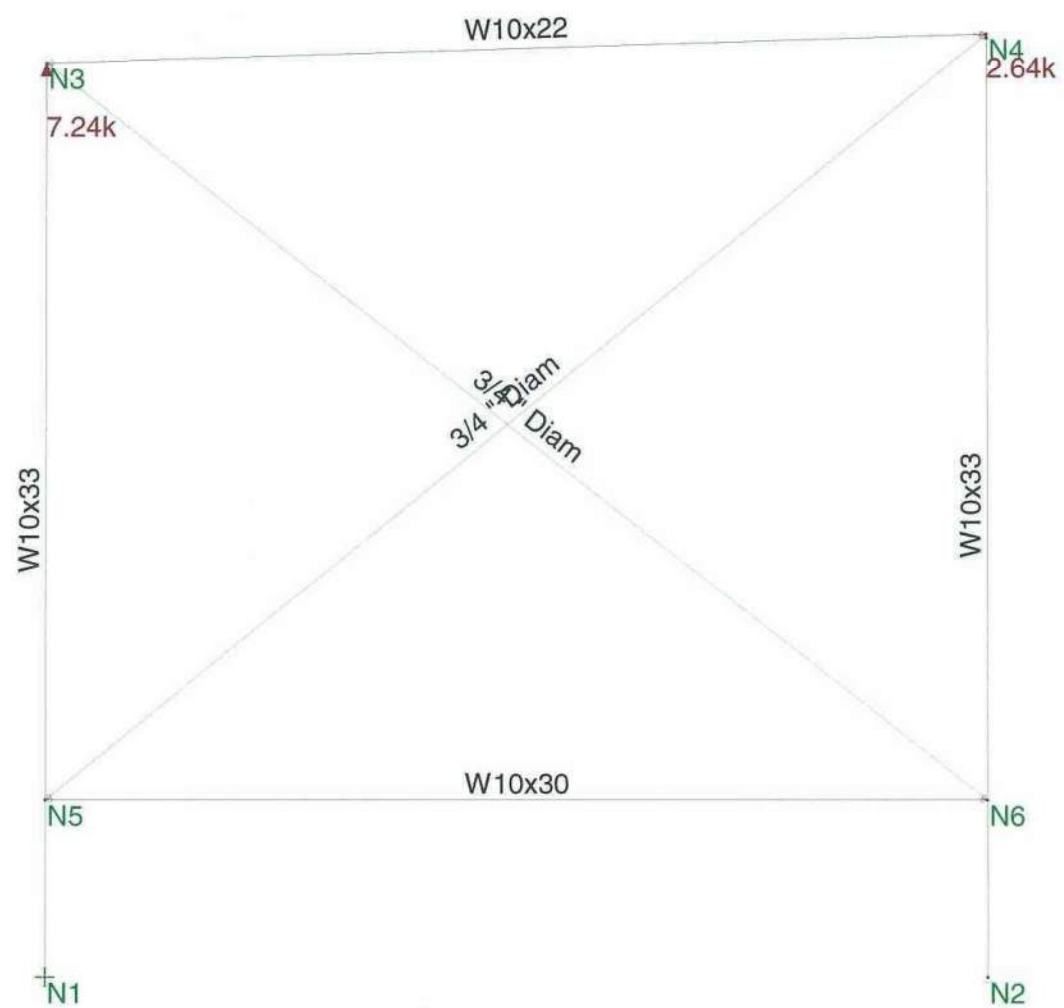
Loads: BLC 2, LL
Results for LC 1, DL+WL

Merrick	Pump House	SK - 2
PIF		Dec 7, 2016 at 2:23 PM
7481-77		Pump House Building Trans Frame...



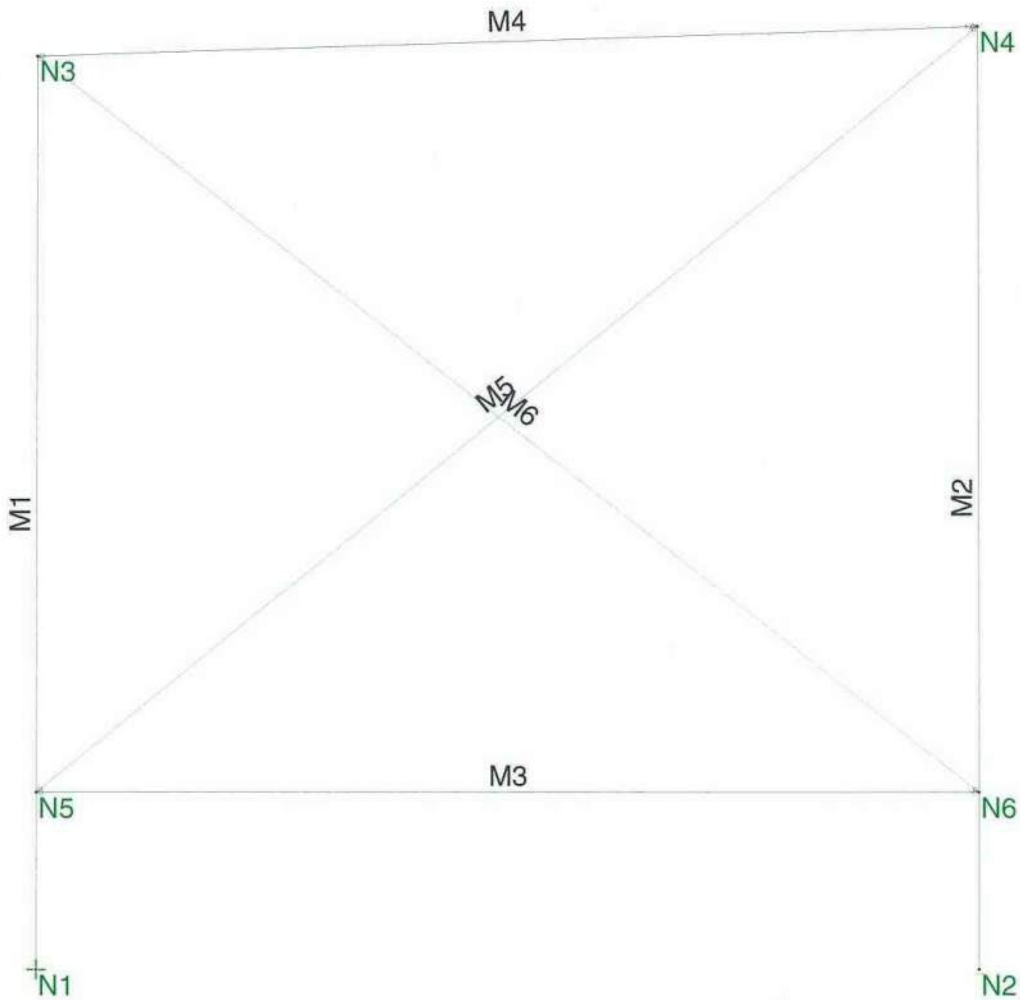
Loads: BLC 4, WL Horz
Results for LC 1, DL+WL

Merrick	Pump House	SK - 4
PIF		Dec 7, 2016 at 2:24 PM
7481-77		Pump House Building Trans Frame...



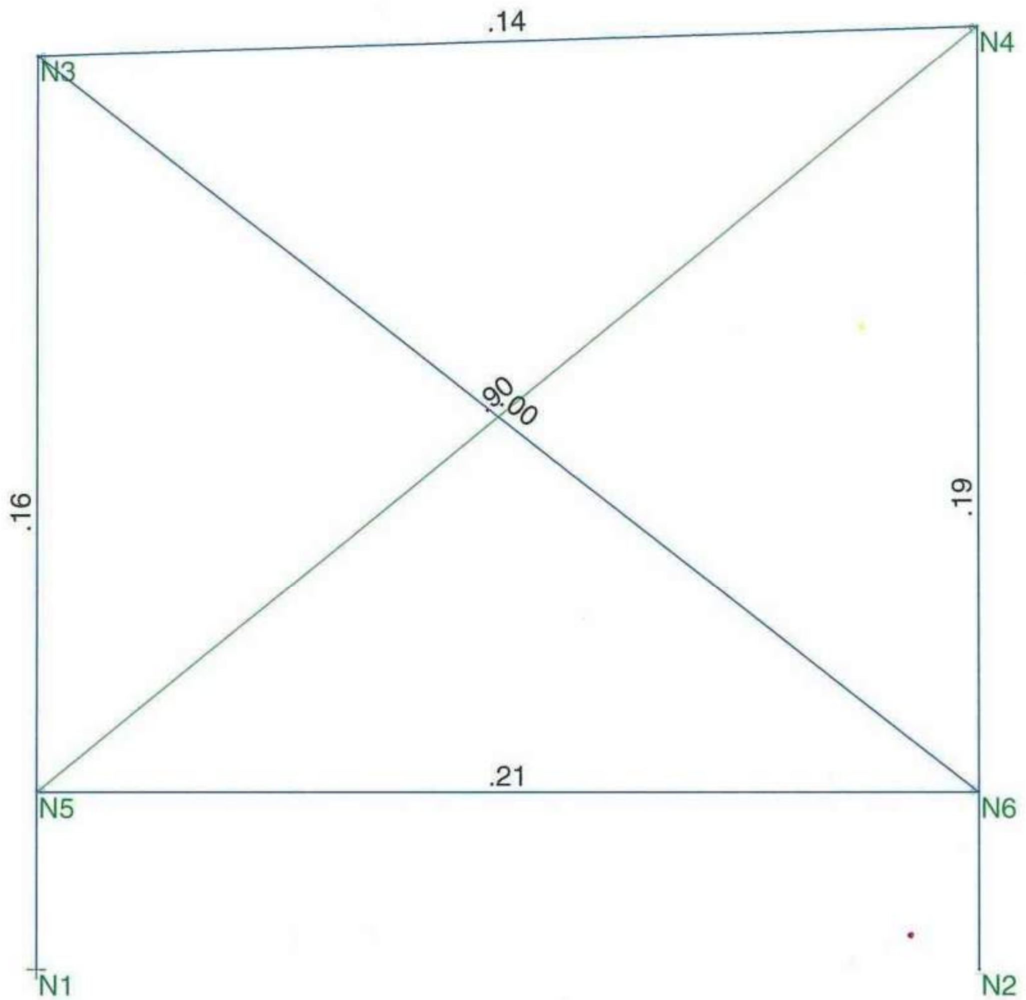
Loads: BLC 5, WL Vertical
Results for LC 1, DL+WL

Merrick	Pump House	SK - 5
PIF		Dec 7, 2016 at 2:24 PM
7481-77		Pump House Building Trans Frame...



Results for LC 2, .6DL+WL

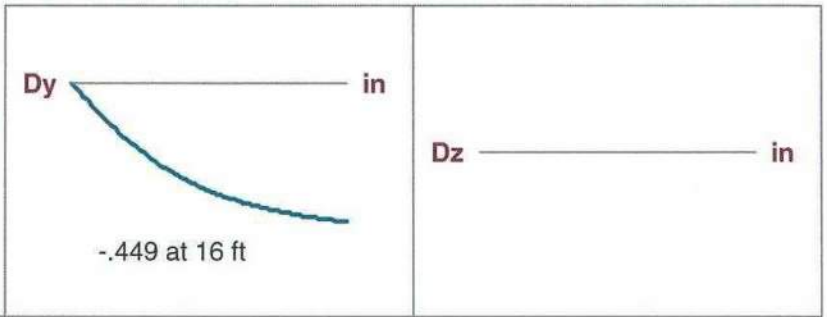
Merrick	Pump House	SK - 7
PIF		Dec 7, 2016 at 2:27 PM
7481-77		Pump House Building Trans Frame...

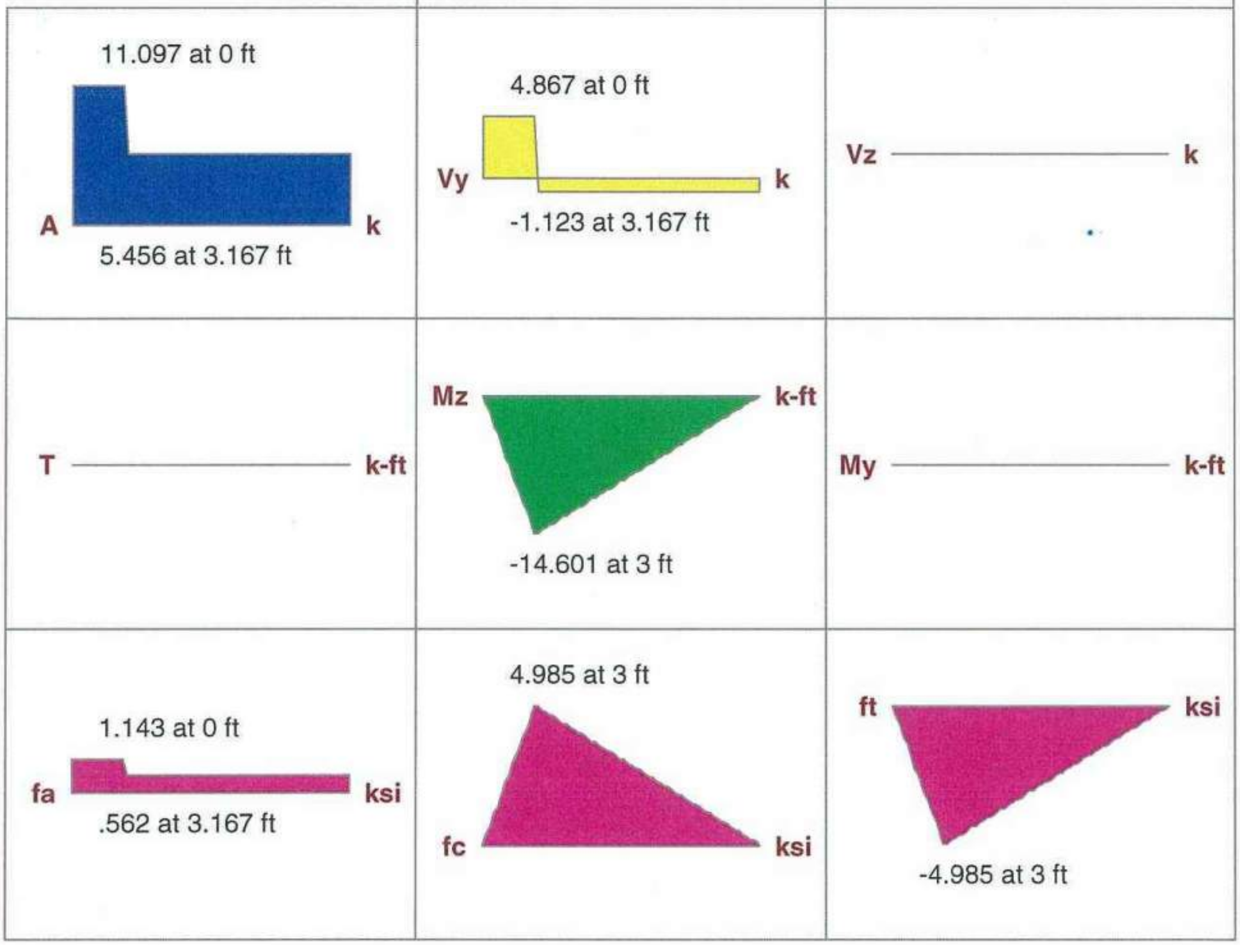


Merrick	Pump House	SK - 6
PIF		Dec 7, 2016 at 2:24 PM
7481-77		Pump House Building Trans Frame...

Column: ***M2***

Shape: **W10x33**
Material: **A992**
Length: **16 ft**
I Joint: **N2**
J Joint: **N4**
LC 1: DL+WL
Code Check: **0.190 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.190**	Max Shear Check	**0.086 (y)**
Location	**3 ft**	Location	**0 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/1522**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

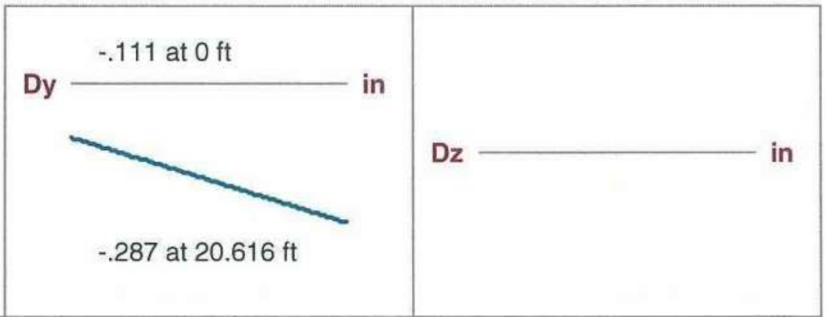
Fy	**50 ksi**
Pnc/om	**142.204 k**
Pnt/om	**290.719 k**
Mny/om	**34.93 k-ft**
Mnz/om	**96.806 k-ft**
Vny/om	**56.434 k**
Vnz/om	**124.405 k**
Cb	**1.444**

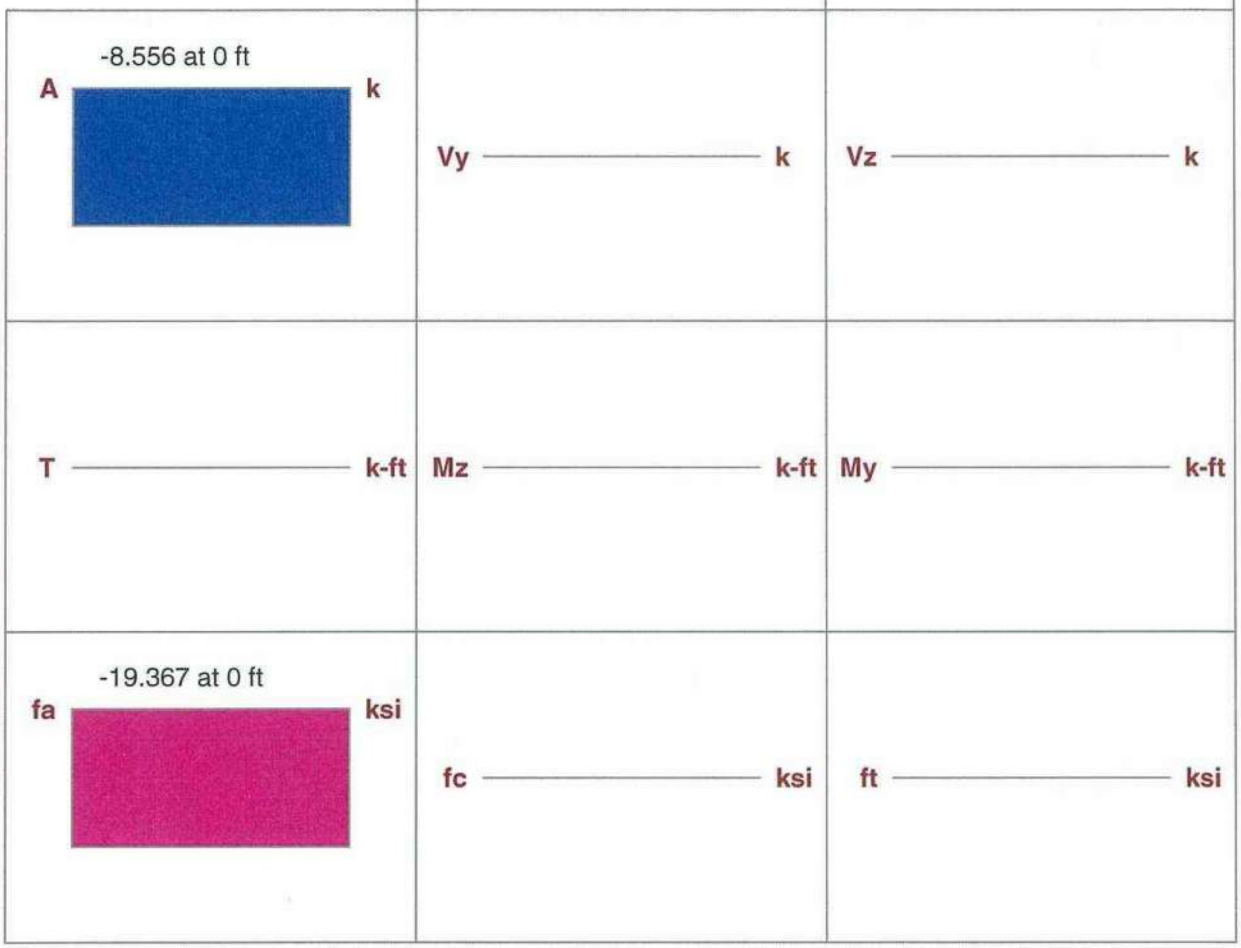
	y-y	z-z
Lb	**16 ft**	**16 ft**
KL/r	**98.894**	**45.752**

L Comp Flange	**16 ft**
Warp Length	**16 ft**
L-torque	**16 ft**
Tau_b	**1**

VBrace: ***M5***

Shape: **3/4 " Diam**
Material: **A36 Gr.36**
Length: **20.616 ft**
I Joint: **N5**
J Joint: **N4**
LC 1: DL+WL
Code Check: **0.898 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

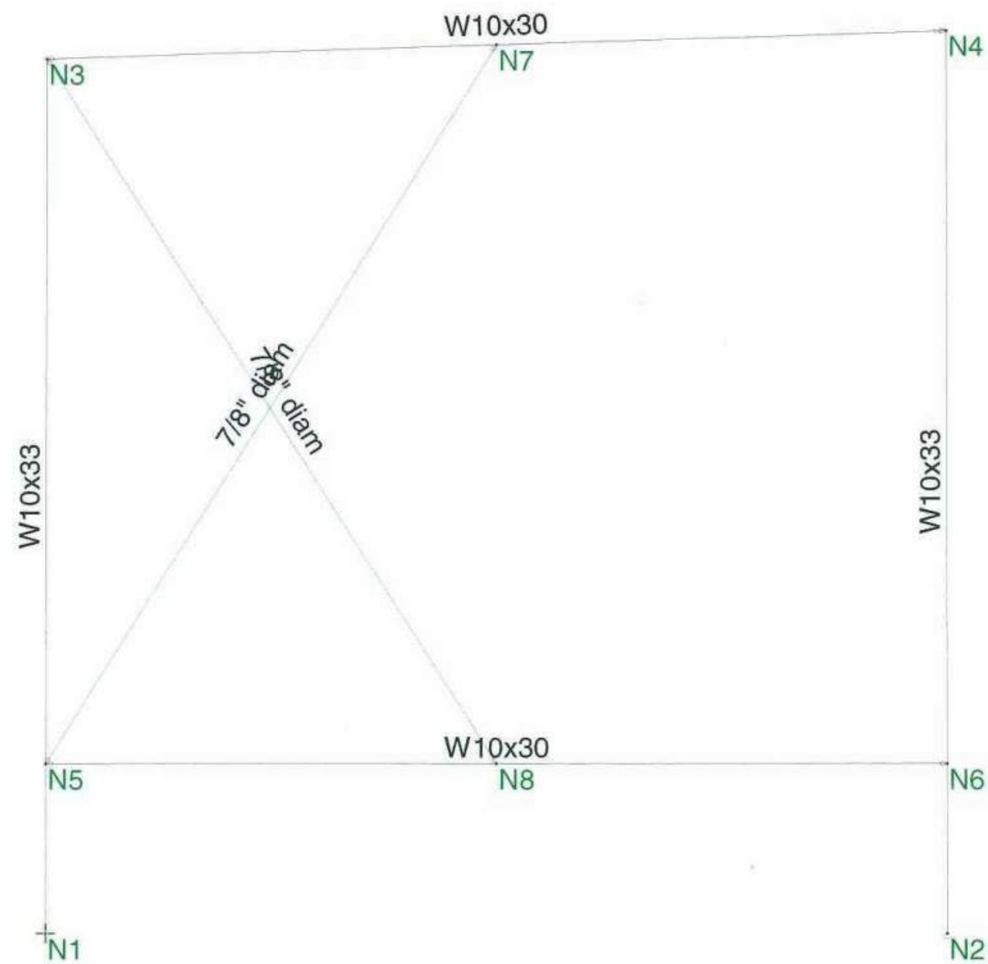
Direct Analysis Method

Max Bending Check	**0.898**	Max Shear Check	**0.000 (s)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1a**	Max Defl Ratio	**L/10000**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

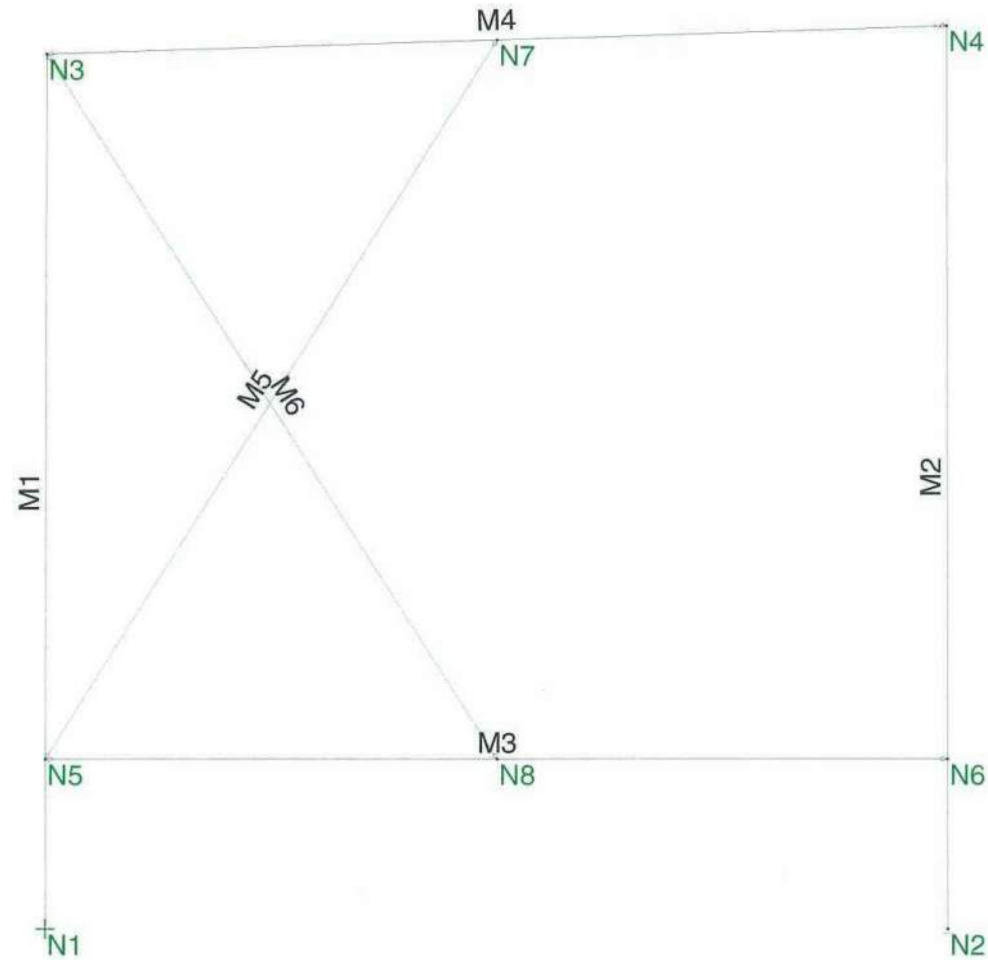
Fy	**36 ksi**
Pnc/om	**.038 k**
Pnt/om	**9.524 k**
Mny/om	**.119 k-ft**
Mnz/om	**.119 k-ft**
Vny/om	**5.714 k**
Vnz/om	**5.714 k**
Cb	**1**

	y-y	z-z
Lb	**20.616 ft**	**20.616 ft**
KL/r	**1319.394**	**1319.394**

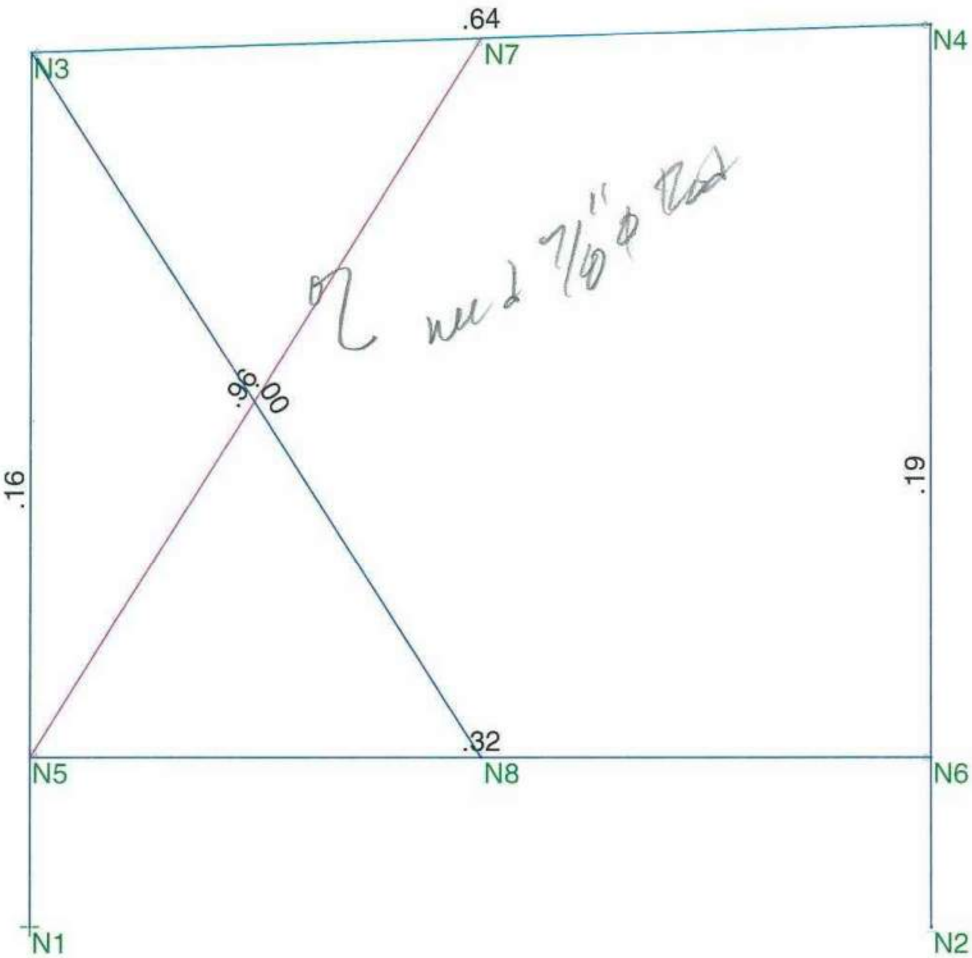
L Comp Flange	**20.616 ft**
Warp Length	**NC**
L-torque	**20.616 ft**
Tau_b	**1**



Merrick	Pump House	SK - 1
PIF		Feb 27, 2017 at 10:10 AM
7481-77		Pump House Building Trans Frame...



Merrick	Pump House	SK - 2
PIF		Feb 27, 2017 at 10:10 AM
7481-77		Pump House Building Trans Frame...

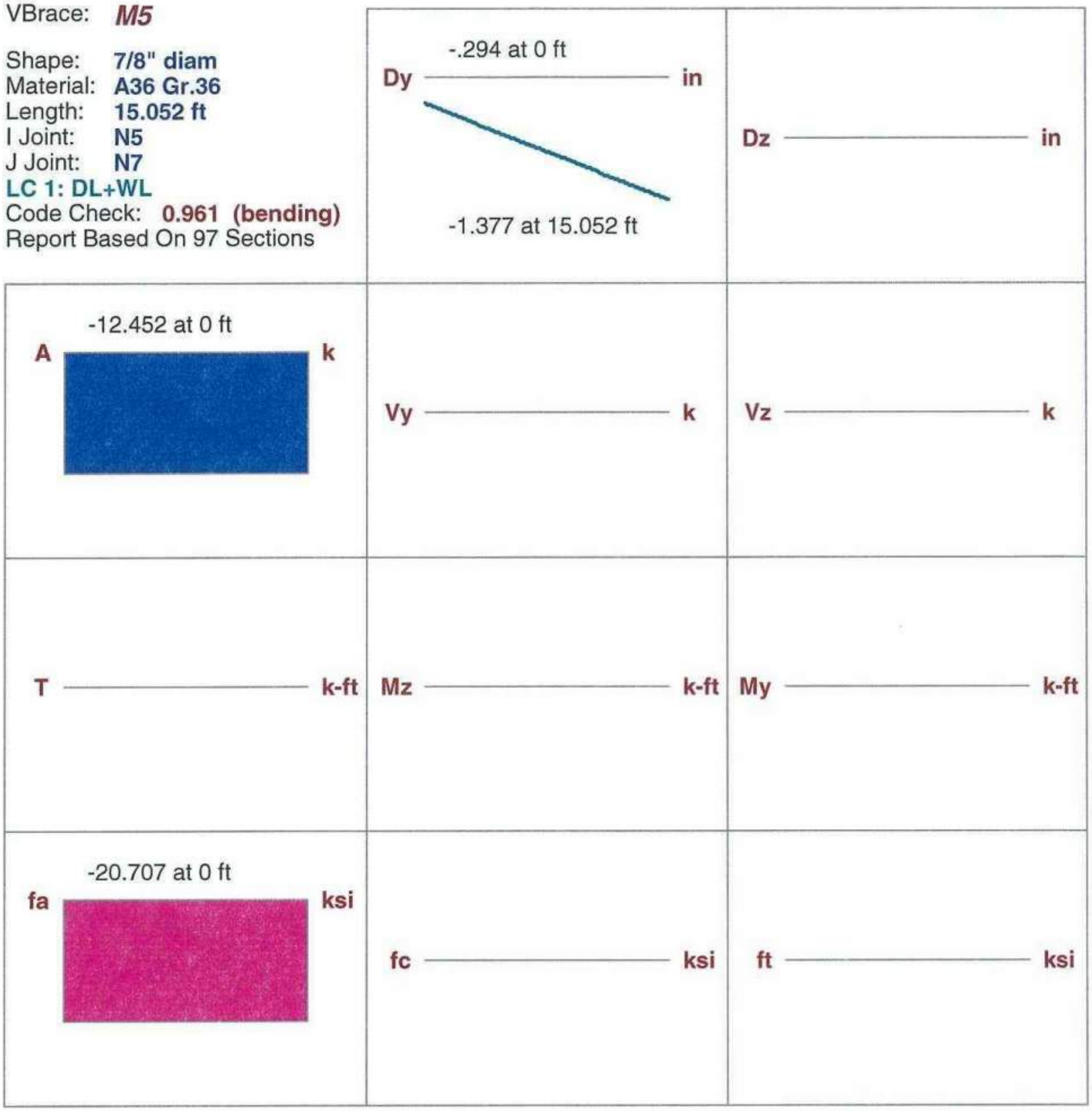


Member Code Checks Displayed (Enveloped)
Results for LC 1, DL+WL

Merrick	Pump House	SK - 3
PIF		Feb 27, 2017 at 10:11 AM
7481-77		Pump House Building Trans Frame...

VBrace: ***M5***

Shape: **7/8" diam**
Material: **A36 Gr.36**
Length: **15.052 ft**
I Joint: **N5**
J Joint: **N7**
LC 1: DL+WL
Code Check: **0.961 (bending)**
Report Based On 97 Sections



AISC 14th(360-10): ASD Code Check

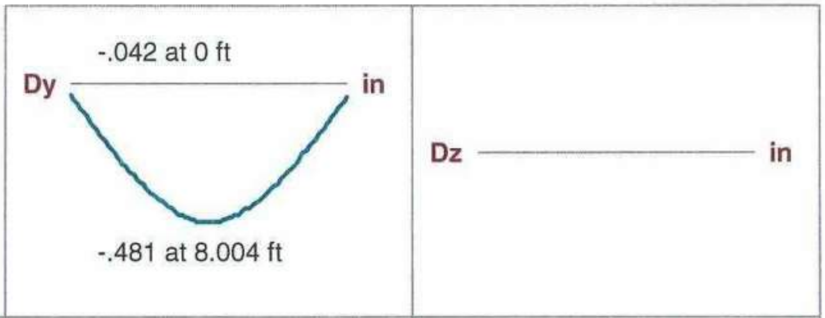
Direct Analysis Method

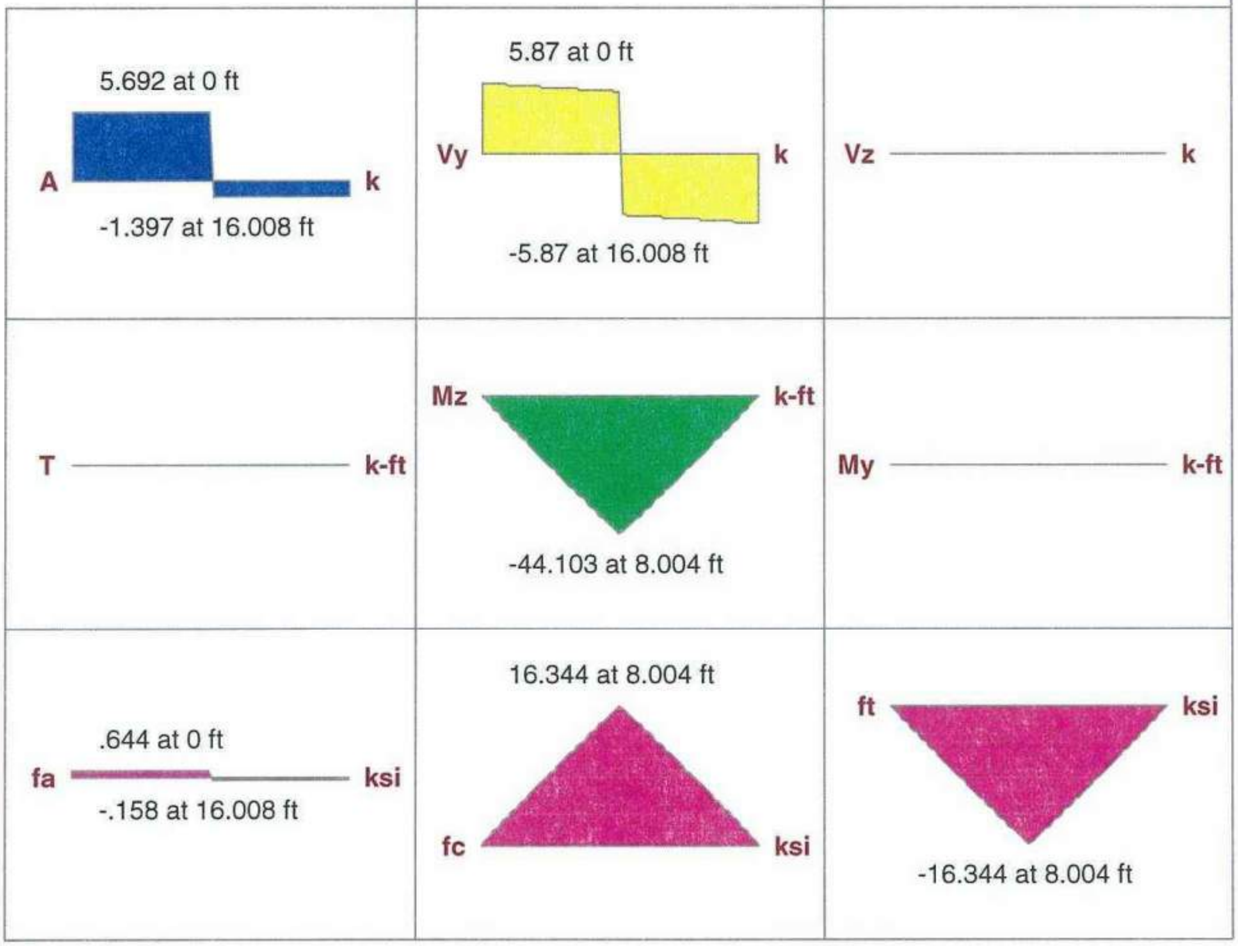
Max Bending Check	**0.961**	Max Shear Check	**0.000 (s)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1a**	Max Defl Ratio	**L/10000**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

Fy	**36 ksi**		y-y	z-z
Pnc/om	**.133 k**	Lb	**15.052 ft**	**15.052 ft**
Pnt/om	**12.963 k**	KL/r	**825.709**	**825.709**
Mny/om	**.189 k-ft**	L Comp Flange	**15.052 ft**	
Mnz/om	**.189 k-ft**	Warp Length	**NC**	
Vny/om	**7.778 k**	L-torque	**15.052 ft**	
Vnz/om	**7.778 k**	Tau_b	**1**	
Cb	**1**			

Beam: ***M4***

Shape: **W10x30**
Material: **A992**
Length: **16.008 ft**
I Joint: **N3**
J Joint: **N4**
LC 1: DL+WL
Code Check: **0.636 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

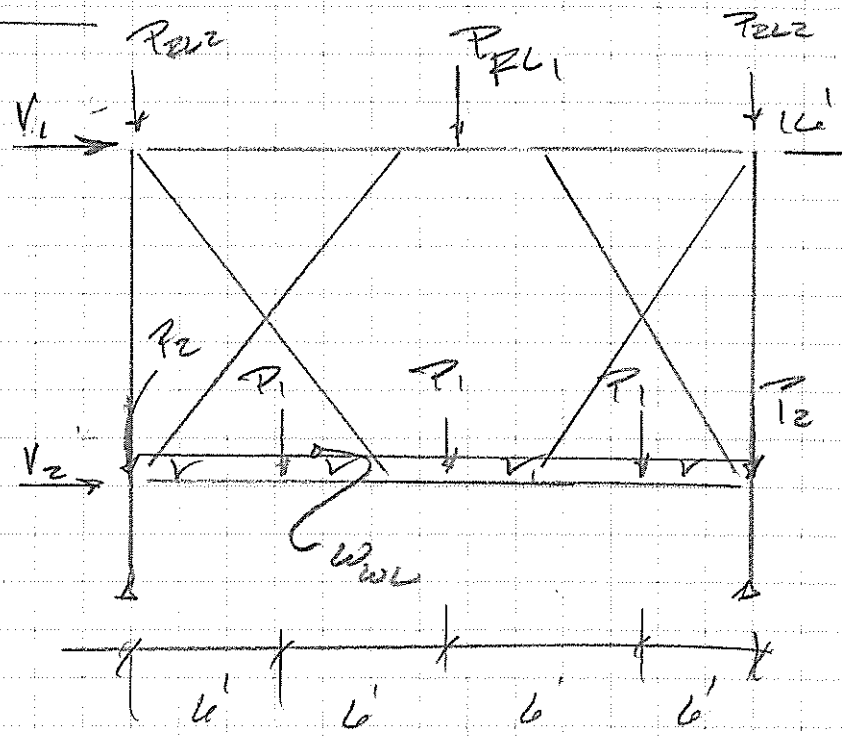
Direct Analysis Method

Max Bending Check	**0.636**	Max Shear Check	**0.093 (y)**
Location	**8.004 ft**	Location	**0 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/440**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

			y-y	z-z
Fy	**50 ksi**	Lb	**16.008 ft**	**16.008 ft**
Pnc/om	**68.025 k**	KL/r	**139.759**	**43.804**
Pnt/om	**264.671 k**			
Mny/om	**22.056 k-ft**	L Comp Flange	**16.008 ft**	
Mnz/om	**74.224 k-ft**	Warp Length	**1.334 ft**	
Vny/om	**63 k**	L-torque	**16.008 ft**	
Vnz/om	**106.459 k**	Tau_b	**1**	
Cb	**1.302**			

Revision	By	Date	Chk'd	Date
	PF			

℄ Long Frame



P_{RL1}

$P_{DL} = 12(30)(16/2)$
$= 2,880$ #

$P_{SL} = 2,880$ #

$P_{WL} = .16(75.8)(12)(16/2)$
$= 4366$ # up

P_{RL2}

$P_{DL} = 2,880/2$
$= 1440$ #

$P_{SL} = 1440$ #

$P_{WL} = 4366/2$
$= 2183$ #

P_1

$P_{DL} = 40(12)(16/2) = 3,840$ #

$P_{LL} = 100(12)(16/2) = 9,600$ #

$w_{WL} = 15(16) = 240$ #/ft

P_2

$P_{DL} = 3840/2 + 15(16)(16/2)$
$= 3840$

$P_{LL} = 9,600/2 = 4,800$ #

Subject: McMurdo Utilities

Pump House

Revision	By	Date	Chk'd	Date
	PF			

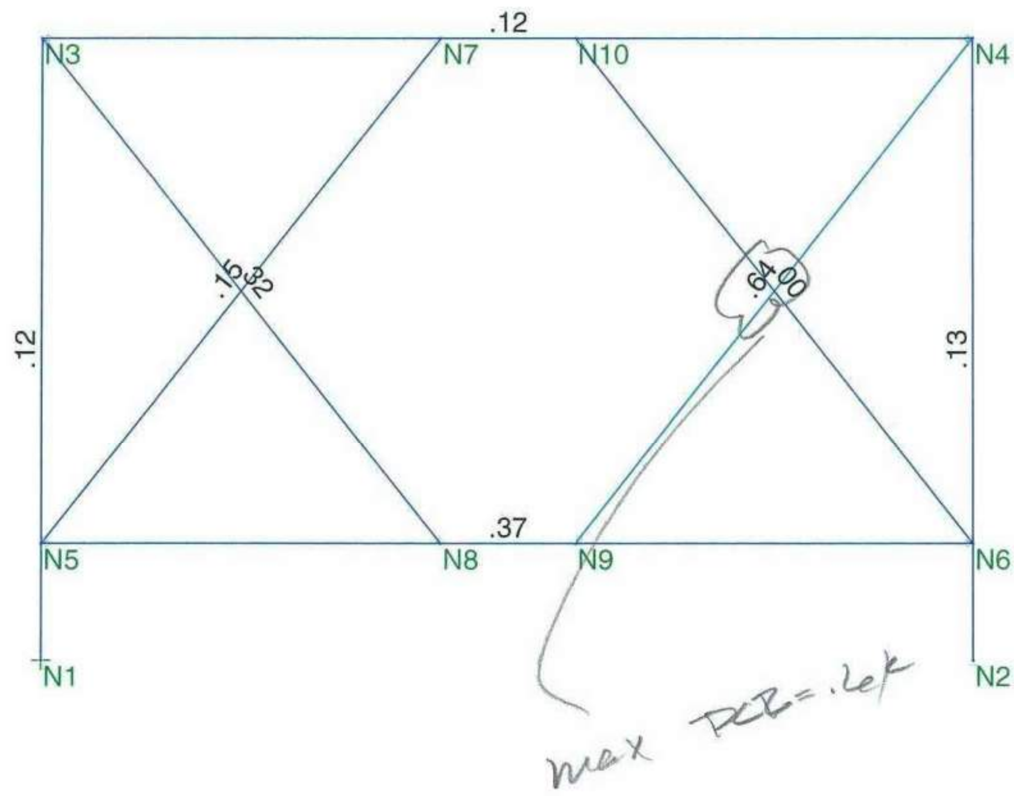
$V_1 = 80(16/2)(13/2)(.6)/1{,}000$

$= 2.5\ k$

$V_2 = 80(16/2)(13/2 + 3/2)(.6)/1{,}000$

$= 3.07\ k$

Use 7/8" φ Rod for bracing
see following print outs



Member Code Checks Displayed
Results for LC 1, DL+WL

Merrick	Pump House	SK - 8
PIF		Feb 28, 2017 at 2:30 PM
7481-77		Pump House Building Long Frame....

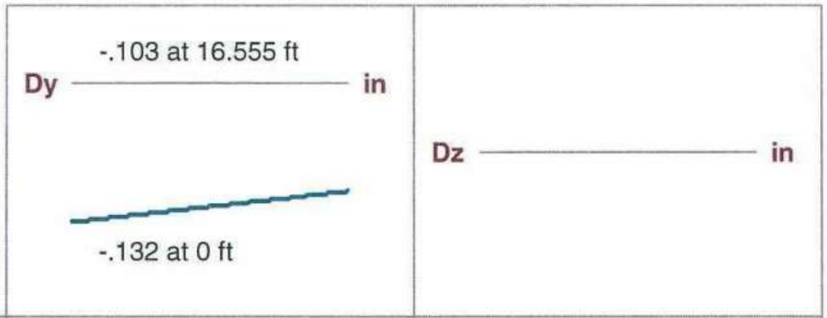
VBrace: ***M7***

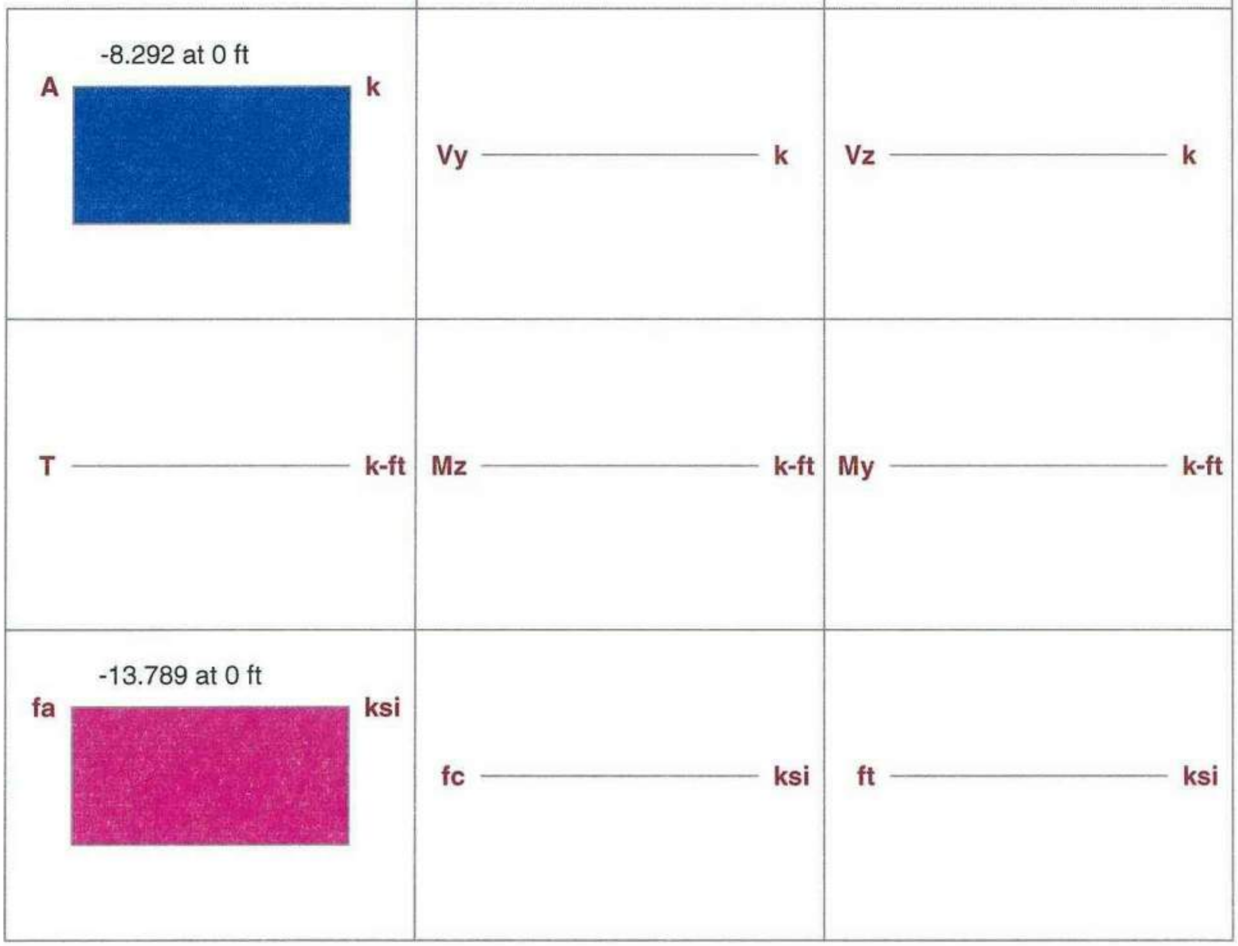
Shape:	**7/8" diam**
Material:	**A36 Gr.36**
Length:	**16.555 ft**
I Joint:	**N9**
J Joint:	**N4**

LC 1: DL+WL

Code Check: **0.640 (bending)**

Report Based On 97 Sections



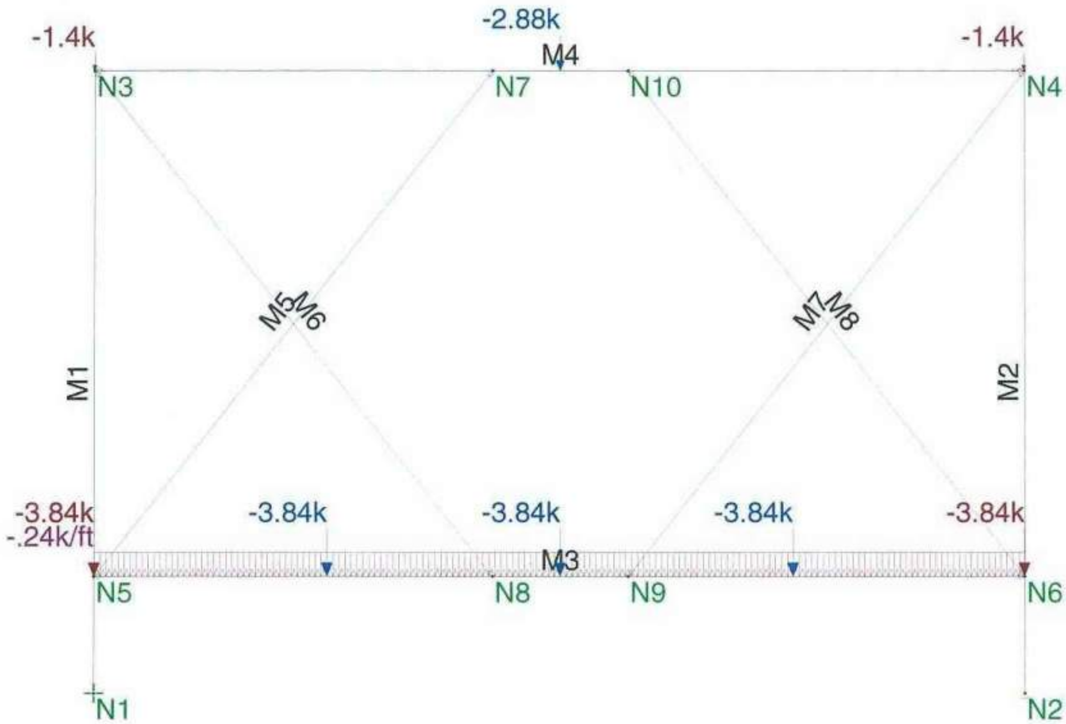


AISC 14th(360-10): ASD Code Check

Direct Analysis Method

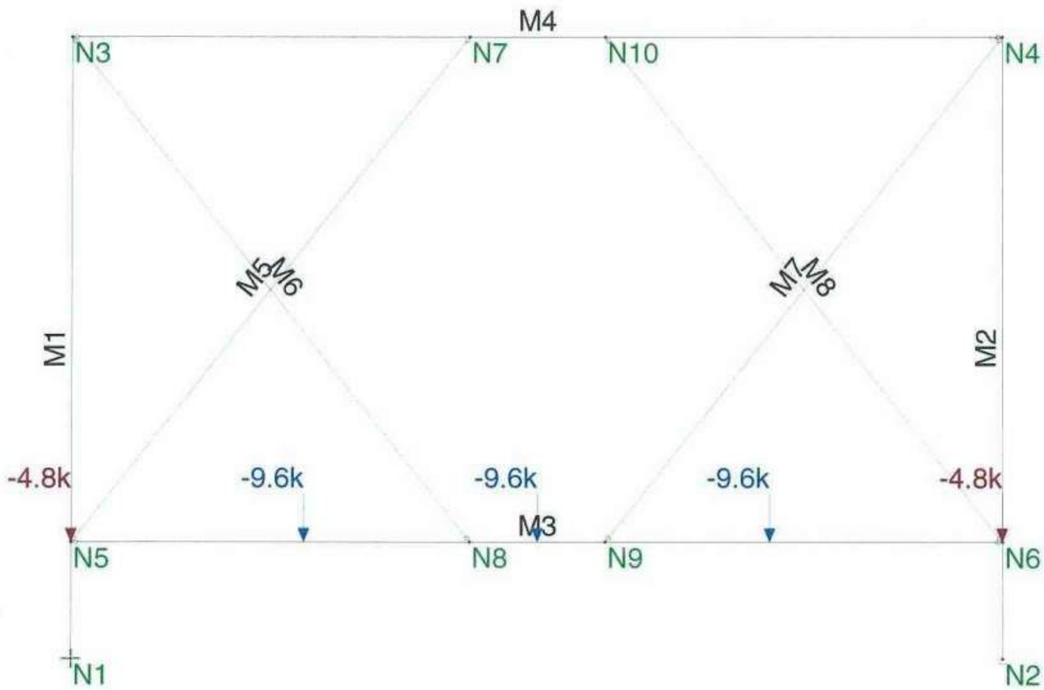
Max Bending Check	**0.640**	Max Shear Check	**0.000 (s)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1a**	Max Defl Ratio	**L/10000**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

			y-y	z-z
Fy	**36 ksi**	Lb	**16.555 ft**	**16.555 ft**
Pnc/om	**.11 k**	KL/r	**908.151**	**908.151**
Pnt/om	**12.963 k**			
Mny/om	**.189 k-ft**	L Comp Flange	**16.555 ft**	
Mnz/om	**.189 k-ft**	Warp Length	**NC**	
Vny/om	**7.778 k**	L-torque	**16.555 ft**	
Vnz/om	**7.778 k**	Tau_b	**1**	
Cb	**1**			



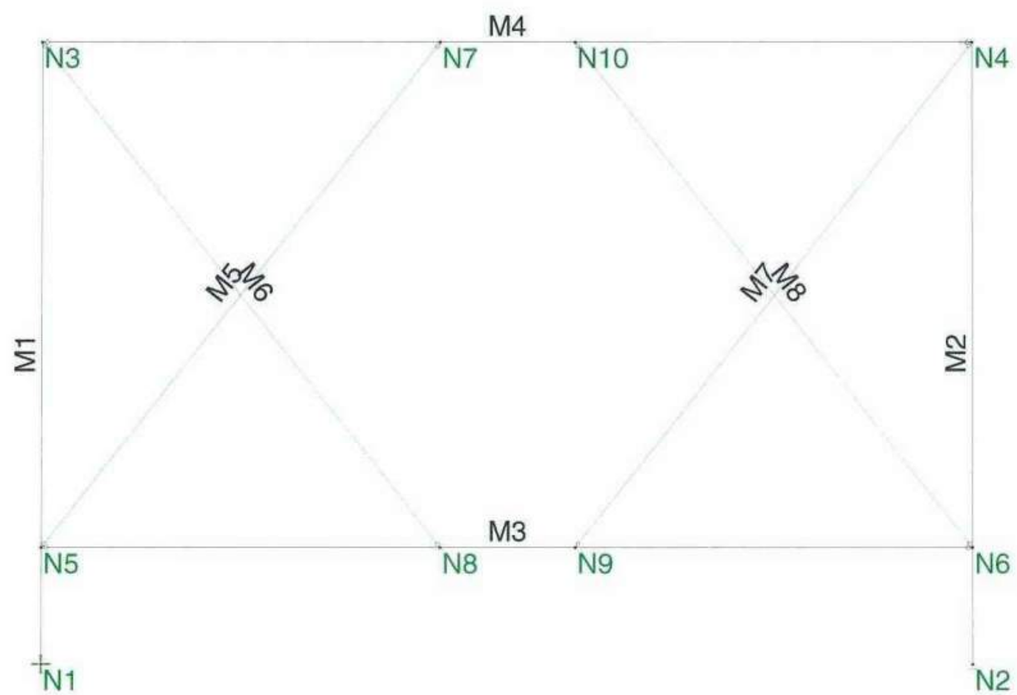
Loads: BLC 1, DL

Merrick	Pump House	SK - 3
PIF		Feb 28, 2017 at 2:11 PM
7481-77		Pump House Building Long Frame....

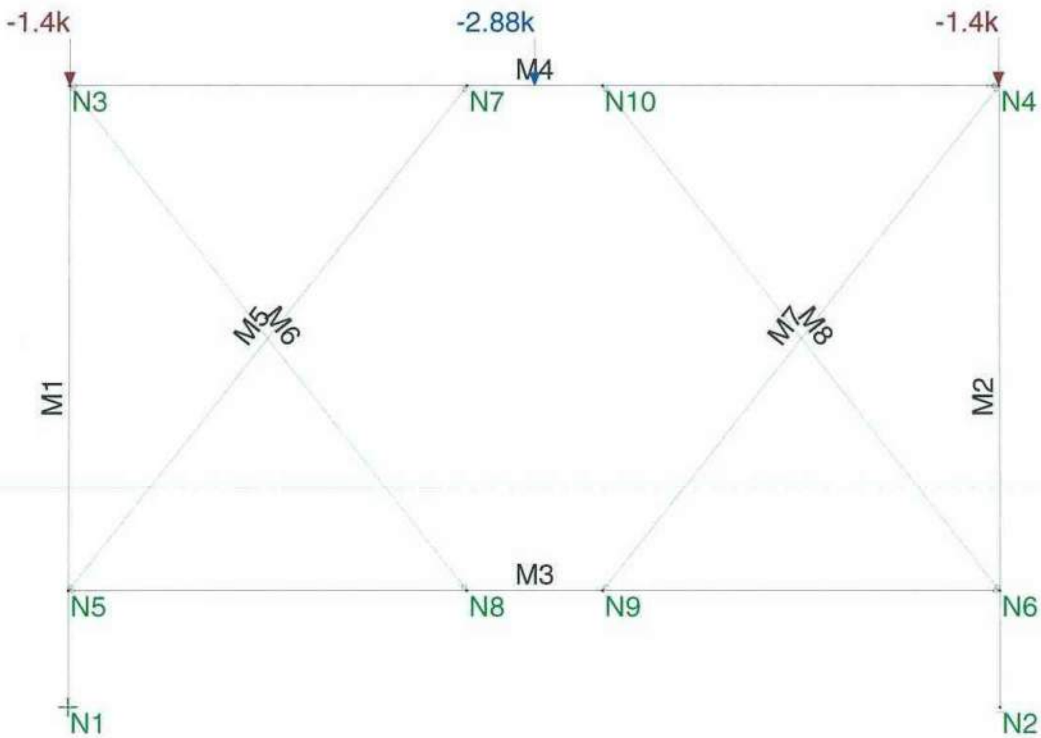


Loads: BLC 2, LL

Merrick	Pump House	SK - 4
PIF		Feb 28, 2017 at 2:11 PM
7481-77		Pump House Building Long Frame....

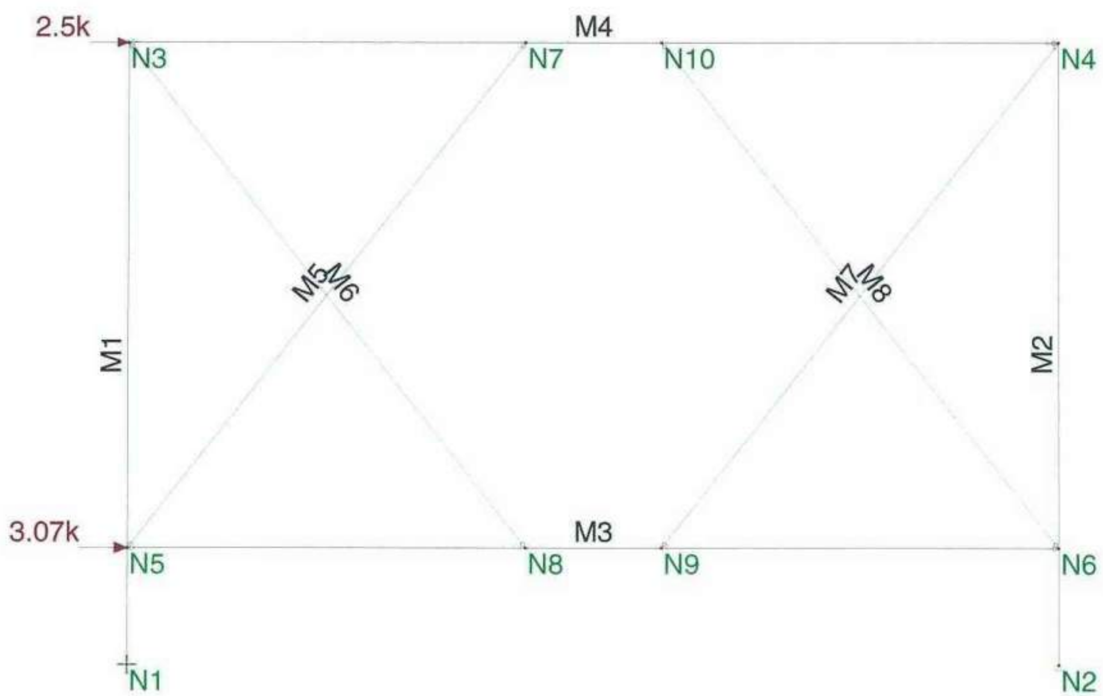


Merrick	Pump House	SK - 2
PIF		Feb 28, 2017 at 2:11 PM
7481-77		Pump House Building Long Frame....



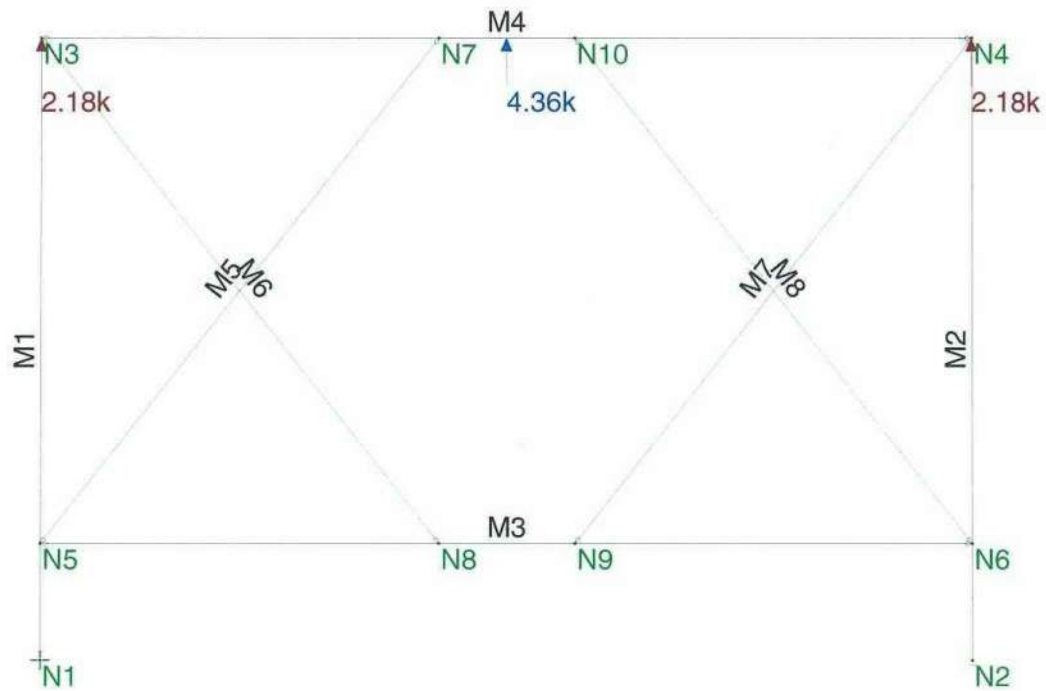
Loads: BLC 3, SL

Merrick	Pump House	SK - 5
PIF		Feb 28, 2017 at 2:12 PM
7481-77		Pump House Building Long Frame....



Loads: BLC 4, WL Horz

Merrick	Pump House	SK - 6
PIF		Feb 28, 2017 at 2:12 PM
7481-77		Pump House Building Long Frame....



Loads: BLC 5, WL Vertical

Merrick	Pump House	SK - 7
PIF		Feb 28, 2017 at 2:12 PM
7481-77		Pump House Building Long Frame....

Subject McMurdo utilities
Pump House

Revision	By	Date	Chk'd	Date
	PG			

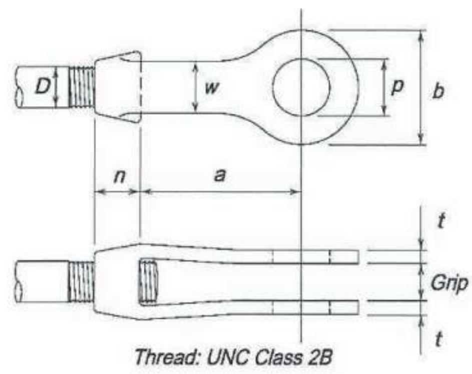
Check Tension Rod Connection

$T_{max\ allowable} = 12.5$ kips

use 2 1/2 Clevis w/
1" ϕ Pin $T_{all} = 12.5k = 12.5k$ OK
See Following Printout

Turnbuckle Capacity for 7/8" ϕ
Rod = 12.5 kips
Turnbuckle Capacity = 12 kips
DCR = 12.5/12 = 1.04 within 4%
OK
See Following print out

Table 15-4
Dimensions and Weights of Clevises



Clevis Number	Dimensions, in.							Weight, lb	Available Strength, kips*	
	Max. *D*	Max. *p*	*b*	*n*	*a*	*w*	*t*		ASD	LRFD
2	5/8	3/4	1 7/16	5/8	3 9/16	1 1/16	5/16 (+1/32, -0)	1	5.83	8.75
2 1/2	7/8	1 1/2	2 1/2	1	4	1 1/4	5/16 (+1/32, -0)	2.5	12.5	18.8
3	1 3/8	1 3/4	3	1 1/4	5 1/16	1 1/2	1/2 (+1/16, -1/32)	4	25.0	37.5
3 1/2	1 1/2	2	3 1/2	1 1/2	6	1 3/4	1/2 (+1/16, -1/16)	6	30.0	45.0
4	1 3/4	2 1/4	4	1 3/4	5 15/16	2	1/2 (+1/16, -1/16)	9	35.0	52.5
5	2 1/8	2 1/2	5	2 1/4	7	2 1/2	5/8 (+3/32, -0)	16	62.5	93.8
6	2 1/2	3	6	2 3/4	8	3	3/4 (+3/32, -0)	26	90.0	135
7	3	3 3/4	7	3	9	3 1/2	7/8 (+1/8, -1/16)	36	114	171
8	4	4 1/4	8	4	10 1/8	4	1 1/2 (+1/8, -1/16)	90	225	338

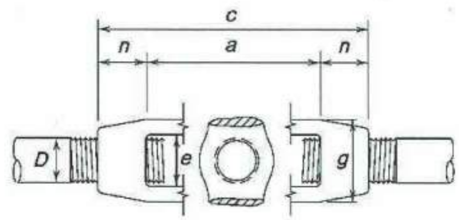
Notes:
Weights and dimensions of clevises are typical; products of all suppliers are essentially similar. User shall verify with the manufacturer that product meets available strength specifications above.
* Tabulated available strengths are based on $\phi = 0.50$, $\Omega = 3.00$. Strength at service load corresponds to a 3:1 safety factor using maximum pin diameter.

Table 15-5
Clevis Numbers Compatible with Various Rods and Pins

Dia. of Tap, in.	Diameter of Pin, in.																	
	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$	$1^1/_2$	$1^3/_4$	2	$2^1/_4$	$2^1/_2$	$2^3/_4$	3	$3^1/_4$	$3^1/_2$	$3^3/_4$	4	$4^1/_4$
$^3/_8$	2	2	2															
$^1/_2$	2	2	2															
$^5/_8$	2	2	2	$2^1/_2$	$2^1/_2$	$2^1/_2$	$2^1/_2$											
$^3/_4$			$2^1/_2$	$2^1/_2$	$2^1/_2$	$2^1/_2$	$2^1/_2$											
$^7/_8$				$2^1/_2$	$2^1/_2$	$2^1/_2$	$2^1/_2$	3										
1					3	3	3	3										
$1^1/_8$					3	3	3	3	$3^1/_2$									
$1^1/_4$					3	3	3	3	$3^1/_2$									
$1^3/_8$						3	3	$3^1/_2$	$3^1/_2$	4								
$1^1/_2$						$3^1/_2$	$3^1/_2$	4	4	5								
$1^5/_8$						4	4	4	5	5	5							
$1^3/_4$							4	5	5	5	5							
$1^7/_8$							5	5	5	5	5							
2							5	5	5	5	5	6	6					
$2^1/_8$								5	5	6	6	6	6					
$2^1/_4$									6	6	6	6	6	7	7			
$2^3/_8$									6	6	6	6	7	7	7	7		
$2^1/_2$									6	6	6	7	7	7	7	7		
$2^5/_8$											7	7	7	7	7	8		
$2^3/_4$											7	7	7	7	8	8		
$2^7/_8$											7	8	8	8	8	8	8	8
3											7	8	8	8	8	8	8	8
$3^1/_8$												8	8	8	8	8	8	8
$3^1/_4$												8	8	8	8	8	8	8
$3^3/_8$												8	8	8	8	8	8	8
$3^1/_2$													8	8	8	8	8	8
$3^5/_8$													8	8	8	8	8	
$3^3/_4$													8	8	8	8	8	
$3^7/_8$														8	8	8		
4														8	8			

Notes:
Tabular values assume that the net area of the clevis through the pin hole is greater than or equal to 125% of the net area of the rod, and is applicable to round rods without upset ends. For other net area ratios, the required clevis size may be calculated by referring to the dimensions tabulated in Tables 15-4 and 7-17.

Table 15-6
Dimensions and Weights of Turnbuckles



Threads: UNC and 4UN Class 2B

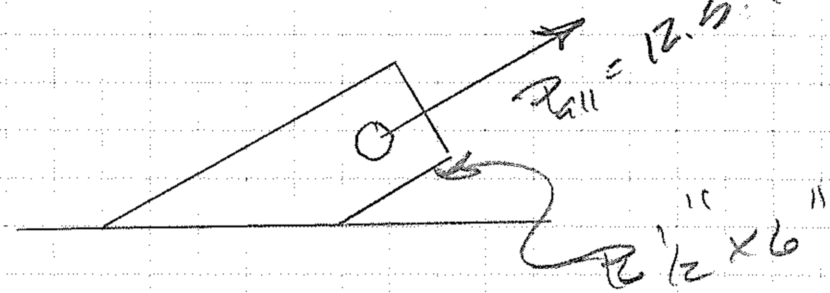
Diameter D, in.	Dimensions, in.					Weight (lb) for Length a, in.						Available Strength, kips	
	a	n	c	e	g	6	9	12	18	24	26	ASD R_n/Ω*	LRFD ϕR_n*
3/8	6	9/16	7 1/8	9/16	1 1/32	0.42						2.00	3.00
1/2	6	25/32	7 9/16	11/16	1 5/16	0.65	0.90	1.20				3.67	5.50
5/8	6	15/16	7 7/8	13/16	1 1/2	0.98	1.35	1.58	2.43			5.83	8.75
3/4	6	1 1/16	8 1/8	15/16	1 23/32	1.45	1.84	2.35	3.06	4.25		8.67	13.0
7/8	6	1 5/16	8 5/8	1 3/32	1 7/8	1.85		3.02	4.20	5.43		12.0	18.0
1	6	1 7/16	8 7/8	1 9/32	2 1/32	2.60		4.02	4.40	6.85	10.0	15.5	23.3
1 1/8	6	1 9/16	9 1/8	1 13/32	2 9/32	4.06		4.70	6.10			19.3	29.0
1 1/4	6	1 9/16	9 1/8	1 9/16	2 17/32	4.00		6.49	7.13	11.3	13.1	25.3	38.0
1 3/8	6	1 13/16	9 5/8	1 11/16	2 3/4	6.15						29.0	43.5
1 1/2	6	1 7/8	9 3/4	1 27/32	3 1/32	6.15		9.70	9.13	16.8	19.4	35.0	52.5
1 5/8	6	2 1/2	11	1 31/32	3 9/32	9.80						40.9	61.3
1 3/4	6	2 1/2	11	2 1/8	3 9/16	9.80		15.3	16.0	19.5		47.2	70.8
1 7/8	6	2 13/16	11 5/8	2 3/8	4	14.0		15.3				62.0	93.0
2	6	2 13/16	11 5/8	2 3/8	4	14.0		15.3		27.5		62.0	93.0
2 1/4	6	3 5/16	12 5/8	2 11/16	4 5/8	19.6		30.9		43.5		80.0	120
2 1/2	6	3 3/4	13 1/2	3	5	23.3		30.9		42.4		100	150
2 3/4	6	4 3/16	14 3/8	3 1/4	5 5/8	31.5				54.0		125	188
3	6	4 5/16	14 5/8	3 5/8	6 1/8	39.5						161	242
3 1/4	6	5 7/16	16 7/8	3 7/8	6 3/4	60.5		79.5				203	305
3 1/2	6	5 7/16	16 7/8	3 7/8	6 3/4	60.5	70.0	79.5				203	305
3 3/4	6	6	18	4 5/8	8 1/2	95.0						280	420
4	6	6	18	4 5/8	8 1/2	95.0						280	420
4 1/4	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
4 1/2	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
4 3/4	9	6 3/4	22 1/2	5 1/4	9 3/4		152					390	585
5	9	7 1/2	24	6	10		200					491	737

Notes:
Weights and dimensions of turnbuckles are typical; products of all suppliers are essentially similar. Users shall verify with the manufacturer that product meets strength specifications above.
* Tabulated available strengths are based on $\phi = 0.50$, $\Omega = 3.00$.

Subject: McMurdo Utilities — Pump House

Revision	By	Date	Chk'd	Date
	PJ			

Size Connection Plate for Clevis



Tension

$P/\Omega_T = F_y(A_g)$ $F_y = 36$ ksi, $\Omega = 1.67$

$= \frac{36(.5)(6)}{1.67}$

$= 64.7$ k > 12.5 k // OK

$\frac{P_n}{\Omega} = F_u A_e$ $F_u = 58$ ksi, $\Omega = 2.0$

$= \frac{36(.5)(6 - 1\text{-}1/8)}{2}$

$= 87.5$ k > 12.5 k // OK

Use PL ½ x 6" for Gusset to Clevis

Shear Rupture

$P_n/\Omega = .6(F_u)(A_{nf})$ $\Omega = 2.0$

$= \frac{.6(58)(26.5)(1 + 1/2)}{2}$

$= 26.1$ k > 12.5 k // OK

Subject Mc Murdo

Utilities

Revision	By	Date	Chk'd	Date
	PF			

Pump House Brace Connection

DL+SL = 3.8K

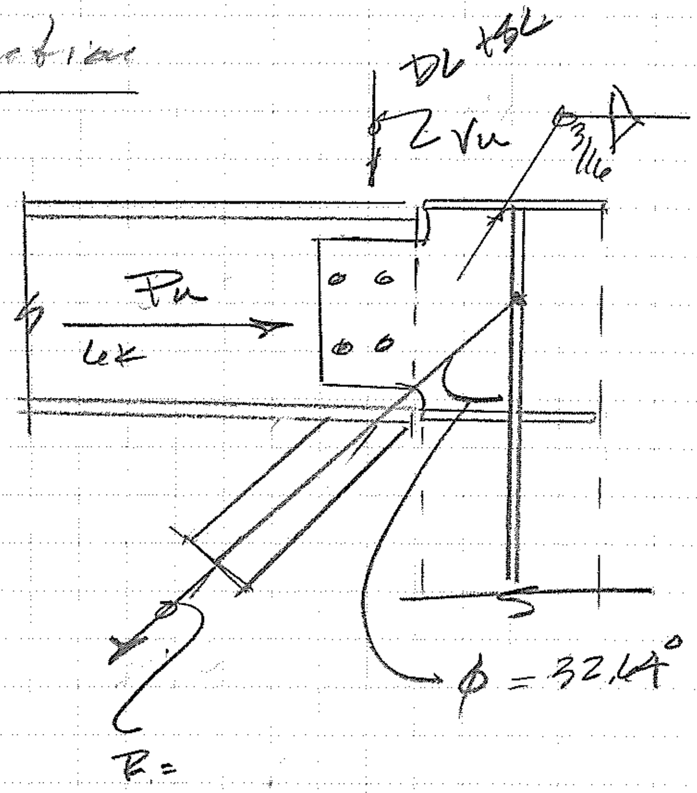
R

DL = 6.2K

LL = 11. K

WL = 1.2K

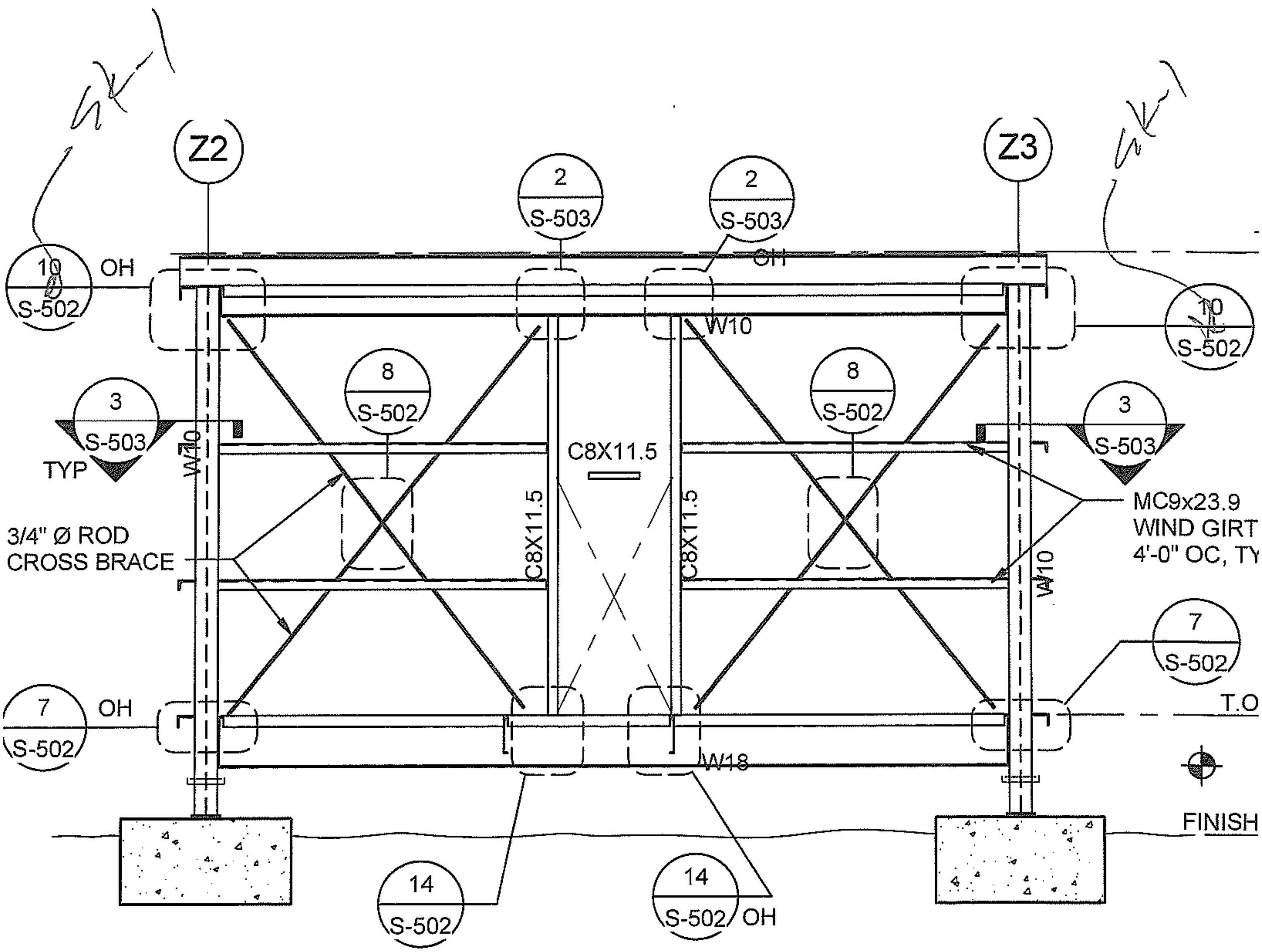
$P_u = 1.2(6.2) + 1.6(11)$
$= 25$ K ← controls



$V_u = 1.6(3.8)$
$= 6.0$ K

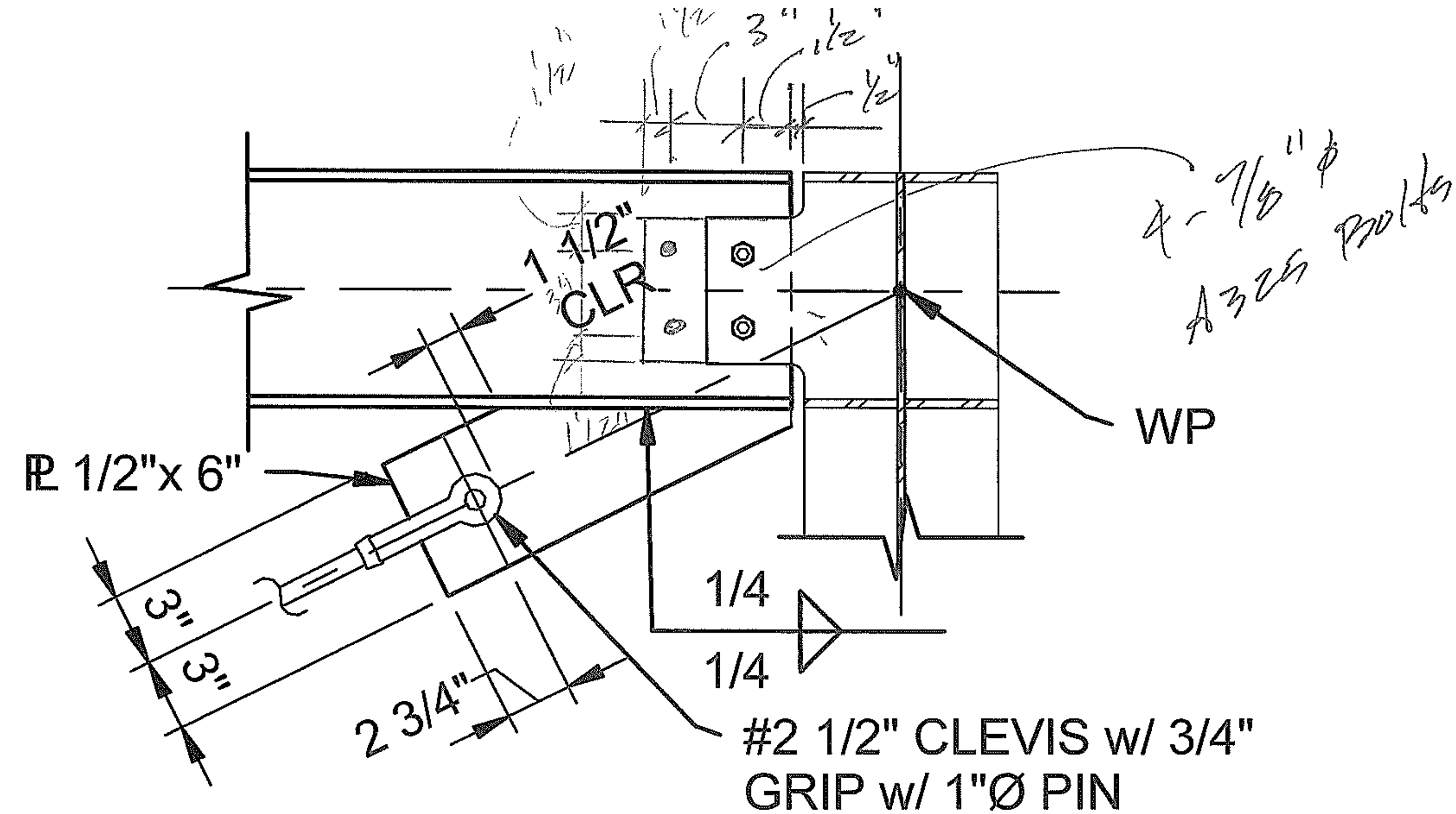
$P_u = 1.6(6)$
$= 9.6$ K

Use 4-7/8" φ A325 Bolts w/ 1" Shear Tab
see following printout



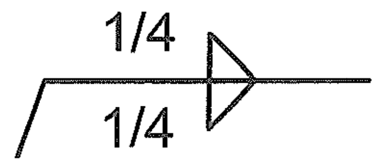
3 ELEVATION

S-101 1/4" = 1'-0"



10 / S-201 DETAIL

1" = 1'-0"



BASIC DESIGN DATA

Non-Seismic Design
Column:
Size: W10X30
Material: A992
Orientation: Web Out of Plane
Axial Force (Tension): 0 kips
Axial Force (Compression): 0 kips
Shear Force: 0 kips

Left Side Beam:
Size: W10X30
Material: A992
Axial Force (Tension): 0 kips
Axial Force (Compression): 17.6 kips
Shear Force: 6 kips
Work Point X: 0 in.
Work Point Y: 0 in.

Single Plate:
Length: 6 in.
Material: A36
Bolts: 7/8"Ø A325-N -STD
Bolt Vertical Spacing: 3 in.
Bolt Vertical Edge Distance: 1.5 in.
Bolt Horizontal Spacing: 3 in.
Bolt Horizontal Edge Distance: 1.5 in.

Lower Left Brace:
Size: L3X3X3/16
Length: 0 Ft

Material: A36
Axial Force (Tension): 25 kips
Axial Force (Compression): 0 kips
Work Point X: 0 in.
Work Point Y: 0 in.
Rise/Run: 1.56/1
Bolt Edge Distance: 1.5 in.

Gusset Plate:
Material: A36
Column Side Length: 10.47 in.
Beam Side Length: 6.2613 in.
Brace Side Length: 5.8211 in.
Column Side Free Edge: x= 7 in., y= 12.5 in.
Beam Side Free Edge: x= 5.4887 in., y= 9.135 in.
Thickness: 0.375 in.
Setback from Column: 0.5 in.
Bolt Edge Distance: 1.5 in.
Gusset-Brace Gap: -6.625 in.

Lower Left Brace to Gusset Connection

Brace Force = 25 kips

Brace to Gusset Weld Size = 1/8 in.
Brace to Gusset Weld Length Along Heel of Angle = 6.625 in.
Brace to Gusset Weld Length Along Toe of Angle = 2.4901 in.

Weld Size = 1/8 ≥ Minimum Weld Size = 1/8 in. (OK)

N/A

Weld Size = 1/8 ≤ Maximum Weld Size = 3/16 in. (OK)

Heel Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*6.625
= 18.443 kips

Toe Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*2.4901
= 6.932 kips

Total Weld Design Strength:

N/A

ØRn = 25.375 ≥ 25 kips (OK)

Maximum Weld Force Gusset Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.375 * (6.625 + 2.4901)
= 73.832 ≥ 25 kips (OK)

Maximum Weld Force Brace Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.1875 * (6.625 + 2.4901)
= 36.916 ≥ 25 kips (OK)

Check Lower Left Brace

Tension Yielding:

ØRn = 0.9*Fy * Ag = 0.9 * 36 * 1.0898
= 35.311 ≥ 25 kips (OK)

N/A

Tension Rupture:

Shear Lag Factor,U = 1-x/L = 1 - 0.8196/6.625 = 0.8763

ØRn = 0.75*Fu * U*Ag
= 0.75*58 *0.8763*1.0898
= 41.543 ≥ 25 kips (OK)

Lower Left Brace Gusset Dimensions:
Column Side, Lgc = 0 in.
Beam Side, Lgb = 6.2613 in.
Beam Side Free Edge, Lvfx = 5.4887 in.
Beam Side Free Edge, Lvfy = 9.135 in.
Column Side Free Edge, Lhfx = 7 in.
Column Side Free Edge, Lhfy = 12.5 in.

Lower Left Brace Gusset Edge Forces:

Special case: 3

Gusset edge moments carried by: Beam interface

Theta = 32.661 Degrees, eb = 5.235 in. ec = 0 in.
Beta = 0 in. BetaBar = 0 in. AlphaBar = 3.6307 in.

Alpha = (Beta + eb)*Tan(Theta) - ec
= (0 + 5.235)*Tan(32.661) - 0
= 3.3558 in.

With Tensile Brace Force:

$r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)^{0.5}$
$= 25 / ((3.3558 + 0)^2 + (0 + 5.235)^2)^{0.5}$
= 4.0204 kips/in.

Hb = Alpha * r = 3.3558 * 4.0204
= 13.492 kips

Hc = ec * r = 0 * 4.0204
= 0 kips

Vb = eb * r = 5.235 * 4.0204
= 21.047 kips

Vc = beta * r = 0 * 4.0204
= 0 kips

Mb = |Vb * (Alpha - AlphaBar)|
= |21.047 * (3.3558 - 3.6307)|

= 5.7856 k-in.

Mc = 0

With Compressive Brace Force:

r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)$^{0.5}$
= 0 / ((3.3558 + 0)^2 + (0 + 5.235)^2)$^{0.5}$
= 0 kips/in.

Hb = Alpha * r = 3.3558 * 0
= 0 kips

Hc = ec * r = 0 * 0
= 0 kips

Vb = eb * r = 5.235 * 0
= 0 kips

Vc = beta * r = 0 * 0
= 0 kips

Mb = 0

Mc = 0

Lower Left Brace Gusset Thickness

Try t = 3/8" Have 1/2"

Maximum Brace Weld Force Gusset Can Develop:
= 0.75 * 0.6*Fu*t*(L1+L2)
= 0.75 * 0.8*58 * 0.375 * (6.625 + 2.4901)
= 89.214 ≥ 25 kips (OK)

Block Shear of Gusset at Brace:

Agv = Anv = 2*L*t = 2*6.625*0.375 = 4.9688 in^2

Agt = Ant = d*t = 3*0.375 = 1.125 in^2

ØRn = 0.75 * (0.6 * Min(Fu * Anv;Fy * Agv) + Ubs * Fu * Ant)
= 0.75 * (0.6*Min(58 * 4.9688; 36 * 4.9688) + 1 * 58 * 1.125)
= 129.4 ≥ 25 kips (OK)

Check Whitmore Section:

Width1 = 1.1547*Lweld = 1.1547*6.625 = 7.6499 in.
Width2 = 0.57735*(6.625 + 2.4901) + 3 = 8.2626 in.
Width, Lw = Max(Width1;Width2) = 8.2626 in.

Lwo = 2.6666 in. of Lw is outside the gusset free edge.

Width of Whitmore Section inside gusset boundaries,
Lwg = 5.596 in.

Whitmore Section Stress:

Tension:

fa = Fx/(Lwg*t + Lwb*twb)
= 25/(5.596 * 0.375 + 0 * 0.3)
= 11.913 ksi

Compression:

fa = Fx/(Lwg*t + Lwb*twb)
= 0/(5.596 * 0.375 + 0 * 0.3)
= 0 ksi

Whitmore Section Yielding:

= 0.9*(Lwg*t*Fyg + Lwb*twb*Fyb)
= 0.9*(5.596 * 0.375 * 36 + 0 * 0.3* 50)
= 67.992 ≥ 25 kips (OK)

Lower Left Brace Gusset to Beam Connection

Horizontal Force on Welds, Hb = 13.492 kips

Vertical Force on Welds, Vb = 21.047 kips

Moment on Welds, M = 0 k-in.

Weld Length on Each Side of Gusset Plate, L = 6.2613 in.

Average Force on Welds per Unit Length = fraverage
= ((V/L+3M/(L^2))^2 + (H/L)^2)$^{0.5}$
= ((21.047/6.2613 + 3* 0/(6.2613^2))^2 + (13.492/6.2613)^2)$^{0.5}$
= 3.9928 kips/in.

fr = fraverage

Maximum useful weld size = 0.7072 * Fu* t / Fexx
= 0.7072 * 58 * 0.375/70
= 0.2197 in.

Use Richard Factor, Rf = 1.25

Required Weld Size, w = Max(Rf*f_avrg;f_peak)/(0.75*0.6*1.41*Fexx)
= 4.991/(0.75*0.6*1.41* 70)
= 0.112 in.

Use 3/16 in. Weld

Left Side Beam to Column Connection

Transfer Force from Right = 0 kips Compression
Transfer Force from Right = 0 kips Tension
Transfer Force from Left = 0 kips Compression
Transfer Force from Left = 0 kips Tension

Vertical Force on Single Plate = V
(Maximum Combined Force)
= 27.047 kips

Horizontal Force on Single Plate = H
(Maximum Combined Force)
H (Tension)= 0 kips
H (Compression)= 0 kips

Design Single Plate

3/16" shear tab

Plate Length = 6 in.
Plate Width = 6.5 in.
Plate Thickness = 0.375 in.
Bolts: (4)7/8"Ø A325-N -STD
Bolt Holes on S. Plate:0.9375" Horiz. X 0.9375" Vert.
Bolt Holes on Gusset:0.9375" Horiz. X 0.9375" Vert.

Bolt Vertical Spacing = 3 ≥ Min. Spacing = 2.3333 in. (OK)

Vert. Edge Dist. on S. Plate = 1.5 ≥ Min. Edge Dist. = 1.5 in. (OK)

Bolt Shear Strength:

Eccentricity, ex = 3.5 in.
Vertically: 2 Bolts with 3 in. Spacing
Horizontally: 2 Bolts with 3 in. Spacing
Resultant Load (27.047 kips) Inclined 0 Degrees from Vertical
Inclined Eccentic Load Coefficient, C = 1.8382

ØRn = C*Fv = 1.8382 * 21.648 = 39.792 ≥ 27.047 kips (OK)

Bolt Bearing

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs

Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.
Equiv. Bolt Factor, ef = C/Nb $\leq$ 1 = 1.8382 / 4 = 0.4595
ØRn = ef * Nh*(Fbe + Fbs * (Nl - 1)) * t
= 0.4595 * 2 * (53.831 + 91.35 * (2-1))*0.375
= 50.038 $\geq$ 27.047 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.

With Compressive Force:
ØRn = ef * Nl * Fbs * Nh * t
= 0.4595 * 2 * 91.35 * 2 * 0.375
= 62.969 $\geq$ 0 kips (OK)

With Tensile Force:
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.4595 * 2 * (53.831 + 91.35 * (2 - 1)) * 0.375
= 50.038 $\geq$ 0 kips (OK)

Bolt Bearing on Beam Web:

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
ØRn = ef * Nh*Fbs * Nl * t
= 0.4595 * 2 * 102.4 * 2 * 0.3
= 56.455 $\geq$ 27.047 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 1.0313 * 65 = 60.328 kips/in.

With Tensile Force
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.4595 * 2 * (60.328 + 102.4 * (2 - 1)) * 0.3
= 44.861 $\geq$ 0 kips (OK)

With Compressive Force
ØRn = ef * Nl * Fbs * Nh * t
= 0.4595 * 2 * 60.328 * 102.4 * 2 * 0.3
= 56.455 $\geq$ 0 kips (OK)

Single Plate Combined Tension and Shear

The following formulae have been derived using an interaction equation of the form $ft/Ft + (fv/Fv)^2 = 1$ (Ref. "Combined Shear and Tension Stress", Subhash C. Goel, Engineering Journal,3rd Q 1986, AISC).

Load Angle, Ø = Atn(H/V) = 0 Degees
A = Sin(Ø) = 0
B = Cos(Ø) = 01.

Rupture:

Net Area, An = (L - Nl * (dv + 0.0625)) * t
= (6 - 2 * (0.9375 + 0.0625)) * 0.375
= 1.5 in^2

ØRn = 0.75 * 0.6*An*Fu = 0.75 * 0.6 * 1.5 * 58
= 39.15 $\geq$ 27.047 kips (OK)

Yielding:

Ag= L*t = 6 * 0.375 = 2.25 in^2

ØRn = 0.9 * 0.6*Ag*Fy = 0.9 * 0.6 * 2.25 * 36
= 43.74 $\geq$ 27.047 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 1:

An1 = (L - Lv - (Nl - 0.5) * (dv + 0.0625)) * t
= (6 - 1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.375
= 1.125 in^2
An2 = (W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= (6.5 - 0.5 - 1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.375
= 1.125 in^2

ØRn = 0.75 * (fv1 * An1 +ft2* An2)
= 0.75 * (34.8 * 1.125 +58* 1.125)
= 78.3 $\geq$ 27.047 kips (OK)

Pattern 2:

An1 = (L - 2*Lv - (Nl - 0.5) * (dv + 0.0625)) * t
= (6 - 2*1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.375
= 0.5625 in^2
An2 = 2*(W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= 2*(*6.5 - 0.5 - - 1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.375
= 2.25 in^2
ØRn = 0.75 * (fv1 * An1 +ft2* An2)
= 0.75 * (34.8 * 0.5625 +58* 2.25)
= 112.6 $\geq$ 27.047 kips (OK)

Beam Web Tear-out:

Combined Tension and Shear

Load Angle, Ø = Atn(H/V) = 0 Degees
A = Sin(Ø) = 0
B = Cos(Ø) = 01.

Ag = 3.141 in^2 An = 2.541 in^2

Rupture:

ØRn = 0.75 * 0.6*An*Fu = 0.75 * 0.6 * 2.541 * 65

= 74.324 ≥ 27.047 kips (OK)

Yielding:

ØRn = 0.9 * 0.6*Ag*Fy = 0.9 * 0.6 * 3.141 * 50
= 84.807 ≥ 27.047 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 2:

Ag1 = 0.9 in^2 An1 = 0.6 in^2 Ag2 = 2.7 in^2
An2 = 1.8 in^2

ØRn = 0.75 * (fv1 * An1 +ft2* An2)
= 0.75 * (39 * 0.6 +65* 1.8)
= 105.3 ≥ 27.047 kips (OK)

Plate Bending:

Net Area, An = 1.5 in^2
Net Section Modulus, Sn = 1.7055 in^3
e = (tp+tw)/2 = (0.375 + 0.3) / 2 = 0.3375 in^2
Stress = H/An + (Mo + V * (c + Lh))/Sn + 6*(H*e/2)/(t*An)
= 0/1.5 + (0 + 27.047 * (0.5 + 1.5))/1.7055+ 6*(0 * 0.3375/2)/(0.375*1.5)
= 31.718 ≤ 0.9*Fy = 32.4 ksi OK

Plate Buckling:

Maximum Stress:
= H/An + 6*(H * ex/2)/(t*An)+(V*cx+Mom)/S
= 0 /1.5 + 6 * (0 * 0.3375 / 2) / (0.375 * 1.5) + (27.047 * 2 + 0) / 1.7055
= 31.718 ksi

Design Bending Stress for Lateral Buckling:

c = 2 in., ho = L = 6 in., 2c/ho = 0.6667, K = 2.5
m = $(Fy / K)^{0.5}$ * ho / (0.98*$E^{0.5}$ * 2 * tp)
= $(36 / 2.5)^{0.5}$ * 6 / (0.98 * E * 2 * 0.375)
= 0.1819
Q = 1

ØFcr = 0.9*Fy * Q = 0.9*36 * 1
= 32.4 ≥ 31.718 ksi OK

Compression Buckling of Plate:

Using K = 1.2 and L = 2 in.
r = t/($12^{0.5}$) = 0.375/3.464 = 0.1083 in.
KL/r = 22.17

Lc = KL/r * $(Fy/E)^{0.5}$ /PI
= 22.17 * $(36/29000.)^{0.5}$ /3.1416
= 0.2486

Fcr = $0.658^{(Lc^2)}$*Fy
= $0.658^{0.0618}$ * 36 = 35.08 ksi

Pn = Lp*t*Fcr = 6*0.375*35.08 = 81 kips
Mu = Pu*e/2 = 0*0.3375/2 = 0 k-in.
Mn = Fy*Lp*t^2 /4 = 36*6 * 0.375^2 /4 = 7.5938 k-in.

Utilization Factor:

Pu / (0.9 * Pn) < 0.2
Pu / (2*0.9*Pn) + Mu/(0.9*Mn)
= 0 / (2*0.9 * 81) + 0 / (0.9 * 7.5938)
= 0 ≤ 1.0 OK

Plate to Column Weld:

Weld Size = 0.1875 ≥ Min. Weld Size = 0.1875 in. (OK)

Weld Stresses:

fr = $[((H / L) + 6*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((0 / 6) + 6*0/6^2)^2 + (27.047/6)^2]^{0.5}$
= 4.5078 kips/in.

fraverage = $[((H / L) + 3*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((0 / 6) + 3*0/6^2)^2 + (27.047/6)^2]^{0.5}$
= 4.5078 kips/in.

Required Weld Size = Max(fr; 1.25 * fraverage) / (0.75*0.6*1.414 * Fexx)
= Max(4.5078; 1.25 * 4.5078) / (0.75*0.6*1.414 * 70)
= 0.1265 ≤ 3/16 in. (OK)

Useful weld size:
= Min(0.75*0.6 * tp * Fup; 2 * 0.75*0.6 * tc * Fuc) / (0.75*0.6*1.414 * Fexx)
= Min(0.75*0.6 * 0.375 * 58; 2 * 0.75*0.6 * 0.3 * 65) / (0.75*0.6*1.414 * 70)
= 0.2197 ≥ 0.1265 in. (OK)

Beam and Column Local Stresses
for Left Side Beam

Beam Web Local Yielding:

Force from Bottom, Rbot = $((1.73*HbBot)^2 + (VbBot+3MbBot/LBot)^2)^{0.5}$
= $((1.73*13.492)^2 + (21.047+3*5.7856/6.2613)^2)^{0.5}$
= 33.349 kips

Required Web Thickness = Rbot / (1 *Fy * (L+2.5*k))
= 33.349 / (1 * 50 *(6.2613+2.5*0.81))
= 0.0805 in. ≤ 0.3 in. (OK)

Beam Web Crippling:

Force from Bottom, Rbot = VbBot+3MbBot/LBot
= 21.047+3*5.7856/6.2613
= 2.7721 kips

Design Strength for Bottom Loading, ØRn:
= 0.75* 0.4 * $E^{0.5}$ * tw^2 *(1+(4*(Nbot/d)-0.2)*$(tw/tf)^{1.5}$)*$(Fy*tf/tw)^{0.5}$
= 0.75* 0.4 * 170.3 *0.3^2 *(1+(4*(6.2613/10.47)-0.2) *$(0.3/0.51)^{1.5}$)*$(50*0.51/0.3)^{0.5}$
= 84.315 kips ≥ 2.7721 kips (OK)

Column Web Bending and out of Plane Shear:

H = Fx/L
= 0/ 6
= 0 kips/ in.
Moment, M = H*Wc/4 = 0 * 8.85/ 4 = 0 kip-in/in.

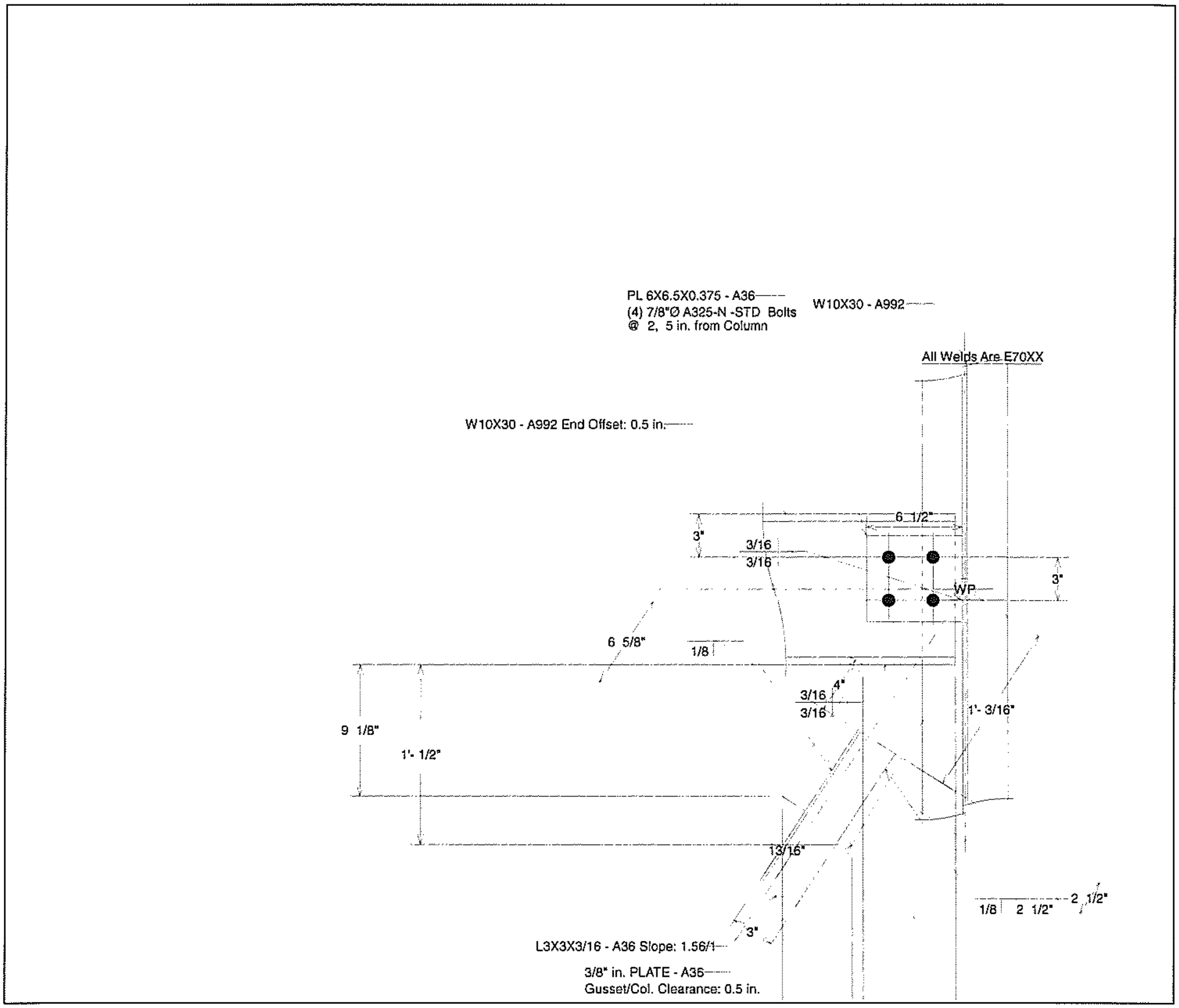
Bending Strength:

ØMn = 0.9 * Fy * tw^2 /4
= 0.9 * 50 * 0.3^2 /4
= 1.0125 ≥ 0 kip-in/in. (OK)

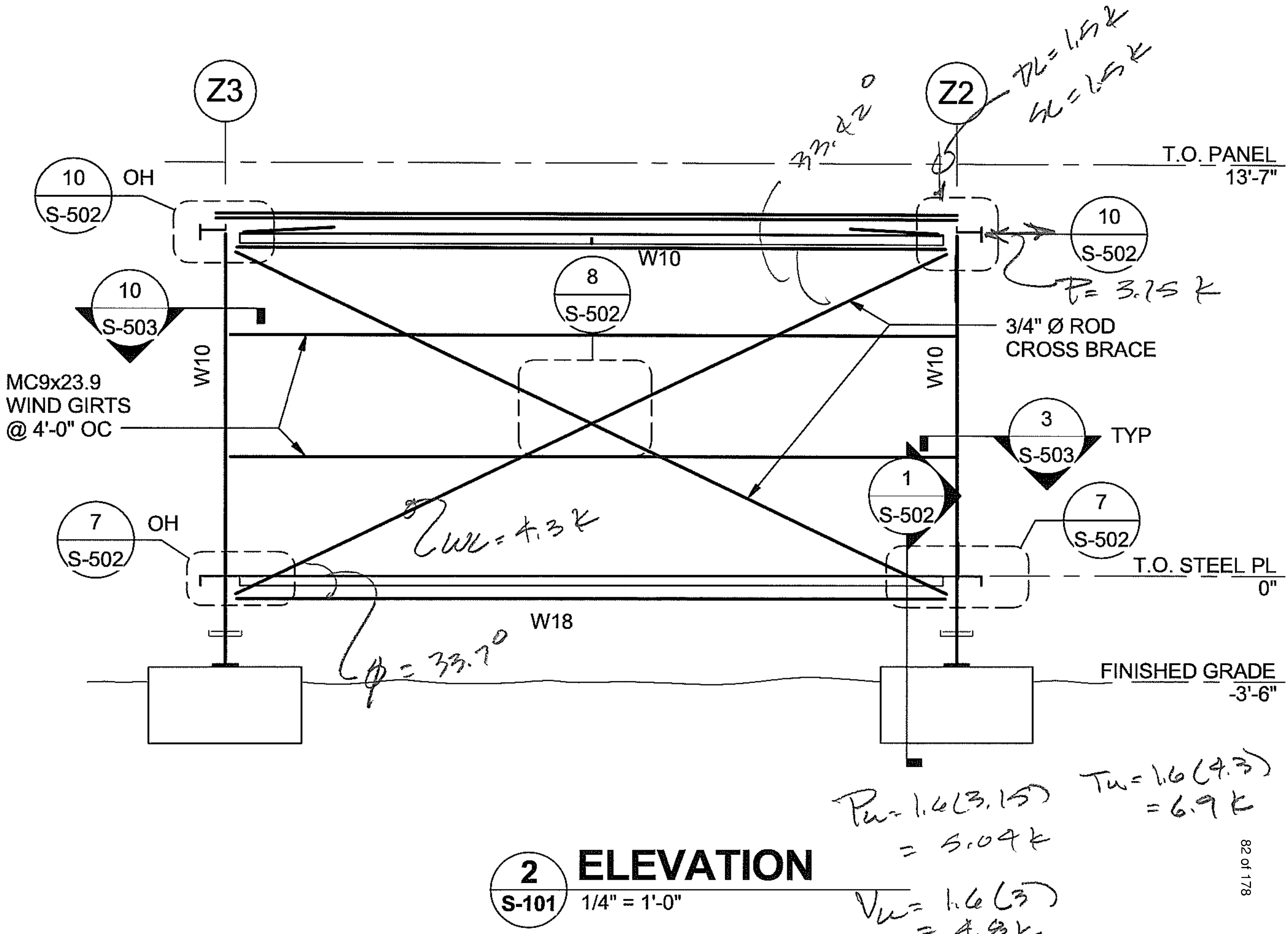
Shear Stress:

fv = H / (2*tw) = 0 / (2*0.3)
= 0 ≤ Fv = 1 * 0.6*Fy = 1 * 0.6 * 50 = 30 ksi OK

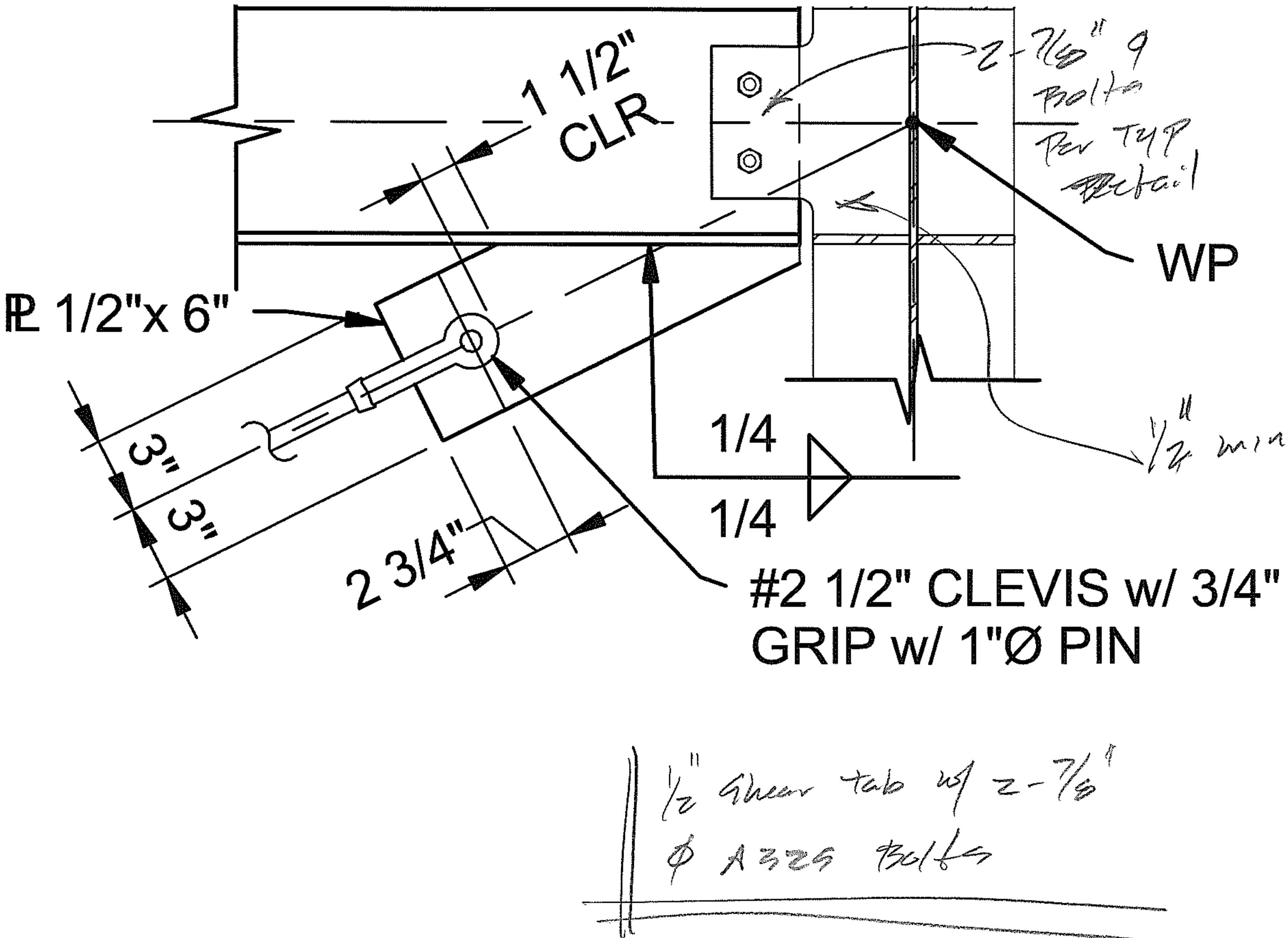
--*-*-*-*-*-*-*-*-*-*-END-*-*-*-*-*-*-*-*-*-*-*-*


PL 6X6.5X0.375 - A36
(4) 7/8"Ø A325-N -STD Bolts
@ 2, 5 in. from Column
W10X30 - A992
All Welds Are E70XX
W10X30 - A992 End Offset: 0.5 in.
6 1/2"
3"
3/16
3/16
WP
3"
6 5/8"
1/8
3/16
4"
3/16
1'- 3/16"
9 1/8"
1'- 1/2"
13/16"
1/8
2 1/2"
2 1/2"
3"
L3X3X3/16 - A36 Slope: 1.56/1
3/8" in. PLATE - A36
Gusset/Col. Clearance: 0.5 in.

Scale: 1" = 1'



2
S-101
ELEVATION
1/4" = 1'-0"



10
S-201

DETAIL

1" = 1'-0"

DETAIL

3. SEE 4/- FOR BEAM SCHEDULE.

WHERE OCCURS
TOP AND BOTTOM)

1 S-501 BEAM TO COLUMN CONNECTION

1 1/2" = 1'-0"

BEAM SCHEDULE, U.N.O.

BEAM	BOLT SIZE	NO BOLTS	SHEAR PLATE	STIFF PLATE	WELD	
					W1	W2
W10, C10	7/8" DIA.	2	1/4"	3/8"	1/4"	3/16"
W18	7/8" DIA.	4	3/8"	3/8"	5/16"	1/4"

4 S-501 BEAM SCHEDULE

1 1/2" = 1'-0"

BASIC DESIGN DATA

Non-Seismic Design
Column:
Size: W10X30
Material: A992
Orientation: Web Out of Plane
Axial Force (Tension): 0 kips
Axial Force (Compression): 0 kips
Shear Force: 0 kips

Left Side Beam:
Size: W10X30
Material: A992
Axial Force (Tension): 10.8 kips
Axial Force (Compression): 4.8 kips
Shear Force: 4.8 kips
Work Point X: 0 in.
Work Point Y: 0 in.

Single Plate:
Length: 6 in.
Material: A36
Bolts: 7/8"Ø A325-N -STD
Bolt Vertical Spacing: 3 in.
Bolt Vertical Edge Distance: 1.5 in.
Bolt Horizontal Spacing: 3 in.
Bolt Horizontal Edge Distance: 1.5 in.

Lower Left Brace:
Size: L3X3X3/16 N/A
Length: 0 Ft

Material: A36
Axial Force (Tension): 6.9 kips
Axial Force (Compression): 0 kips
Work Point X: 0 in.
Work Point Y: 0 in.
Rise/Run: 1/1.515
Bolt Edge Distance: 1.5 in.

Gusset Plate:
Material: A36
Column Side Length: 10.47 in.
Beam Side Length: 10 in.
Brace Side Length: 4.93 in.
Column Side Free Edge: x= 13.25 in., y= 7.75 in.
Beam Side Free Edge: x= 5.762 in., y= 3.5079 in.
Thickness: 0.375 in.
Setback from Column: 0.5 in.
Bolt Edge Distance: 1.5 in.
Gusset-Brace Gap: -3 in.

Lower Left Brace to Gusset Connection

Brace Force = 6.9 kips

Brace to Gusset Weld Size = 1/8 in.
Brace to Gusset Weld Length Along Heel of Angle = 3 in.
Brace to Gusset Weld Length Along Toe of Angle = 1.1276 in.

Weld Size = 1/8 ≥ Minimum Weld Size = 1/8 in. (OK)

Weld Size = 1/8 ≤ Maximum Weld Size = 3/16 in. (OK)

N/A

Heel Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*3
= 8.3514 kips

Toe Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*1.1276
= 3.139 kips

Total Weld Design Strength:

ØRn = 11.49 ≥ 6.9 kips (OK) N/A

Maximum Weld Force Gusset Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.375 * (3 + 1.1276)
= 33.434 ≥ 6.9 kips (OK)

Maximum Weld Force Brace Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.1875 * (3 + 1.1276)
= 16.717 ≥ 6.9 kips (OK)

Check Lower Left Brace

Tension Yielding:

ØRn = 0.9*Fy * Ag = 0.9 * 36 * 1.0898
= 35.311 ≥ 6.9 kips (OK) N/A

Tension Rupture:

Shear Lag Factor,U = 1-x/L = 1 - 0.8196/3 = 0.7268

ØRn = 0.75*Fu * U*Ag
= 0.75*58 *0.7268*1.0898
= 34.457 ≥ 6.9 kips (OK)

Lower Left Brace Gusset Dimensions:
Column Side, Lgc = 0 in.
Beam Side, Lgb = 10 in.
Beam Side Free Edge, Lvfx = 5.762 in.
Beam Side Free Edge, Lvfy = 3.5079 in.
Column Side Free Edge, Lhfx = 13.25 in.
Column Side Free Edge, Lhfy = 7.75 in.

Lower Left Brace Gusset Edge Forces:

Special case: 3

Gusset edge moments carried by: Beam interface

Theta = 56.573 Degrees, eb = 5.235 in. ec = 0 in.
Beta = 0 in. BetaBar = 0 in. AlphaBar = 5.5 in.

Alpha = (Beta + eb)*Tan(Theta) - ec
= (0 + 5.235)*Tan(56.573) - 0
= 7.931 in.

With Tensile Brace Force:

$r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)^{0.5}$
$= 6.9 / ((7.931 + 0)^2 + (0 + 5.235)^2)^{0.5}$
= 0.7261 kips/in.

Hb = Alpha * r = 7.931 * 0.7261
= 5.7586 kips

Hc = ec * r = 0 * 0.7261
= 0 kips

Vb = eb * r = 5.235 * 0.7261
= 3.8011 kips

Vc = beta * r = 0 * 0.7261
= 0 kips

Mb = |Vb * (Alpha - AlphaBar)|
= |3.8011 * (7.931 - 5.5)|

= 9.2405 k-in.

Mc = 0

With Compressive Brace Force:

r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)$^{0.5}$
= 0 / ((7.931 + 0)^2 + (0 + 5.235)^2)$^{0.5}$
= 0 kips/in.

Hb = Alpha * r = 7.931 * 0
= 0 kips

Hc = ec * r = 0 * 0
= 0 kips

Vb = eb * r = 5.235 * 0
= 0 kips

Vc = beta * r = 0 * 0
= 0 kips

Mb = 0

Mc = 0

Lower Left Brace Gusset Thickness

Try t = 3/8"

Maximum Brace Weld Force Gusset Can Develop:
= 0.75 * 0.6*Fu*t*(L1+L2)
= 0.75 * 0.6*58 * 0.375 * (3 + 1.1276)
= 40.399 ≥ 6.9 kips (OK)

Block Shear of Gusset at Brace:

Agv = Anv = 2*L*t = 2*3*0.375 = 2.25 in^2

Agt = Ant = d*t = 3*0.375 = 1.125 in^2

ØRn = 0.75 * (0.6 * Min(Fu * Anv;Fy * Agv) + Ubs * Fu * Ant)
= 0.75 * (0.6*Min(58 * 2.25; 36 * 2.25) + 1 * 58 * 1.125)
= 85.388 ≥ 6.9 kips (OK)

Check Whitmore Section:

Width1 = 1.1547*Lweld = 1.1547*3 = 3.4641 in.
Width2 = 0.57735*(3 + 1.1276) + 3 = 5.3831 in.
Width, Lw = Max(Width1;Width2) = 5.3831 in.

Lwo = 0.917 in. of Lw is outside the gusset free edge.

Width of Whitmore Section inside gusset boundaries,
Lwg = 4.4661 in.

Whitmore Section Stress:

Tension:

fa = Fx/(Lwg*t + Lwb*twb)
= 6.9/(4.4661 * 0.375 + 0 * 0.3)
= 4.1199 ksi

Compression:

fa = Fx/(Lwg*t + Lwb*twb)
= 0/(4.4661 * 0.375 + 0 * 0.3)
= 0 ksi

Whitmore Section Yielding:

= 0.9*(Lwg*t*Fyg + Lwb*twb*Fyb)
= 0.9*(4.4661 * 0.375 * 36 + 0 * 0.3* 50)
= 54.263 ≥ 6.9 kips (OK)

Lower Left Brace Gusset to Beam Connection

Horizontal Force on Welds, Hb = 5.7586 kips

Vertical Force on Welds, Vb = 3.8011 kips

Moment on Welds, M = 0 k-in.

Weld Length on Each Side of Gusset Plate, L = 10 in.

Average Force on Welds per Unit Length = fraverage
= ((V/L+3M/(L^2))^2 + (H/L)^2)$^{0.5}$
= ((3.8011/10 + 3* 0/(10^2))^2 + (5.7586/10)^2)$^{0.5}$
= 0.69 kips/in.

fr = fraverage

Maximum useful weld size = 0.7072 * Fu* t / Fexx
= 0.7072 * 58 * 0.375/70
= 0.2197 in.

Use Richard Factor, Rf = 1.25

Required Weld Size, w = Max(Rf*f_avrg;f_peak)/(0.75*0.6*1.41*Fexx)
= 0.8625/(0.75*0.6*1.41* 70)
= 0.0194 in.

Use 3/16 in. Weld

Left Side Beam to Column Connection

Transfer Force from Right = 0 kips Compression
Transfer Force from Right = 0 kips Tension
Transfer Force from Left = (-0.9586) kips Compression
Transfer Force from Left = 10.8 kips Tension

Vertical Force on Single Plate = V
(Maximum Combined Force)
= 8.6011 kips

Horizontal Force on Single Plate = H
(Maximum Combined Force)
H (Tension)= 10.8 kips
H (Compression)= 0 kips

Design Single Plate

Plate Length = 6 in.
Plate Width = 3.5 in.
Plate Thickness = 0.5 in.
Bolts: (2)7/8"Ø A325-N -STD
Bolt Holes on S. Plate:0.9375" Horiz. X 0.9375" Vert.
Bolt Holes on Gusset:0.9375" Horiz. X 0.9375" Vert.

Bolt Vertical Spacing = 3 ≥ Min. Spacing = 2.3333 in. (OK)

Vert. Edge Dist. on S. Plate = 1.5 ≥ Min. Edge Dist. = 1.5 in. (OK)

Bolt Shear Strength:

Eccentricity, ex = 2.0188 in. (Includes the effect of Transfer Force Ecc.)
Vertically: 2 Bolts with 3 in. Spacing
Horizontally: 1 Bolts with 3 in. Spacing
Resultant Load (13.806 kips) Inclined 51.466 Degrees from Vertical
Inclined Eccentic Load Coefficient, C = 1.3008

ØRn = C*Fv = 1.3008 * 21.648 = 28.159 ≥ 13.806 kips (OK)

Bolt Bearing

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs

Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.
Equiv. Bolt Factor, ef = C/Nb $\leq$ 1 = 1.3008 / 2 = 0.6504
ØRn = ef * Nh*(Fbe + Fbs * (Nl - 1)) * t
= 0.6504 * 1 * (53.831 + 91.35 * (2-1))*0.5
= 47.213 $\geq$ 8.6011 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.

With Compressive Force:
ØRn = ef * Nl * Fbs * Nh * t
= 0.6504 * 2 * 91.35 * 1 * 0.5
= 59.414 $\geq$ 0 kips (OK)

With Tensile Force:
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.6504 * 2 * (53.831 + 91.35 * (1 - 1)) * 0.5
= 35.012 $\geq$ 10.8 kips (OK)

Bolt Bearing on Beam Web:

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
ØRn = ef * Nh*Fbs * Nl * t
= 0.6504 * 1 * 102.4 * 2 * 0.3
= 39.951 $\geq$ 8.6011 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu $\leq$ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 1.0313 * 65 = 60.328 kips/in.

With Tensile Force
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.6504 * 2 * (60.328 + 102.4 * (1 - 1)) * 0.3
= 23.542 $\geq$ 10.8 kips (OK)

With Compressive Force
ØRn = ef * Nl * Fbs * Nh * t
= 0.6504 * 2 * 60.328 * 102.4 * 1 * 0.3
= 39.951 $\geq$ 0 kips (OK)

Single Plate Combined Tension and Shear

The following formulae have been derived using an interaction equation of the form ft/Ft + $(fv/Fv)^2$ =1 (Ref. "Combined Shear and Tension Stress", Subhash C. Goel, Engineering Journal,3rd Q 1986, AISC).

Load Angle, Ø = Atn(H/V) = 51.466 Degees
A = Sin(Ø) = 0.7822
B = Cos(Ø) = 0.623

Rupture:

Net Area, An = (L - Nl * (dv + 0.0625)) * t
= (6 - 2 * (0.9375 + 0.0625)) * 0.5
= 2 in^2

ØRn = 0.75* 0.18 * (A/ B) * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * An * Fu / B
= 0.75 * 0.18 * (0.7822 / 0.623) * (-1 + (1 + $(0.623 / 0.7822)^2$ / $0.09)^{0.5}$) * 2 * 58 / 0.623
= 57.975 $\geq$ 13.806 kips (OK)

Yielding:

Ag= L*t = 6 * 0.5 = 3 in^2

ØRn = 1^2 * 0.18 * $(A / B)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(B / A)^2$ / (0.09 * $1^2))^{0.5}$) * Ag * Fy/A
= 1^2 * 0.18 * $(0.7822 / 0.623)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(0.623 / 0.7822)^2$ / (0.09 * $1^2))^{0.5}$) * 3 * 36/0.7822
= 69.224 $\geq$ 13.806 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 1:

An1 = (L - Lv - (Nl - 0.5) * (dv + 0.0625)) * t
= (6 - 1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.5
= 1.5 in^2
An2 = (W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= (3.5 - 0.5 - 1.5 - (1 - 0.5) * (0.9375 + 0.0625)) * 0.5
= 0.5 in^2

Adjusted Design Stress:

ft1 = 0.75*0.18 * $(A / B)^2$ * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.7822 / 0.623)^2$ * (-1 + (1 + $(0.623 / 0.7822)^2$ / $0.09)^{0.5}$) * 58
= 22.675 ksi

Fv1 = ft1 * B / A = 22.675 * 0.623 / 0.7822 = 18.059 ksi

ft2 = 0.75*0.18 * $(B/ A)^2$ * (-1 + (1 + $(A / B)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.623 / 0.7822)^2$ * (-1 + (1 + $(0.7822 / 0.623)^2$ / $0.09)^{0.5}$) * 58
= 16.405 ksi

Fv2 = ft2 * A / B = 16.405 * 0.7822 / 0.623 = 20.599 ksi

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (18.059 * 1.5 + 16.405 * 0.5)/0.623
= 56.648 $\geq$ 13.806 kips (OK)

Pattern 2:

An1 = (L - 2*Lv - (Nl - 0.5) * (dv + 0.0625)) * t
= (6 - 2*1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.5
= 0.75 in^2

An2 = 2*(W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= 2*(*3.5 - 0.5 - - 1.5 - (1 - 0.5) * (0.9375 + 0.0625)) * 0.5
= 1 in^2

Adjusted Design Stress:
(Same as Above)

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (18.059 * 0.75 + 16.405 * 1)/0.623
= 48.074 ≥ 13.806 kips (OK)

Beam Web Tear-out:

Combined Tension and Shear

Load Angle, Ø = Atn(H/V) = 51.466 Degees
A = Sin(Ø) = 0.7822
B = Cos(Ø) = 0.623

Ag = 3.141 in^2 An = 2.541 in^2

Rupture:

ØRn = 0.75* 0.18 * (A/ B) * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * An * Fu / B
= 0.75 * 0.18 * (0.7822 / 0.623) * (-1 + (1 + $(0.623 / 0.7822)^2$ / $0.09)^{0.5}$) * 2.541 * 65 / 0.623
= 82.548 ≥ 13.806 kips (OK)

Yielding:

ØRn = 1^2 * 0.18 * $(A / B)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(B / A)^2$ / (0.09 * 1^2 $))^{0.5}$) * Ag * Fy/A
= 1^2 * 0.18 * $(0.7822 / 0.623)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(0.623 / 0.7822)^2$ / (0.09 * 1^2 $))^{0.5}$) * 3.141 * 50/0.7822
= 100.7 ≥ 13.806 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 2:

Ag1 = 0.9 in^2 An1 = 0.6 in^2 Ag2 = 0.9 in^2
An2 = 0.6 in^2

Adjusted Design Stress:

ft1 = 0.75*0.18 * $(A / B)^2$ * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.7822 / 0.623)^2$ * (-1 + (1 + $(0.623 / 0.7822)^2$ / $0.09)^{0.5}$) * 65
= 25.412 ksi

Fv1 = ft1 * B / A = 25.412 * 0.623 / 0.7822 = 20.238 ksi

ft2 = 0.75*0.18 * $(B/ A)^2$ * (-1 + (1 + $(A / B)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.623 / 0.7822)^2$ * (-1 + (1 + $(0.7822 / 0.623)^2$ / $0.09)^{0.5}$) * 65
= 18.385 ksi

Fv2 = ft2 * A / B = 18.385 * 0.7822 / 0.623 = 23.085 ksi

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (20.238 * 0.6 + 18.385 * 0.6)/0.623
= 37.198 ≥ 13.806 kips (OK)

Plate Bending:

Net Area, An = 2 in^2
Net Section Modulus, Sn = 2.274 in^3
e = (tp+tw)/2 = (0.5 + 0.3) / 2 = 0.4 in^2
Stress = H/An + (Mo + V * (c + Lh))/Sn + 6*(H*e/2)/(t*An)
= 10.8/2 + (0.162 + 8.6011 * (0.5 + 1.5))/2.274+ 6*(10.8 * 0.4/2)/(0.5*2)
= 25.996 ≤ 0.9*Fy = 32.4 ksi OK

Plate Buckling:

Maximum Stress:
= H/An + 6*(H * ex/2)/(t*An)+(V*cx+Mom)/S
= 0 /2 + 6 * (0 * 0.4 / 2) / (0.5 * 2) + (8.6011 * 2 + 0.162) / 2.274
= 7.636 ksi

Design Bending Stress for Lateral Buckling:

c = 2 in., ho = L = 6 in., 2c/ho = 0.6667, K = 2.5
m = $(Fy / K)^{0.5}$ * ho / (0.98*$E^{0.5}$ * 2 * tp)
= $(36 / 2.5)^{0.5}$ * 6 / (0.98 * E * 2 * 0.5)
= 0.1364
O = 1

ØFcr = 0.9*Fy * O = 0.9*36 * 1
= 32.4 ≥ 7.636 ksi OK

Compression Buckling of Plate:

Using K = 1.2 and L = 2 in.
r = t/($12^{0.5}$) = 0.5/3.464 = 0.1443 in.
KL/r = 16.627

Lc = KL/r * $(Fy/E)^{0.5}$ /PI
= 16.627 * $(36/29000.)^{0.5}$ /3.1416
= 0.1865

Fcr = $0.658^{(Lc^2)}$*Fy
= $0.658^{0.0348}$ * 36 = 35.48 ksi

Pn = Lp*t*Fcr = 6*0.5*35.48 = 108 kips
Mu = Pu*e/2 = 0*0.4/2 = 0 k-in.
Mn = Fy*Lp*t^2 /4 = 36*6 * 0.5^2 /4 = 13.5 k-in.

Utilization Factor:

Pu / (0.9 * Pn) < 0.2
Pu / (2*0.9*Pn) + Mu/(0.9*Mn)
= 0 / (2*0.9 * 108) + 0 / (0.9 * 13.5)
= 0 ≤ 1.0 OK

Plate to Column Weld:

Weld Size = 0.1875 ≥ Min. Weld Size = 0.1875 in. (OK)

Weld Stresses:

fr = $[((H / L) + 6*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((10.8 / 6) + 6*0.162/6^2)^2 + (8.6011/6)^2]^{0.5}$
= 2.3223 kips/in.

fraverage = $[((H / L) + 3*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((10.8 / 6) + 3*0.162/6^2)^2 + (8.6011/6)^2]^{0.5}$
= 2.3117 kips/in.

Required Weld Size = Max(fr; 1.25 * fraverage) / (0.75*0.6*1.414 * Fexx)
= Max(2.3223; 1.25 * 2.3117) / (0.75*0.6*1.414 * 70)
= 0.0649 ≤ 3/16 in. (OK)

Useful weld size:
= Min(0.75*0.6 * tp * Fup; 2 * 0.75*0.6 * tc * Fuc) / (0.75*0.6*1.414 * Fexx)
= Min(0.75*0.6 * 0.5 * 58; 2 * 0.75*0.6 * 0.3 * 65) / (0.75*0.6*1.414 * 70)
= 0.293 ≥ 0.0649 in. (OK)

Beam and Column Local Stresses for Left Side Beam

Beam Web Local Yielding:

Force from Bottom, Rbot = $((1.73*HbBot)^2 + (VbBot+3MbBot/LBot)^2)^{0.5}$
= $((1.73*5.7586)^2 + (3.8011+3*9.2405/10)^2)^{0.5}$

= 11.936 kips

Required Web Thickness = Rbot / (1 *Fy * (L+2.5*k))
= 11.936 / (1 * 50 *(10+2.5*0.81))
= 0.0199 in. $\leq$ 0.3 in. (OK)

Beam Web Crippling:

Force from Bottom, Rbot = VbBot+3MbBot/LBot
= 3.8011+3*9.2405/10
= 2.7722 kips

Design Strength for Bottom Loading, ØRn:
= 0.75* 0.4 * $E^{0.5}$ *
tw^2 *(1+(4*(Nbot/d)-0.2)*$(tw/tf)^{1.5}$)*$(Fy*tf/tw)^{0}$.
= 0.75* 0.4 * 170.3 *0.3^2 *(1+(4*(10/10.47)-0.2)
$(0.3/0.51)^{1.5}$)$(50*0.51/0.3)^{0.5}$
= 111.6 kips $\geq$ 2.7722 kips (OK)

Column Web Bending and out of Plane Shear:

H = Fx/L
= 10.8/ 6
= 1.8 kips/ in.
Moment, M = H*Wc/4 = 1.8 * 8.85/ 4 = 3.9825 kip-in/in.

Bending Strength:

ØMn = 0.9 * Fy * tw^2 /4
= 0.9 * 50 * 0.3^2 /4
= 1.0125 < 3.9825 kip-in/in. (NG)

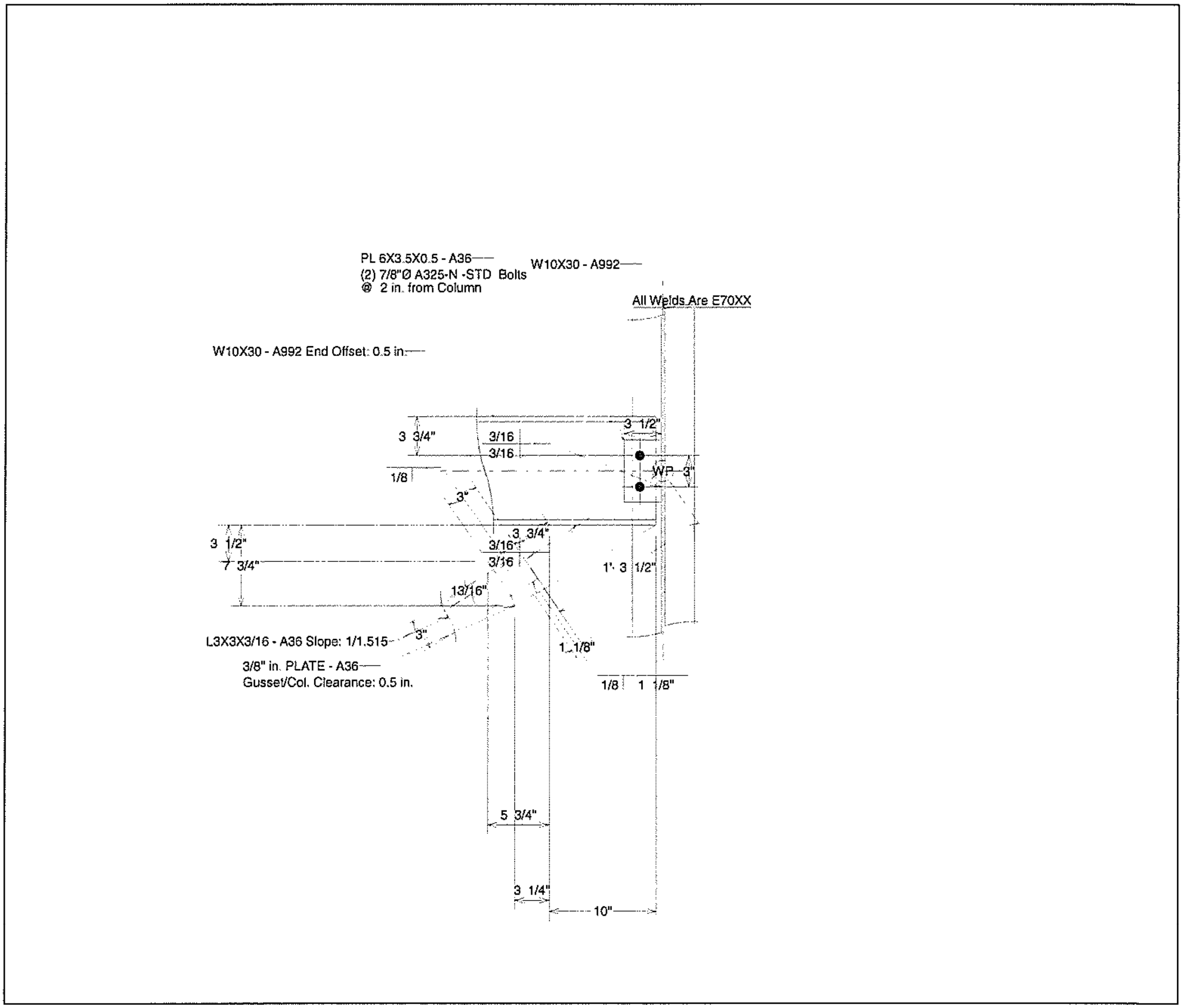
Shear Stress:

fv = H / (2*tw) = 1.8 / (2*0.3)
= 3 $\leq$ Fv = 1 * 0.6*Fy = 1 * 0.6 * 50 = 30 ksi OK

NG not applicable as we have transvers stiff to trast load to flanges

Design is incomplete or not satisfactory.

--*-*-*-*-*-*-*-*-*-*-*-END-*-*-*-*-*-*-*-*-*-*-*-*-*


PL 6X3.5X0.5 - A36
(2) 7/8"Ø A325-N -STD Bolts
@ 2 in. from Column
W10X30 - A992
All Welds Are E70XX
W10X30 - A992 End Offset: 0.5 in.
3 3/4"
3/16
3/16
1/8
3 1/2"
WP
3"
3"
3 1/2"
7 3/4"
3 3/4"
3/16
3/16
13/16"
1' 3 1/2"
L3X3X3/16 - A36 Slope: 1/1.515
3"
1 1/8"
3/8" in. PLATE - A36
Gusset/Col. Clearance: 0.5 in.
1/8
1 1/8"
5 3/4"
3 1/4"
10"

Scale: 3/4" = 1'

MERRICK & COMPANY

Engineering Calculation Sheet

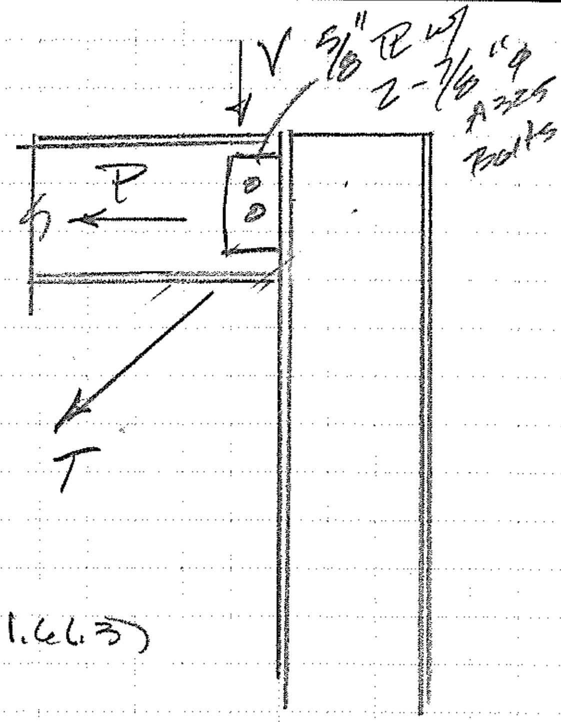
011-2010A

Date
Sheet of
Contract 1481-77
Calculation No.

Subject McMurdo
utilities

Revision	By	Date	Chk'd	Date
	TB			

Connection Design



V

$V_{DL} = 1.1$ k

$V_{LL} = .5$ k

$SL = .73$ k

V_u

$= 1.2(1.1) + .5$

$= 1.8$ k

P

$P_{DL} = .5$ k

$P_{LL} = .62$ k

$P_{WL} = .3$ k

P_u

$= 1.2(.5) + (.62) + 1.6(.3)$

$= 1.7$ k

T

$P_{DL} = .94$ k

$P_{LL} = 1.17$ k

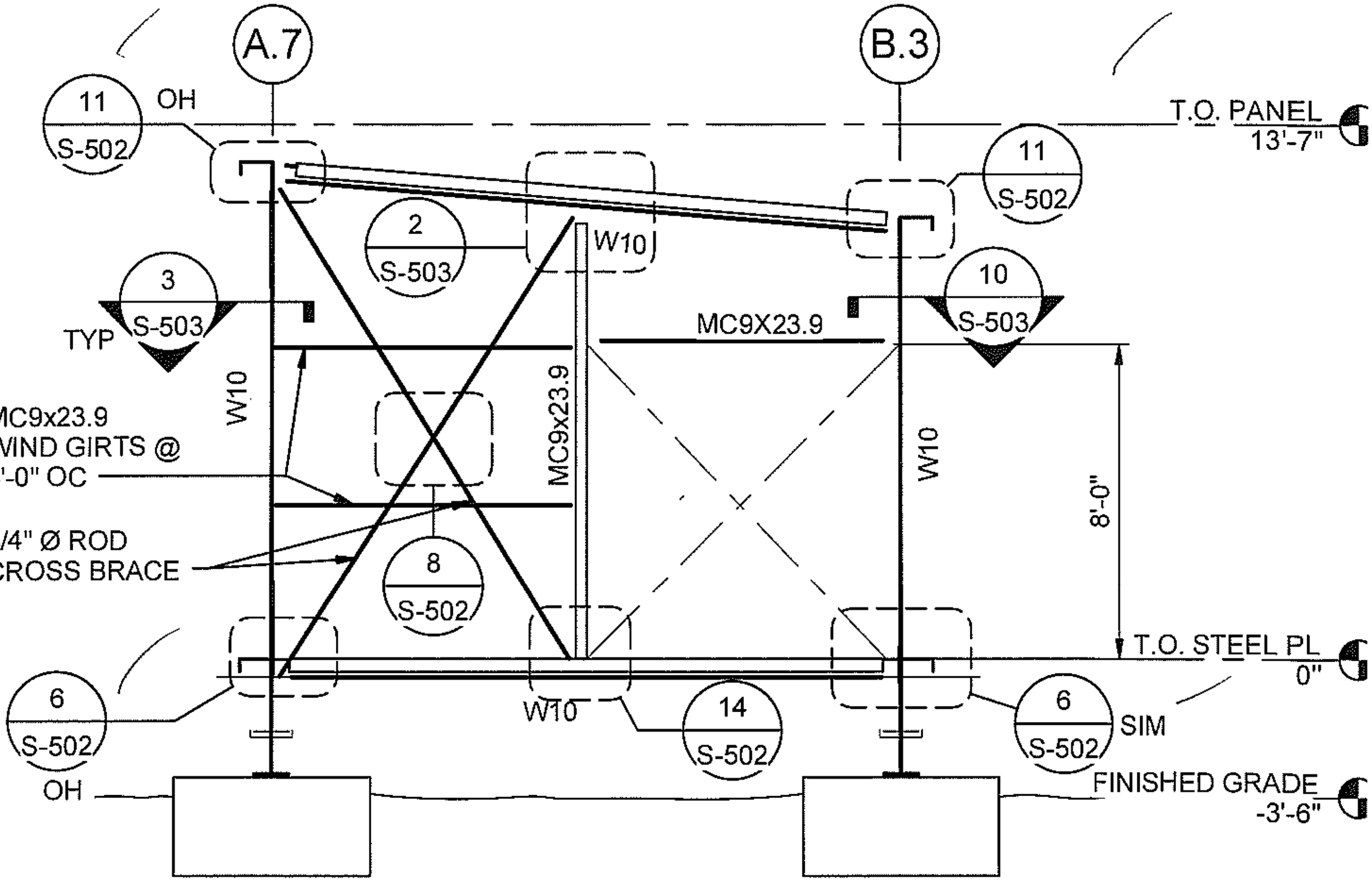
$P_{WL} = 12.6$ k

T_u

$= 1.2(.94) + 1.17 + 1.6(12.6)$

$= 22.5$ k

use 5/8" Shear tab w/
2-7/8" φ A325 Bolts
see following Print
out



1 S-101 ELEVATION

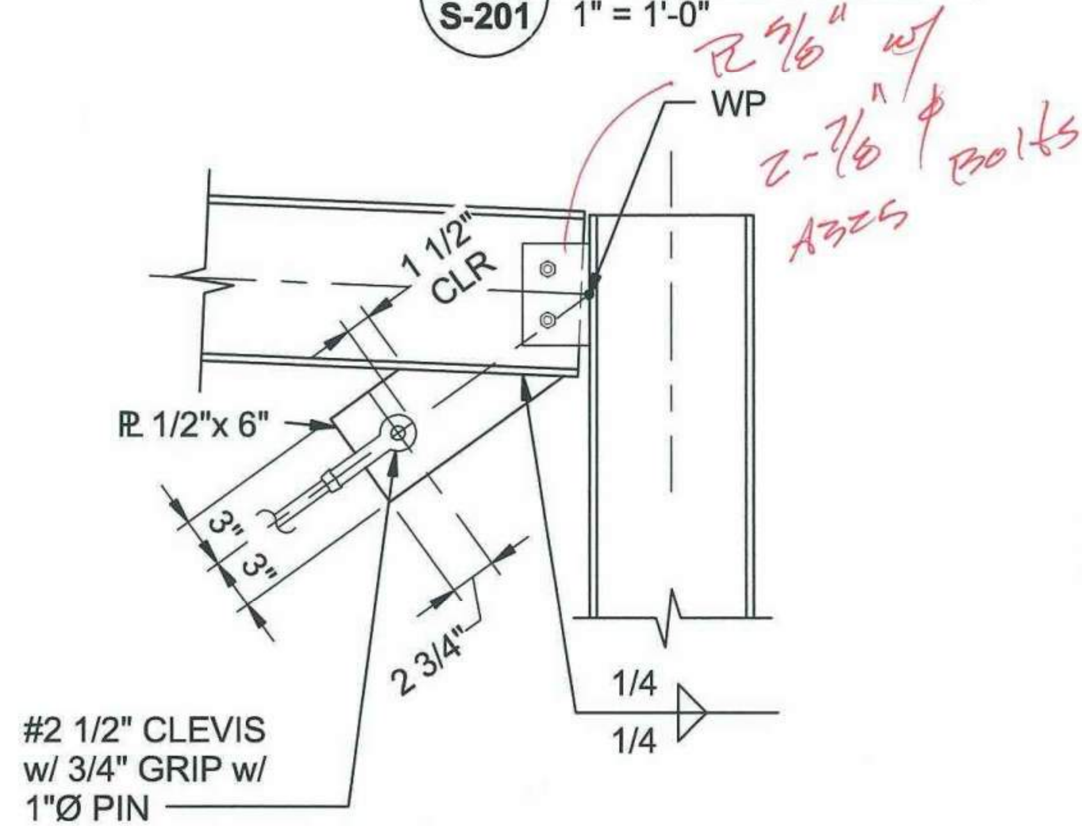
1/4" = 1'-0"

TION

6
S-201
DETAIL
1" = 1'-0"

VP

3/4"

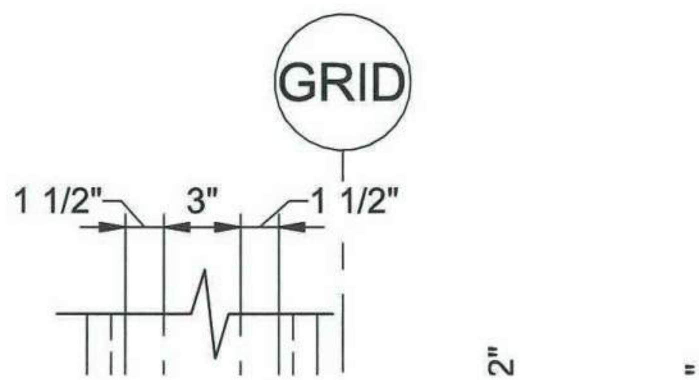


MC
FRA
SUF

3/16

11
S-201
DETAIL
1" = 1'-0"

OOR FRAME
MOVABLE
SUPPORT
(2) 7/8"Ø
OLTS



BASIC DESIGN DATA

Non-Seismic Design

Column:
Size: W10X30
Material: A992
Orientation: Web In Plane
Axial Force (Tension): 0 kips
Axial Force (Compression): 0 kips
Shear Force: 0 kips

Left Side Beam:
Size: W10X30
Material: A992
Axial Force (Tension): 12 kips
Axial Force (Compression): 0 kips
Shear Force: 1.8 kips
Work Point X: 0 in.
Work Point Y: 0 in.

Single Plate:
Length: 6 in.
Material: A36
Bolts: 7/8"Ø A325-N -STD
Bolt Vertical Spacing: 3 in.
Bolt Vertical Edge Distance: 1.5 in.
Bolt Horizontal Spacing: 3 in.
Bolt Horizontal Edge Distance: 1.5 in.

Lower Left Brace: N/A
Size: L3X3X3/16
Length: 3 Ft

Material: A36
Axial Force (Tension): 22.5 kips
Axial Force (Compression): 0 kips
Work Point X: -5.25 in.
Work Point Y: 0 in.
Rise/Run: 1.94/1
Bolt Edge Distance: 1.5 in.

Gusset Plate:
Material: A36
Column Side Length: 10.47 in.
Beam Side Length: 4.25 in.
Brace Side Length: 4.4781 in.
Column Side Free Edge: x= 3.1662 in., y= 7.5873 in.
Beam Side Free Edge: x= 3 in., y= 5.75 in.
Thickness: 0.375 in.
Setback from Column: 0.5 in.
Bolt Edge Distance: 1.5 in.
Gusset-Brace Gap: -5.875 in.

Lower Left Brace to Gusset Connection

N/A

Brace Force = 22.5 kips

Brace to Gusset Weld Size = 1/8 in.
Brace to Gusset Weld Length Along Heel of Angle = 5.875 in.
Brace to Gusset Weld Length Along Toe of Angle = 2.2082 in.

Weld Size = 1/8 ≥ Minimum Weld Size = 1/8 in. (OK)

Weld Size = 1/8 ≤ Maximum Weld Size = 3/16 in. (OK)

Heel Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*5.875
= 16.355 kips

Toe Weld:
ØRn = ß * 0.75*0.6*Fexx*0.707*w*L
= 1*0.75*0.6*70*0.707*0.125*2.2082
= 6.1473 kips

Total Weld Design Strength:

ØRn = 22.502 ≥ 22.5 kips (OK) N/A

Maximum Weld Force Gusset Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.375 * (5.875 + 2.2082)
= 65.474 ≥ 22.5 kips (OK)

Maximum Weld Force Brace Can Develop:
= 1 * 0.6*Fy*t*L
= 1 * 0.6*36 * 0.1875 * (5.875 + 2.2082)
= 32.737 ≥ 22.5 kips (OK)

Check Lower Left Brace

Tension Yielding:

ØRn = 0.9*Fy * Ag = 0.9 * 36 * 1.0898
= 35.311 ≥ 22.5 kips (OK) N/A

Tension Rupture:

Shear Lag Factor, U = 1-x/L = 1 - 0.8196/5.875 = 0.8605

ØRn = 0.75*Fu * U*Ag
= 0.75*58 *0.8605*1.0898
= 40.795 ≥ 22.5 kips (OK)

Lower Left Brace Gusset Dimensions:
Column Side, Lgc = 0 in.
Beam Side, Lgb = 4.25 in.
Beam Side Free Edge, Lvfx = 3 in.
Beam Side Free Edge, Lvfy = 5.75 in.
Column Side Free Edge, Lhfx = 3.1662 in.
Column Side Free Edge, Lhfy = 7.5873 in.

Lower Left Brace Gusset Edge Forces:

Special case: 3

Gusset edge moments carried by: Beam interface

Theta = 27.269 Degrees, eb = 5.235 in. ec = (-0.015) in.
Beta = 0 in. BetaBar = 0 in. AlphaBar = 2.625 in.

Alpha = (Beta + eb)*Tan(Theta) - ec
= (0 + 5.235)*Tan(27.269) - (-0.015)
= 2.7135 in.

With Tensile Brace Force:

$r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)^{0.5}$
$= 22.5 / ((2.7135 + (-0.015))^2 + (0 + 5.235)^2)^{0.5}$
= 3.8203 kips/in.

Hb = Alpha * r = 2.7135 * 3.8203
= 10.309 kips

Hc = ec * r = (-0.015) * 3.8203
= 0 kips

Vb = eb * r = 5.235 * 3.8203
= 19.999 kips

Vc = beta * r = 0 * 3.8203
= 0 kips

Mb = |Vb * (Alpha - AlphaBar)|
= |19.999 * (2.7135 - 2.625)|

= 1.769 k-in.

Mc = 0

With Compressive Brace Force:

$r = Fx / ((Alpha + ec)^2 + (beta + eb)^2)^{0.5}$
$= 0 / ((2.7135 + (-0.015))^2 + (0 + 5.235)^2)^{0.5}$
= 0 kips/in.

Hb = Alpha * r = 2.7135 * 0
= 0 kips

Hc = ec * r = (-0.015) * 0
= 0 kips

Vb = eb * r = 5.235 * 0
= 0 kips

Vc = beta * r = 0 * 0
= 0 kips

Mb = 0

Mc = 0

Lower Left Brace Gusset Thickness

Try t = 3/8"

Maximum Brace Weld Force Gusset Can Develop:
= 0.75 * 0.6*Fu*t*(L1+L2)
= 0.75 * 0.6*58 * 0.375 * (5.875 + 2.2082)
= 79.114 ≥ 22.5 kips (OK)

Block Shear of Gusset at Brace:

Agv = Anv = 2*L*t = 2*5.875*0.375 = 4.4063 in^2

Agt = Ant = d*t = 3*0.375 = 1.125 in^2

ØRn = 0.75 * (0.6 * Min(Fu * Anv;Fy * Agv) + Ubs * Fu * Ant)
= 0.75 * (0.6*Min(58 * 4.4063; 36 * 4.4063) + 1 * 58 * 1.125)
= 120.3 ≥ 22.5 kips (OK)

Check Whitmore Section:

Width1 = 1.1547*Lweld = 1.1547*5.875 = 6.7839 in.
Width2 = 0.57735*(5.875 + 2.2082) + 3 = 7.6668 in.
Width, Lw = Max(Width1;Width2) = 7.6668 in.

Lwo = 3.6795 in. of Lw is outside the gusset free edge.

Width of Whitmore Section inside gusset boundaries, Lwg = 3.9873 in.

Whitmore Section Stress:

Tension:

fa = Fx/(Lwg*t + Lwb*twb + Lwc*twc)
= 22.5/(3.9873 * 0.375 + 0 * 0.3 + 0 * 0.3)
= 15.048 ksi

Compression:

fa = Fx/(Lwg*t + Lwb*twb + Lwc*twc)
= 0/(3.9873 * 0.375 + 0 * 0.3 + 0 * 0.3)
= 0 ksi

Whitmore Section Yielding:

Design Strength = 0.9*(Lwg*t*Fyg + Lwb*twb*Fyb + Lwc*twc*Fyc)
= 0.9*(3.9873 * 0.375 * 36 + 0 * 0.3* 50 + 0 * 0.3* 50)
= 48.446 ≥ 22.5 kips (OK)

Lower Left Brace Gusset to Beam Connection

Horizontal Force on Welds, Hb = 10.309 kips

Vertical Force on Welds, Vb = 19.999 kips

Moment on Welds, M = 0 k-in.

Weld Length on Each Side of Gusset Plate, L = 4.25 in.

Average Force on Welds per Unit Length = fraverage
$= ((V/L+3M/(L^2))^2 + (H/L)^2)^{0.5}$
$= ((19.999/4.25 + 3^* 0/(4.25^2))^2 + (10.309/4.25)^2)^{0.5}$
= 5.2941 kips/in.

fr = fraverage

Maximum useful weld size = 0.7072 * Fu* t / Fexx
= 0.7072 * 58 * 0.375/70
= 0.2197 in.

Use Richard Factor, Rf = 1.25

Required Weld Size, w = Max(Rf*f_avrg;f_peak)/(0.75*0.6*1.41*Fexx)
= 6.6176/(0.75*0.6*1.41* 70)
= 0.1486 in.

Use 3/16 in. Weld

Left Side Beam to Column Connection

Transfer Force from Right = 0 kips Compression
Transfer Force from Right = 0 kips Tension
Transfer Force from Left = (-10.309) kips Compression
Transfer Force from Left = 12 kips Tension

Vertical Force on Single Plate = V
(Maximum Combined Force)
= 21.799 kips

Horizontal Force on Single Plate = H
(Maximum Combined Force)
H (Tension)= 12 kips
H (Compression)= 0 kips

Design Single Plate

Plate Length = 6 in.
Plate Width = 3.5 in.
Plate Thickness = 0.625 in.
Bolts: (2)7/8"Ø A325-N -STD
Bolt Holes on S. Plate:0.9375" Horiz. X 0.9375" Vert.
Bolt Holes on Gusset:0.9375" Horiz. X 0.9375" Vert.

Bolt Vertical Spacing = 3 ≥ Min. Spacing = 2.3333 in. (OK)

Vert. Edge Dist. on S. Plate = 1.5 ≥ Min. Edge Dist. = 1.5 in. (OK)

Bolt Shear Strength:

Eccentricity, ex = 2.0083 in. (Includes the effect of Transfer Force Ecc.)
Vertically: 2 Bolts with 3 in. Spacing
Horizontally: 1 Bolts with 3 in. Spacing
Resultant Load (24.884 kips) Inclined 28.832 Degrees from Vertical
Inclined Eccentic Load Coefficient, C = 1.2085

ØRn = C*Fv = 1.2085 * 24.353 = 29.43 ≥ 24.884 kips (OK)

Bolt Bearing

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.
Equiv. Bolt Factor, ef = C/Nb ≤ 1 = 1.2085 / 2 = 0.6042
ØRn = ef * Nh*(Fbe + Fbs * (Nl - 1)) * t
= 0.6042 * 1 * (53.831 + 91.35 * (2-1))*0.625
= 54.827 ≥ 21.799 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 2.0625 * 58 = 107.7 kips/in.
Use: Fbs = 91.35 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 91.35 kips/in.
= 0.75 * 1.2 * 1.0313 * 58 = 53.831 kips/in.

With Compressive Force:
ØRn = ef * Nl * Fbs * Nh * t
= 0.6042 * 2 * 91.35 * 1 * 0.625
= 68.996 ≥ 0 kips (OK)

With Tensile Force:
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.6042 * 2 * (53.831 + 91.35 * (1 - 1)) * 0.625
= 40.658 ≥ 12 kips (OK)

Bolt Bearing on Beam Web:

Vertical Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
ØRn = ef * Nh*Fbs * Nl * t
= 0.6042 * 1 * 102.4 * 2 * 0.3
= 37.115 ≥ 21.799 kips (OK)

Horizontal Load:

Bearing Strength/Bolt/Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 2.0625 * 65 = 120.7 kips/in.
Use: Fbs = 102.4 kips/in.
Bearing Strength/Bolt/Thickness Using Bolt Edge Distance = Fbre
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= 0.75 * 1.2 * Lc * Fu ≤ 0.75 * 2.4 * d * Fu = 102.4 kips/in.
= 0.75 * 1.2 * 1.0313 * 65 = 60.328 kips/in.

With Tensile Force
ØRn = ef * Nl * (Fbe + Fbs * (Nh - 1)) * t
= 0.6042 * 2 * (60.328 + 102.4 * (1 - 1)) * 0.3
= 21.871 ≥ 12 kips (OK)

With Compressive Force
ØRn = ef * Nl * Fbs * Nh * t
= 0.6042 * 2 * 60.328 * 102.4 * 1 * 0.3
= 37.115 ≥ 0 kips (OK)

Single Plate Combined Tension and Shear

The following formulae have been derived using an interaction equation of the form $ft/Ft + (fv/Fv)^2 = 1$
(Ref. "Combined Shear and Tension Stress", Subhash C. Goel, Engineering Journal,3rd Q 1986, AISC).

Load Angle, Ø = Atn(H/V) = 28.832 Degees
A = Sin(Ø) = 0.4822
B = Cos(Ø) = 0.876

Rupture:

Net Area, An = (L - Nl * (dv + 0.0625)) * t
= (6 - 2 * (0.9375 + 0.0625)) * 0.625
= 2.5 in^2

ØRn = 0.75* 0.18 * (A/ B) * $(-1 + (1 + (B / A)^2 / 0.09)^{0.5})$ * An * Fu / B
= 0.75 * 0.18 * (0.4822 / 0.876) * $(-1 + (1 + (0.876 / 0.4822)^2 / 0.09)^{0.5})$ * 2.5 * 58 / 0.876
= 63.191 ≥ 24.884 kips (OK)

Yielding:

Ag= L*t = 6 * 0.625 = 3.75 in^2

ØRn = 1^2 * 0.18 * $(A / B)^2$ * $(-1 / 0.9 + (1 / (0.9^2) + (B / A)^2 / (0.09 * 1^2))^{0.5})$ * Ag * Fy/A
= 1^2 * 0.18 * $(0.4822 / 0.876)^2$ * $(-1 / 0.9 + (1 / (0.9^2) + (0.876 / 0.4822)^2 / (0.09 * 1^2))^{0.5})$ * 3.75 * 36/0.4822
= 77.039 ≥ 24.884 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 1:

An1 = (L - Lv - (Nl - 0.5) * (dv + 0.0625)) * t
= (6 - 1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.625
= 1.875 in^2
An2 = (W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= (3.5 - 0.5 - 1.5 - (1 - 0.5) * (0.9375 + 0.0625)) * 0.625
= 0.625 in^2

Adjusted Design Stress:

ft1 = 0.75*0.18 * $(A / B)^2$ * $(-1 + (1 + (B / A)^2 / 0.09)^{0.5})$ * Fu
= 0.75*0.18 * $(0.4822 / 0.876)^2$ * $(-1 + (1 + (0.876 / 0.4822)^2 / 0.09)^{0.5})$ * 58
= 12.189 ksi

Fv1 = ft1 * B / A = 12.189 * 0.876 / 0.4822 = 22.143 ksi

ft2 = 0.75*0.18 * $(B/ A)^2$ * $(-1 + (1 + (A / B)^2 / 0.09)^{0.5})$ * Fu
= 0.75*0.18 * $(0.876 / 0.4822)^2$ * $(-1 + (1 + (0.4822 / 0.876)^2 / 0.09)^{0.5})$ * 58
= 28.158 ksi

Fv2 = ft2 * A / B = 28.158 * 0.4822 / 0.876 = 15.5 ksi

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (22.143 * 1.875 + 28.158 * 0.625)/0.876
= 67.482 ≥ 24.884 kips (OK)

Pattern 2:

An1 = (L - 2*Lv - (Nl - 0.5) * (dv + 0.0625)) * t

= (6 - 2*1.5 - (2 - 0.5) * (0.9375 + 0.0625)) * 0.625
= 0.9375 in^2
An2 = 2*(W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * t
= 2*(*3.5 - 0.5 - - 1.5 - (1 - 0.5) * (0.9375 + 0.0625)) * 0.625
= 1.25 in^2

Adjusted Design Stress:
(Same as Above)

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (22.143 * 0.9375 + 28.158 * 1.25)/0.876
= 63.875 ≥ 24.884 kips (OK)

Beam Web Tear-out:

Combined Tension and Shear

Load Angle, Ø = Atn(H/V) = 28.832 Degees
A = Sin(Ø) = 0.4822
B = Cos(Ø) = 0.876

Ag = 3.141 in^2 An = 2.541 in^2

Rupture:

ØRn = 0.75* 0.18 * (A/ B) * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * An * Fu / B
= 0.75 * 0.18 * (0.4822 / 0.876) * (-1 + (1 + $(0.876 / 0.4822)^2$ / $0.09)^{0.5}$) * 2.541 * 65 / 0.876
= 71.979 ≥ 24.884 kips (OK)

Yielding:

ØRn = 1^2 * 0.18 * $(A / B)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(B / A)^2$ / $(0.09 * 1^2))^{0.5}$) * Ag * Fy/A
= 1^2 * 0.18 * $(0.4822 / 0.876)^2$ * (-1 / 0.9 + (1 / (0.9^2) + $(0.876 / 0.4822)^2$ / $(0.09 * 1^2))^{0.5}$) * 3.141 * 50/0.4822
= 89.622 ≥ 24.884 kips (OK)

Block Shear:

Vertical (An1,Ft1) and Horizontal (An2,Ft2) Sections:

Pattern 2:

Ag1 = 0.9 in^2 An1 = 0.6 in^2 Ag2 = 0.9 in^2
An2 = 0.6 in^2

Adjusted Design Stress:

ft1 = 0.75*0.18 * $(A / B)^2$ * (-1 + (1 + $(B / A)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.4822 / 0.876)^2$ * (-1 + (1 + $(0.876 / 0.4822)^2$ / $0.09)^{0.5}$) * 65
= 13.66 ksi

Fv1 = ft1 * B / A = 13.66 * 0.876 / 0.4822 = 24.816 ksi

ft2 = 0.75*0.18 * $(B/ A)^2$ * (-1 + (1 + $(A / B)^2$ / $0.09)^{0.5}$) * Fu
= 0.75*0.18 * $(0.876 / 0.4822)^2$ * (-1 + (1 + $(0.4822 / 0.876)^2$ / $0.09)^{0.5}$) * 65
= 31.556 ksi

Fv2 = ft2 * A / B = 31.556 * 0.4822 / 0.876 = 17.371 ksi

ØRn = (Fv1 * An1 + Ft2 * An2)/B
= (24.816 * 0.6 + 31.556 * 0.6)/0.876
= 38.609 ≥ 24.884 kips (OK)

Plate Bending:

Net Area, An = 2.5 in^2
Net Section Modulus, Sn = 2.8425 in^3

e = (tp+tw)/2 = (0.625 + 0.3) / 2 = 0.4625 in^2
Stress = H/An + (Mo + V * (c + Lh))/Sn + 6*(H*e/2)/(t*An)
= 12/2.5 + (0.18 + 21.799 * (0.5 + 1.5))/2.8425+ 6*(12 * 0.4625/2)/(0.625*2.5)
= 30.858 ≤ 0.9*Fy = 32.4 ksi OK

Plate Buckling:

Maximum Stress:
= H/An + 6*(H * ex/2)/(t*An)+(V*cx+Mom)/S
= 0 /2.5 + 6 * (0 * 0.4625 / 2) / (0.625 * 2.5) + (21.799 * 2 + 0.18) / 2.8425
= 15.402 ksi

Design Bending Stress for Lateral Buckling:

c = 2 in., ho = L = 6 in., 2c/ho = 0.6667, K = 2.5
m = $(Fy / K)^{0.5}$ * ho / (0.98*$E^{0.5}$ * 2 * tp)
= $(36 / 2.5)^{0.5}$ * 6 / (0.98 * E * 2 * 0.625)
= 0.1091
Q = 1

ØFcr = 0.9*Fy * Q = 0.9*36 * 1
= 32.4 ≥ 15.402 ksi OK

Compression Buckling of Plate:

Using K = 1.2 and L = 2 in.
r = t/($12^{0.5}$) = 0.625/3.464 = 0.1804 in.
KL/r = 13.302

Lc = KL/r * $(Fy/E)^{0.5}$ /PI
= 13.302 * $(36/29000.)^{0.5}$ /3.1416
= 0.1492

Fcr = $0.658^{(Lc^2)}$*Fy
= $0.658^{0.0223}$ * 36 = 35.666 ksi

Pn = Lp*t*Fcr = 6*0.625*35.666 = 135 kips
Mu = Pu*e/2 = 0*0.4625/2 = 0 k-in.
Mn = Fy*Lp*t^2 /4 = 36*6 * 0.625^2 /4 = 21.094 k-in.

Utilization Factor:

Pu / (0.9 * Pn) < 0.2
Pu / (2*0.9*Pn) + Mu/(0.9*Mn)
= 0 / (2*0.9 * 135) + 0 / (0.9 * 21.094)
= 0 ≤ 1.0 OK

Plate to Column Weld:

Weld Size = 0.25 ≥ Min. Weld Size = 0.25 in. (OK)

Weld Stresses:

fr = $[((H / L) + 6*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((12 / 6) + 6*0.18/6^2)^2 + (21.799/6)^2]^{0.5}$
= 4.1619 kips/in.

fraverage = $[((H / L) + 3*Mo/L^2)^2 + (V/L)^2]^{0.5}$
= $[((12 / 6) + 3*0.18/6^2)^2 + (21.799/6)^2]^{0.5}$
= 4.1546 kips/in.

Required Weld Size = Max(fr; 1.25 * fraverage) / (0.75*0.6*1.414 * Fexx)
= Max(4.1619; 1.25 * 4.1546) / (0.75*0.6*1.414 * 70)
= 0.1166 ≤ 1/4 in. (OK)

Useful weld size:
= Min(0.75*0.6 * tp * Fup; 2 * 0.75*0.6 * tc * Fuc) / (0.75*0.6*1.414 * Fexx)
= Min(0.75*0.6 * 0.625 * 58; 2 * 0.75*0.6 * 0.51 * 65) / (0.75*0.6*1.414 * 70)
= 0.3662 ≥ 0.1166 in. (OK)

Beam and Column Local Stresses for Left Side Beam

Beam Web Local Yielding:

Force from Bottom, Rbot = $((1.73 * HbBot)^2 + (VbBot+3MbBot/LBot)^2)^{0.5}$
= $((1.73*10.309)^2 + (19.999+3*1.769/4.25)^2)^{0.5}$
= 27.741 kips

Required Web Thickness = Rbot / (1 *Fy * (L+2.5*k))
= 27.741 / (1 * 50 *(4.25+2.5*0.81))
= 0.0884 in. ≤ 0.3 in. (OK)

Beam Web Crippling:

Force from Bottom, Rbot = VbBot+3MbBot/LBot
= 19.999+3*1.769/4.25
= 1.2487 kips

Design Strength for Bottom Loading, ØRn:
= $0.75 * 0.4 * E^{0.5} * tw^2 *(1+(4*(Nbot/d)-0.2)*(tw/tf)^{1.5})*(Fy*tf/tw)^0$.
= $0.75 * 0.4 * 170.3 *0.3^2 *(1+(4*(4.25/10.47)-0.2) *(0.3/0.51)^{1.5})*(50*0.51/0.3)^{0.5}$
= 69.619 kips ≥ 1.2487 kips (OK)

Column Web Local Yielding:

Force from Beam, RColumn = $(H^2 + (1.73*V)^2)^{0.5}$
= $((12)^2 + (1.73*21.799)^2)^{0.5}$ = 39.576 kips

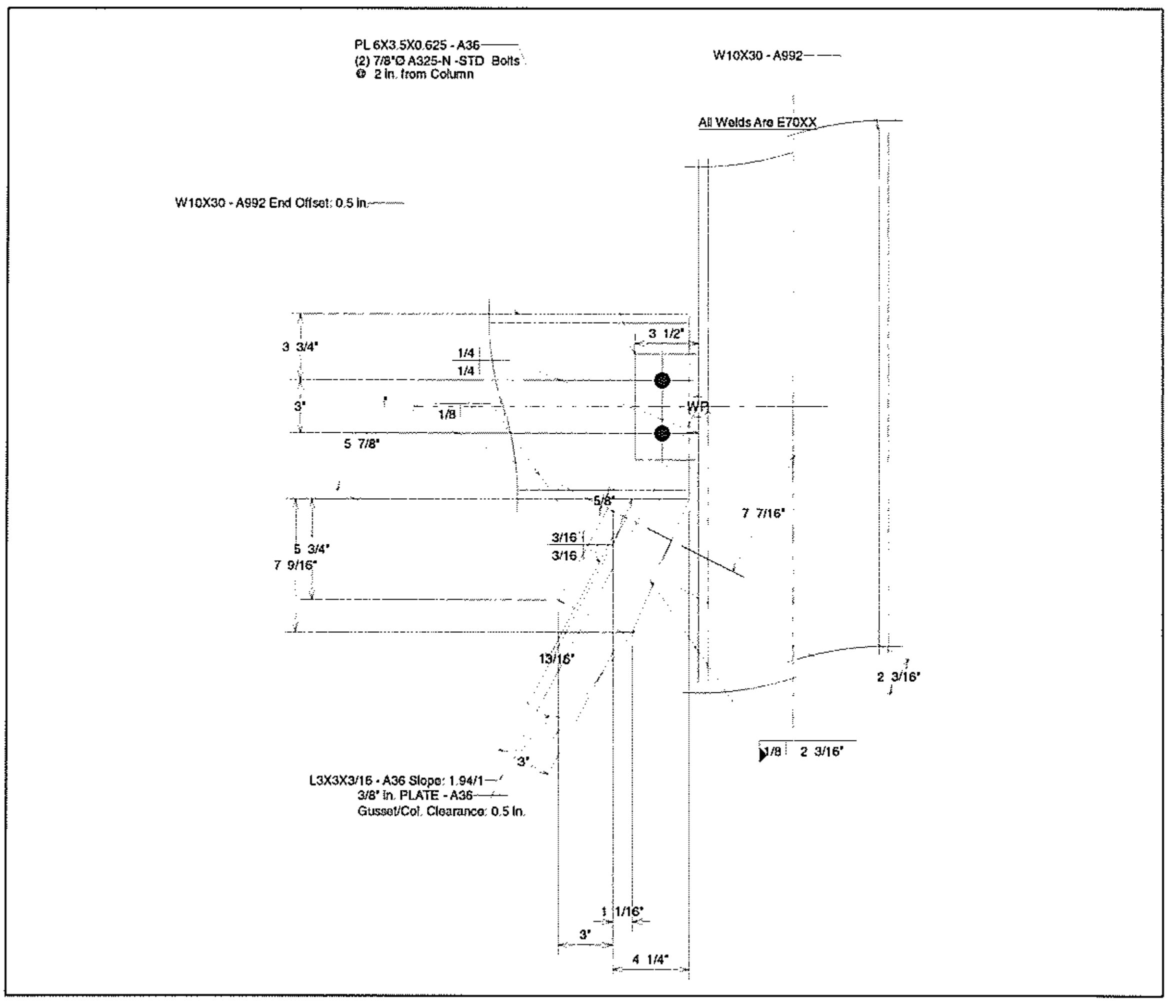
Required Web Thickness = RColumn / (1 * Fy * (N+5*k))
= 39.576 / (1 * 50 * (6 +5*0.81))
= 0.0788 in. ≤ 0.3 in. (OK)

Column Web Crippling:

Force from Beam, RColumn = 0 kips

Design Strength, ØRn:
= $0.75*0.8 * E^{0.5} * tw^2 *(1+3*(N/d)*(tw/tf)^{1.5})*(Fy*tf/tw)^{0.5}$
= $0.75*0.8 * 170.3 * 0.3^2 *(1+3*(6/10.47) *(0.3/0.51)^{1.5})*(50*0.51/0.3)^{0.5}$
= 150.5 kips ≥ 0 kips (OK)

--*-*-*-*-*-*-*-*-*-*-END-*-*-*-*-*-*-*-*-*-*-*-*


PL 6X3.5X0.625 - A36
(2) 7/8"Ø A325-N -STD Bolts
@ 2 in. from Column
W10X30 - A992
All Welds Are E70XX
W10X30 - A992 End Offset: 0.5 in.
3 3/4"
1/4
1/4
3 1/2"
3"
1/8
WP
5 7/8"
5/8"
7 7/16"
3/16
3/16
5 3/4"
7 9/16"
13/16"
2 3/16"
1/8 2 3/16"
3"
L3X3X3/16 - A36 Slope: 1.94/1
3/8" In. PLATE - A36
Gusset/Col. Clearance: 0.5 In.
1 1/16"
3"
4 1/4"

Scale: 1" = 1'

Subject McMurdo
utilities

Revision	By	Date	Chk'd	Date
	PF			

Size Pumphouse Footings

$P_{Down\,max} = 19{,}400$ # $q_{all} = 2{,}100$ psf

min footing size $= \left(\frac{19{,}400}{2{,}100}\right)^{1/2}$
$= 3.04$ ft

Check for uplift

$P_{up\,max} = 6{,}700$ # .6DL + WL

Assume 2'-6" thick footing

(Area)(T)(150) = 6,700 # T = 2.5'

Area = 17.87 ft²
width = $(17.87)^{1/2}$
= 4.23 ft

Try: 4'-6" x 4'-6" x 2'-6" footing

Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	PF			

Check Sliding

$V_T = 5.2 + 4.7$

one frame $= 9.8$ Kips

$P_b/b = 120\frac{(2.0)^2(3)}{2}$

$= 720$ #/ft

SF = 2

$\gamma = 120$ #/ft³

$\phi = .35$

$\frac{P_b/b}{SF} = 720/2$

$= 360$ #/ft

Sliding Resistance

$R = (360)(5.0)(2) + (5.0^2(2.5)(150)(.35)) + 7{,}100\ (.35)$

(Footing wt; Footing comp)

$= 3600 + 3281 + 2485$

$= 9366$ #

DCR $= \frac{9{,}800}{9366} = 1.04$ within 5% OK

Use 5' x 5' x 2'-6" Footings for Pump House

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 12/16 Sheet 102 of 178 of

Contract 7481-77

Calculation No.

Subject McMurdo
utilities

Revision	By	Date	Chk'd	Date
	PF			

Check Pad Footings for Comp

$P_{TL\,max}$ = 19.4 k allowable

$P_{u\,max}$ = 35.68 k

use 5'x5'x2'-6" footing w/ 7-#6 Bars Bott see following Print out

SQUARE PAD FOOTING - CONCENTRIC LOAD

Job: McMurdo utilities

Location:

		Pdead:	1.40 k		Incl ftg weight?:	NO	Floor live load factors	
f'c:	5 ksi	PRLL:	1.00 k		Qmin:	2100 psf	f_1 =	0.5
fy:	60 ksi	PFLL:	3.00 k		Dmin:	30 in	f_2 =	0.2
Tslab:	0.0 in	Psp:	20.00 k		Bmin:	60 in		
Tof:	1.0 in	Psn:	0.00 k		Qd:	0 psf/ft		
Cx:	10.00 in	S or W?:	W		Qb:	0 psf/ft		
cover:	3.0 in		Service	Ultimate	Qmax:	2100 psf		
Top Bars:	#6	Pdl=	5.40 k	35.68 k	Soil den:	120 pcf		
Bottom Bars:	#6	Pdls=	**19.40 k**	35.68 k	St inc:	1.000		
Tftg:	30 in	Pds=	0.84 k	0.00 k	ø:	0°		
Round:	0%		Governing	Criteria	coh:	0.00 ksf		
Surcharge=	0 psf		Service	D+L+S	--			
Qded=	0 psf		Ultimate	D+L+S	-			
D=	31 in				-			

Bdown=	5.00 ft
Bup=	5.00 ft
Bftg=	5.00 ft
Qser=	0.78 ksf
Qall=	2.10 ksf
Pu=	35.68
Qult=	1.43 ksf
Mu+=	15 fk
Mu-=	0 fk

Footing: 5 ft - 0 in square by 30 in thick
No top bars required.
-
With (7) #6 bottom bars each way.
-

	Quan	Unit cost	Total
Excavation:	2.39 cy	100	$239.20
Concrete:	2.31 cy	80	185.19
Steel:	95 lbs	1.25	118.28
			$542.67

Supporting data

Concrete		**Moment** Bottom		**One-way shear**		**Two-way shear**	
beta1=	0.8	Ru=	0.0046	Vu=	0 k	Vu=	23 k
m=	14.12	rho req=	0.0001	bo=	60 in	bo=	144 in
Fr=	230 psi		-	øVn=	165 k	øVn=	788 k
b=	60	As=	2.79 in²	Min num=	4		
dr=	25.88	Num=	7 bars	ldallow=	27.0 in	Bend dia=	4.50 in
dn=	25.88	Asact=	3.08 in²	hook?=	N	90 deg?=	Y
Sx=	121.50 in³	ldb=	25.46 in	room?=	Y	Ext=	9
rho max=	0.0314	spacing=	8.13 in	Lbar=	54.00 in	Lhook=	12.53 in
rho min=	0.0018	ld=	18.48 in	wt=	6.76 lbs		
rho used=	0.0020	lhb=	12.73 in	Fbb=	306 psi		
		ldh=	8.08 in				

Moment Top					
Run=	0.0000				
rho reqn=	0.0000				
	-				
Asn=	2.79 in²	Min num=	4		
Numn=	7 bars	ldallow=	27.0 in	Bend dian=	4.50 in
Asactn=	3.08 in²	hookn?=	N	90 degn?=	Y
ldbn=	25.46 in	roomn?=	Y	Extn=	9
spacingn=	8.13 in	Lbarn=	54.00 in	Lhookn=	12.53 in
ldn=	18.48 in	wtn=	0.00 lbs		
lhbn=	12.73 in	Fbn=	0 psi		
ldhn=	8.08 in				

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	PF			

<u>Check Base PL & Anchorage</u>

P_u = 35.68 kips Down

use	3/4" Plate see Following Print out

<u>Check Anchorage for uplift</u>

P_{all} up = 6,700 #

P_u up = 2(6,700)
= 13,400 # = 13.4 k

V_{max} Allowable = 5.2 k

V_u = 2(5.2)
= 10.4 k

use	3/4" Base Plate w/ 4 - 3/4" ϕ Anchor Bolts see following Print out

MERRICK & COMPANY

Date:	12/6/16	Sheet	of
Merrick Project No.:	7481-77		
Calculation No.:			

Calculation Title: McMurdo utilities

Rev.	Pre By	Date
	PIF	

Loads

Rdl	1.4	k
Rll	1	k
Fll	3	k
Rw	20	k
Re	0	k
ϕ	0.9	
DL Coef	1.2	
Rll Coef	0.5	
Fll Coef	0.5	
Rw Coef	1.6	
Re Coef	-	
Ωo Coef	1	
A2	100	in^2
f'c	5	ksi

Column Dim

	W	Clm Type
d	9.00	in
bf	8.00	in
tf	0.44	in
Fy	30	ksi
Ult Load		
Pu	35.7	k
ϕPp	290	k
	OK	

Prelim Pl Area Req

A1	2	in^2
A1	13	in^2
Δ	1.08	in
N	4.7	in
B	23.6	in

Pl Area Used

Use A1	110	in^2
N	11	in
B	10	in
n	2.00	in
m	2.00	in

X	0.12	
λ =	0.362	<= 1
λ n'=	0.77	in

Plate Thickness

tpn	0.31	in
tpc	0.12	in
tpm	0.31	in

} use 3/4" Plate

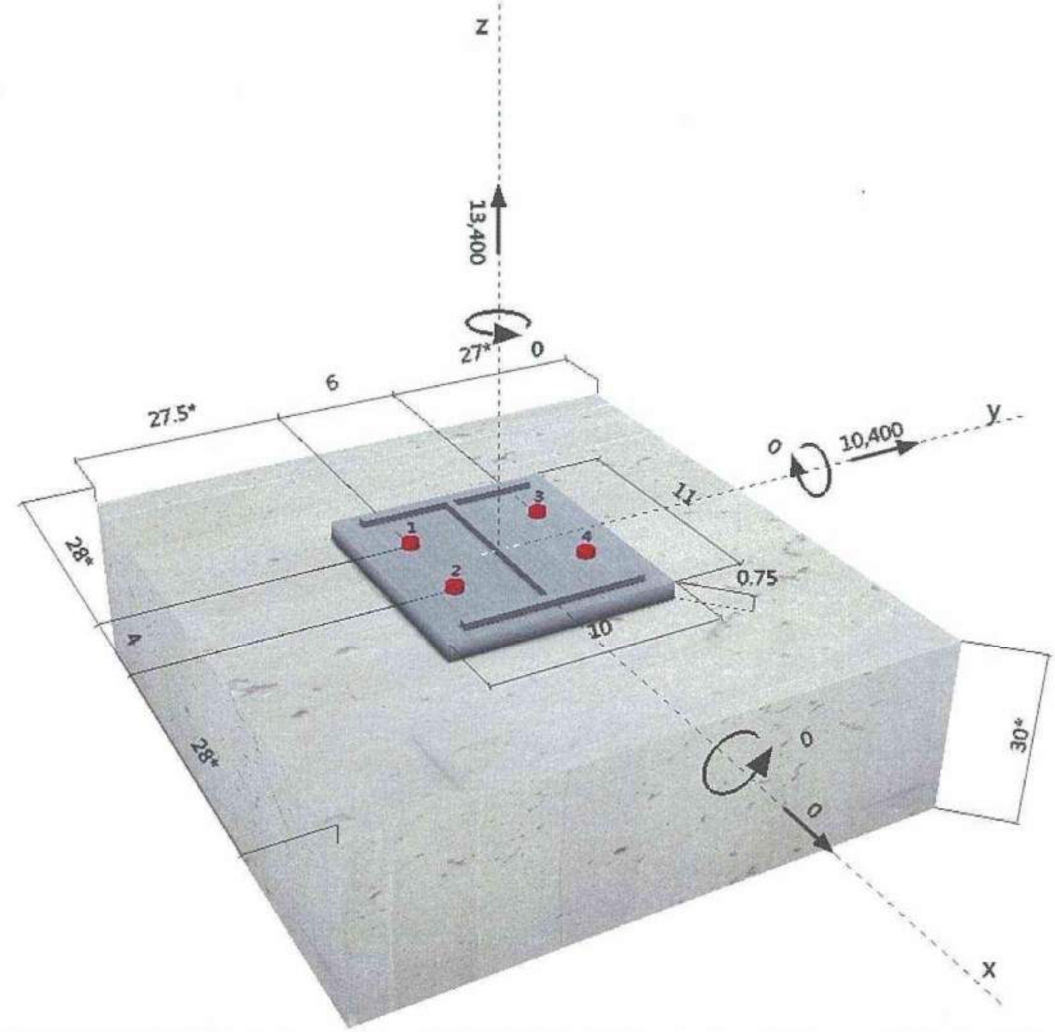
Company:	Merrick	Page:	1
Specifier:	PIF	Project:	McMurdo Utilities
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/6/2016
E-Mail:			

Specifier's comments:

1 Input data

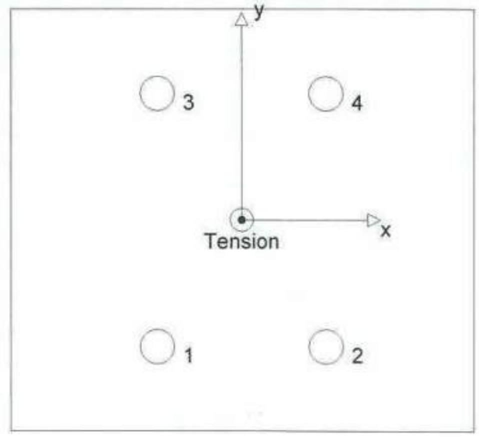
Anchor type and diameter:	**Hex Head ASTM F 1554 GR. 36 3/4**
Effective embedment depth:	h_{ef} = 7.000 in.
Material:	ASTM F 1554
Proof:	Design method ACI 318-08 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 11.000 in. x 10.000 in. x 0.750 in.; (Recommended plate thickness: not calculated
Profile:	W shape (AISC); (L x W x T x FT) = 9.730 in. x 7.960 in. x 0.290 in. x 0.435 in.
Base material:	cracked concrete, 5000, f_c' = 5000 psi; h = 30.000 in.
Reinforcement:	tension: condition B, shear: condition B;
	edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	no

Geometry [in.] & Loading [lb, in.lb]



Company:	Merrick	Page:	2
Specifier:	PIF	Project:	McMurdo Utilities
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/6/2016
E-Mail:			

2 Load case/Resulting anchor forces



Load case: Design loads

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	3350	2600	0	2600
2	3350	2600	0	2600
3	3350	2600	0	2600
4	3350	2600	0	2600

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 13400 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	3350	14529	24	OK
Pullout Strength*	3350	18312	19	OK
Concrete Breakout Strength**	13400	33675	40	OK
Concrete Side-Face Blowout, direction **	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

$N_{sa} = A_{se,N} f_{uta}$ ACI 318-08 Eq. (D-3)
$\phi N_{sa} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.33	58000

Calculations

N_{sa} [lb]
19372

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
19372	0.750	14529	3350

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3.2 Pullout Strength

$N_{pN} = \psi_{c,p} N_p$ ACI 318-08 Eq. (D-14)

$N_p = 8 A_{brg} f'_c$ ACI 318-08 Eq. (D-15)

$\phi N_{pN} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

Variables

$\psi_{c,p}$	A_{brg} [in.^{2}]	f'_c [psi]
1.000	0.65	5000

Calculations

N_p [lb]
26160

Results

N_{pn} [lb]	$\phi_{concrete}$	ϕN_{pn} [lb]	N_{ua} [lb]
26160	0.700	18312	3350

3.3 Concrete Breakout Strength

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ ACI 318-08 Eq. (D-5)

$\phi N_{cbg} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c \lambda \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
7.000	0.000	0.000	27.000	1.000

c_{ac} [in.]	k_c	λ	f'_c [psi]
0.000	24	1	5000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
675.00	441.00	1.000	1.000	1.000	1.000	31430

Results

N_{cbg} [lb]	$\phi_{concrete}$	ϕN_{cbg} [lb]	N_{ua} [lb]
48107	0.700	33675	13400

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	2600	7555	35	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	10400	67350	16	OK
Concrete edge failure in direction y+**	10400	39866	27	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa} = 0.6\, A_{se,V}\, f_{uta}$ ACI 318-08 Eq. (D-20)
$\phi\, V_{steel} \geq V_{ua}$ ACI 318-08 Eq. (D-2)

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.33	58000

Calculations

V_{sa} [lb]
11623

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\, V_{sa}$ [lb]	V_{ua} [lb]
11623	0.650	7555	2600

4.2 Pryout Strength

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N}\, \psi_{ed,N}\, \psi_{c,N}\, \psi_{cp,N}\, N_b \right]$ ACI 318-08 Eq. (D-31)
$\phi\, V_{cpg} \geq V_{ua}$ ACI 318-08 Eq. (D-2)
A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)
$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-08 Eq. (D-6)
$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e_N}{3\, h_{ef}}} \right) \leq 1.0$ ACI 318-08 Eq. (D-9)
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-08 Eq. (D-11)
$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-08 Eq. (D-13)
$N_b = k_c\, \lambda\, \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	7.000	0.000	0.000	27.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ	f'_c [psi]
1.000	-	24	1	5000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
675.00	441.00	1.000	1.000	1.000	1.000	31430

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\, V_{cpg}$ [lb]	V_{ua} [lb]
96214	0.700	67350	10400

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4.3 Concrete edge failure in direction y+

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\, \psi_{ed,V}\, \psi_{c,V}\, \psi_{h,V}\, \psi_{parallel,V}\, V_b$ ACI 318-08 Eq. (D-22)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-08 Eq. (D-2)

A_{Vc} see ACI 318-08, Part D.6.2.1, Fig. RD.6.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-08 Eq. (D-23)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e_v}{3c_{a1}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-26)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-08 Eq. (D-28)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-08 Eq. (D-29)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda\ \sqrt{f'_c}\ c_{a1}^{1.5}$ ACI 318-08 Eq. (D-24)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
20.000	28.000	0.000	1.000	30.000

l_e [in.]	λ	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
6.000	1.000	0.750	5000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
1800.00	1800.00	1.000	0.980	1.000	58113

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
56951	0.700	39866	10400

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.398	0.344	5/3	39	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

6 Warnings

- Load re-distributions on the anchors due to elastic deformations of the anchor plate are not considered. The anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the loading! Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!

Fastening meets the design criteria!

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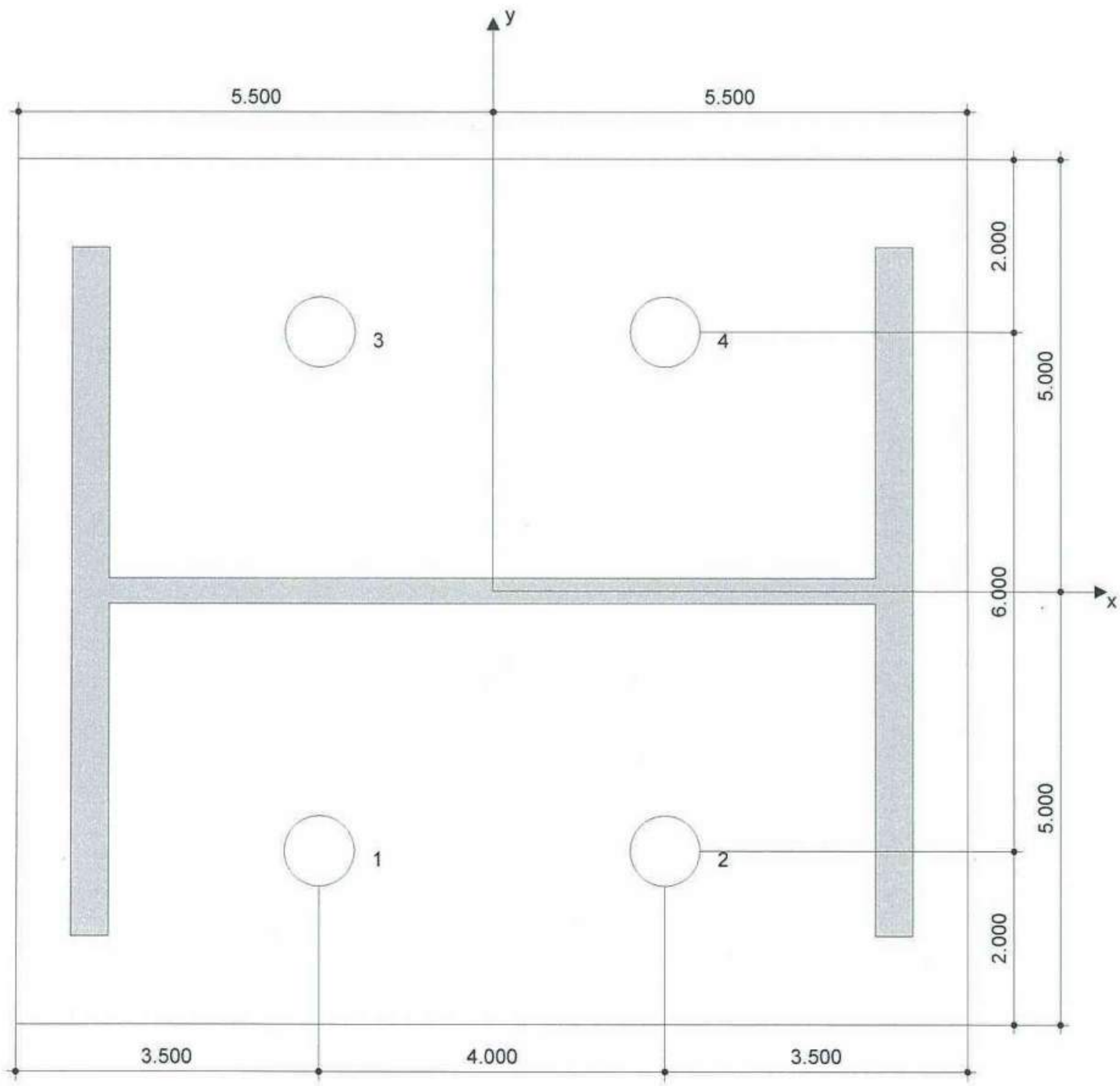
7 Installation data

Anchor plate, steel: -
Profile: W shape (AISC); 9.730 x 7.960 x 0.290 x 0.435 in.
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.750 in.
Recommended plate thickness: not calculated
Drilling method: -
Cleaning: No cleaning of the drilled hole is required

Anchor type and diameter: Hex Head ASTM F 1554 GR. 36 3/4
Installation torque: -
Hole diameter in the base material: - in.
Hole depth in the base material: 7.000 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor in.

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-2.000	-3.000	28.000	32.000	27.500	33.000
2	2.000	-3.000	32.000	28.000	27.500	33.000
3	-2.000	3.000	28.000	32.000	33.500	27.000
4	2.000	3.000	32.000	28.000	33.500	27.000

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8 Remarks; Your Cooperation Duties

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Project Name: McMurdo utilities

Location: McMurdo

By: P Finley

Start Date: 10/31/2016

Comments:

Node BLD

..\DESIGN - DATA\Calcs\Structural\Node Building.wls

ASCE7-10

Local Information

Wind Dir.	Exposure
1	D
2	D
3	D
4	D

Basic Wind Speed: 180 mph

Topography: None

Optional Factors

This project uses load combinations from ASCE 7.

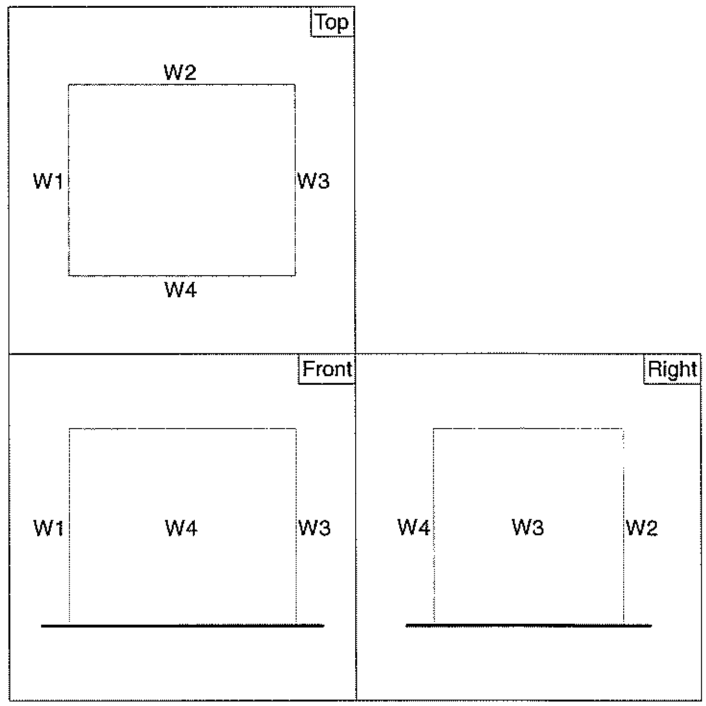
Section - Main Section

Enclosure Classification: Enclosed

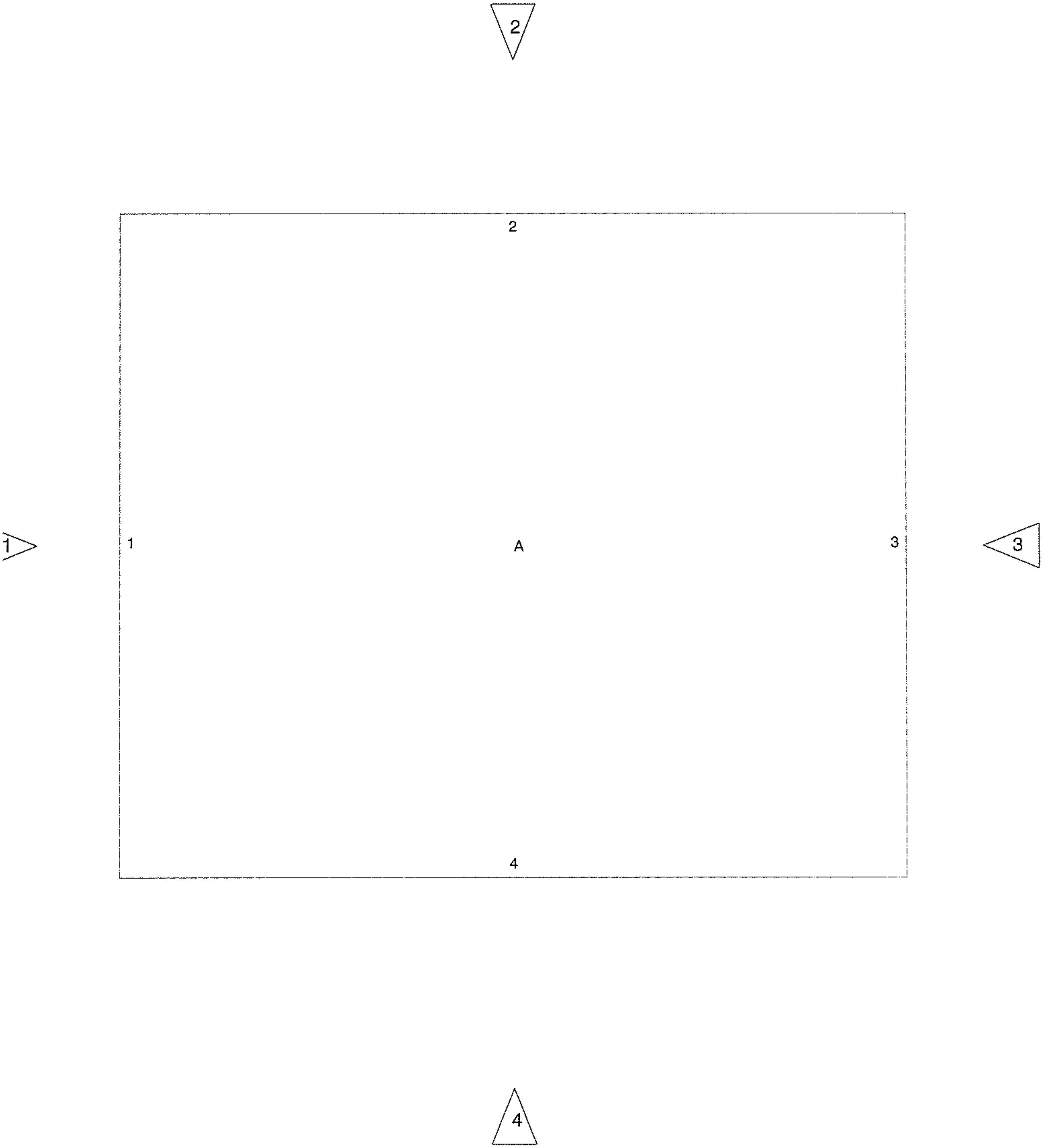
Wall	Length(ft)	Overhang(ft)
1	10.66	0.0
2	12.66	0.0
3	10.66	0.0
4	12.66	0.0

Eave Height: 11 ft
Parapet Height: 0 ft
Parapet Enclosure: Solid

Roof Shape: Flat



Composite Drawing



MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 1

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Windward Wall	11.0	72.6	0.91	0.80	0.18	52.9	39.8	65.9
2	Side Wall	11.0	72.6		-0.70		-46.2	-59.3	-33.2
3	Leeward Wall	11.0	72.6	0.91	-0.46	0.18	-30.4	-43.5	-17.3
4	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
A	Roof	0 to 5.5 *	72.6	0.91	-1.20	0.18	-79.3	-92.3	-66.2
		5.5 to 11.0 *	72.6		-0.75		-49.5	-62.6	-36.5
		11.0 to 12.7 *	72.6		-0.65		-42.9	-56.0	-29.9
		0 to 12.7 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 2

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
2	Windward Wall	11.0	72.6		0.80		52.9	39.8	65.9
3	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
4	Leeward Wall	11.0	72.6	0.91	-0.50	0.18	-33.0	-46.1	-20.0
A	Roof	0 to 5.5 *	72.6	0.91	-1.30	0.18	-85.9	-99.0	-72.8
		5.5 to 10.7 *	72.6		-0.70		-46.2	-59.3	-33.2
		0 to 10.7 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 3

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Leeward Wall	11.0	72.6	0.91	-0.46	0.18	-30.4	-43.5	-17.3
2	Side Wall	11.0	72.6		-0.70		-46.2	-59.3	-33.2
3	Windward Wall	11.0	72.6	0.91	0.80	0.18	52.9	39.8	65.9
4	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
A	Roof	0 to 5.5 *	72.6	0.91	-1.20	0.18	-79.3	-92.3	-66.2
		5.5 to 11.0 *	72.6		-0.75		-49.5	-62.6	-36.5
		11.0 to 12.7 *	72.6		-0.65		-42.9	-56.0	-29.9
		0 to 12.7 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

MWFRS Net Pressures

This data was calculated using the building of all heights method.

Wind Direction 4

#	Surface	z (ft)	q (psf)	G	Cp	GCpi	Ext Pres (psf)	Net w/ +GCpi (psf)	Net w/ -GCpi (psf)
1	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
2	Leeward Wall	11.0	72.6		-0.50		-33.0	-46.1	-20.0
3	Side Wall	11.0	72.6	0.91	-0.70	0.18	-46.2	-59.3	-33.2
4	Windward Wall	11.0	72.6	0.91	0.80	0.18	52.9	39.8	65.9
A	Roof	0 to 5.5 *	72.6	0.91	-1.30	0.18	-85.9	-99.0	-72.8
		5.5 to 10.7 *	72.6		-0.70		-46.2	-59.3	-33.2
		0 to 10.7 *	72.6		-0.18		-11.9	-25.0	1.2

This is load case 1 in ASCE 7-10 Figure 27.4-8. See Figure 27.4-8 for other cases.

* Distance from windward edge.

MERRICK & COMPANY — **Engineering Calculation Sheet**

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Node BLD Dims

*Assume Risk Cat III BLD.

V= 180 mph wind speed

K_d = .85

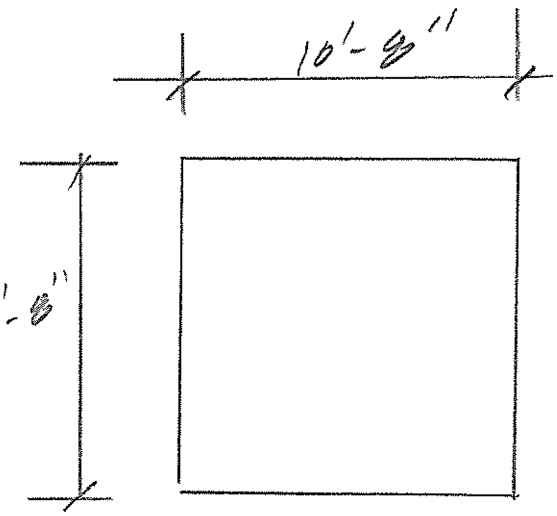
K_{zt} = 1.0

K_z = 1.03

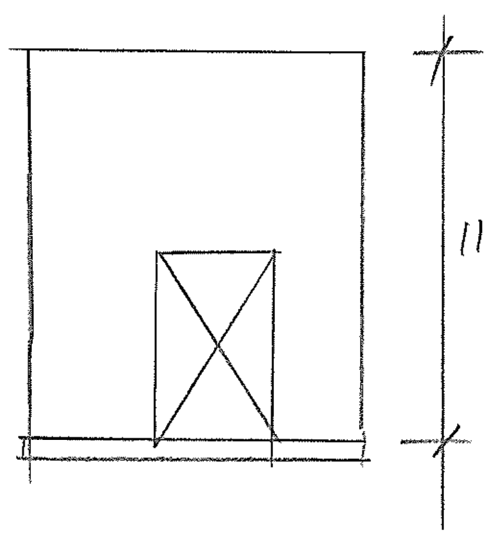
$q = .00256(.85)(1)(1.03)(180)^2$

= 72.6 psf strength

= 43.6 psf allowable



Plan



MERRICK & COMPANY — **Engineering Calculation Sheet** 011-2010A

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Contract 7181-77

Calculation No.

Subject McMurdo utilities

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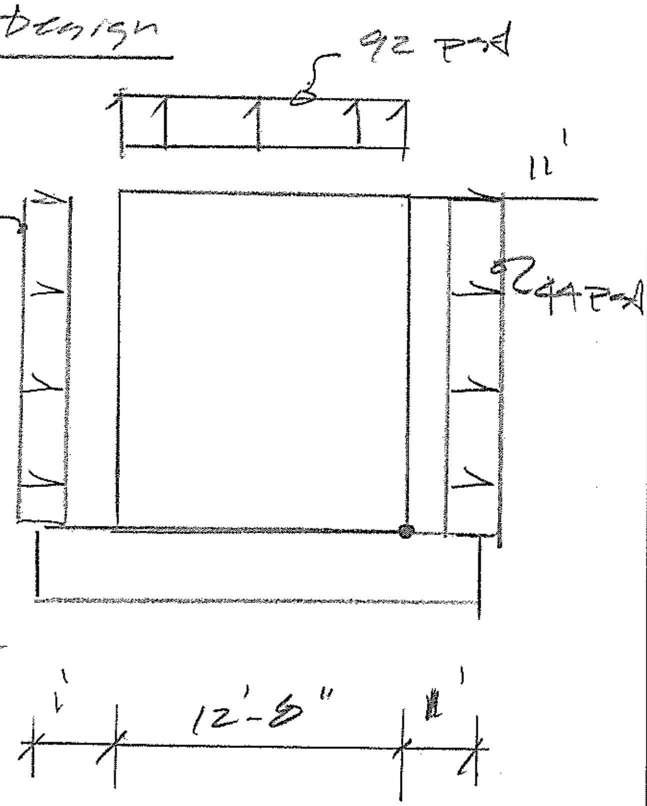
	RF			

Check OT & uplift for FND Design



$M_D = 40(10.66)\frac{(11)^2}{2}$

$+ 44(10.66)\frac{(11)^2}{2}$

$+ 92(10.66)\frac{(12.66)^2}{2}$

= 132,767 #-ft strength

.6M_D = 76,660 #-St allowable

$V_T = 40(11)(10.66)$

$+ 44(10.66)(11)$

= 9850 # strength

= 5910 # allowable

Uplift force to foundation

$R_1 = 76{,}660 / 12.66$

= 6,055 # up

$$R_2 = \frac{40(10.66)\frac{(11)^2}{2} + 44(10.66)\frac{(11)^2}{2} - 92(10.66)\frac{(12.66)^2}{2}}{12.66}$$

= 1929 # up

MERRICK & COMPANY

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utilities

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Check Loads transverse in the 12'-8" Direction

$M_D = 12.66\frac{(40)(11)^2}{2}$

$+ 46\frac{(12.66)(11)^2}{2}$

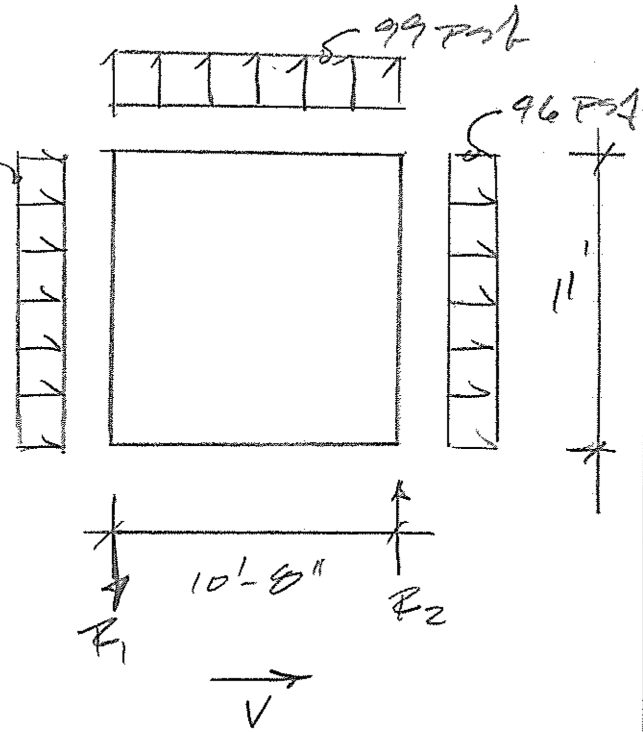
$+ 99\frac{(12.66)(10.66)^2}{2}$

$= 137,002$ #-ft strength

$.6 M_D = 82,249$ #-ft allowable

$R_1 = 82,249 / 10.66$

$= 7716$ # up



$$R_2 = \frac{12.66\frac{(40)(11)^2}{2} + 46\frac{(12.66)(11)^2}{2} - 99\frac{(12.66)(10.66)^2}{2}}{10.66}$$

$R_2 = 501$ # up

$V = 40(12.66)(11) + 46(12.66)(11)$

$= 11,976$ # strength

$= 7186$ # allowable

Subject: McMurdo Utilities

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	BB			

Size Pad Foundations

use 2' thick Footings

$(2)(150)(x)^2(.80) = 7716/2$ ← # of Footings one side

$x = 4'$

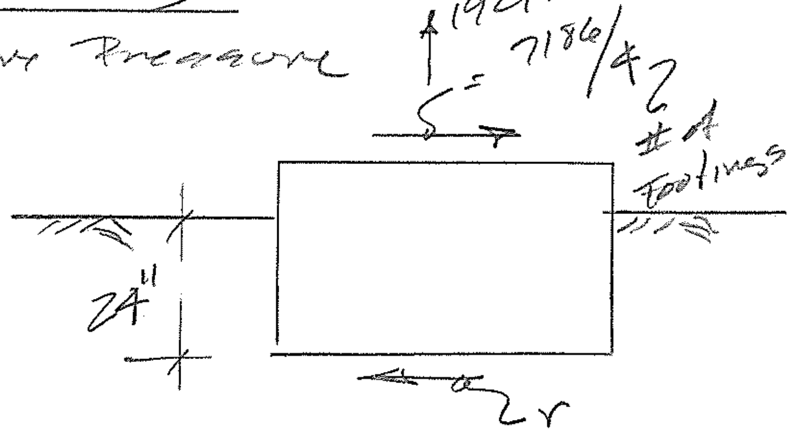
so use **4'x4'x1'-6" thick min Pad Footings for uplift**

Check sliding of Footing

use Friction & Passive Pressure

$V' = 7186/4$

$= 1800$ #



Passive pressure

$P_b/b = \frac{120(2.0)^2(3)}{2}$ ← Kp $\gamma = 120$ #/ft³

$= 720$ #/ft $\phi = .35$ sliding coef

use SF = 2.0

$\frac{P_b/b}{SF} = (720/2)$

$= 360$ #/ft

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Sliding Resistance

$r = 360(4) + \underbrace{(4)^2(2.5)(150)(.80)}_{\text{footing wt}}(.35) - 965$

$= 2155$ # per footing for 2 footings

$r = 360(4)$

$= 1440$ # per footing for 2 footings

$r_T = 2(2155) + 2(1440)$

$= 7190$ # ≈ 7186 # of shear

Use 4'x4'x2'-6" thick footings for Node Rooms

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Engineering Calculation Sheet

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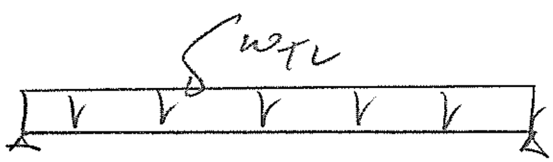
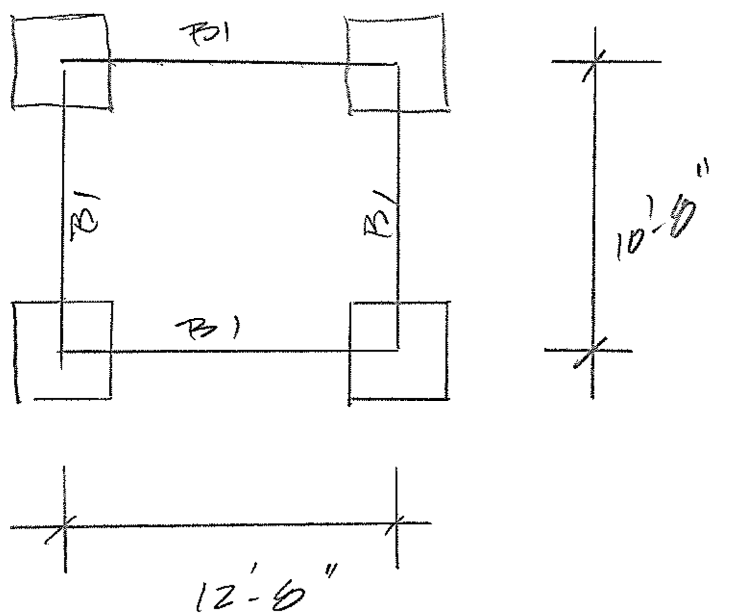
Size Bm's For Node BLD

B1





w_{TL}

Roof

$w_{DL} = 25(10.66/2) + 25(11)$ ← wall

$+ 25(10.66/2)$
Floor

$= 542$ #/ft

$w_{LL} = 50(10.66/2)$

$= 267$ #/ft

$M_{TL} = \frac{(542+267)(12.66)^2}{8}$

$= 16,188$ #-ft
$= 16.2$ k-ft allowable } Downward force

MERRICK® & COMPANY

Engineering Calculation Sheet

011-2010A

Date ______ Sheet ______ of ______

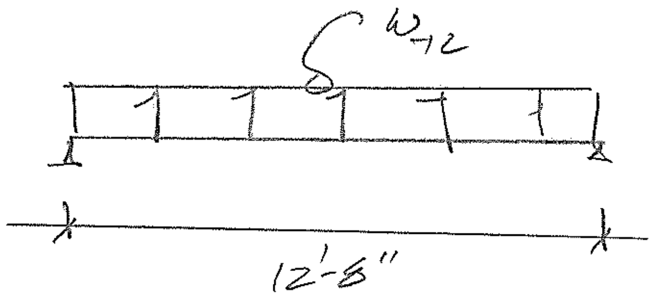
Contract ______

Calculation No. ______

Subject ______

Revision	By	Date	Chk'd	Date

Check bm for uplift



w_{TL}

$w_{DL} = 542$ #/ft

$w_{WL} = 7716 / 12.66'$

up $= 610$ #/ft up

$T_u = 285 (3")$

$= 855$ #-in/ft

$w_{TL} = 610 - .6(542)$

$= 285$ #/ft up

Bending DCR = .09

See following printout

Stress w/ torsion $F_{ut} = 29.3$ ksi // OK

See following printout

MERRICK & COMPANY

Date: 11/7/2016	Sheet of
Project No.:	7481-77
By:	PIF

BEAM LOADS AND ANALYSIS - STEEL WIDEFLANGE BEAMS

Job Name: McMurdo utilities

Des:

Fy:	50 ksi	
E:	29000 ksi	
L:	12.7 ft	Beam Length
Lb:	12.7 ft	unbraced length

Applied Loads

Mappl =	5.71 k-ft	
Mu =	9.1 k-ft	
ϕ =	0.9	
D max =	1 in	
D est =	0.03 in	
Ireq =	6 in4	estimate

Member Properties

TRY:	W10X30
Sx=	32.4 in³
Ix=	170.0 in4
Iy=	16.7 in4
Zx=	36.6 in³
d=	10.47 in
h =	8.60 in
J	0.62 in
Cw	414.0 in
ry	1.374 in
ho	9.96 in
tf =	0.51 in
bf =	5.81 in
tw =	0.30 in
rts =	1.60

Check Flexural Compact Requirements

Flang

λ = b/(2*tf) =	5.70
λp = .38*sqrt(E/Fy) =	9.15
λr = 1*sqrt(E/Fy) =	24.08
b/t<=.38*sqrt(E/Fy) =	Member is Compact

Web

λ = h/tw =	28.7
λp = 3.76*sqrt(E/Fy) =	90.6
λr = 5.7*sqrt(E/Fy) =	137.3
h/t<=3.76*sqrt(E/Fy) =	Member is Compact

Lengths

Lp =	4.9 ft
Lr =	16.1 ft
Cb:	1
Fcr =	48.8 ksi

STRENGTH DESIGN

Compact I Shapes

If Lb<=Lp

Mp = 152.5 k-ft	=Fy*Zx	(eq F2-1)
ϕMn = 137.3 k-ft		

If Lp < Lb <= Lr

Mn = 112.4 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((Lb-Lp)/(Lr-Lp))) <=Mp	(eq F2-2)
ϕMn = 101.2 k-ft		

If Lb > Lr

Mn = 131.7 k-ft	=Fcr*Sx <= Mp	(eq F2-3)
ϕMn = 118.5 k-ft		

Non-compact flanges

Mn = 165.9 k-ft	=Cb(Mp-(Mp-.7*Fy*Sx)*((λb-λp)/(λr-λp))) <=Mp	(eq F3-1)
ϕMn = 149.3 k-ft		

Slender Flanges

kc = 0.747		
Mn = 1623.1 k-ft	=.9*E*kc*Sx / λ^2	(eq F3-2)
ϕMn = 1460.8 k-ft		

Member is Compact

Lp < Lb <= Lr

USE (eq F2-2)

ϕMn =	**101.2 k-ft**	**DCR =**	**0.09**	OK	Strength Design
Mn/Ω =	**67.3 k-ft**	**DCR =**	**0.08**	OK	Allowable Stress Design

L=	12.66	ft	
E =	29000	ksi	
Cw =	414	in^6	
G =	11200	ksi	
J =	0.62	in^4	
a =	41.58	in	
Qf =	7.09	in^3	Need get these from tables in Design Guide in the appendix
Qw =	18.3	in^3	
Sw1 =	10.7	in^4	
Wno =	14.5	in^2	
Tu =	-0.855	Kip-in/ft	
L/a =	3.654		
tu(L)/(G*J) :	-0.002		This has to change based on type of torsion
tw	0.3		
tf	0.51		

x =	0.25	
ϕ =	-0.0089	Need to determine these from tables in Design Guide in the appendix
x1 =	0	
ϕ' =	0	For Mid Span
x2 =	-0.5	
ϕ'' =	6.16E-05	
X3 =	0	
ϕ''' =	0.00E+00	

τ t =	0	ksi	Web Shear Stress	Stresses at Mid Span
τ w =	0.00	ksi	Flange Shear Stress / Warping	
σ ω =	25.89	ksi	Normal Stress / Warping	
σ bx =	3.37	ksi		

Location				
Mid Span		σ ω ksi	σ b ksi	Fut ksi
	Flange	25.9	3.4	29.3

$F_u = \frac{101.2(12)}{32.4} = 37.40$ ksi > 29.3 ksi

∥ ok

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date 11/16 Sheet of

Contract 7481-71

Calculation No.

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	PL			

Check Utility Bent Design

$V = 180$ mph wind speed

$q = .00256(K_z)(K_{zt})(K_d) \times V^2$

$K_d = .95$

$K_{zt} = 1.0$

$K_z = 1.03$

$q = .00256(1.03)(1)(.95)(180)^2$

$q = 81.0$ psf strength

$.6(q) = 48.7$ psf allowable

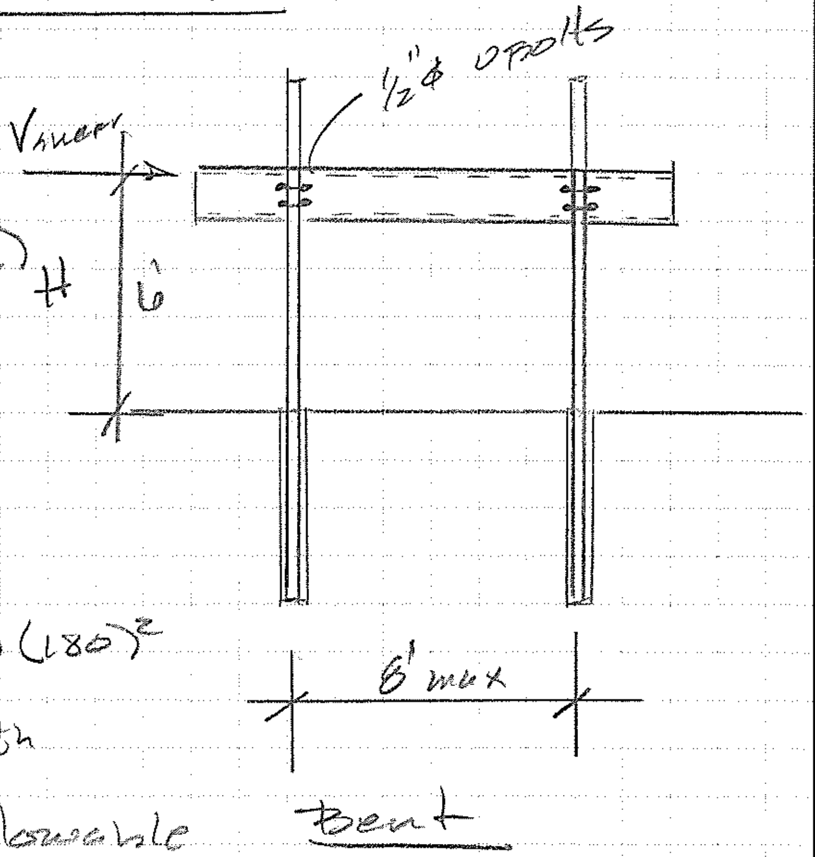
$F = q_z G C_f A_f$ (29.5-1)

Assume $G = 1.0$

use $C_f = .8$

$F = 48.7(1)(.8)(A_f)$

$= 39(A_f)$ psf



MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Contract 7481-77

Calculation No.

Subject Mc Murdo utilities

Revision	By	Date	Chk'd	Date
	PF			

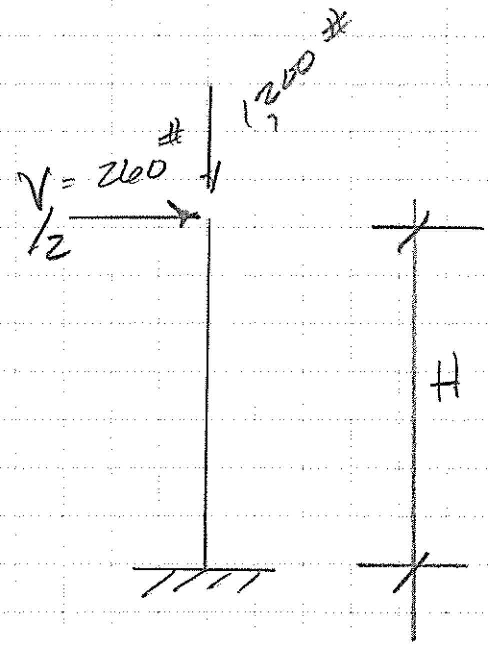
Assume 10' spacing of Bents

* what is the max Height allowed for the Bent

* Use 2 - 8" mains w/ water
  W = 50 #/LF/Pipe Assume another 10 #/f for insulation

$W_T = (60)(2)(10)$
$= 1200\#$

$V = (39)(10)(16/12)$
$= 520\#$



* Set Deflection to $l/100$

Max Height allowed set at 6' above grade. Use 7' for analysis assuming a 2' Active Zone

MERRICK & COMPANY

Date:	3/29/17	Sheet	of
Project No.:			
By:	PIF		

FLAGPOLE COLUMN AND CAISSON

Job:	McMurdo Utilities
Location:	Single Rack

Ftop:	260 lbs	A= 1.9 ft^2		
h:	6.00 ft	S1= 667 psf	S1 < Passive Pressure x 15, OK	Unconstrained
Passive:	400 pcf	S3= 2000 psf	S3 < Passive Pressure x 15, OK	Constrained
b (diam):	0.50 ft	SP= 6362 psf	Gravity Soil Bearing	
d-(trial depth):	5.00 ft	d= 4.62 ft		
P:	1200 lbs			
Constrained?:	no	M = 1632	#-ft	

} min 5' embedment

Per IBC 1806.3.4 Double Passive Pressure = 200 pcf to 400 pcf

Delta max=	0.72 in
Fy:	35 ksi
E:	29000 ksi
Ireq=	1.6207 in^4
USE=	PIPE 3 STD
USE=	3X3X1/8 TUBE STEEL

} use 3"ϕ Xstrong

Single Rack Support
set Height to 6' max
use 3½ϕ extra strong Pipe
see following Calc for
Capacity Calc

basic load combinations of Section 1605.3.2 that include wind or earthquake loads.

1806.2 Presumptive load-bearing values. The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

> **Exception:** A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

1806.3 Lateral load resistance. Where the presumptive values of Table 1806.2 are used to determine resistance to lateral loads, the calculations shall be in accordance with Sections 1806.3.1 through 1806.3.4.

1806.3.1 Combined resistance. The total resistance to lateral loads shall be permitted to be determined by combining the values derived from the lateral bearing pressure and the lateral sliding resistance specified in Table 1806.2.

1806.3.2 Lateral sliding resistance limit. For clay, sandy clay, silty clay, clayey silt, silt and sandy silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

1806.3.3 Increase for depth. The lateral bearing pressures specified in Table 1806.2 shall be permitted to be increased by the tabular value for each additional foot (305 mm) of depth to a maximum of 15 times the tabular value.

1806.3.4 Increase for poles. Isolated poles for uses such as flagpoles or signs and poles used to support buildings that are not adversely affected by a $^1/_2$-inch (12.7 mm) motion at the ground surface due to short-term lateral loads shall be permitted to be designed using lateral bearing pressures equal to two times the tabular values.

SECTION 1807
FOUNDATION WALLS, RETAINING WALLS AND EMBEDDED POSTS AND POLES

1807.1 Foundation walls. Foundation walls shall be designed and constructed in accordance with Sections 1807.1.1 through 1807.1.6. Foundation walls shall be supported by foundations designed in accordance with Section 1808.

1807.1.1 Design lateral soil loads. Foundation walls shall be designed for the lateral soil loads set forth in Section 1610.

1807.1.2 Unbalanced backfill height. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill height shall be permitted to be measured from the exterior finish ground level to the top of the interior concrete slab.

1807.1.3 Rubble stone foundation walls. Foundation walls of rough or random rubble stone shall not be less than 16 inches (406 mm) thick. Rubble stone shall not be used for foundation walls of structures assigned to *Seismic Design Category* C, D, E or F.

1807.1.4 Permanent wood foundation systems. Permanent wood foundation systems shall be designed and installed in accordance with AWC PWF. Lumber and plywood shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B and Section 5.2) and shall be identified in accordance with Section 2303.1.9.1.

TABLE 1806.2
PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.

MERRICK & COMPANY — Engineering Calculation Sheet

011-2010A

Date: 3/1 | Sheet ___ of ___

Contract: 7481-77

Calculation No.

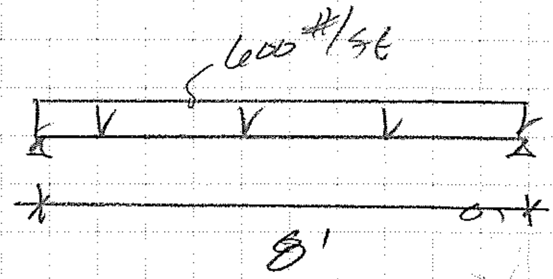
Subject: McMurdo utilities

Revision	By	Date	Chk'd	Date
	PF			

Check Bent size & span

$M = \frac{600(8)^2}{8}$

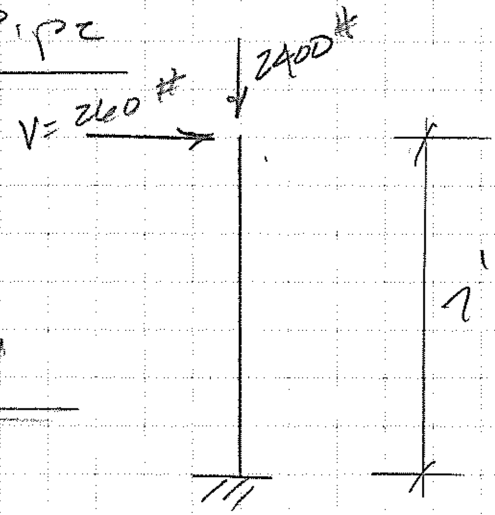
$= 4{,}800\ \#\text{-ft} = 4.8\ k\text{-ft}$



$M_{all} = 14\ k\text{-ft}$ || Okay for C8x11.5

↑ see following print out

Check 3" x strong Pipe

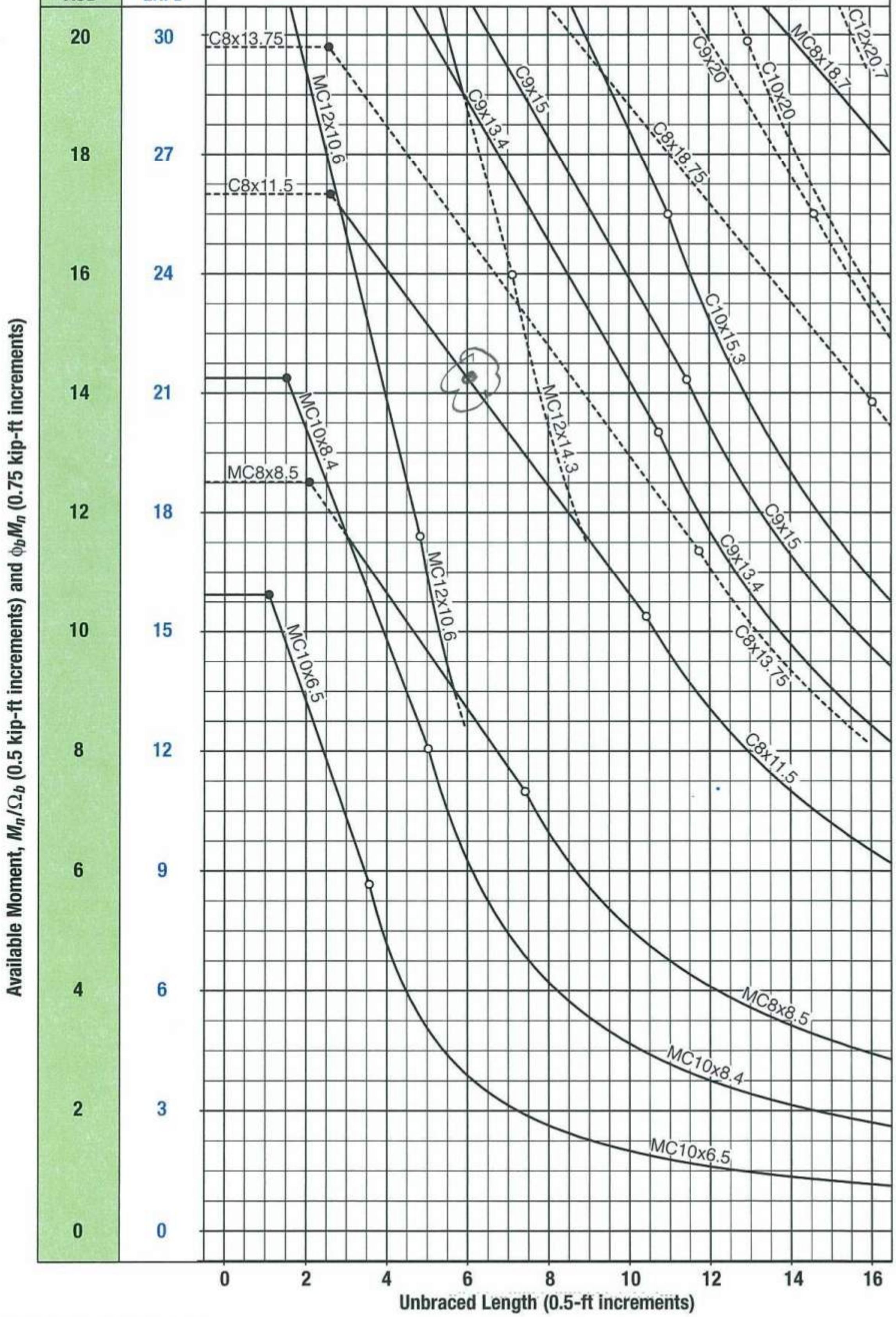


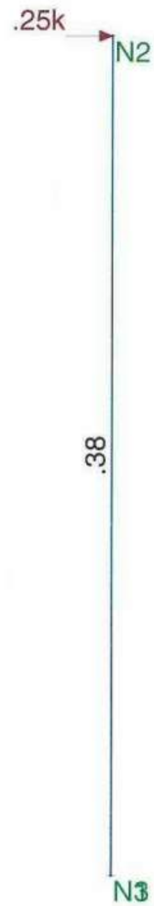
Pipe stanchion ok

DCR = .38 see following print out

$F_y = 36$ ksi $C_b = 1$	
M_n/Ω_b	$\phi_b M_n$
kip-ft	kip-ft
ASD	LRFD

Table 3-11 (continued)
Channels
Available Moment vs. Unbraced Length



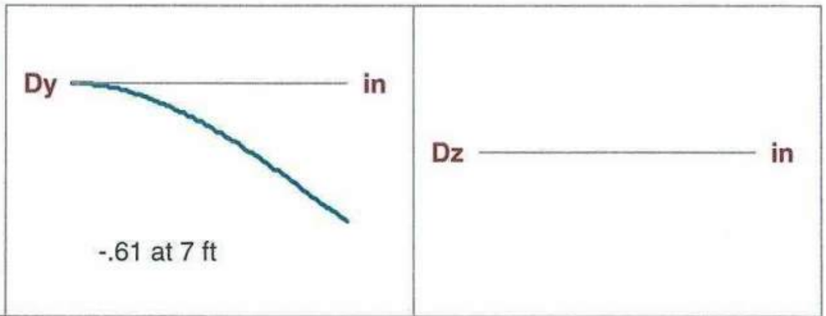


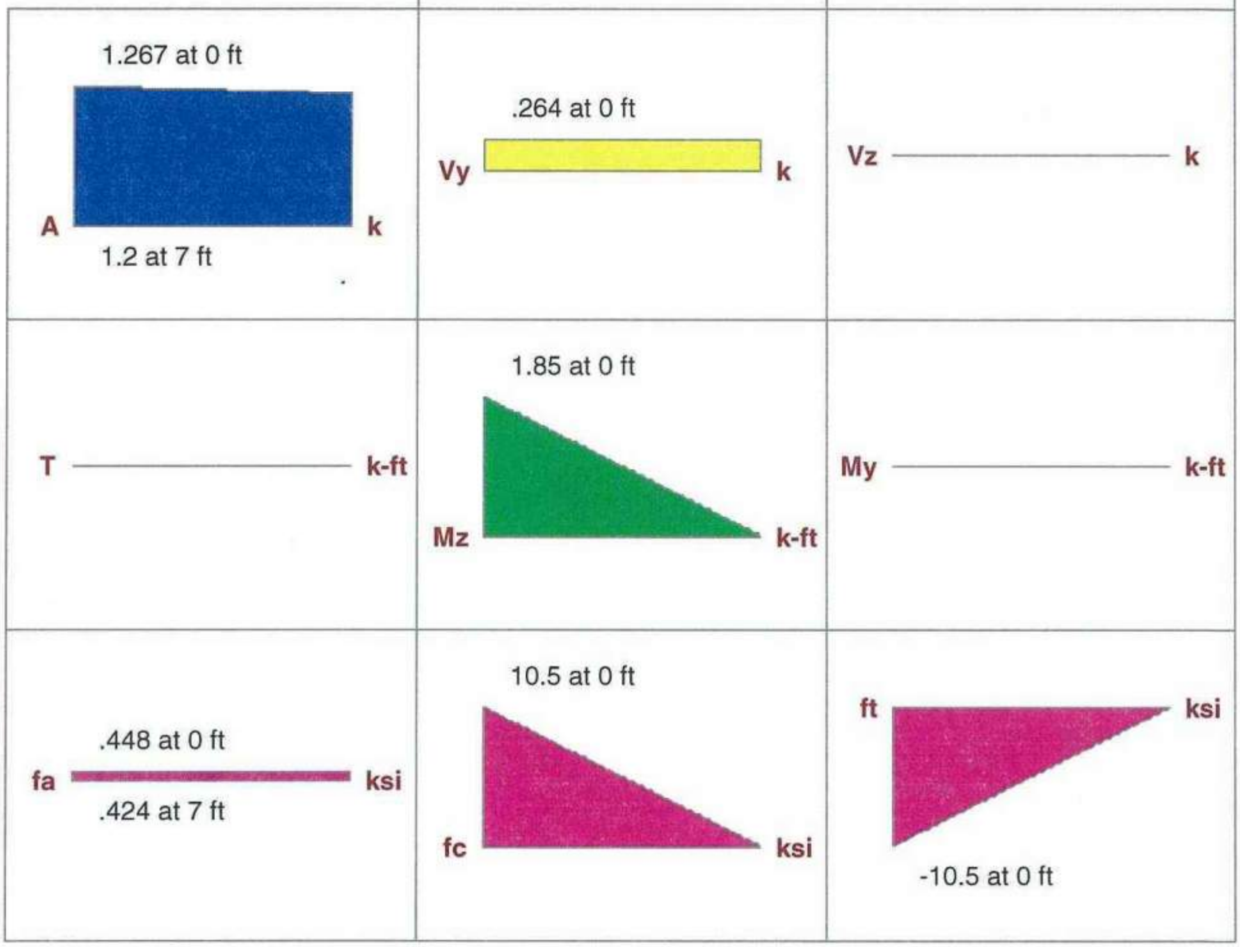
Member Code Checks Displayed
Loads: BLC 2, WL
Results for LC 1, DL + WL

		SK - 2
		Feb 24, 2017 at 2:00 PM
		Bent Column.r3d

Column: ***M1***

Shape: **PIPE_3.0X**
Material: **A53 Gr.B**
Length: **7 ft**
I Joint: **N1**
J Joint: **N2**
LC 1: DL + WL
Code Check: **0.378 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.378**	Max Shear Check	**0.015 (s)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/138**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

			y-y	z-z
Fy	**35 ksi**	Lb	**7 ft**	**7 ft**
Pnc/om	**44.996 k**	KL/r	**73.464**	**73.464**
Pnt/om	**59.311 k**			
Mny/om	**5.082 k-ft**	L Comp Flange	**7 ft**	
Mnz/om	**5.082 k-ft**	Warp Length	**.583 ft**	
Vny/om	**17.793 k**	L-torque	**7 ft**	
Vnz/om	**17.793 k**	Tau_b	**1**	
Tn/om	**4.779 k-ft**			
Cb	**1.667**			

MERRICK & COMPANY

FLAGPOLE COLUMN AND CAISSON

Job:	McMurdo Utilities
Location:	Double Rack

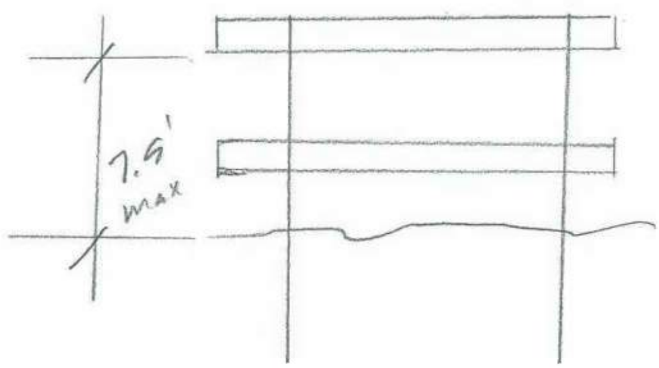
Ftop:	520 lbs	A=	2.9 ft^2		
h:	7.50 ft	S1=	867 psf	S1 < Passive Pressure x 15, OK	Unconstrained
Passive:	400 pcf	S3=	2600 psf	S3 < Passive Pressure x 15, OK	Constrained
b:	0.50 ft	SP=	6437 psf	Gravity Soil Bearing	
d-trial:	6.50 ft	d=	6.49 ft		
P:	1200 lbs				
Constrained?:	no	M =	3990	#-ft	

Per IBC section 1806.3.4 Double passive pressure = 200 pcf to 400 pcf

Delta max=	0.90 in	
Fy:	35 ksi	
E:	29000 ksi	
Ireq=	4.9531 in^4	
USE=	PIPE 4 STD	use 3½" Ø
USE=	4X4X3/16	TUBE STEEL

extra strong Pipe I = 6.28 in⁴ > 4.953 in⁴

Double Rack set max height to 7.5'. Use 3½" x-strong Pipe for stanchions see Following Pages for Capacity Calc



MERRICK® & COMPANY

Engineering Calculation Sheet

011-2010A

Date 3/29 Sheet 140 of 178 of

Contract 7481-27

Calculation No.

Subject Mc Murdo

utilities

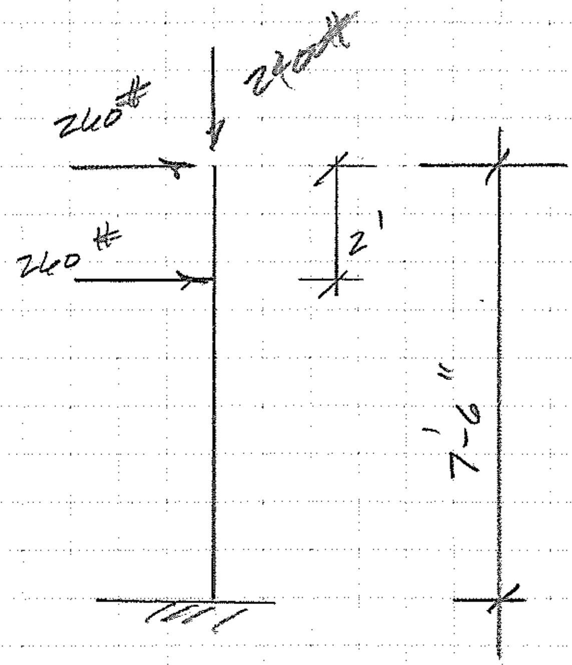
Revision	By	Date	Chk'd	Date
	RB			

Double Rack

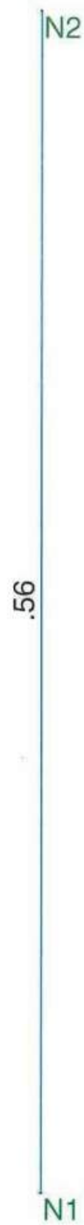
V_{wind} = 240#

P = 2400#

use 3 1/2" φ Extra strong pipe. set deflection to .9 inches



for 3 1/2" φ x strong pipe DCR = .96
see following printout



Member Code Checks Displayed
Results for LC 1, DL+LL

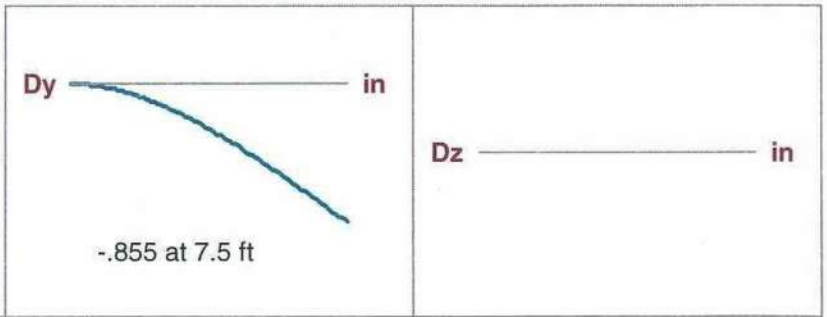
SK - 1

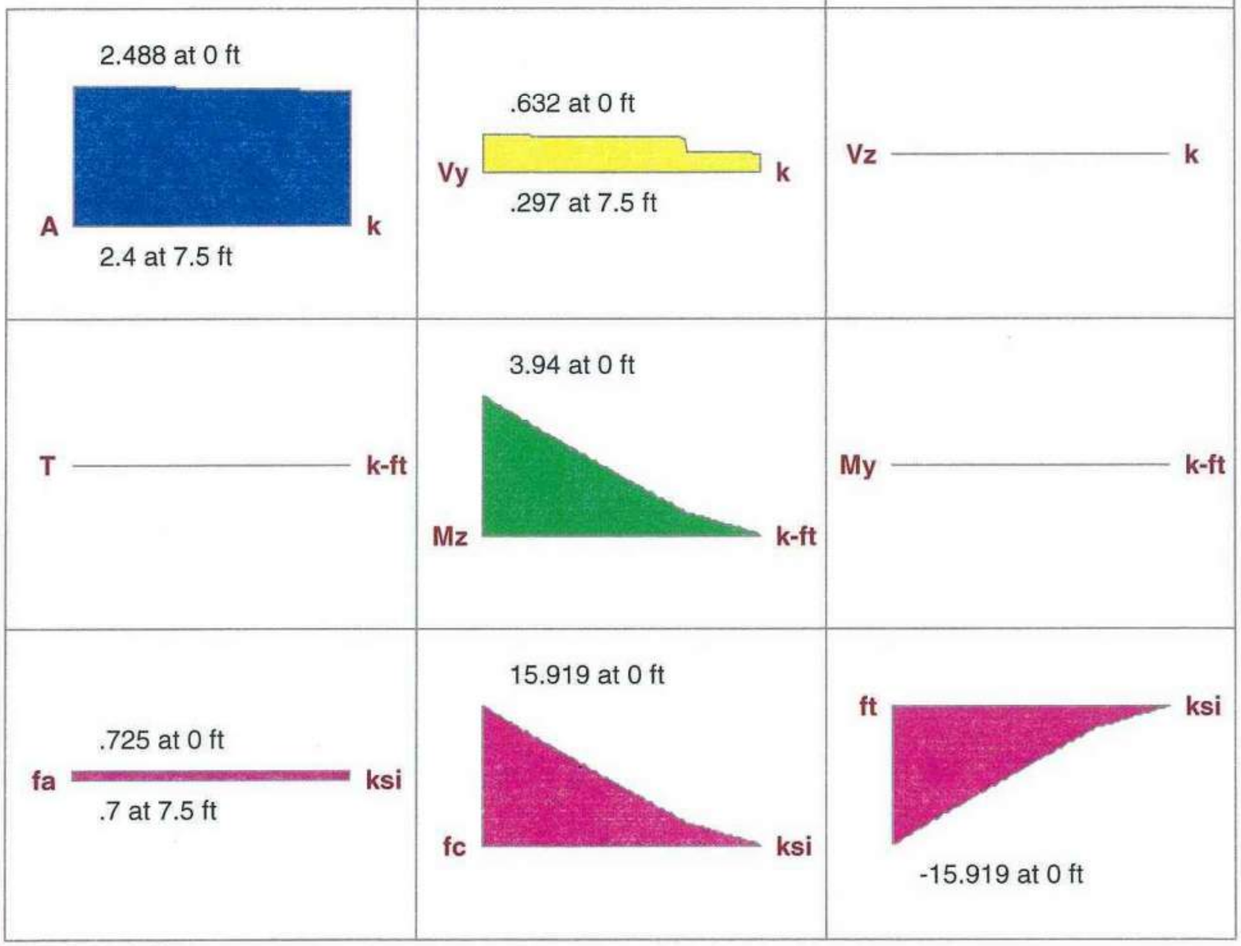
Mar 29, 2017 at 8:42 AM

Bent 1.r3d

Column: ***M1***

Shape: **PIPE_3.5X**
Material: **A36 Gr.36**
Length: **7.5 ft**
I Joint: **N1**
J Joint: **N2**
LC 1: DL+LL
Code Check: **0.560 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.560**	Max Shear Check	**0.028 (s)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/105**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

			y-y	z-z
Fy	**36 ksi**	Lb	**7.5 ft**	**7.5 ft**
Pnc/om	**57.802 k**	KL/r	**68.391**	**68.391**
Pnt/om	**73.94 k**			
Mny/om	**7.311 k-ft**	L Comp Flange	**7.5 ft**	
Mnz/om	**7.311 k-ft**	Warp Length	**.625 ft**	
Vny/om	**22.182 k**	L-torque	**7.5 ft**	
Vnz/om	**22.182 k**	Tau_b	**1**	
Tn/om	**6.876 k-ft**			
Cb	**1.862**			

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	TF			

Clamping force of uBolts (P)

$$P = \frac{T}{(K)D}$$

D = .5"

T = 50 #-ft

K = .2

$$P = \frac{50(12)}{(.2)(.5)}$$

$$= 6,000\ \#$$

By inspection 2-1/2" ϕ u Bolts okay for any load utilities will apply to channel

Suggested Tightening Torque1 Values To Produce Corresponding Bolt Clamping Loads

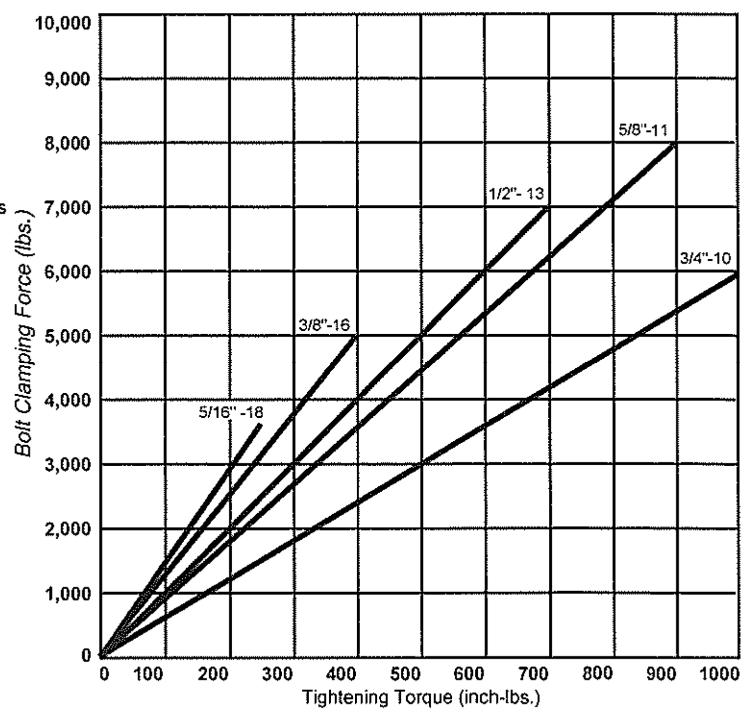
Size	Bolt Dia. D (in.)	Tensile Stress Area A (sq. in.)	SAE Grade 2 Bolts: Tensile Strength (min psi)	SAE Grade 2: Proof Load (psi)	SAE Grade 2: Clamp[2] Load P (lb.)	SAE Grade 2: Tightening Torque Dry K=0.20	SAE Grade 2: Tightening Torque Lub. K=0.15	SAE Grade 5 Bolts: Tensile Strength (min psi)	SAE Grade 5: Proof Load (psi)	SAE Grade 5: Clamp[2] Load P (lb.)	SAE Grade 5: Tightening Torque Dry K=0.20	SAE Grade 5: Tightening Torque Lub. K=0.15	SAE Grade 7[3]: Clamp[2] Load P (lb.)	SAE Grade 7: Tightening Torque Dry K=0.20	SAE Grade 7: Tightening Torque Lub. K=0.15	SAE Grade 8[4]: Clamp[2] Load P (lb.)	SAE Grade 8: Tightening Torque Dry K=0.20	SAE Grade 8: Tightening Torque Lub. K=0.15
						lb. in.	lb. in.				lb. in.	lb. in.		lb. in.	lb. in.		lb. in.	lb. in.
4-40	0.1120	0.00604	74,000	55,000	240	5	4	120,000	85,000	380	8	6	480	11	8	540	12	9
4-48	0.1120	0.00661			280	6	5			420	9	7	520	12	9	600	13	10
6-32	0.1380	0.00909			380	10	8			580	16	12	720	20	15	820	23	17
6-40	0.1380	0.01015			420	12	9			640	18	13	800	22	17	920	25	19
8-32	0.1640	0.01400			580	19	14			900	30	22	1100	36	27	1260	41	31
8-36	0.1640	0.01474			600	20	15			940	31	23	1160	38	29	1320	43	32
10-24	0.1900	0.01750			720	27	21			1120	43	32	1380	52	39	1580	60	45
10-32	0.1900	0.02000			820	31	23			1285	49	36	1580	60	45	1800	68	51
1/4-20	0.2500	0.0318			1320	66	49			2020	96	75	2500	120	96	2860	144	108
1/4-28	0.2500	0.0364			1500	76	56			2320	120	86	2860	144	108	3280	168	120
						lb. ft.	lb. ft.				lb. ft.	lb. ft.		lb. ft.	lb. ft.		lb. ft.	lb. ft.
5/16-18	0.3125	0.0524			2160	11	8			3340	17	13	4120	21	16	4720	25	18
5/16-24	0.3125	0.0580			2400	12	9			3700	19	14	4560	24	18	5220	25	20
3/8-16	0.3750	0.0775			3200	20	15			4940	30	23	6100	40	30	7000	45	35
3/8-24	0.3750	0.0878			3620	23	17			5600	35	25	6900	45	45	7900	50	35
7/16-14	0.4375	0.1063			4380	30	24			6800	50	35	8400	60	45	9550	70	55
7/16-20	0.4375	0.1187			4900	35	25			7550	55	40	9350	70	50	10700	80	60
1/2-13	0.5000	0.1419			5840	50	35			9050	75	55	11200	95	70	12750	110	80
1/2-20	0.5000	0.1599			6600	55	40			10700	90	65	12600	100	80	14400	120	90
9/16-12	0.5625	0.1820			7500	70	55			11600	110	80	14350	135	100	16400	150	110
9/16-18	0.5625	0.2030			8400	80	60			12950	120	90	16000	150	110	18250	170	130
5/8-11	0.6250	0.2260			9300	100	75			14400	150	110	17800	190	140	20350	220	170
5/8-18	0.6250	0.2560			10600	110	85			16300	170	130	20150	210	160	23000	240	180
3/4-10	0.7500	0.3340			13800	175	130			21300	260	200	26300	320	240	30100	380	280
3/4-16	0.7500	0.3730			15400	195	145			23800	300	220	29400	360	280	33600	420	320
7/8-9	0.8750	0.4620	60,000	33,000	11400	165	125			29400	430	320	36400	520	400	41600	600	460
7/8-14	0.8750	0.5090			12600	185	140			32400	470	350	40100	580	440	45800	660	500
1-8	1.0000	0.6060			15000	250	190			38600	640	480	47700	800	600	54500	900	680
1-12	1.0000	0.6630			16400	270	200			42200	700	530	52200	860	660	59700	1000	740
1-1/8-7	1.1250	0.7630			18900	350	270	105,000	74,000	42300	800	600	60100	1120	840	68700	1280	960
1-1/8-12	1.1250	0.8560			21200	400	300			47500	880	660	67400	1260	940	77000	1440	1080
1-1/4-7	1.2500	0.9690			24000	500	380			53800	1120	840	76300	1580	1100	87200	1820	1360
1-1/4-12	1.2500	1.0730			26600	550	420			59600	1240	920	84500	1760	1320	96600	2000	1500
1-3/8-6	1.3750	1.1550			28600	660	490			64100	1460	1100	91000	2080	1560	104000	2380	1780
1-3/8-12	1.3750	1.3150			32500	740	560			73000	1680	1260	104000	2380	1780	118400	2720	2040
1-1/2-6	1.5000	1.4050			34800	870	650			78000	1940	1460	111000	2780	2080	126500	3160	2360
1-1/2-12	1.5000	1.5800			39100	980	730			87700	2200	1640	124005	3100	2320	142200	3560	2660

Notes:

1. Tightening torque values are calculated from the formula $T = KDP$, where T = tightening torque, lb-in.; K = torque-friction coefficient; D = nominal bolt diameter, in.; and P = bolt clamping load developed by tightening, lb.
2. Clamp load is also known as preload or initial load in tension on bolt. Clamp load (lb.) is calculated by arbitrarily assuming usable bolt strength is 75% of bolt proof load (psi) times tensile stress area (sq. in.) of threaded section of each bolt size. Higher or lower values of clamp load can be used depending on the application requirements and the judgement of the designer.
3. Tensile strength (min psi) of all Grade 7 bolts is 133,000. Proof load is 105,000 psi.
4. Tensile strength (min psi) of all Grade 8 bolts is 150,000 psi. Proof load is 120,000 psi.

Ref.: Fastening Reference. Machine Design. Nov. 1977.

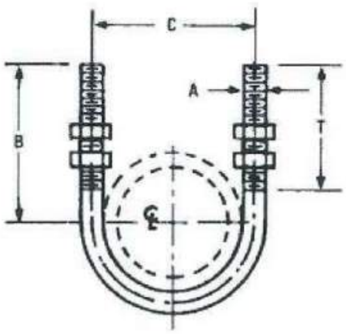
Bolt Clamping Force vs. Tightening Torque for Unlubricated Steel Bolts.



D

CATALOG 13

FIG. 137
STANDARD U-BOLT WITH 4 HEX NUTS



Material: Carbon steel, 304 (137SS) and 316 (137SX) stainless steel

Finish: Plain, electro-galvanized.

Service: Designed for support or guide of heavy loads.

Approvals: Complies with Federal Specifications WW-H-171-E (Type# 24), A-A-1192 A (Type# 24), and MSS SP-58 and SP-69 (Type# 24).

Ordering: Specify pipe size, figure number and finish. Sizes ½" to 1" can be furnished with ⅜" rod size.

Notes: U-bolts with longer tangents or longer threads are available. Also available with plastic coating.

Available domestic

PIPE SIZE	PIPE OD	A	B	C	T	WGT EACH (lbs)	MAX REC LOAD (lbs)
½	0.840	¼-20	2¾	1 3/16	2⅜	0.10	485
¾	1.050	¼-20	2¾	1⅜	2⅜	0.10	485
1	1.315	¼-20	2¾	1⅝	2⅜	0.10	485
1¼	1.660	⅜-16	2⅞	2 1/16	2⅜	0.26	1220
1½	1.900	⅜-16	3	2⅜	2½	0.28	1220
2	2.375	⅜-16	3¼	2 13/16	2½	0.32	1220
2½	2.875	½-13	3¾	3 7/16	3	0.70	2260
3	3.500	½-13	4	4 1/16	3	0.76	2260
3½	4.000	½-13	4¼	4 9/16	3	0.80	2260
4	4.500	½-13	4½	5 1/16	3	0.86	2260
5	5.563	½-13	5	6⅛	3	1.00	2260
6	6.625	⅝-11	6⅛	7⅜	3¾	1.98	3620
8	8.625	⅝-11	7⅛	9⅜	3¾	2.26	3620
10	10.750	¾-10	8⅜	11⅝	4	3.94	5420
12	12.750	⅞-9	9⅝	13¾	4¼	6.40	7540
14	14.000	⅞-9	10¼	15	4¾	8.30	7540
16	16.000	⅞-9	11¼	17	4¾	9.20	7540
18	18.000	1-8	12⅝	19⅛	4¾	13.50	9920
20	20.000	1-8	13⅝	21⅛	4¾	14.60	9920
24	24.000	1-8	15⅝	25⅛	4¾	16.90	9920

Calculations – U Bolt Clamping Force

Connekt, LLC
Our Job is to Make Yours Easier

U- Bolt Clamping Force :

For U-bolt of dia. 1/2" the pretension torque is 65 ft. lbs.

$$\text{Clamping force 'P'} = \frac{Torque}{K * Diameter}$$

K = 0.2 (For new U-bolt and nut with lubricated threads.)

$$P = \frac{65 * 12}{0.2 * 0.5}$$

P =7800 lbs.

MERRICK & COMPANY

Engineering Calculation Sheet

011-2010A

Date Sheet of

Contract 7981-77

Calculation No.

Subject McMurdo

Utilities

Revision	By	Date	Chk'd	Date
	PF			

Utility Piping Anchors

Anchor Piping for Bellows load

4"φ spring const = 212#/in

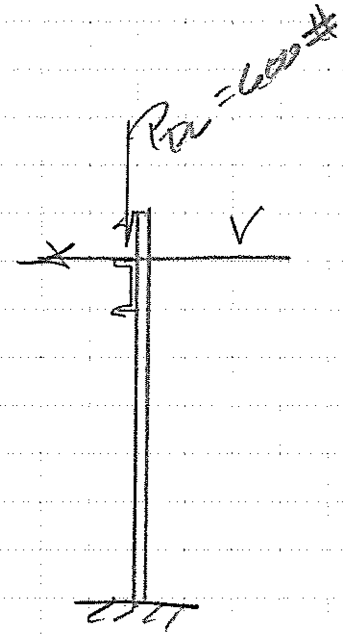
6"φ spring const = 317#/in

Have 2 - 4"φ Pipes & 1 - 6"φ

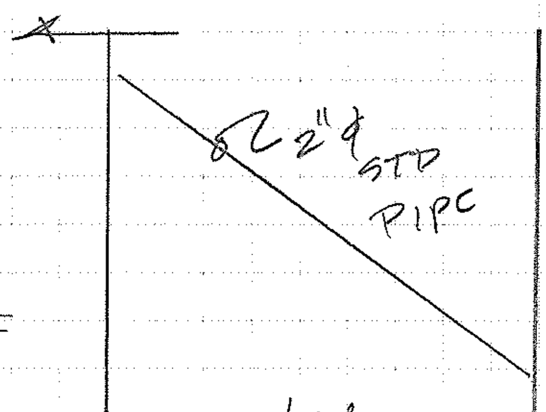
use 2.5" exp & contraction

$V = 2(212)(2.5) + (317)(2.5)$

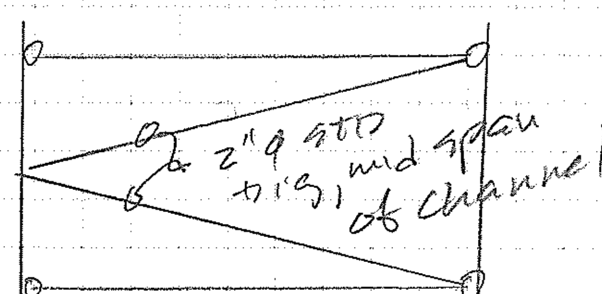
$= 1853\#$

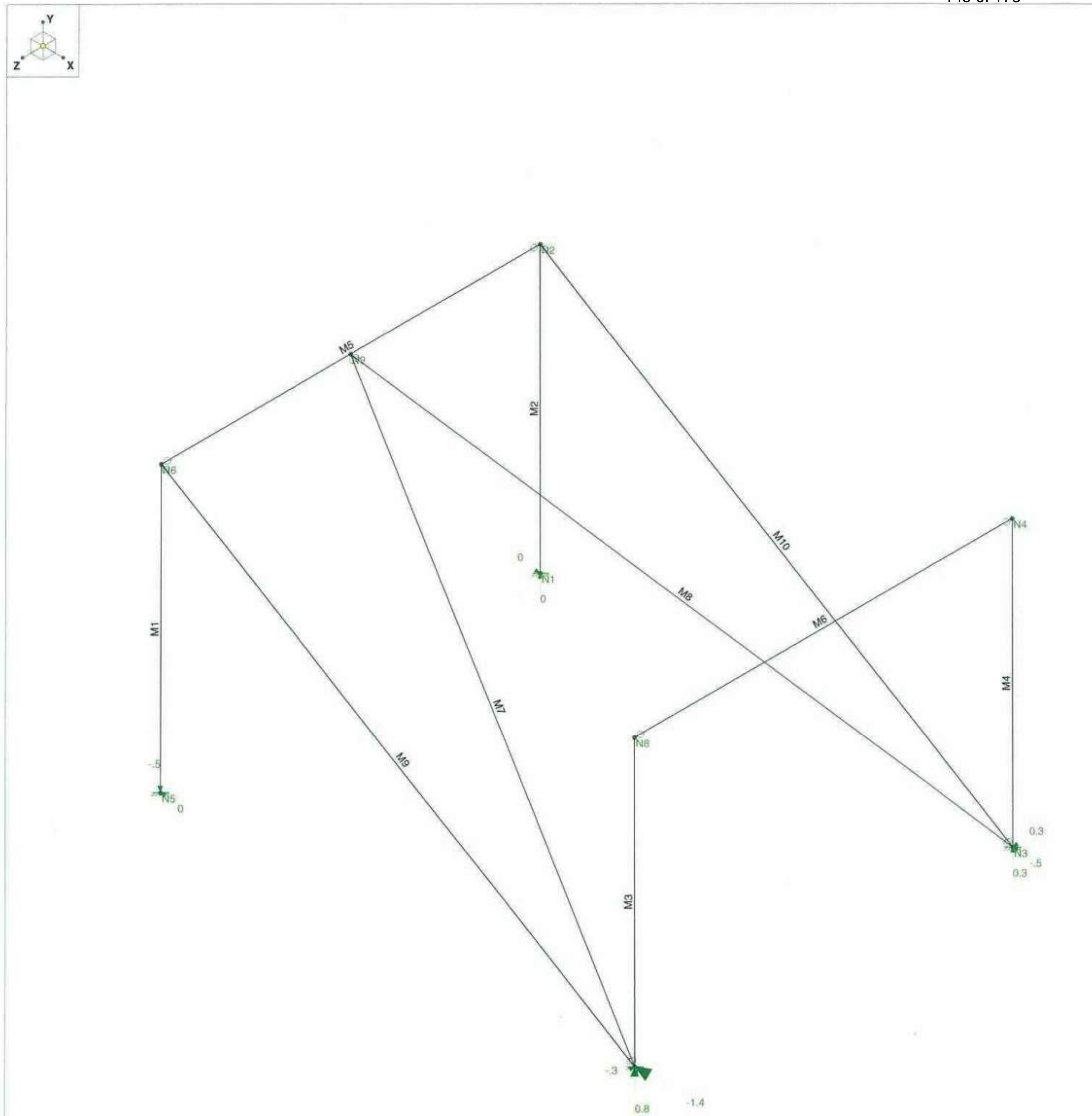


C8X11.5 Channels & 2"φ STD pipe is good, see following printout



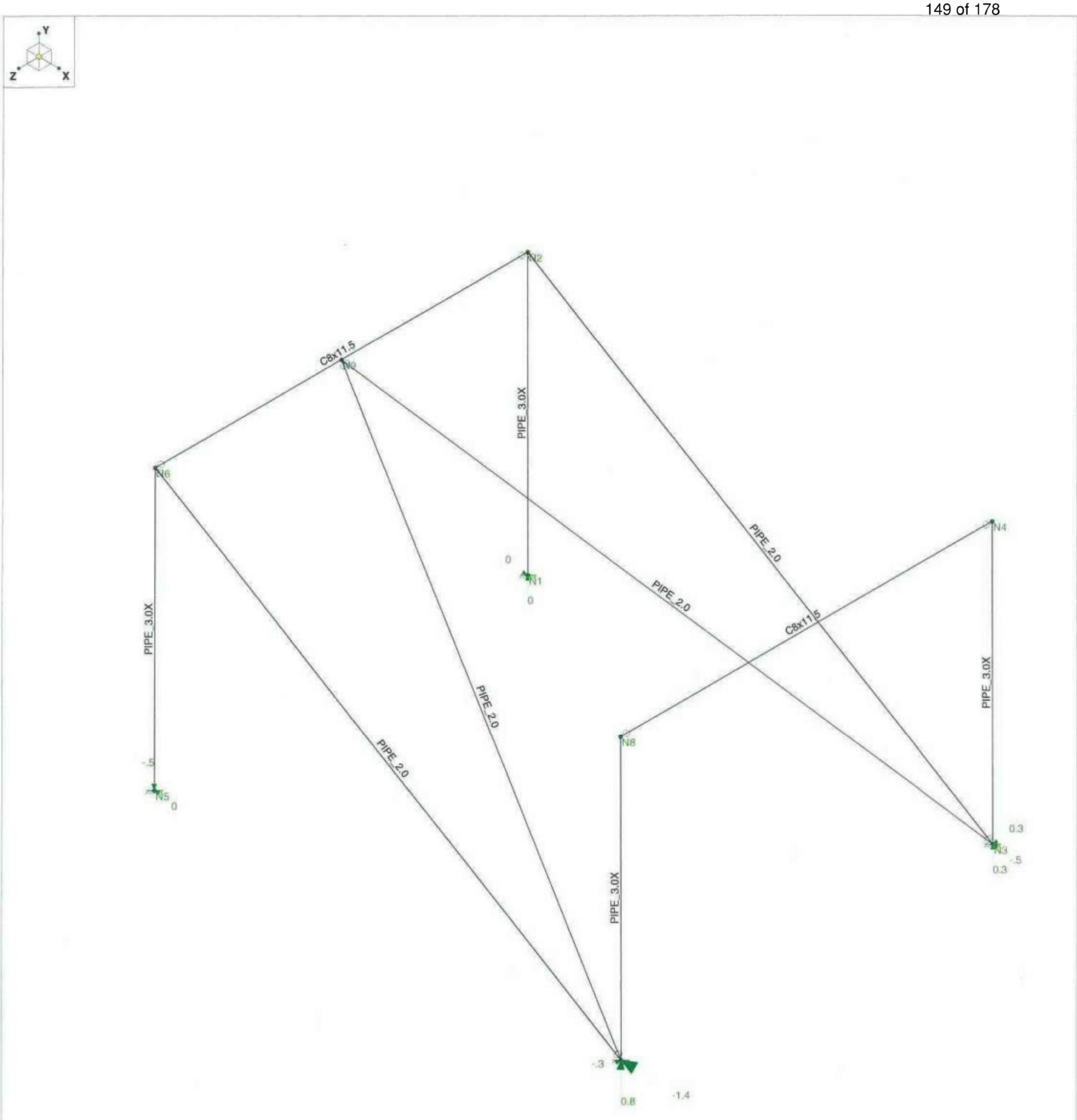
elev view





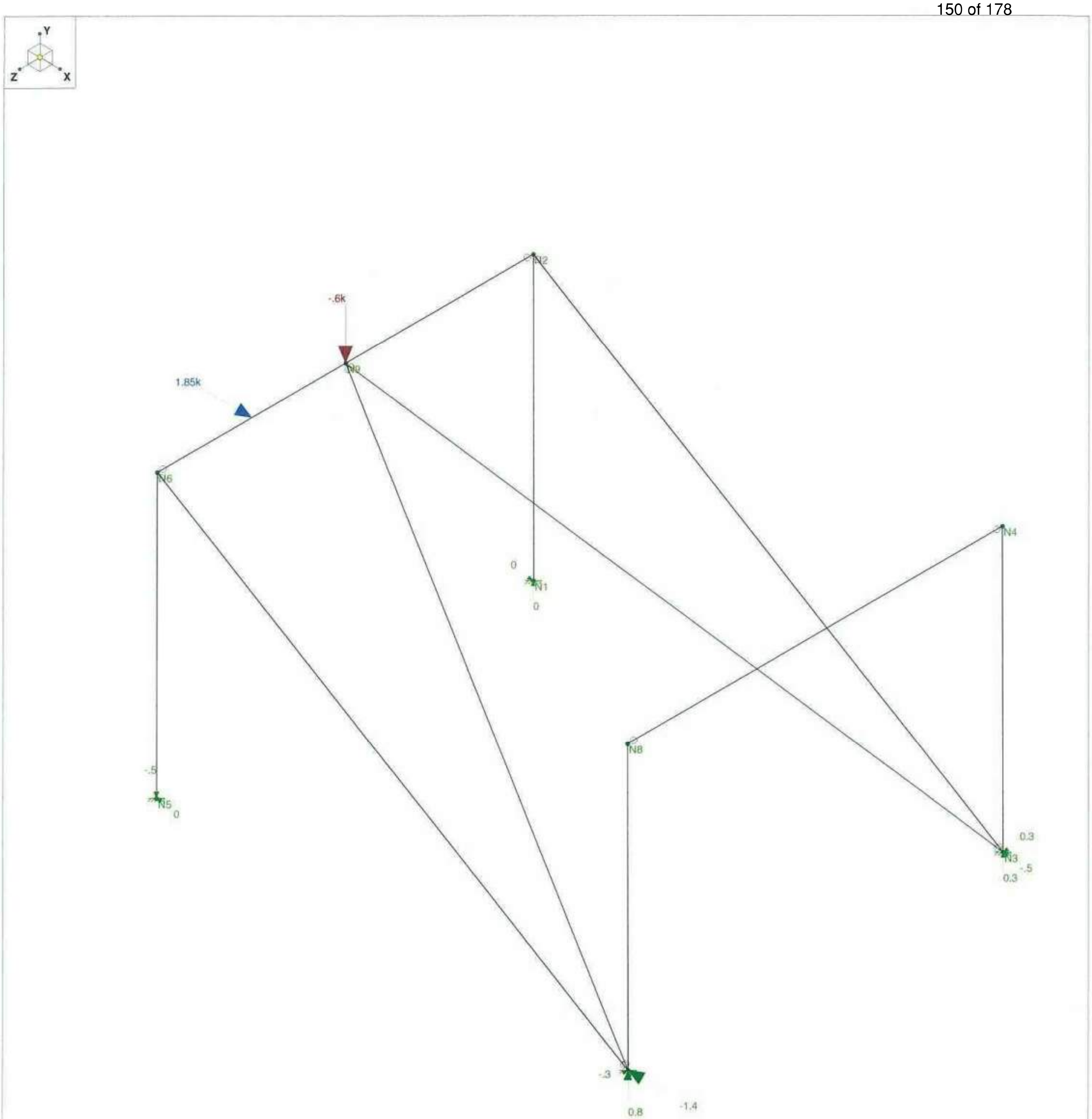
Results for LC 1, DL+Thermal
Reaction and Moment Units are k and k-ft

		SK - 3
		June 25, 2017 at 3:51 PM
		Anchor Calc.r3d



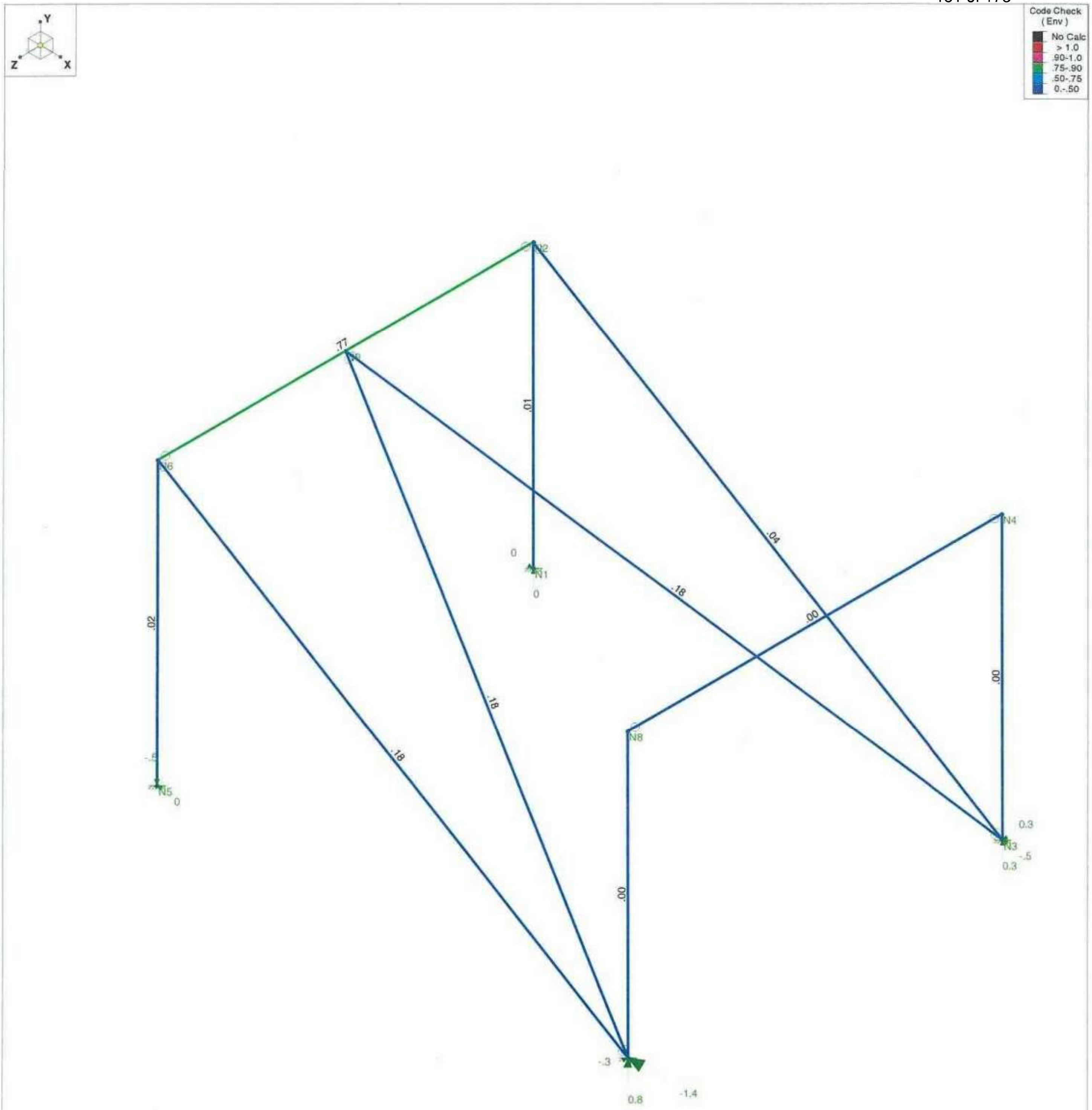
Results for LC 1, DL+Thermal
Reaction and Moment Units are k and k-ft

		SK - 4
		June 25, 2017 at 3:51 PM
		Anchor Calc.r3d



Loads: LC 1, DL+Thermal
Results for LC 1, DL+Thermal
Reaction and Moment Units are k and k-ft

		SK - 2
		June 25, 2017 at 3:51 PM
		Anchor Calc.r3d



Member Code Checks Displayed (Enveloped)
Results for LC 1, DL+Thermal
Reaction and Moment Units are k and k-ft

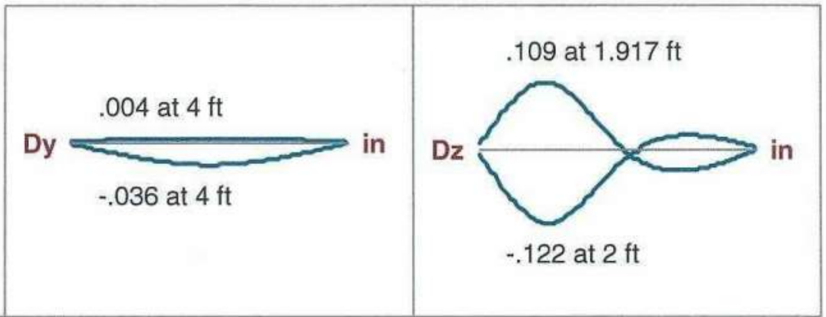
SK - 1

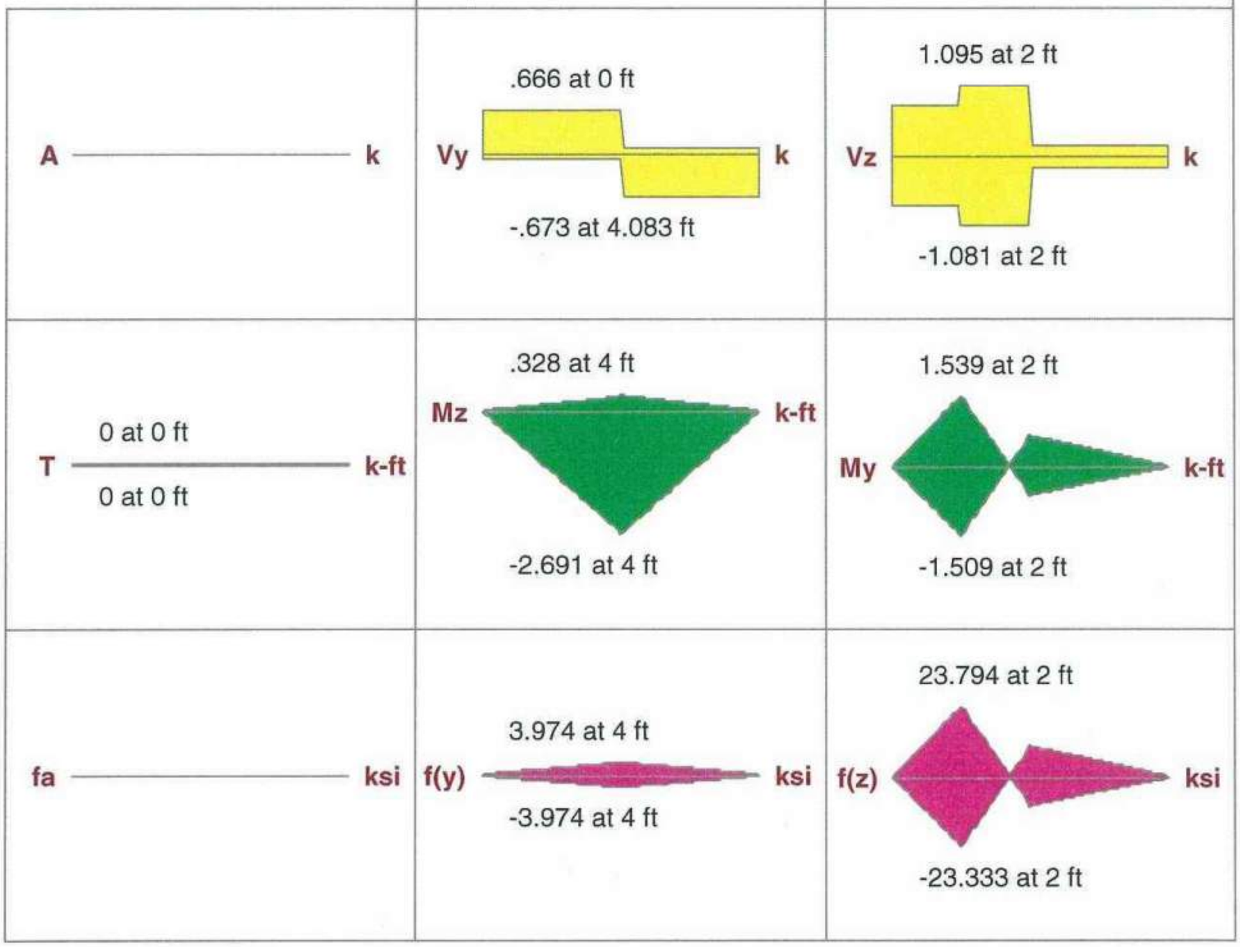
June 25, 2017 at 3:49 PM

Anchor Calc.r3d

Beam: *M5*

Shape: **C8x11.5**
Material: **A36 Gr.36**
Length: **8 ft**
I Joint: **N6**
J Joint: **N2**
Envelope
Code Check: **0.771 (LC 2)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.771 (LC 2)**	Max Shear Check	**0.049 (z) (LC 1)**
Location	**2 ft**	Location	**2 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/821**
Bending Flange	**Compact**	Compression Flange	**Non-Slender**
Bending Web	**Compact**	Compression Web	**Non-Slender**

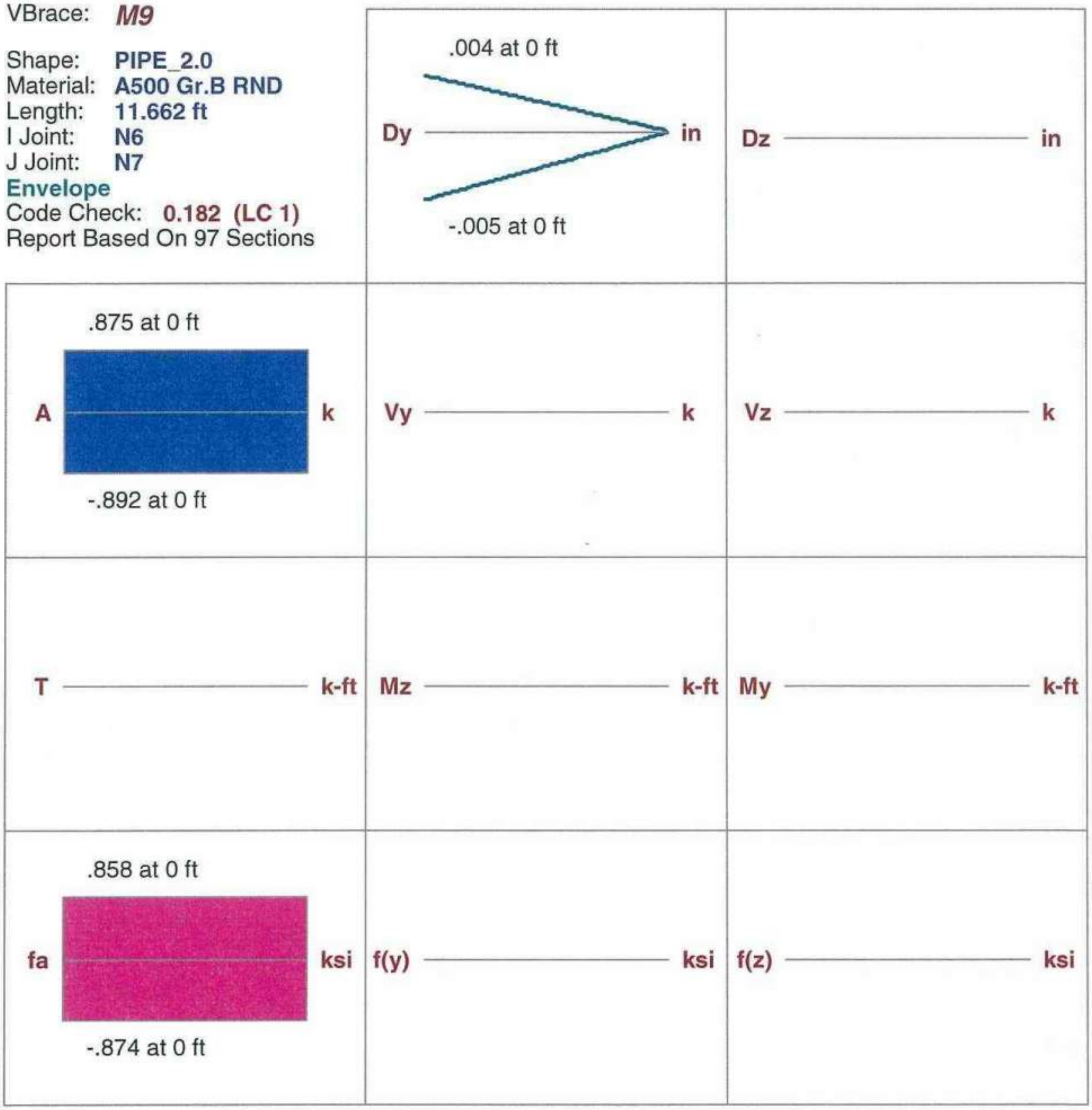
Fy	**36 ksi**
Pnc/om	**21.365 k**
Pnt/om	**72.647 k**
Mny/om	**2.231 k-ft**
Mnz/om	**16.367 k-ft**
Vny/om	**22.764 k**
Vnz/om	**22.8 k**
Cb	**1.318**

	y-y	z-z
Lb	**8 ft**	**8 ft**
KL/r	**153.975**	**30.913**

L Comp Flange	**8 ft**
L-torque	**8 ft**
Tau_b	**1**

VBrace: *M9*

Shape: **PIPE_2.0**
Material: **A500 Gr.B RND**
Length: **11.662 ft**
I Joint: **N6**
J Joint: **N7**
Envelope
Code Check: **0.182 (LC 1)**
Report Based On 97 Sections



AISC 14th(360-10): ASD Code Check

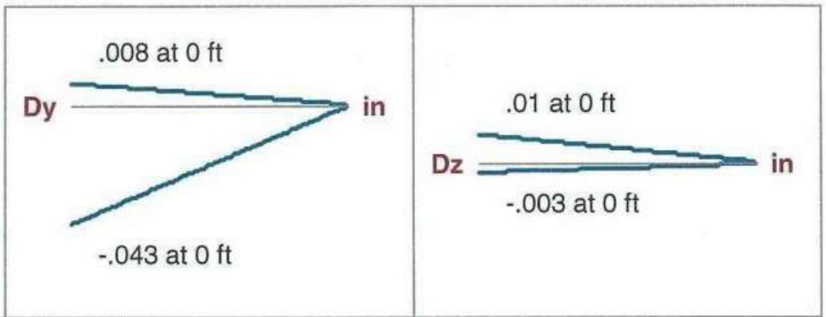
Direct Analysis Method

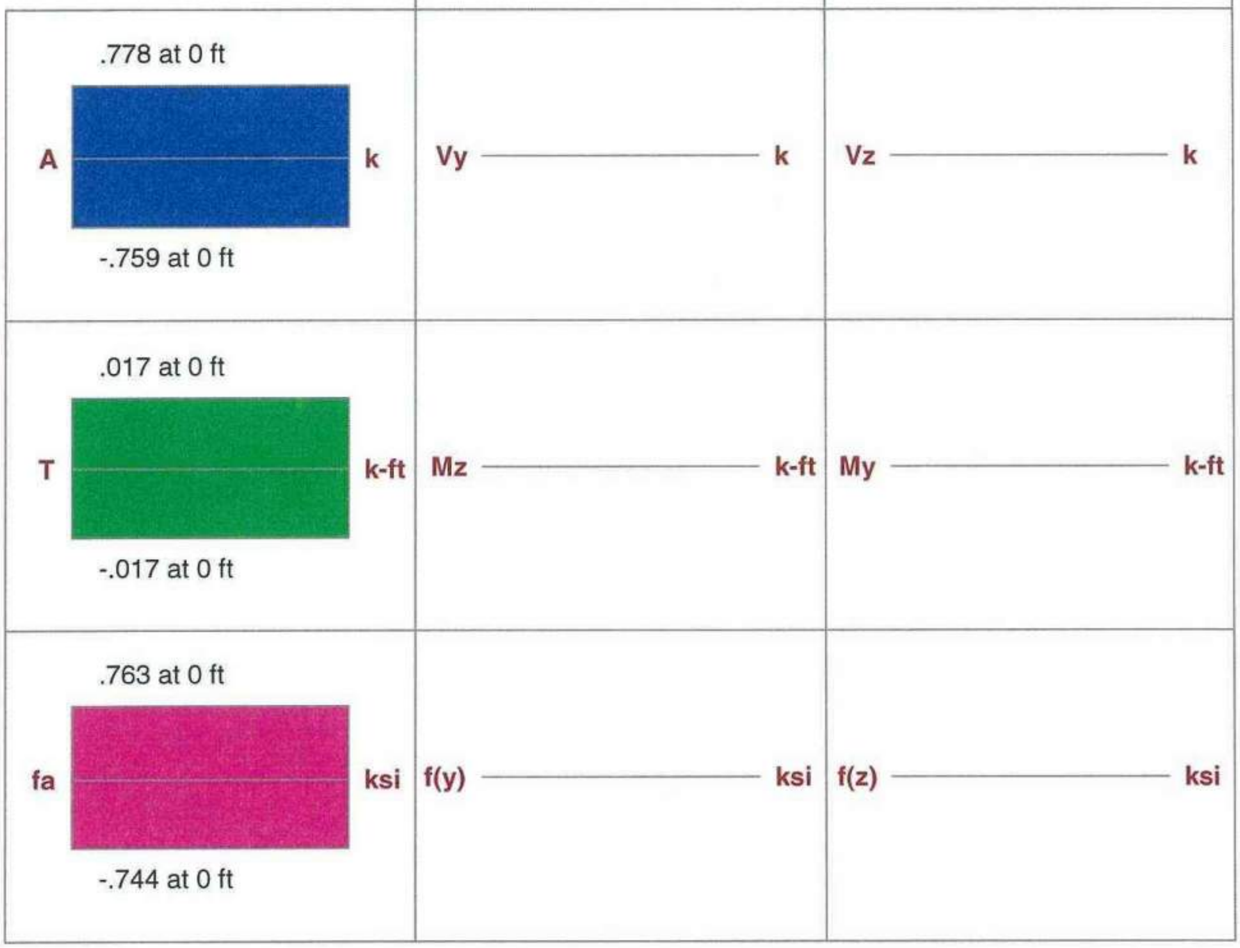
Max Bending Check	**0.182 (LC 1)**	Max Shear Check	**0.000 (s) (LC 1)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1b***	Max Defl Ratio	**L/10000**
Bending	**Compact**	Compression	**Non-Slender**

			y-y	z-z
Fy	**42 ksi**	Lb	**11.662 ft**	**11.662 ft**
Pnc/om	**4.812 k**	KL/r	**178.491**	**178.491**
Pnt/om	**25.653 k**			
Mny/om	**1.494 k-ft**	L Comp Flange	**11.662 ft**	
Mnz/om	**1.494 k-ft**	L-torque	**11.662 ft**	
Vny/om	**7.696 k**	Tau_b	**1**	
Vnz/om	**7.696 k**			
Tn/om	**1.413 k-ft**			
Cb	**1**			

VBrace: *M7*

Shape: **PIPE_2.0**
Material: **A500 Gr.B RND**
Length: **12.329 ft**
I Joint: **N9**
J Joint: **N7**
Envelope
Code Check: **0.181 (LC 1)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.181 (LC 1)**	Max Shear Check	**0.013 (s) (LC 2)**
Location	**0 ft**	Location	**0 ft**
Equation	**H1-1b***	Max Defl Ratio	**L/10000**
Bending	**Compact**	Compression	**Non-Slender**

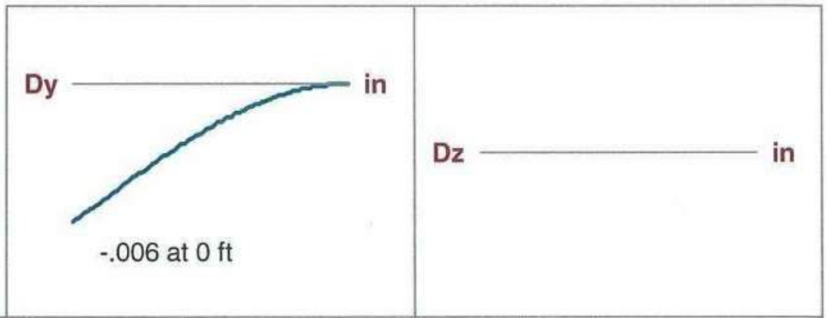
Fy	**42 ksi**
Pnc/om	**4.306 k**
Pnt/om	**25.653 k**
Mny/om	**1.494 k-ft**
Mnz/om	**1.494 k-ft**
Vny/om	**7.696 k**
Vnz/om	**7.696 k**
Tn/om	**1.413 k-ft**
Cb	**1**

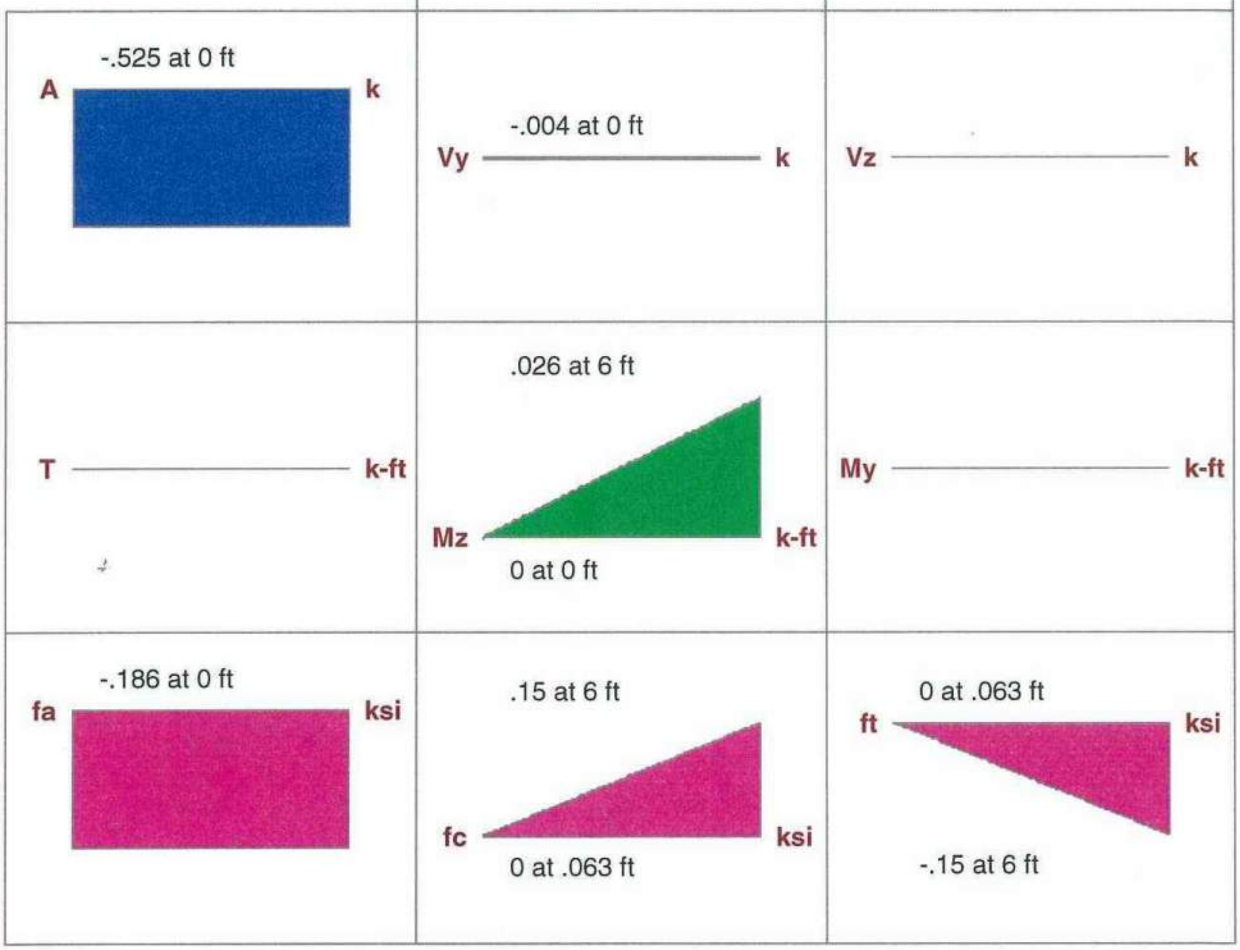
	y-y	z-z
Lb	**12.329 ft**	**12.329 ft**
KL/r	**188.699**	**188.699**

L Comp Flange	**12.329 ft**
L-torque	**12.329 ft**
Tau_b	**1**

Column: *M1*

Shape: **PIPE_3.0X**
Material: **A500 Gr.B RND**
Length: **6 ft**
I Joint: **N6**
J Joint: **N5**
LC 1: DL+Thermal
Code Check: **0.008 (bending)**
Report Based On 97 Sections





AISC 14th(360-10): ASD Code Check

Direct Analysis Method

Max Bending Check	**0.008**	Max Shear Check	**0.000 (s)**
Location	**6 ft**	Location	**0 ft**
Equation	**H1-1b**	Max Defl Ratio	**L/10000**
Bending	**Compact**	Compression	**Non-Slender**

			y-y	z-z
Fy	**42 ksi**	Lb	**6 ft**	**6 ft**
Pnc/om	**55.79 k**	KL/r	**62.969**	**62.969**
Pnt/om	**71.174 k**			
Mny/om	**6.099 k-ft**	L Comp Flange	**6 ft**	
Mnz/om	**6.099 k-ft**	L-torque	**6 ft**	
Vny/om	**21.352 k**	Tau_b	**1**	
Vnz/om	**21.352 k**			
Tn/om	**5.734 k-ft**			
Cb	**1.677**			

MERRICK® BUILDING QUALITY SOLUTIONS

Engineering Calculation Sheet

Contract 7481-77

Calculation No.

Subject McMurdo utilities

Revision	By	Date	Chk'd	Date
	PF			

Light Pole Base Calc

wind speed
Risk cat I

V = 150 mph ultimate

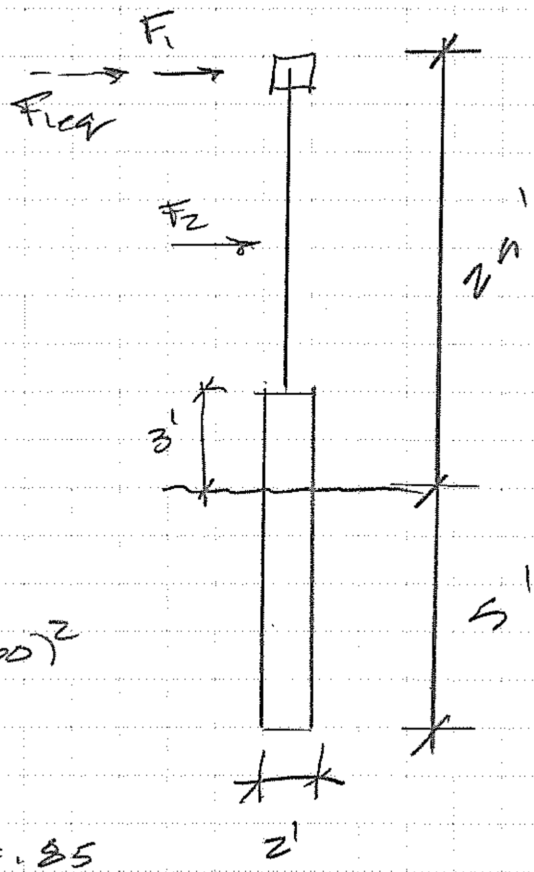
$q_z = .00256\, k_z\, k_{zt}\, k_d\, (V)^2$

$k_d = .95$

$k_{zt} = .85$

$k_z = 1.12$

$q = .00256\,(1.12)(.85)(.95)(150)^2$
$= 52$ psf ult



$F = q_z\, G\, C_f\, A_F$ $G = .85$

$F_1 = 52(.85)(1.3)(2.9)$ $A_{F_1} = 2.9\ ft^2$ $C_f = 1.3$
$= 167$ # ult $A_{F_2} = 12.5\ ft^2$ $C_f = .7$

$F_2 = 52(.85)(.7)(12.5)$
$= 387$ # ult

$F_{1eq} = \dfrac{167(25) + 387(25/2)}{25}$

$= 361$ # ult

$F_{1eq\ all} = 217$ #

MERRICK® & COMPANY

Date:	3/8/17	Sheet	of
Project No.:	7481-77		
By:	PIF		

FLAGPOLE COLUMN AND CAISSON

Job: McMurdo
Location: utilities

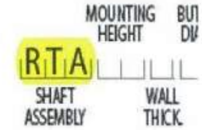
Ftop:	217 lbs	A= 0.8 ft^2		
h:	25.00 ft	S1= 333 psf	S1 < Passive Pressure x 15, OK	Unconstrained
Passive:	200 pcf	S3= 1000 psf	S3 < Passive Pressure x 15, OK	Constrained
b (diam):	2.00 ft	SP= 887 psf	Gravity Soil Bearing	
d-(trial depth):	5.00 ft	d= 4.95 ft		
P:	2000 lbs			0.76167
Constrained?:	no	M = 5427	#-ft	

2' Diam Base
is good w/ 6' embedment

A Mtg. Hgt.	B Wall Thickness	C Butt Dia.	Total Lum. Weight	Maximum EPA 120	130	140	150	160	170	180	Old Catalog Number	Catalog Number
06	0.125	4	165	10.2	8.6	7.3	6.3	5.5	4.8	4.3	78-001	RTA06B4A4-**
08	0.125	4	100	6.7	5.6	4.6	4.0	3.4	2.9	2.6	78-002	RTA08B4A4-**
08	0.188	4	160	10.0	8.3	7.0	6.1	5.2	4.6	4.0	78-015	RTA08D4A4-**
10	0.125	4	60	4.7	3.8	3.1	2.6	2.1	1.8	1.5	78-003	RTA10B4A4-**
10	0.188	4	100	7.2	5.9	4.9	4.2	3.5	3.1	2.7		RTA10D4A4-**
10	0.125	5	150	9.4	7.8	6.6	5.7	4.9	4.3	3.7	78-012	RTA10B5A4-**
10	0.188	5	240	14.2	11.9	10.0	8.8	7.6	6.6	6.0		RTA10D5A4-**
12	0.125	4	40	3.3	2.5	1.9	1.5	1.2	1.0	-	78-004	RTA12B4A4-**
12	0.188	4	70	5.3	4.3	3.4	2.9	2.3	2.0	1.7	78-018	RTA12D4A4-**
12	0.125	5	100	7.1	5.8	4.8	4.1	3.5	3.0	2.6	78-009	RTA12B5A4-**
12	0.156	5	140	9.0	7.4	6.2	5.3	4.6	3.9	3.4	78-009W3	RTA12C5A4-**
12	0.188	5	175	11.0	9.1	7.6	6.6	5.7	4.9	4.3	78-009W4	RTA12D5A4-**
14	0.125	4	45	2.1	1.5	1.0	-	-	-	-	78-005	RTA14B4A4-**
14	0.188	4	40	3.9	3.1	2.3	1.9	1.5	1.2	1.0	78-019	RTA14D4A4-**
14	0.125	5	70	5.4	4.3	3.5	2.9	2.4	2.1	1.7	78-010	RTA14B5A4-**
14	0.156	5	100	7.0	5.7	4.7	4.0	3.3	2.9	2.4	78-021	RTA14C5A4-**
14	0.188	5	125	8.6	7.1	5.9	5.0	4.2	3.7	3.2	78-022	RTA14D5A4-**
16	0.188	4	45	2.8	2.0	1.4	1.0	-	-	-	78-027	RTA16D4A4-**
16	0.125	5	55	4.0	3.1	2.4	1.9	1.5	1.2	1.0	78-011	RTA16B5A4-**
16	0.156	5	70	5.5	4.3	3.5	2.9	2.3	1.9	1.6	78-029	RTA16C5A4-**
16	0.156	5	70	5.1	4.2	3.5	3.0	2.5	2.1	1.9	51-002S48	RTA16C5B4-**
16	0.188	5	95	6.9	5.5	4.5	3.8	3.1	2.7	2.3	78-030	RTA16D5A4-**
16	0.188	6	230	13.7	11.5	9.8	8.5	7.4	6.4	5.6		RTA16D6B4-**
18	0.125	5	40	2.9	2.1	1.5	1.1	-	-	-	78-007	RTA18B5A4-**
18	0.156	5	40	4.1	3.2	2.4	1.9	1.5	1.2	1.0	78-031	RTA18C5A4-**
18	0.188	5	60	5.3	4.2	3.3	2.7	2.2	1.8	1.5	78-032	RTA18D5A4-**
18	0.156	6	140	9.0	7.4	6.2	5.4	4.6	4.0	3.5		RTA18C6B4-**
18	0.188	6	180	11.2	9.4	7.9	6.9	5.9	5.1	4.5		RTA18D6B4-**
18	0.156	7	220	13.6	11.3	9.6	8.4	7.2	6.3	5.5		RTA18C7B4-**
20	0.125	5	40	1.9	1.2	-	-	-	-	-	78-008	RTA20B5A4-**
20	0.156	5	40	3.0	2.1	1.5	1.1	-	-	-	78-033	RTA20C5A4-**
20	0.188	5	40	4.1	3.0	2.3	1.8	1.4	1.0	-		RTA20D5A4-**
20	0.125	6	70	5.2	4.2	3.5	2.9	2.5	2.1	1.7	51-001	RTA20B6B4-**
20	0.156	6	100	7.2	5.9	4.9	4.2	3.6	3.1	2.6	51-002	RTA20C6B4-**
20	0.188	6	140	9.2	7.6	6.4	5.5	4.7	4.0	3.5	51-003	RTA20D6B4-**
20	0.156	7	175	11.2	9.3	7.9	6.8	5.8	5.1	4.4	51-004	RTA20C7B4-**
20	0.188	7	230	14.0	11.7	9.9	8.6	7.4	6.4	5.6	51-005	RTA20D7B4-**
20	0.156	8	260	15.8	13.3	11.3	9.8	8.4	7.3	6.4	51-006	RTA20C8B4-**

Catalog Number Syste

The catalog number for Hapc
following identification systen



Catalog Number Example

RTA 30 D 8

Round Tapered Aluminum, 3C
.188" Wall Thickness, 8" Butt
Diameter, 4-Bolt Base, Satin

Wall Thickness

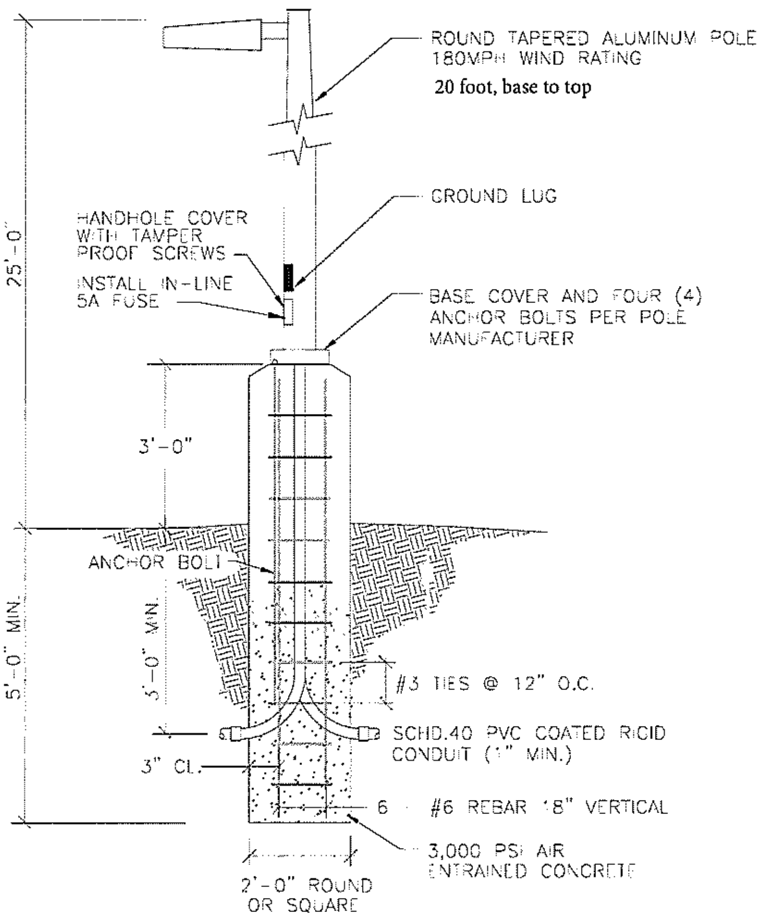
B = .125"
C = .156"
D = .188"
E = .219"
F = .250"
G = .312"

Butt Diameter

4 = 4"
5 = 5"
6 = 6"
7 = 7"
8 = 8"
9 = 9"
1 = 10"

Top Diameter

A = 3"
B = 4.5"



NOTES:

1. CONNECT ALL STEEL TO GROUND WIRE.
2. POLE BASE SHALL BE 36" ABOVE FINISHED GRADE WHEN LOCATED IN PAVED PARKING AREA. PROVIDE TROWEL FINISH TO ALL EXPOSED CONCRETE SURFACES.

LIGHT POLE BASE DETAIL

SCALE: NONE

7.0 CALCULATIONS — Project Design Loads: ASCE 7-10 — Reference Key: ASCE 7-10 (ASCE 7-05)

Color Key: Design Input Resultant

7.1 BASIC DESIGN LOADS

CAT = IV — Risk Category — Table 1.5-2 (Occupancy Category, Table 1-1)

7.1.1 WIND LOADS

Wind Design Parameters:

EXP =	D	Exposure	Section 26.7.3 (Sect. 6.5.6)
V =	180 MPH	Basic wind speed	Section 26.5 (Sect. 6.5.4)
G =	0.85	Gust effect factor for rigid structures	Section 26.9, Sect. 7.6 (Sect. 6.5.8)
K_d =	1.0	Wind directionality factor	Table 26.6-1 (Table 6-4)
K_z =	1.08	Velocity pressure exposure coefficient (varies)	Table 29.3-1 (Table 6-3)
K_{zt} =	1.0	Topographic factor	Section 26.8 (Sect. 6.5.7)
I =	1.0	Importance Factor	N/A (Table 6-1)
ψ_w =	1.0	Strength Design Factor	N/A (1.6, Sect. 2.3.2)

$q_z = 0.00256(K_z)(K_{zt})(K_d)(V^2)*I*\psi_w$ (Strength Level) — Eq. 29.3-1 (Eq. 6-28)

q_z = 89.6 psf

7.1.2 LIVE LOADS

Chapter 4

Platforms:

w_{ap} =	60.0 psf	Access platform live load	Table 4-1
w_{mp} =	125.0 psf	Maintenance platform live load	
w_{ps} =	100.0 psf	Stair live load	
w_r =	20.0 psf	Roof live load	

7.1.3 SNOW LOADS

p_g = 40.0 psf	Ground snow load	Attachment 8.1
C_e = 1.0	Exposure Factor	Table 7-2
C_t = 1.2	Thermal Factor	Table 7-3
I_s = 1.2	Importance Factor	Table 1.5-2 (Table 7-4)

$p_f = 0.7*C_e*C_t*I_s*p_g =$ 40.3 psf — Eq. 7.3-1 (Eq. 7-1)

$w_s = \max(p_f, (\text{if } (p_g > 20, 20\text{psf}*I_s, p_g*I_s))) =$ 40.3 psf — Design roof snow load

MCMURDO STATION Tank FND

BLDG. 126 WATER STORAGE TANK

INSULATION AND HEATING

SURFACE AREAS

TOP: $A = 3.142 \times R^2$
$R = 15'$

$A = 706.86$

BOTTOM: $A = 706.86$

CIRCUMFERENCE: $C = 3.142 \times D$
DIA. = 30'

$C = 94.25$

HEIGHT: 16' -0"

SIDES SURFACE AREA: 94.25' × 16'-0" = 1508' ⊕

TOTAL SURFACE AREA: 707 + 707 + 1508' ⊕ = 2922' ⊕

VOLUME: $V = 3.142 \times R^2 \times H$ -1ft

V = 10603 CU.FT

1 CU.FT WATER = 7.5 GAL

7.5 × 10603 CU.FT = 79,522 GALS (TANK CAP.)

WEIGHTS

WATER: ONE CUBIC FOOT = 62.5 LBS (FRESH WATER)

= 64.3 LBS (SALT WATER)

10603 CU.FT. × 62.5 LBS = 662,688 LBS

10603 CU.FT. × 64.3 LBS = 681,773 LBS

STEEL PLATING: 3/8" THK. = 15.30 LBS P/SQ. FT.

SURFACE AREA = 2922+707 SQ.FT × 15.30 LBS = 55,500 LBS

(Add add'l roof area to account for framing members)

TOTAL WEIGHT OF FULL TANK FND

55,500 + 662,688 = 718,200 LBS (FRESH WATER)

INSULATION WEIGHTS

DOW CHEMICAL COMPANY

STYROFOAM BRAND INSULATION

STYROFOAM DENSITY = 1.80 LB./CU.FT.

1.80 ÷ 12 = 0.15 LBS P/IN. × 6 = 0.9 LBS P/SQ.FT.

RECOMMEND (3) 2" THK. LAYERS, 48"×96" SHTS. WITH OVERLAPPING SEAMS WITH THE FIRST LAYER VAPOR AND WEATHERPROOFED

ALL SURFACES ARE TO BE INSULATED

2922 SQ.FT. × 0.9 LBS P/SQ.FT. = 2630 LBS
(TOP & SIDES)

TOP AND SIDES TO HAVE CORRUGATATED .021 ALUMINUM JACKETING.

WEIGHT .282 LB. P/SQ.FT.

2215 SQ.FT. × .282 LBS. = 625 LBS

SECOND LAYER TO BE VAPOR PROOFED WITH CHILDERS CHIL-PRUF CP-22

CHIL-PRUF - CP-22

COVERAGE = (FOR INSULATION) 6.8 GALS P/100 □'

WEIGHT = 8.1 LBS P/US GAL.

1838 SQ ÷ 100 = 18.38 × 6.8 GALS = 125 × .10% =

12.5 GALS + 125 GALS = 138 GALS REQ'D.

28 5 GAL CANS

WEIGHT 138 GALS x 8.1 LBS P/GAL = 1118 LBS

STRAPPING 200' CARTONS

STRAPPING TO BE INSTALLED 12" ON CNTRS STARTING WITH THE BOTTOM OF ALUM. JACKETING.

STRAPPING TO BE = T-304, 3/4 WIDTH, .020 THK. 25 GA, - 25 GAGE IS .875 LB. P/ SQ. FT.

.875 ÷ 144 = 0.006 LB. P/SQ. IN.

.006 x 12" = 0.072 LB. ÷ 4 = 0.018 LB. x 3 = 0.054 LB. PER 12" LG. 3/4" WIDE STRIP

WEIGHT = 0.054 LB. x 200' = 11 LBS PER CARTON.

CIRCUM. = 94 FT.

REQUIRE (2) ROWS OF 100' INSTALLATION STRAPS 12" ON CNTRS. REQUIRE (24) 100' STRAPS (APPROX)

2400 FT. ÷ 200' (CARTON) = (12) CARTONS x 11 LBS. = 132 LBS

TOTAL WEIGHT OF INSTALLATION

WATER =	662,688 LB.
TANK STL. PLATE =	55,500
INSULATION =	2630
CORR. ALUM =	625
VAPOR BARRIER =	1118
STRAPPING =	132
TOTAL WEIGHT =	722,700lbs (Minimum)

572486 ÷ 707 # = 810 LBS P/SQ. FT. OR 5.6 LBS P/SQ. IN.

STYROFOAM - SQUARE EDGE - INSULATION
QUANTITY = (TOP & SIDES) = 1838 SQ. FT.
STD. 48" x 96" SHT. = 32 SQ. FT.
1838 ÷ 32 SQ. FT = 57 SHTS x .10% = 6 OR
63 SHTS. P/LAYER x 2 = 126 SHTS. TOTAL.

TANK BOTTOM SUPPORT/INSULATION
TANK BOTTOM SQ. FT. = 707
TANK TO BE SUPPORTED ON EXISTING 6" x 12" TIMBERS LAYED ON COMPACTED SOIL. 3/4" THK. C-C EXT. PLYWOOD SHEETS TO BE LAIN PERPENDICULAR TO 6" x 12" TIMBERS TO SUPPORT TANK BOTTOM INSULATION AND TANK. TOP OF BOTTOM INSULATION TO HAVE A SECOND LAYER OF 3/4" C-C EXT. PLYWOOD SHEETING.

WEIGHT OF TANK INSTALLATION ON BOTTOM INSULATION SUPPORT IS:
810 LBS P/SQ. FT. OR 5.6 LBS P/SQ. IN.

BOTTOM INSULATION TO BE:
(2) 3". THK. LAYERS OF DOW HIGH LOAD 60, 24" x 96" SHEETS. EACH LAYER TO BE INSTALLED PERPENDICULAR TO PLYWOOD SHEATHING AND EACH OTHER.

7.1.4 SEISMIC LOADS

Seismic Design Parameters:

S_{DS} =	0.300 g	Design spectral response	Attachment 8.1
S_{D1} =	0.085 g		
S_1 =	0.128 g		
SDC =	C	Seismic Design Category	Table 11.6
I =	1.50	Importance Factor	
R =		Response Modification Factor	Table 15.4
Ω_0 =		Overstrength Factor	
C_d =		Deflection Amplification Factor	
C_s =	S_{DS} *I/R	Seismic Response Coefficient	Eq. 12.8-2
C_{s_min} =	$0.8*S_1$ *I/R	Minimum Seismic Coefficient for $S_1 \geq 0.6g$	Eq. 15.4-2
E_h =	Ω_0*C_S	Horizontal Seismic Load Effect for Connections	Eq. 12.4-7
E_v =	$0.2*S_{DS}$ = 0.060 g	Vertical Seismic Load Effect	Eq. 12.4-4

Item (i)	Structure Type	R_i	Ω_{0_i}	C_{d_i}	C_{s_i}	E_{h_i}
mf	Moment-resisting frame systems: Moment frame w/ unlimited height	1	1	1	0.450	0.450
bf	Building Frame Systems: Braced frame w/ unlimited height	1.5	1	1.5	0.300	0.300
p	Inverted pendulum type structures: T-Supports	2	2	2	0.225	0.450
e	All other self-supporting structures not specifically addressed, ie. skid supported equipment	1.25	2	2.5	0.360	0.720
t	Flat bottom ground-supported tanks, mechanically anchored	3	2	2.5	0.150	0.300
r	Rigid equipment, Sect. 15.4.2 (T < 0.06s)	3.33	3.33	3.33	0.135	0.450

Table 15.4: Seismic Coefficients for Nonbuilding Structures

7.2 FOUNDATION DESIGN PARAMETERS

Soils:

q_a = 2100 psf	Allowable Net Soil Bearing Pressure	Per Geotechnical Report
ψ_s = 1.333	Design Factor for Short-Term Loading	
$q_s = \psi_s * q_a$ = 2799 psf	Allowable Net Short-Term Soil Bearing Pressure	
μ = 0.35	Coefficient of Sliding Friction for foundations on soil	
μ_w = 0.4	Coefficient of Sliding Friction for steel on wood	

7.3 WATER STORAGE TANK FOUNDATION

Atmospheric

Design in Accordance with ASCE-7 and AWWA D103 [D100 equivalent]

W_s = 60.0 kip		Total weight of tank shell and insulation (To Be Verified)		See attached
V_t = 80000 gal	10695 ft^3	Volume of tank	254.65 BBL	
γ_w = 8.35 lb/gal	62.5 lb/ft^3	Density of product (water)		
$W_p = \gamma_w * V_t$ =	668.0 kip	Weight of product		
h_t = 192.0 in	16.00 ft	Height of tank		
D = 360.0 in	30.00 ft	Diameter of tank		
D_{bc} = 364.0 in		Diameter of bolt circle		
N = 12		Number of Anchors		
d_n = 1.00 in		Nominal bolt diameter (1" min.)		
X_s = 96.0 in	8.00 ft	Height of full tank center-of-gravity from base		
H = 16.0 ft		Maximum design fluid level		
t_u = 0.375 in		Tank shell thickness		
E = 29000000 psi		Elastic modulus of tank material		
T_L = 6.0 s		Regional long-period transition period		Geotechnical report App.-F
F_a = 1.00		Sect. 8.1.0		
$S_o = S_{DS}$ =	0.300 g	Peak ground acceleration, Section 7.1.4		
R_i = 2.5		D103 Table 6 [28], (2.5 for self-anchored, 3.0 for mechanically anchored)		
R_c = 1.5		D103 Table 6 [28], (2.5 for self-anchored, 3.0 for mechanically anchored)		
K = 1.5		Coefficient to adjust damping		
S_{D1} = 0.085 g				
$T_s = S_{D1}/S_{DS}$ =	0.283			

Seismic Load:

$Tc = 2\pi[D/3.68*g*\tanh(3.68H/D)]^{0.5}$ — Natural period of the convective (sloshing) mode, AWWA Eq. 14-18 [13-22]

Tc = 3.224 s

H/D = 0.53

Ti = 0.0 s — Natural impulsive period of the tank system, AWWA Sect. 14.3 [13.5.1]

$S_{ai} = S_{DS}$ = 0.300 g — $0 \le Ti \le Ts$, AWWA Eq. 14-9 [13-9]

$S_{ac} = \min(S_{DS}, K*S_{D1}/Tc)$ = 0.040 g — $Tc \le T_L$, AWWA Eq. 14-12 [13-12]

$A_i = \max(Sai*I/1.4Ri, 0.36S1*I/R_i)$ — Impulsive spectral acceleration parameter, AWWA Eq. 14-16 [13-16]

A_i = 0.129 g

$A_c = S_{ac}*I/1.4R_c$ — Convective spectral acceleration parameter, AWAA Eq. 14-17 [13-18] (Sloshing)

A_c = 0.028 g

Overturning:

D/H = 1.875

W_i = if(D/H>1.333, tanh(0.866D/H)Wp/(0.866D/H), (1.0-0.218D/H)Wp) — Effective impulse weight, AWWA Eq. 14-20 [13-24]

W_i = 380.6 kip

W_c = (0.23D/H) tanh(3.67H/D)Wp — Effective convective weight, AWWA Eq. 14-22 [13-26]

W_c = 276.8 kip

X_i = if(D/H>1.333, 0.375H, (0.5-0.094D/H)H) — Effective moment arm for impulsive lateral seismic force, AWWA 14-24/25 [13-29]

X_i = 6.00 ft

X_c = H(1.0-(cosh(3.67H/D)-1)/(3.67H/D)sinh(3.67H/D)) — Effective moment arm for convective lateral seismic force, AWWA Eq. 14-26 [13-30]

X_c = 9.85 ft

$Av = 0.14S_{DS}$ = 0.042 g — Vertical seismic force component, AWWA Sect. 14.3.4.3 [13.5.4.3]

$M_e = ((A_i(W_iX_i + W_sX_s))^2 + (A_cW_cX_c)^2)^{0.5} + 0.4A_v(W_s+W_p)D/2$ — Overturning moment at base, AWWA Eq. 14-19 [13-23]

M_e = 547.0 kip-ft

F_y = 36000 psi	Yield strength of shell bottom
t_a = 0.375 in	Thickness of bottom shell annulus
G = 1.0	Specific gravity of contents
$G_e = G(1\text{-}0.4E_v)$ = 0.98	Effective specific gravity
$w_a = \min(7.9t_a(F_yHG_e)$^0.5, $1.28HDG_e)$	Overturning resisting force for self-anchored, AWWA Eq. 14-33 [13-37]
w_a = 53 lb/ft	
$L = 0.216t_a(F_y/H_e)$^0.5	Projection of annular ring, AWWA Eq. 14-34 [13-38]
L = 0.19 ft **OK, < 0.035D**	
$w_t = W_s/\pi D$	Weight of shell acting at base, AWWA Eq. 14-37 [13-41]
w_t = 637 lb/ft	
$J = M_e/(D^2(w_t(1\text{-}0.4A_v)+w_a))$	Anchorage ratio for overturning, AWWA Eq. 14-32 [13-36]
J = 0.895 **< 1.54, OK Self-Anchored**	
$V_i = A_i(W_s+W_i)$ = 56.6 kip	Impulsive seismic base shear
$V_c = A_c \cdot W_c$ = 7.8 kip	Convective seismic base shear
$V_e = (V_i^2+V_c^2)$^0.5	Total seismic base shear, AWAA Eq. 14-27 [13-31]
V_e = 57.2 kip	

Freeboard:

$A_f = K^*S_{D1}^*I/T_c$ = 0.059 g	Convective design acceleration for sloshing, AWAA Eq. 14-49 [13-53]
$d_f = 0.5DA_f$ = $0.5^*D^*A_f$ = 0.89 ft	Minimum height of freeboard, AWWA Eq. 14-48 [13-52]

Sliding:

$V_s = \tan30(W_s+W_p)(1\text{-}0.4Av)$	Sliding resistance, AWWA Eq. 14-53 [13-57]
V_s = 413.2 kip	
$FSs = V_s/V_e$	Safety factor for sliding
FSs = 7.23 **OK, > 1.0**	
$V_s = \mu_w^*(Ws+Wp)(1\text{-}0.4Av)$	Steel tank on wood sliding resistance
V_s = 286.3 kip	
$FSs = V_s/V_e$	Safety factor for sliding
FSs = 5.01 **OK, > 1.0**	

Minimum Design Displacements for Piping:

Upward:	4.0in	AWWA Table 8 [30]
Downward:	1.0in	
Horiz.	2.0in	

Wind Load:

h_t/D = 0.53		Determine C_F for wind load on Tank	
C_F = 0.60		Value for round cross-section with smooth surface	Fig. 29.5-1 (Fig. 6-21)
K_z = 1.08		Velocity pressure exposure coefficient	Table 29.3-1 (Table 6-3)
q_z = 89.6 psf		Velocity pressure for rigid component, Sect. 7.1.1 (Strength Level)	
F_s = 45.7 psf		Wind force on structure (Min. 30^*C_F)	Eq. 29.5-1 (Eq. 6-28)
$A_w = (h_t+2ft)(D+1.5ft)$ =		567.0 sq ft — Horizontal wind exposed area including insulation and protrusions	
$V_w = F_s{}^*A_w$ =	25.9 kip	Equivalent wind shear at base, Sect. 7.1	
C_p = 0.50		Average at tank roof, Figure 27.4-2 (Fig.6-7):	
$F_v = q_z{}^*G^*C_p$ =	38.1 psf	Vertical wind force on structure (Min. 30psf)	
$A_r = \pi((D+1.17ft)^2)/4$ =		763 sq ft — Roof wind exposed area	

h_l = 0.0 ft			Minimum depth of product
$W_l = \gamma_w{}^*\pi D^2{}^*h_l/4$ =		0.0 kip	Minimum weight of product

$M_w = V_w{}^*0.55^*(h_t+2ft) + F_v{}^*A_r{}^*(D)/2$ — Wind overturning moment at base

M_w = 692.1 kip-ft

$M_r = 0.9^*D^*(W_s+Wl)/2$ — Resisting moment at base for foundation design

M_r = 810.0 kip-ft

M_w/M_r = 0.85 — **OK, < 1.0** — **No Anchorage Required**

$V_s = \tan30(W_s+W_l)$ — Sliding resistance, AWWA Eq. 15-3 [13-57]

V_s = 34.6 kip

$FS_s = V_s/V_w$ — Safety factor for sliding

FS_s = 1.34 — **OK, > 1.0**

$V_s = \mu_w{}^*(Ws+W_l)$ — Steel tank on wood sliding resistance

V_s = 24.0 kip

$FSs = V_s/V_w$ — Safety factor for sliding when empty

FSs = 0.93 — **NG, < 1.0** — (OK at 170mph wind for Risck Category II)

Snow Load:

$w_{ts} = w_s{}^*A_r$ = 30.8 kip — Total snow load — Sect. 7.1.3

Round Footing Design:

$t = 0.67$ ft — Foundation thickness
$q_s = 2799$ psf — Allowable bearing pressure, Sect. 7.2.1

$S = 30.17$ ft — Diameter of foundation
$A = \pi S^2/8 + 30$ — Area of footing (taken as 1/2 the area of the foundation plus one row of timbers)
$A = 387.4$ sq ft
$S_d = \pi S^3/32$ — Section modulus
$S_d = 2696$ ft^3
$D_f = 0.0$ kip — Weight of foundation (neglected)

Seismic Resistance:

$F_{ev} = 0.4A_v*(W_s+W_p) =$ 12.2 kip — Vertical seismic force, Sect. 7.1.4
$q_{max} = (W_s+W_p+D_f+0.7F_{ev}+0.2w_{ts})/A + 0.7(M_e+V_e*t/2)/S_d$
$q_{max} = 2064$ psf — Maximum bearing pressure

$D/C = q_{max}/q_s$ — Demand-to-Capacity ratio
$D/C = 0.74$ **OK, < 1.0**
$q_{min} = 0.6(W_s+W_p+D_f)/A - 0.7(M_e+V_e*t/2)/S_d)$ — Min. bearing pressure
$q_{min} = 980$ psf

Wind Resistance:

$q_{max} = (W_s+W_p+D_f+0.75w_{ts})/A + 0.6(M_w+V_w*t/2)/S_d$ — Maximum bearing pressure
$q_{max} = 2094$ psf

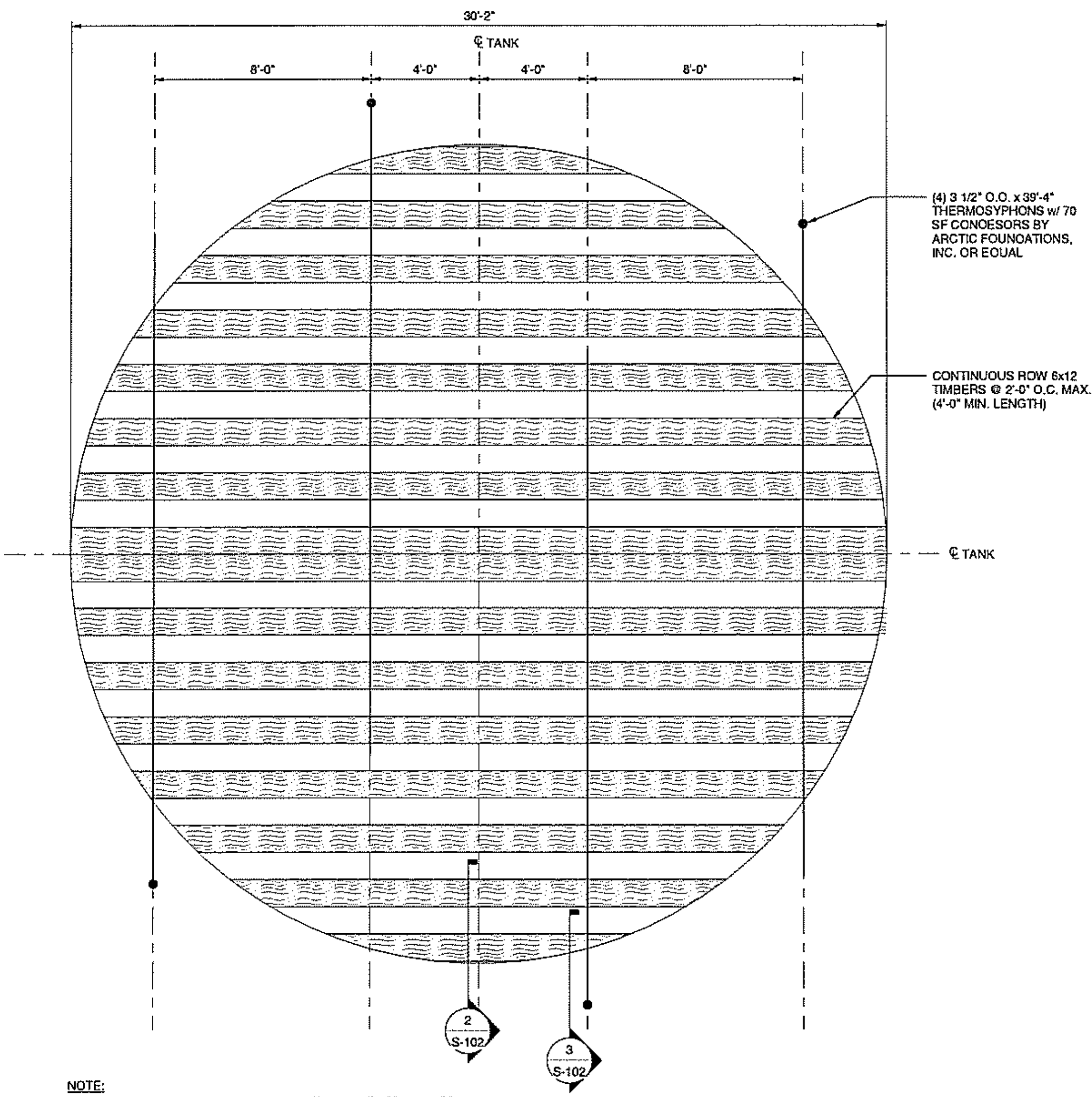
$D/C = q_{max}/q_s$ — Demand-to-Capacity ratio
$D/C = 0.75$ **OK, < 1.0**
$q_{min} = (0.6(W_s+D_f+W_l)/A - 0.6(M_w+V_w*t/2)/S_d$ — Min. bearing pressure
$q_{min} = -63$ psf

Bearing Pressure:

$q_{max} = W_s+Wp+D_f+w_{ts}/A$ — Maximum bearing pressure
$q_{max} = 1958$ psf
$D/C = q_{max}/q_a$ — Demand-to-Capacity ratio
$D/C = 0.93$ **OK, < 1.0**

Base Shear Fasteners:

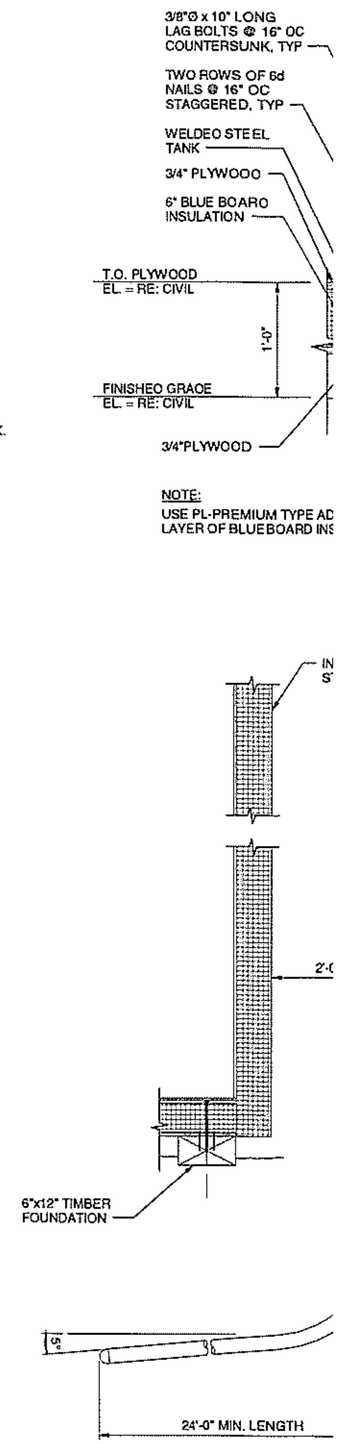
V_b = max(0.7Ve, 0.6Ws) =	40.0 kip		Maximum unfactored base shear
Z_n = Z*Cd*Cdi =	66lb*1.6*1.1 =	116 lb	Allowable shear for 6d nails
Z_l = Z*Cd*Cdi =	220lb*1.6*1.1 =	387 lb	Allowable shear for 3/8in lag screws
s_n = 0.67 ft		Equivalent nail spacing (two rows)	
s_l = 1.33 ft		Lag bolt spacing	
l_t = 377.00 ft		Total length of foundation timbers	
v_n = Zn*lt/sn =	65.4 kip		
v_l = Zl*lt/sl =	109.8 kip		
D/C = V_b/min(vn,vl)		Demand-to-Capacity ratio	
D/C = 0.61	**OK, < 1.0**		



NOTE:
1. REFER TO DWG. S-002-10 FOR STRUCTURAL GENERAL NOTES.
2. INSTALL SLOPING THERMOSYPHON SYSTEM PER VENDOR SPECIFICATIONS.

1 TANK FOUNDATION PLAN
3/8" = 1'-0"

PLAN NORTH

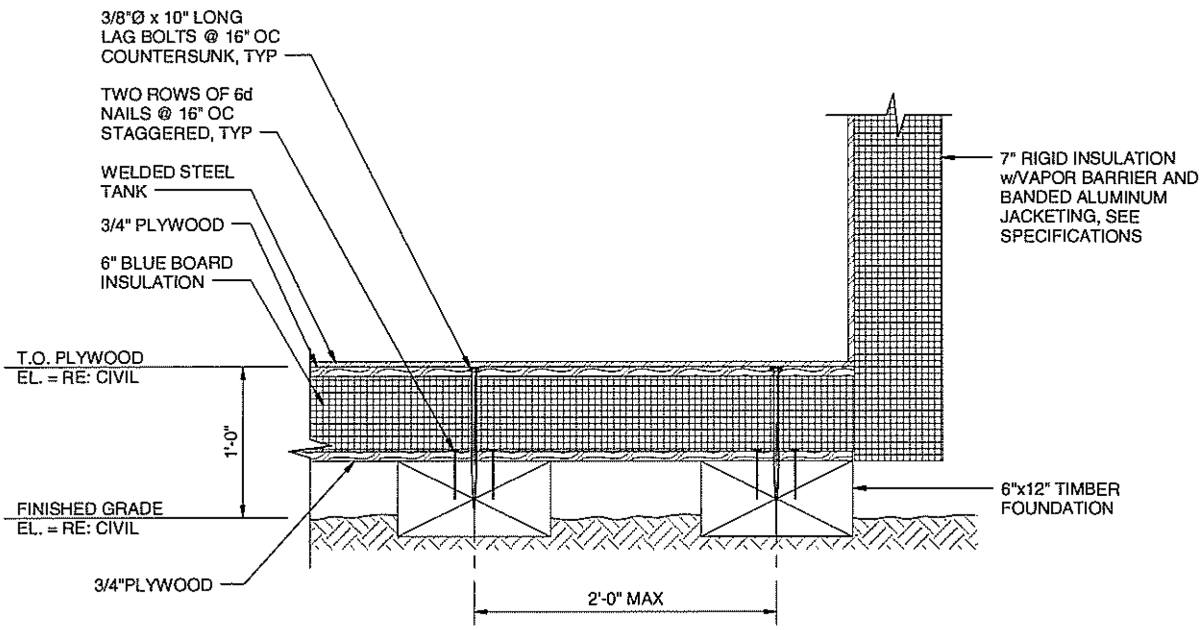


3 TANK THREMOSY
3/4" = 1'-0"

1 2 3 4 5

39'-4"
NS w/ 70
BY
ATIONS,

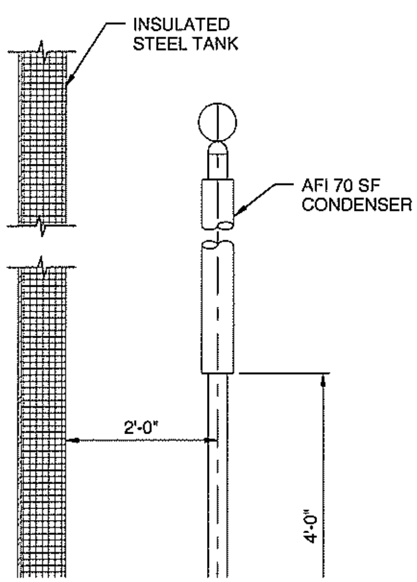
OW 6x12
O.C. MAX.
TH)



NOTE:
USE PL-PREMIUM TYPE ADHESIVE (STOCK #0000244) BETWEEN LAYER OF BLUEBOARD INSULATION AND PLYWOOD.

2 TANK FOUNDATION SECTION

1 1/2" = 1'-0"



INCHES
CENTIMETERS

NATIONAL SCIENCE FOUNDATION
OFFICE OF POLOR PROGRAMS
WASHINGTON, D.C. NSF
CONTRACT OFP. 0000373

REVISION LOG

REV.	DATE	DESCRIPTION	DFTG.	APPD.
A	06/08/2016	30% SUBMITTAL	MGL	PIF
B	12/23/2016	60% SUBMITTAL	MGL	PIF

STATION
MS
ES DESIGN
TURAL

MERRICK® & COMPANY

Engineering Calculation Sheet

011-2010A

Date ______ Sheet ______ of ______

Contract ______

Calculation No. ______

Subject: McMurdo utilities

Revision	By	Date	Chk'd	Date

Head walls at Culverts

$q = \gamma H k_a$

$\gamma = 100$

$H = 5.5'$

$q = 100(5.5)(.30)$

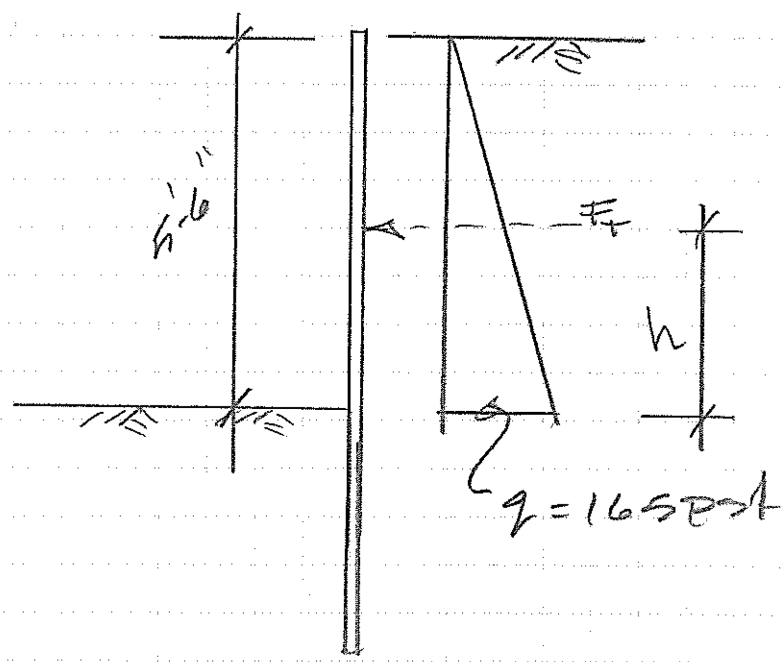
$= 165 \text{ psf}$

$F_T = 165(1/2)(5.5)$

$= 454 \text{ \#/ft}$

$h = 5.5(1/3)$

$= 1.83 \text{ ft}$



MERRICK® & COMPANY

Date:	6/20/17	Sheet	of
Project No.:			
By:	PIF		

FLAGPOLE COLUMN AND CAISSON

Job:
Location: Head walls

Ftop:	908 lbs	A= 4.0 ft^2			
h:	1.83 ft	S1= 800 psf		S1 < Passive Pressure x 15, OK	Unconstrained
Passive:	400 pcf	S3= 2400 psf		S3 < Passive Pressure x 15, OK	Constrained
b (diam):	0.66 ft	SP= 300 psf		Gravity Soil Bearing	
d-(trial depth):	6.00 ft	d= 5.49 ft			
P:	0 lbs				
Constrained?:	no	M =	1662	#-ft	

Delta max=	0.06 in	
Fy:	35 ksi	
E:	29000 ksi	
Ireq=	2.0096 in^4	
USE=	PIPE 3 STD	
USE=	3X3X3/16	TUBE STEEL

$F_{top} = 454(2)$
$= 908$ #

use 3" ϕ x strong soldier Piles spaced at 2' oc max w/ 5'-6" Max Height & 6' embedment

Check Bending on 3" ϕ Pipe

$M = 1662$ #-ft $= 20$ k-in

$F_y = 36$ ksi

$Z = 4.07\ in^3$

$\Omega = 1.67$

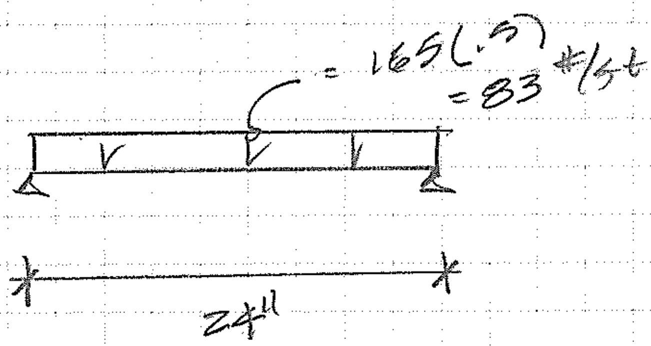
$M_n = F_y Z$
$= 36(4.07)$
$= 146.5$ k-in

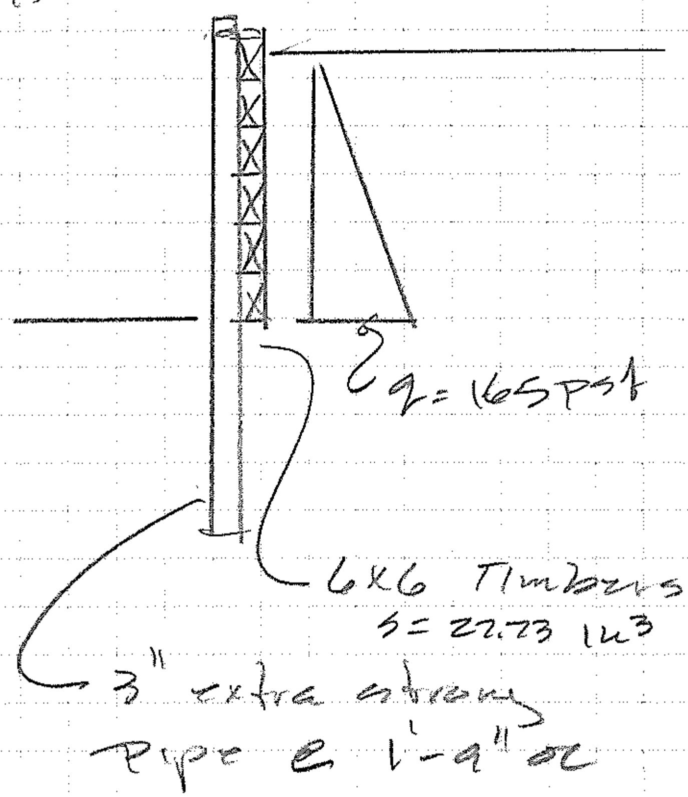
$\frac{M_n}{\Omega} = 87.7$ k-in > 20 k-in ‖ OK

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	TH			

check timber walls





$M = \frac{83(24/12)^2}{8}$

$= 41.5$ #-ft

$= 498$ #-in

$V = 83(2/2)$

$= 83$ #

$F'_b = F_b C_d C_m C_t C_L C_F$

$C_d = .9$

$C_m = 1.0$

$C_t = 1$

$C_L = 1$

$C_F = 1$

$F_b = 750$ psi

$F'_b = 750(.9)$

$= 675$ psi

$f'_b = 498 / 27.73 = 18$ psi

∥ OK

Subject McMurdo Utilities

Revision	By	Date	Chk'd	Date
	TF			

Check Shear

$F_v = 170$ psi

$f_v = 83/(5.5)^2 = 2.7$ psi okay

Check Bearing

$F_{c\perp} = 700$ psi

$f_{c\perp} = \dfrac{83(2)}{(1)(5.5)} = 30$ psi okay

use 6x6 DFL #2 timbers for Retaining wall

For Soldier Pile

use 3" ø extra strong Pipe w/ 6' embedment
space piping @ 2'-0" oc
see following Printout

MERRICK & COMPANY

Technical Calculations

E001-Electrical

Calculation Title:
McMurdo Station Antarctica Street Lighting
7/19/2017

Prepared For:
NSF/ASC

Prepared By:
Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, Co 80111-4703

COLORADO REGISTERED PROFESSIONAL ENGINEER
R. ORLANDO TRUJILLO
46226

7-27-17

TABLE OF CONTENTS

EXECUTIVE SUMMARY

IES RP-8-14 Roadway Lighting Standard for local street classification with medium pedestrian traffic was the bases of design for McMurdo Station street lighting. The proposed light pole configuration is a LED light fixture mounted on a 20-ft steel tapered pole with a 2-ft cyclical concrete base. The concrete base will consist of a finished surface of 3-ft above ground to provide traffic protection. Light poles have been placed throughout the site impacted by new construction for general lighting along all roadways. Detail wiring for each fixtures is not provided as part to the site infrastructure design. Wiring details will be provided during new construction. Final determination of street lighting will be determined during building construction to determine if light fixture should be mounted on a building structure or remain on the proposed light pole location.

SECTION 1 INTRODUCTION

New street lighting will be provided throughout McMurdo Station will meet IES RP-8-14 Roadway Lighting Standard for local street classification with medium pedestrian traffic as specified in Table 3 below:

Table 3. Lighting Design Criteria for Streets

STREET CLASSIFICATION	PEDESTRIAN AREA CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m^2)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO LV_{max}/L_{avg}
MAJOR	HIGH	1.2	3.0	5.0	0.3
	MEDIUM	0.9	3.0	5.0	0.3
	LOW	0.6	3.5	6.0	0.3
COLLECTOR	HIGH	0.8	3.0	5.0	0.4
	MEDIUM	0.6	3.5	6.0	0.4
	LOW	0.4	4.0	8.0	0.4
LOCAL	HIGH	0.6	6.0	10.0	0.4
	MEDIUM	0.5	6.0	10.0	0.4
	LOW	0.3	6.0	10.0	0.4

L_{avg} - minimum maintained average pavement luminance
L_{min} - minimum pavement luminance
LV_{max} - maximum veiling luminance

Light fixtures will be placed throughout all areas impacted by new construction. Detail wiring for each fixtures is not provided as part to the site infrastructure design. Wiring details will be provided during new construction. Final determination of street lighting will be determined during building construction to determine if light fixture should be mounted on a building structure or remain on the proposed light pole location.

SECTION 2 GENERAL CRITERIA

SECTION 3 DESIGN INPUT

The design inputs are as follow:

- 20-ft round-tapered pole mounted on a concrete base with a finish surface 0f 3-ft above ground. Total light fixture height is 23-ft.
- IES R8-14 Roadway Lighting design criteria has specified the light levels as indicated in Table 3 listed above.
- The project RFP has specified LED type light fixture for exterior roadway lighting.
- Vendor data sheets for the selected light fixtures will be used as data input into the Lighting Analysts Illumination Engineering Software (AGi32) for roadways analysis.
- Total light loss factor = 0.75
  - Luminaire Dirt Depreciation (LDD) = 0.900
  - Luminaire Ambient Temp. Factor (LATF) = 0.980
  - Lamp Lumen Depreciation (LDD) = 0.850
- Lumen Arm Length = 1.625’
- Road Classification: Type III, Short
- Upward Waste Light Ratio = 0.0

SECTION 4 METHODOLOGY

Merrick conducted a detailed calculation using scaled AutoCAD site drawings and AGI lighting software. IES lighting files for the specified light fixtures were used in the lighting model calculate the results. Multiple lighting iterations and fixture placement were performed to determine the specified location for each light fixture.

SECTION 5 REFERENCES

CODES, STANDARDS, REFERENCES:

UFC 3-501-01 (6 Oct 2015) Electrical Engineering

NFPA 70E Standard for Electrical Safety in the Work Place

NFPA 70 National Electrical Code 2014

IESNA (Illuminating Engineers Society of North America) Lighting Handbook (10th Edition)

IESNA (Illuminating Engineers Society of North America) IES RP-8 Roadway Lighting

SECTION 6 CONCLUSIONS

The light level calculations meeting the input criteria produced the following results as summarized below:

Calculated Road Luminance:

- Local Street Classification with Pedestrian Area Classification
  - Avg. Luminance = 5.0 cd/m² > .5 (Table 3 below)
  - Avg. Uniformity = 5.0 cd/m < 6.0 (Table 3 below) (using 1 cd/m² for min)
  - Lmax/Lmin= 28.4>10 (Table 3 below) (Due to spacing needed to lower Avg)
  - Veiling Luminance = 5.6 < 0.4 (Table 3 below)
  - Illuminance Max/Min = 2.0 > 1.4 (Table 8 below) (Due to spacing needed to lower Avg)
  - Illuminance E_{avg}/E_{min} = 1.48 < 6.0 (Table 8 below)

Table 3. Lighting Design Criteria for Streets

STREET CLASSIFICATION	PEDESTRIAN AREA CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m^2)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO LV_{max}/L_{avg}
MAJOR	HIGH	1.2	3.0	5.0	0.3
	MEDIUM	0.9	3.0	5.0	0.3
	LOW	0.6	3.5	6.0	0.3
COLLECTOR	HIGH	0.8	3.0	5.0	0.4
	MEDIUM	0.6	3.5	6.0	0.4
	LOW	0.4	4.0	8.0	0.4
LOCAL	HIGH	0.6	6.0	10.0	0.4
	MEDIUM	0.5	6.0	10.0	0.4
	LOW	0.3	6.0	10.0	0.4

L_{avg} - minimum maintained average pavement luminance
L_{min} - minimum pavement luminance
LV_{max} - maximum veiling luminance

Table 8. Illumination for Intersections

Illumination for Intersections				
Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification in Lux/fc			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0.2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/ Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/ Local	18.0/1.8	14.0/1.4	8.0/0.8	6.0

Note: The High, Medium, and Low Pedestrian Areas are described in **Section 5.1.1**.

Lighting design did not meet all design criteria specified in IES RP-8-14 due to irregular road shapes and turns, and the needed average Illuminance. An acceptable average luminance was calculated with minimal dark spots. There are minimums of 0 due to spacing needs, and assumptions that there are or will be lighting on the exterior of buildings where the road connects to. There are many intersections where the new lighting is not being applied. It is assumed that there is existing lighting at the intersection at the continued roadway.

SECTION 7 CALCULATIONS

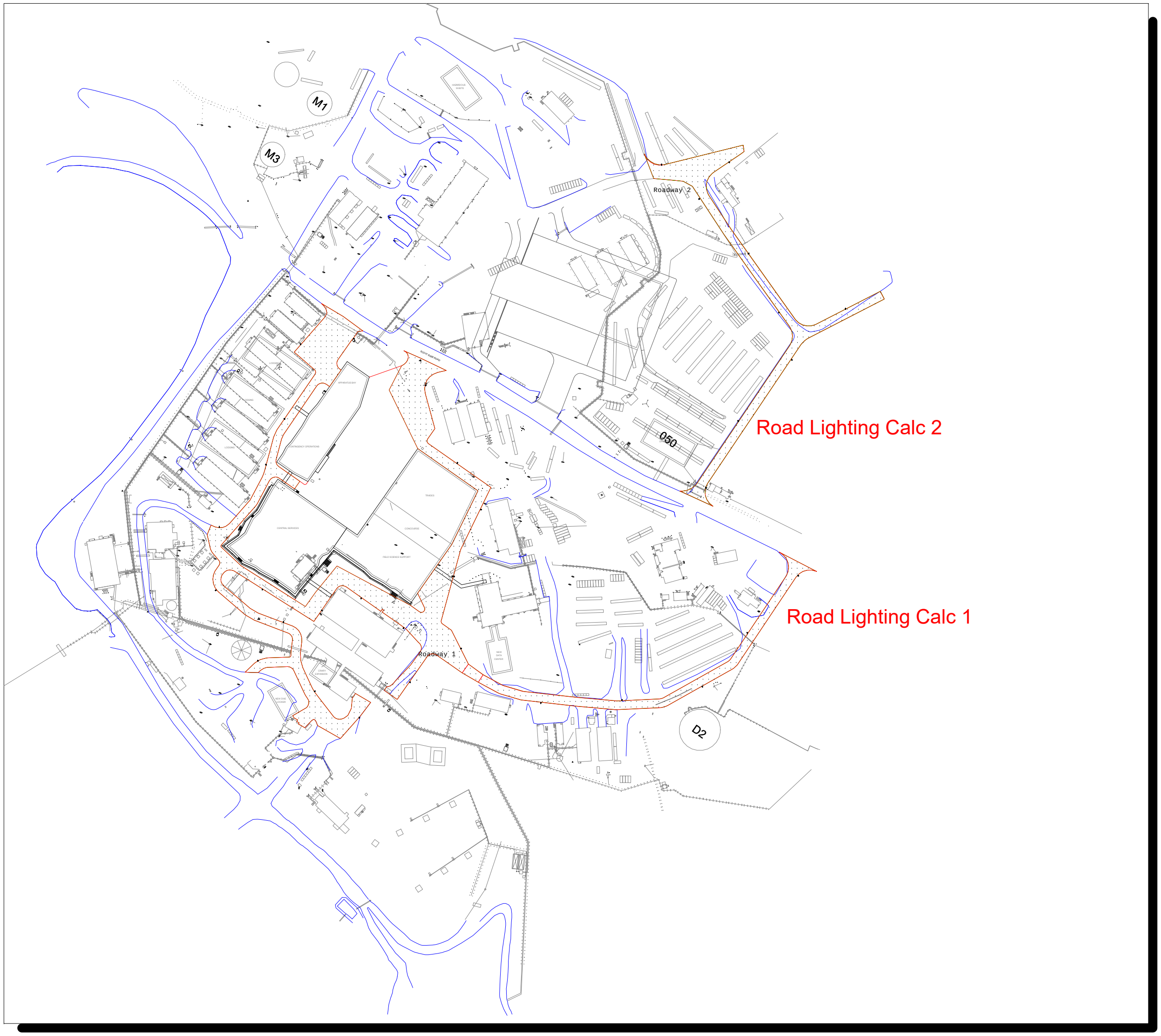
See Appendix.

APPENDIX

Lighting Calculations

Luminaire Schedule						
Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	34	BXSPA_3NA-U-CONFIGURED	SINGLE	N.A.	1.000	BXSPAx3NA-U CONFIGURED FROM XSPAx3GA-U or BXSPAx3GA-U

Numeric Summary					
Label	CalcType	Avg	Max	Min	Max/Min
Road Lighting Calc_2	Illuminance	5.54	26.8	0.0	N.A.
Road Lighting Calc 1	Illuminance	4.37	28.4	0.0	N.A.



#	Date	Comments

Revisions

Drawn By:SM
Checked By:OT
Date:3/6/2017
Scale: N/A

McMurdo

Technical Calculations

E004-Electrical

Calculation Title:
McMurdo Station Antarctica
Coordination Study

Prepared For:
NSF/ASC

Prepared By:
Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, Co 80111-4703

TABLE OF CONTENTS

SECTION 1 EXECUTIVE SUMMARY

Coordination study was conducted for McMurdo Station based on existing over protective devices (OCP's) and trip settings. It is not the intent of this study to adjust existing trip setting on overcurrent protective devices located on each generator output and feeder breakers located in McMurdo Power Station. Exterior padmounted equipment (SW-1 thru SW-6) located adjacent to the existing power plant have existing fuse protection and will be modeled as is and will not be replaced as part of the AIMS project. All new equipment will be coordinated with existing equipment. Modifications to 5kV OCP's will remain as is and new adjustments to this equipment will be deferred to future power station upgrades or stability studies.

McMurdo's power system is a micro-grid independent from commercial power stations tied into larger grids. Micro-grids have limited power generation capability and sensitive to power disturbances if not properly managed. Power management techniques must be applied at a micro level that includes building load leveling, starting kVA management, and properly coordinated system to ensure fault conditions are eliminated as close to the fault as possible. Micro-grids are subject to system de-stabilization when an un-coordinated system shuts down large sections of the grid when a lower level device failed to isolate the system.

OCP's devices are coordinated from the first device usually located at generator output down to the last device located ahead of the building connected load. McMurdo power plant existing generators have OCP's trip points set to protect each generator. These set points also limits the largest service transformer that can be installed without compromising overall system coordination. As a result, findings indicate that a 500kVA transformer is the largest transformer that can be installed without compromising system coordination with McMurdo station generators. Careful selection of fuse devices or more advanced OCP equipment may increase the largest transformer to a 750kVA. Long-term system stability and coordination will be achieved when equipment is specified within the limits of the micro-grid.

Fault current calculations identified low fault currents for B166, B167, and B188. The fault currents were evaluated as part of the coordination study and preliminary results indicates these buildings are subject to system failures and possible fire hazard if an OCP does not clear a fault condition in a timely manner. Fault currents to branch breakers are below 300-amps, which would trip a breaker with a bolted fault in approximately 40 seconds far exceeding the preferred 0.01 to .5 second time-period. Brand circuits with high impedance faults will extend the trip time with high risk of a building fire.

SECTION 2 INTRODUCTION

CODES, STANDARDS, REFERENCES:

UFC 3-501-01 (6 Oct 2015) Electrical Engineering

UFC 3-550-01 UFC 3-550-01 Exterior Electrical Power Distribution (1 September, 2-16)

NFPA 70E Standard for Electrical Safety in the Work Place

NFPA 70 National Electrical Code 2014

IEEE Std 399 Recommended Practices for Industrial and Commercial Power System Analysis.

IEEE 242-2001 IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

Merrick conducted a coordination study based on existing OCP trip settings. All devices were modeled in EasyPower™ and Time Current Curves (TCC's) were created from existing conditions. The existing devices modeled are:

1. Generator output breakers: GE Multilin SR489
2. 5kV Service Feeder Breakers: GE Multilin SR735
3. Pad-mounted Feeder Switches: Cultler-Hammer fuses, Type CL, Style CLE, Current limiting, 250E
4. 5kV Overhead Fuse Cutouts: AB Chance Fuse Link, Model K
5. Service Transformer primary fuses (Either or combination of sized at 1.25% primary rated current: Cooper, Current Limiting, Style NX, C-Rated and/or AB Chance Fuse Link, Model K.

The coordination study was based on the standard fuses used by McMurdo and the intent of this study is to maintain the standard fuse for new installation unless otherwise determined by the new building design.

SECTION 3 GENERAL CRITERIA

The existing site will remain in operation during all AIMS phased construction. The modeling will be performed based on the following assumption:

1. Existing overhead feeders scheduled to remain will be modeled for system coordination.
2. Scott Base and Wind Turbines will not be considered as power generation into the system model.
3. McMurdo power plant is operating voltage at nominal voltage of 4.16kV.
4. Merrick was informed by McMurdo Site utilities that existing transformers do not have load tap changers. Therefore, fault currents will be calculated based on standard tap settings and reflected on to TCC curves.
5. Transformer impedance data is not available. All calculations will be based on an assumed 5% impedance on transformers. Therefore, fault currents will be calculated based on a typical impedance value and reflected on to TCC curves.
6. EasyPower™ model generated by this study will be used for further system dynamic and stability studies where the coordination study can be adjusted to best meet system performance.

SECTION 4 DESIGN INPUT

1. Existing feeder conductors sizes, distances, and configuration provided by as-built drawings and field verification results gathered during Merrick's 2017 McMurdo deployment.
2. Existing transformers sizes and rated nominal voltage rating.
3. Individual transformer impedances are not available; therefore, an assumed input of 5% impedance.
4. Generation equipment will be modeled based on on-site data collection and data provided by the owner.
5. Individual kW demand data is not available for each building. Peak demand will be based on onsite survey of each building, building square footage, UFC standards, and available onsite power flow data.
6. Individual Generator impedance data will be incorporated into the model with an adjusted KW rating due to fuel source.
7. EasyPower™ Set points:
   a. Bus under voltage=0.95pu
   b. Bus over voltage= 1.05pu
   c. Overload Threshold= -10% of rating
8. All devices are modeled in EasyPower™ and Time Current Curves (TCC's) are created from existing OCP trip devices and trip settings: The existing devices modeled are:
   a. Generator output breakers: GE Multilin SR489
   b. 5kV Service Feeder Breakers: GE Multilin SR735
   c. Pad-mounted Feeder Switches: Cultler-Hammer fuses, Type CL, Style CLE, Current limiting, 250E
   d. 5kV Overhead Fuse Cutouts: AB Chance Fuse Link, Model K
   e. Service Transformer primary fuses (Either or combination of sized at 1.25% primary rated current: Cooper, Current Limiting, Style NX, C-Rated and/or AB Chance Fuse Link, Model K.

SECTION 5 METHODOLOGY

An EasyPower™ electrical model for McMurdo Station will be developed that includes all system components of the existing 5kV distribution system. Existing trip devices will be modeled with their current settings and not intended to be modified as part of this study. Fault currents will be evaluated against the trip setting of each device for selection of new OCP devices. OCP's will be evaluated for system application when used by small scale reciprocating application similar to McMurdo Stations. Manufacture equipment available interrupting rating (AIC's) of electrical equipment is subject to specified system impedances typically lower than offered by a power plant similar to McMurdo. As a result, manufacturer AIC ratings must be adjusted to the install system to ensure proper selection of installed devices.

The study will provide a typical TCC curves for key components for distribution system and are as follow:

1. 1200kW/1500kVA Engine Generator/5kV Swtichgear
2. 1400kW/1750kVA Engine Generator/5kV Switchgear
3. 1000kVA Service Transformer
4. 750kVA Service Transformer
5. 500kVA Service Transformer
6. 300 kVA Service Transformer
7. 225kVA Service Transformer
8. 150kVA Service Transformer
9. 112.5kVA Service Transformer
10. 75kVA Service Transformer

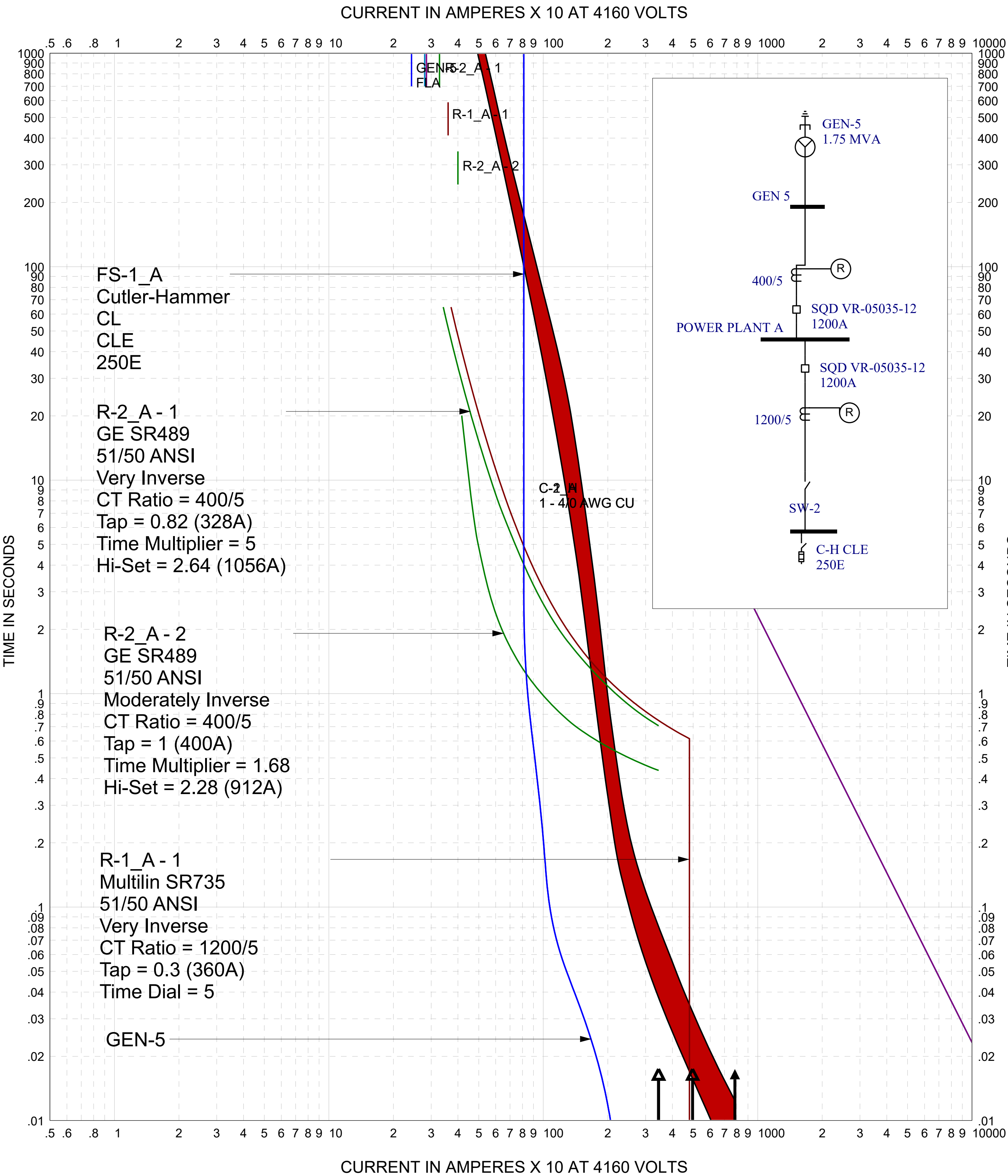
SECTION 6 REFERENCES

Refer to Section 2 Introduction.

SECTION 7 CONCLUSIONS

Generator output breakers limit the size of all downstream devices for micro-grids when full system coordination is required. As a result, downstream devices are limited in size thereby reducing the sizes of service transformers that can be used without compromising overall system coordination. The coordination study revealed that a 500kVA transformer offers the optimum system coordination with the existing power plant. Transformer larger than 500kVA become problematic when coordinating transformer inrush currents and primary fuses with existing feeder breakers/fuses and existing generator output breakers. McMurdo future development of the micro-grid will provide long-term system reliability and system stability if the system is fully coordinated. Proper selection of transformer and transformer protection device will contribute to the overall long-term system performance.

SECTION 8 CALCULATIONS



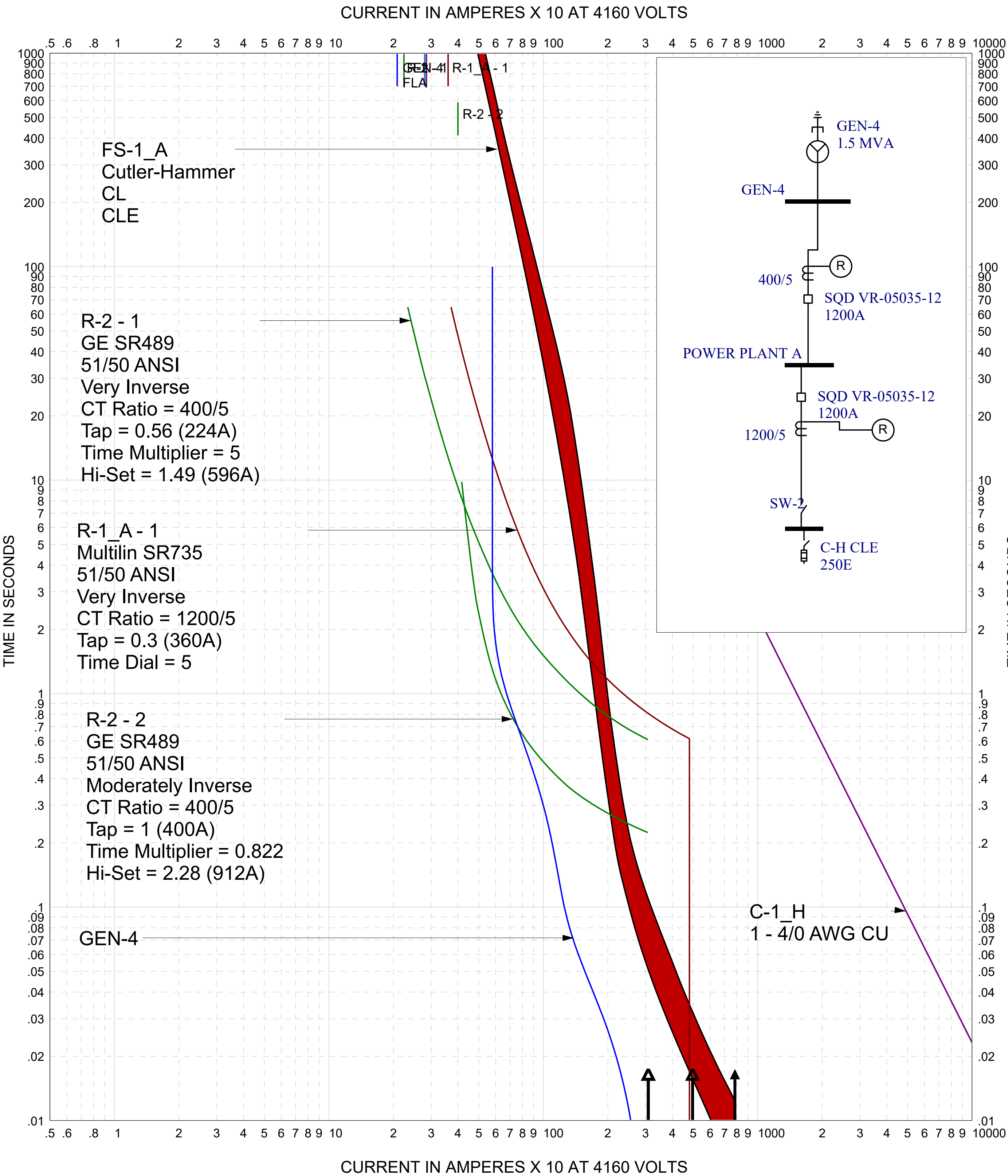
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

1.75kVA Generator

FAULT:
DATE: Mar 01, 2017
BY:
REVISION: 1

MCM PRIMARY DISTRIBUTION



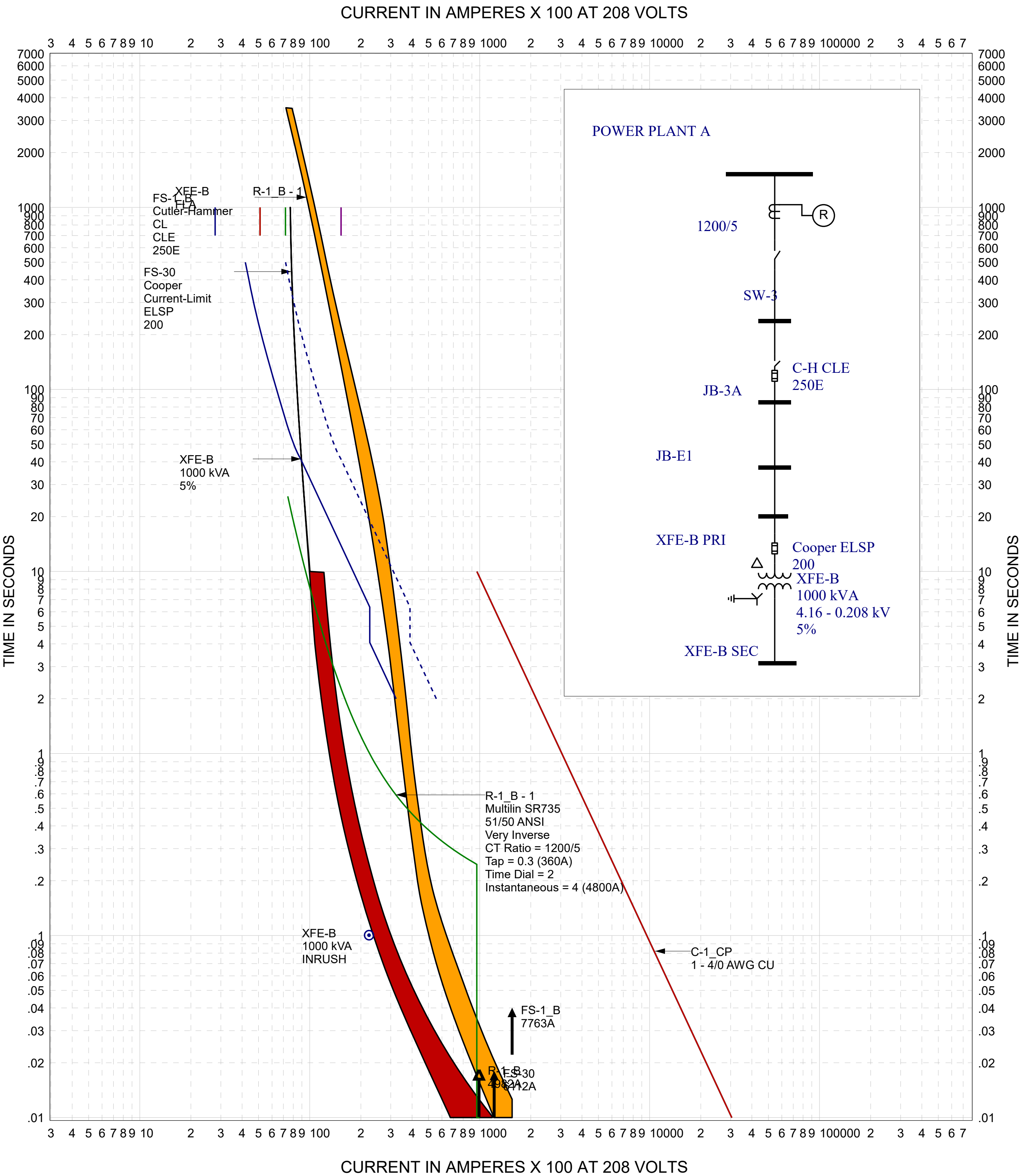
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

TCC-2

FAULT:
DATE: Mar 01, 2017
BY:
REVISION: 1

MCM PRIMARY DISTRIBUTION



MERRICK & COMPANY

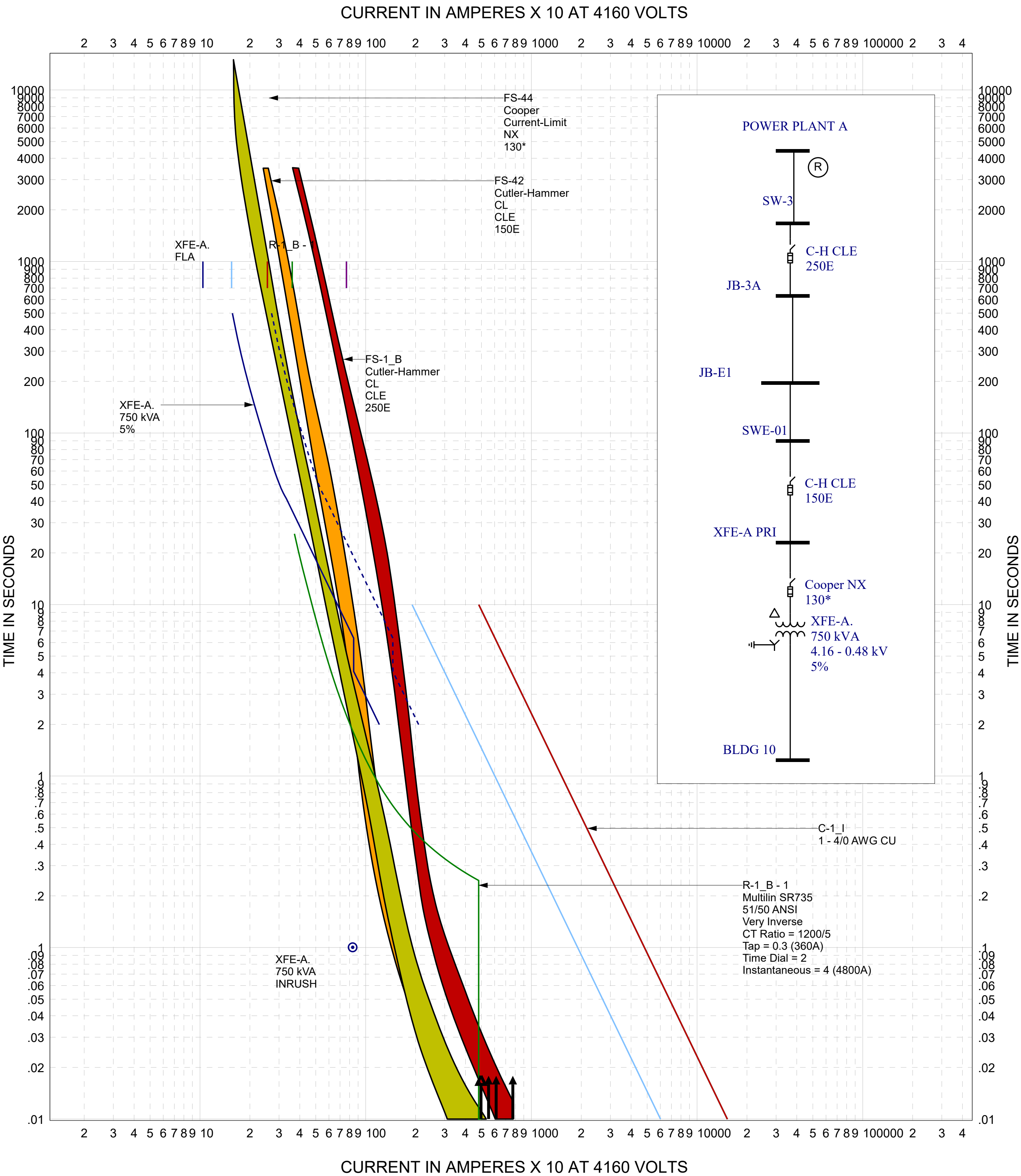
EasyPower®
TIME-CURRENT CURVES

1000kVA Transformer

Typical 1000 KVA Coordination Curve

FAULT:
DATE: Feb 28, 2017
BY: ROT
REVISION: 1

MCM PRIMARY DISTRIBUTION



MERRICK & COMPANY

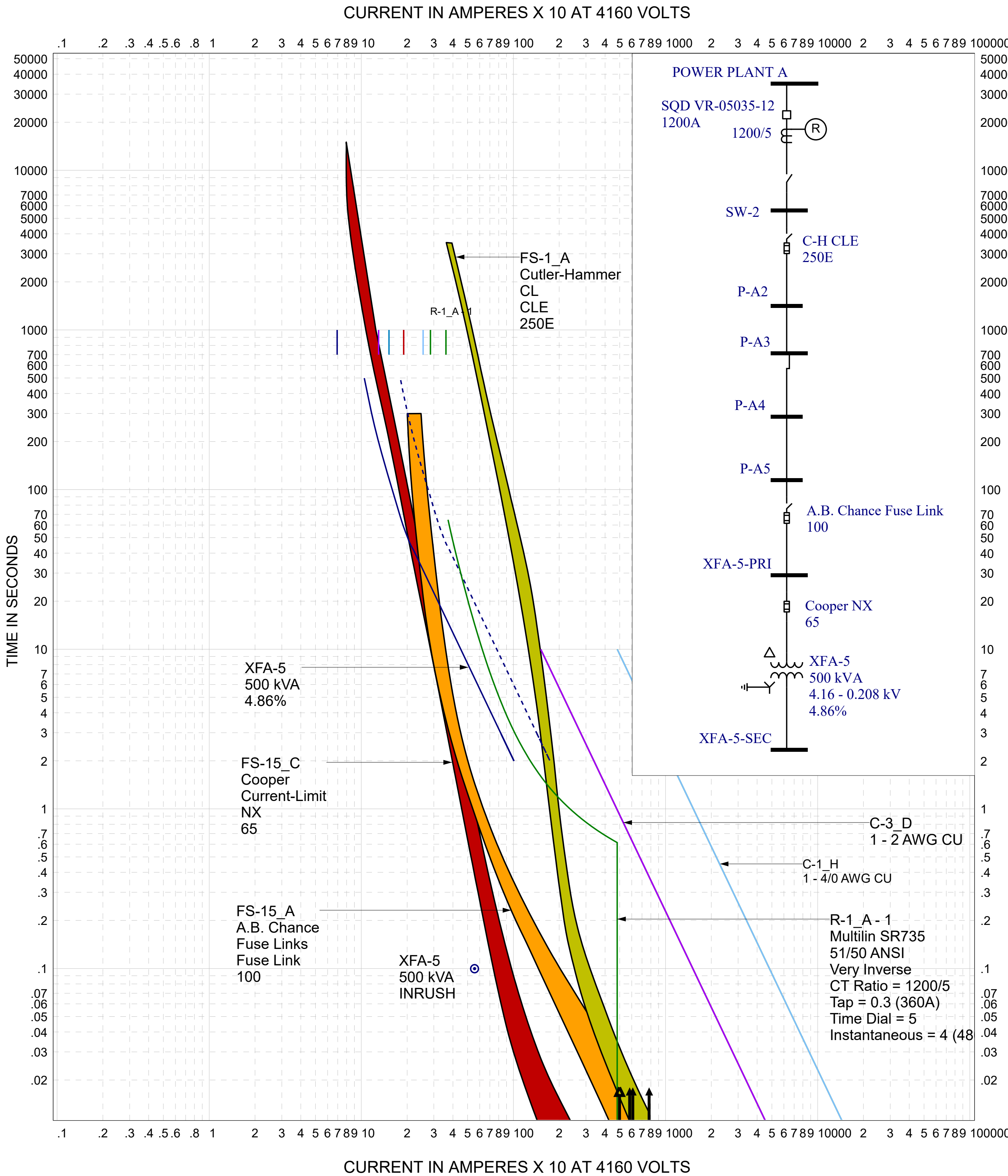
EasyPower®
TIME-CURRENT CURVES

750kVA Transformer

Typical 750kVA Transformer

FAULT:
DATE: Feb 28, 2017
BY: ROT
REVISION: 1

MCM PRIMARY DISTRIBUTION



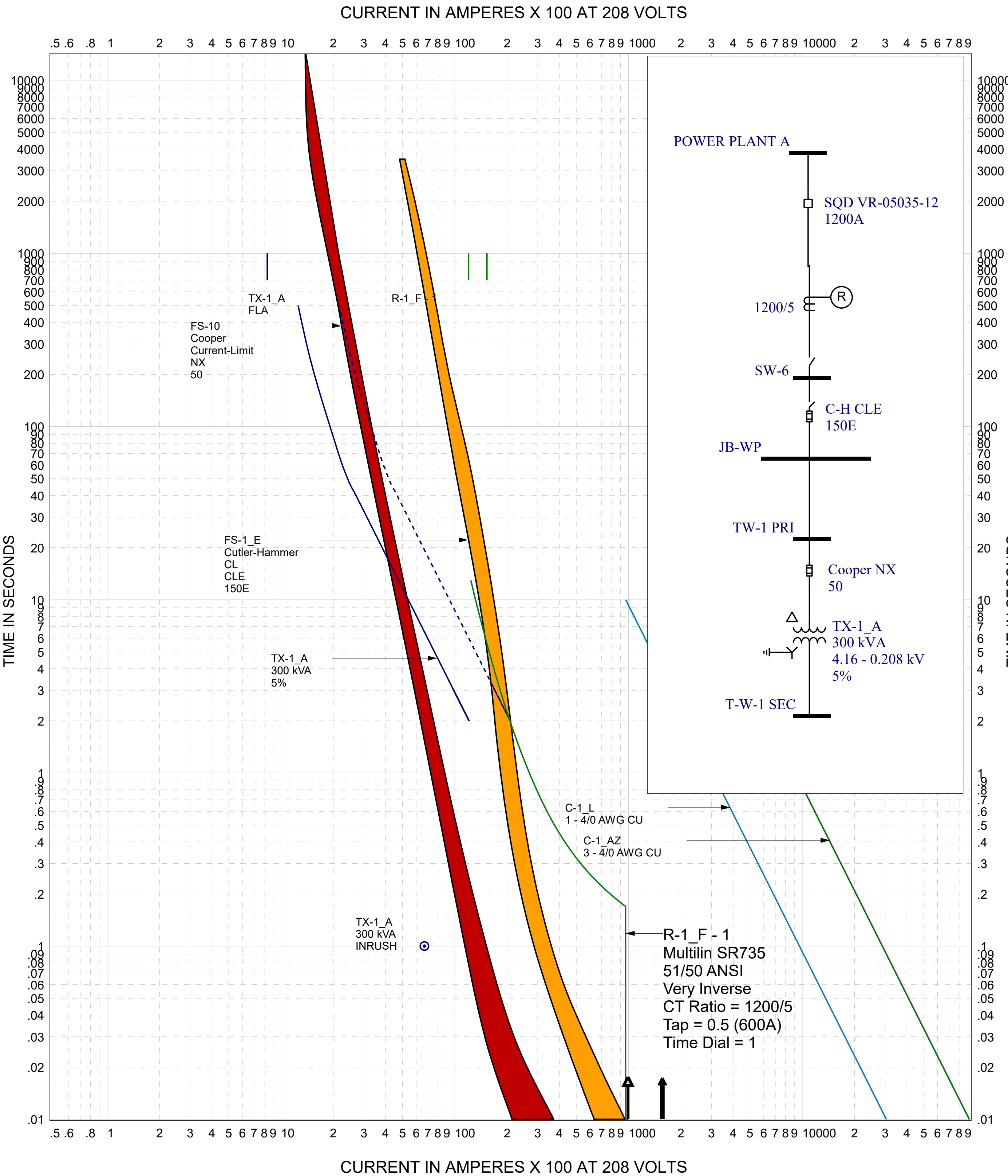
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

500kVA Transformer

Typical 500kVA Cooridnation

FAULT:
DATE: Feb 28, 2017
BY: ROT
REVISION: 1



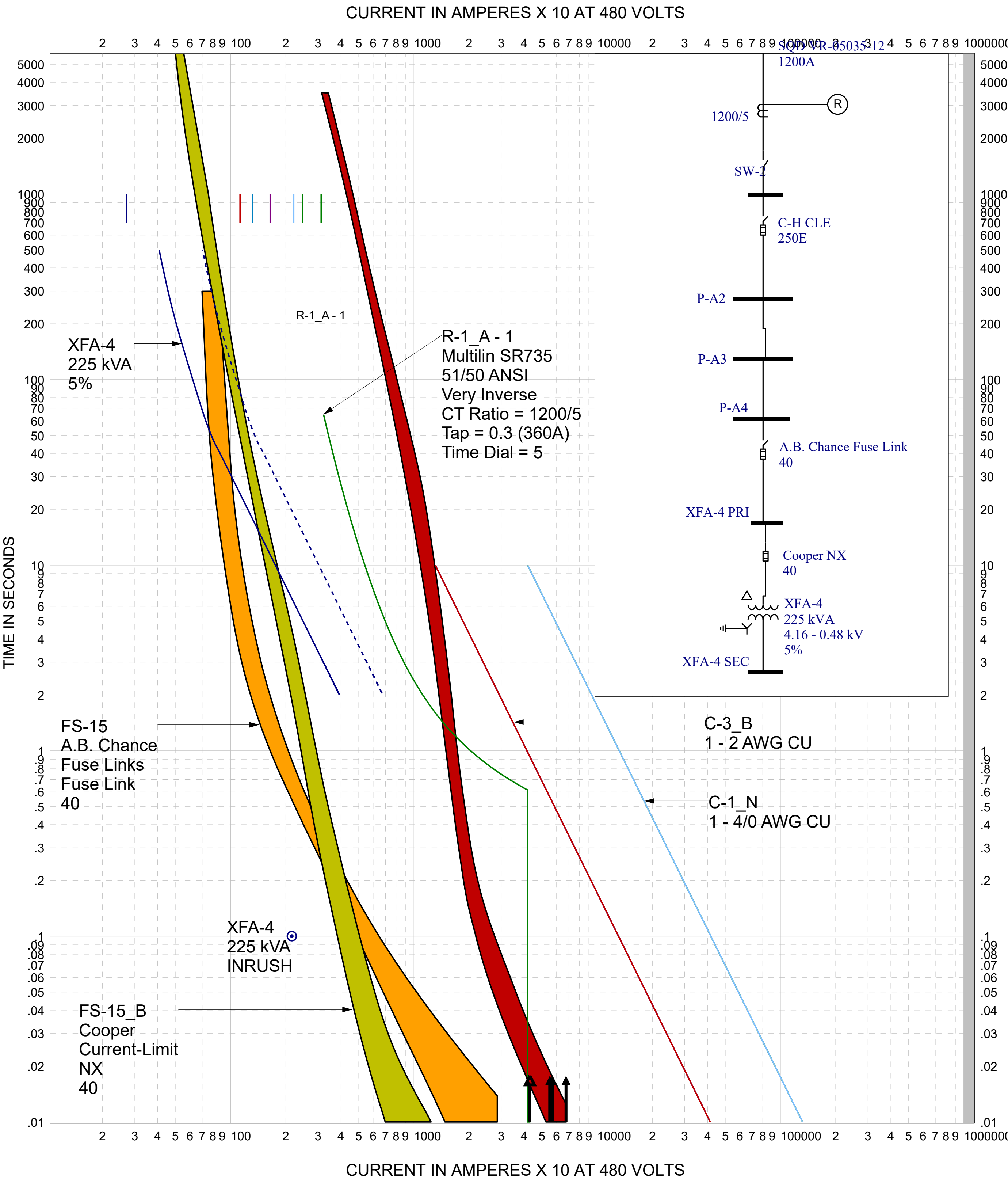
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

300kVA Transformer

Typical 300kVA Transformer

FAULT:
DATE: Feb 28, 2017
BY: ROT
REVISION: 1



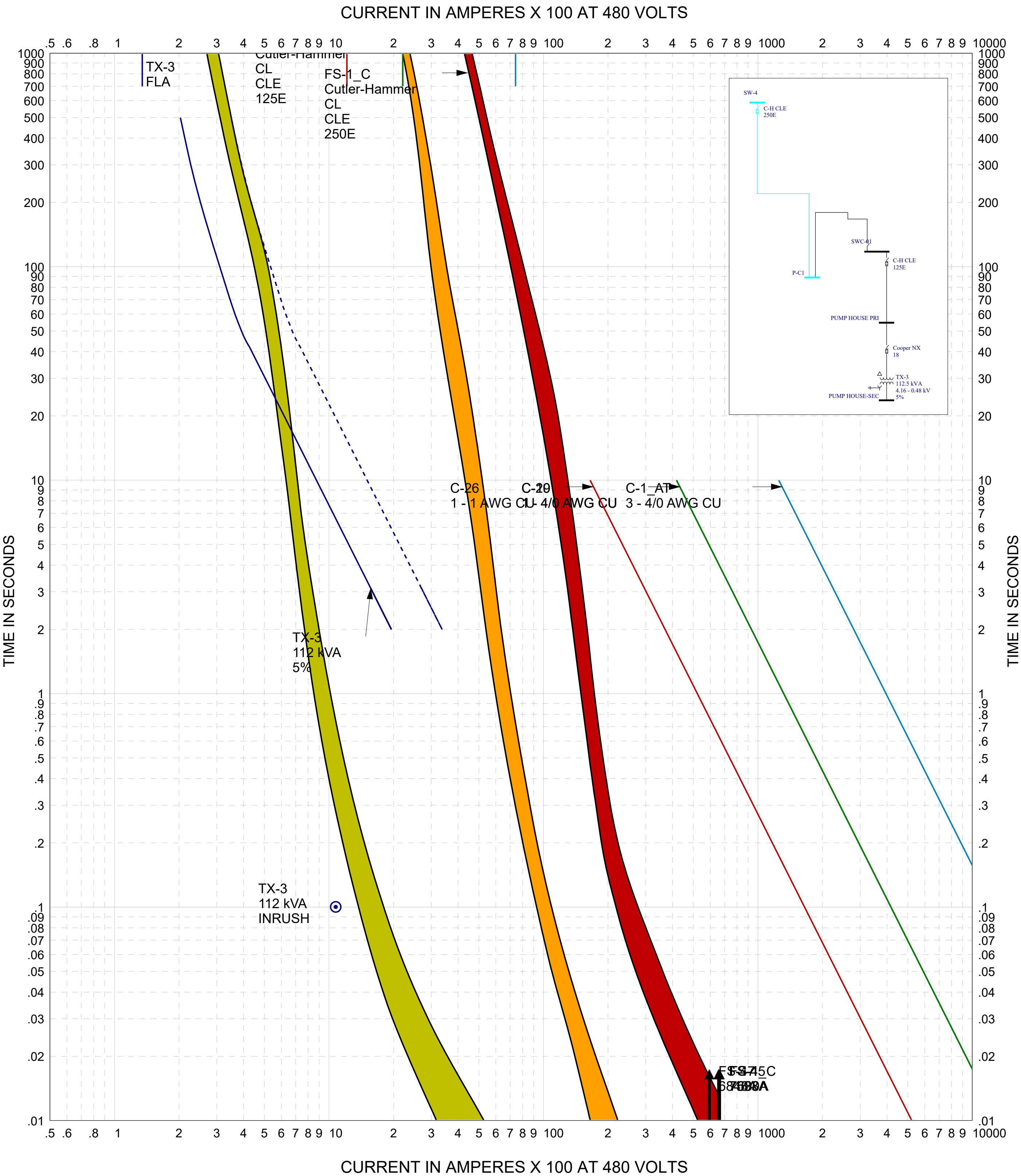
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

225kVA Transformer

Typical 225kVA Transformer

FAULT:
DATE: Feb 28, 2017
BY: ROT
REVISION: 1



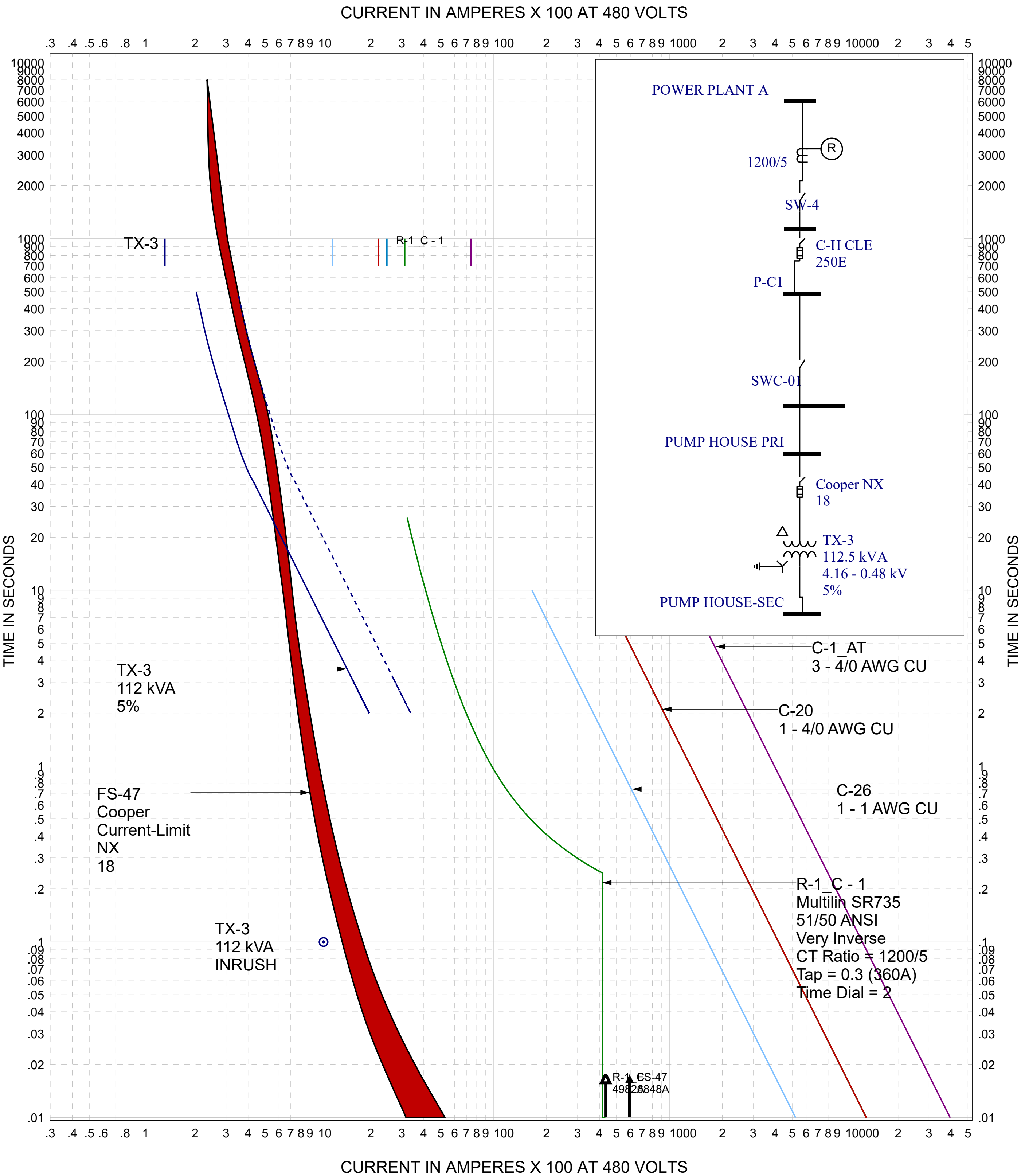
MERRICK & COMPANY

EasyPower®
TIME-CURRENT CURVES

112.5 kVA Transformer

Typical TCC for 112.5 kVA

FAULT:
DATE: Mar 03, 2017
BY: ROT
REVISION: 1



MERRICK & COMPANY

EasyPower®

TIME-CURRENT CURVES

75kVA Transformer

Typical 75kVA Transformer

FAULT:

DATE: Feb 28, 2017

BY: ROT

REVISION: 1

LAFAYETTE POWER SYSTEMS

GENERATOR SPECIFICATIONS -- Arrangement No. SAP 10004475

Completed by: MSR 2-Feb-04

Excitation	Volts	Kilowatt	Appl.	Frequency	Power Factor	Generator Frame
PM	4160	1130		60	0.80	825

Type	Pitch	Poles	Synchronous Speed	Number of Bearings	Winding Type	Enclosure Type
SR4B	0.6667	4	1800	2	Form	IP22

Connection	Number of Leads	Wires Per Lead	SAE Mounting Flywheel No.	SAE Mounting Housing No.
STAR	6	1	521	"00"

************ **Generator Efficiency at 0.80 Power Factor Per NEMA and IEC at 115 ° C** ************

Load Per Unit	Kilowatts	Efficiency (%)
0.00	0.0	0.0
0.25	282.5	92.4
0.50	565.0	95.5
0.75	847.5	96.4
1.00	1130.0	96.7
1.25	1412.5	96.8

************ **Generator Resistances and Reactances** ************

Resistances at 25 ° C Stator (Ohms)	Resistances at 25 ° C Field (Ohms)	Generator Impedance Base Ohms	Short Circuit Ratio
0.0545	1.01524	12.2518	0.5698

Reactances

		Per Unit	Ohms
Subtransient - Direct Axis	**X"D**	0.1086	1.3309
Subtransient - Quadrature Axis	**X"Q**	0.0915	1.1215
Transient - Saturated	**X'D**	0.1518	1.8594
Synchronous - Direct Axis	**XD**	2.1384	26.1994
Synchronous - Quadrature Axis	**XQ**	1.0051	12.3139
Negative Sequence	**X2**	0.1001	1.2263
Zero Sequence	**X0**	0.0022	0.0271

************ **Generator Time Constants** ************

		Seconds
Open Circuit Transient - Direct Axis	T'DO	6.66483
Short Circuit Transient - Direct Axis	T'D	0.47303
Open Circuit Subtransient - Direct Axis	T"DO	0.01576
Short Circuit Subtransient - Direct Axis	T"D	0.00199
Open Circuit Subtransient - Quadrature Axis	T"QO	0.01069
Short Circuit Subtransient - Quadrature Axis	T"Q	0.00003
Armature Short Circuit	TA	0.04433

************ **Excitation** ************

	No Load	0.8 PF
Excitation Voltage	8	22
Excitation Current	1.5	4.1

************ **Ratings** ************

Line-to-Line Voltage	4160 **Volt**
Line-to-Neutral Voltage	2402 **Volt**
KVA Rating	1413 **kVA**
Rated RMS Current (3 Phase)	196 **Amps**

************ **Voltage Regulation and Accuracy** ************

Voltage Level Adjustment	Constant Speed	With 3 Percent Speed Change
+/- 5 percent of rated	+/- 1 percent	+/- 2 percent

Waveform Deviation Line-to-Line No Load
Less Than 5 Percent

Telephone Influence Factor
Less Than 50

************ **Mechanical Information** ************

Center of Gravity

Dimension X	Dimension Y	Dimension Z
-1054.1 mm	0.0 mm	0.0 mm

Generator Weight	Rotor Weight	Stator Weight
4876 kg	1775 kg	3101 kg

Rotor Balance
0.025 mm Deflection
Peak-to-Peak

Overspeed Capacity
150 Percent of Synchronous Speed

************ **Generator Cooling Requirements** ************

Heat Dissipated	Airflow Required
38.23 KW	162.36 cu m/min

************ **Generator Temperature and Insulation Data** ************

Stator Rise (°C)	Rotor Rise (°C)	Insulation Class (°C)	Insulation Res. as Shipped
80	80	155	100.0 Megaohms min at 40°C

Generator Motor Starting Capability

Percent Voltage Dip	Across the Line Starting SKVA
2.5	262
5.0	537
7.5	827
10.0	1134
12.5	1458
15.0	1801
17.5	2165
20.0	2551
22.5	2962
25.0	3401
27.5	3871
30.0	4373
32.5	4913
35.0	5495
37.5	6122
40.0	6803

Generator Current Decrement Data

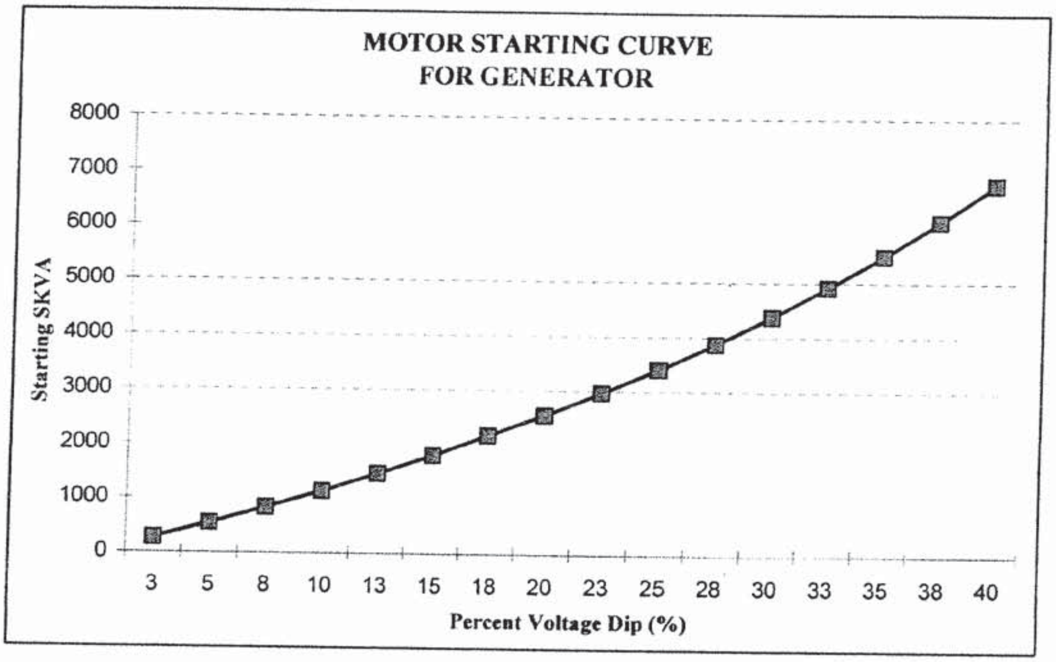
Base Voltage = 4160

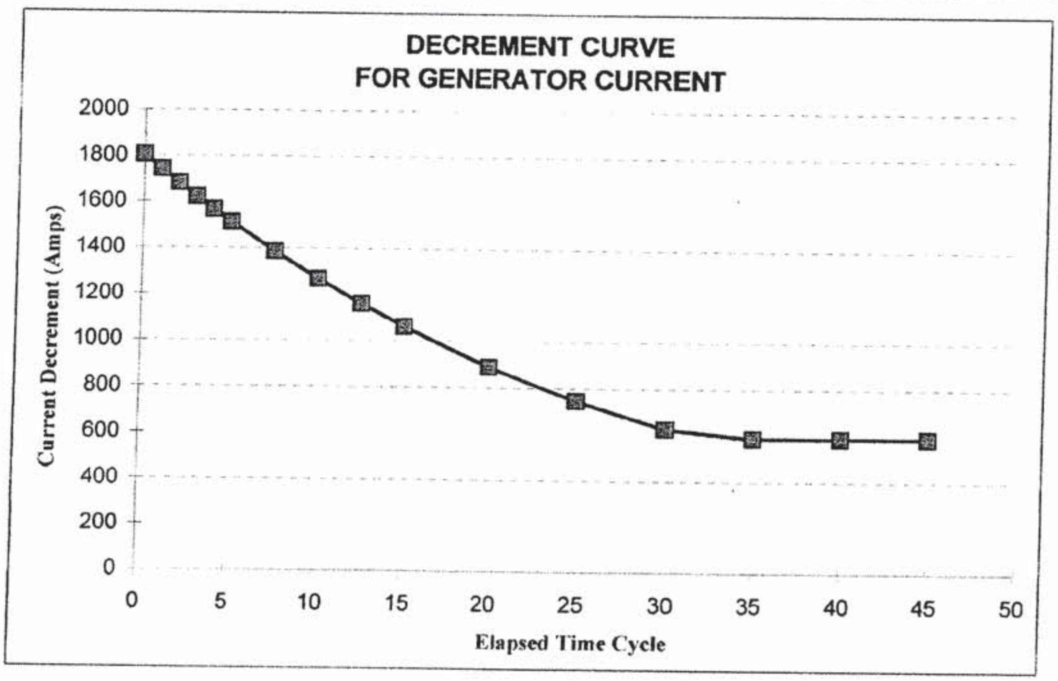
Elapsed Time (Cycles)	Decrement Current (Amps)
0.0	1805
1.0	1742
2.0	1682
3.0	1624
4.0	1567
5.0	1513
7.5	1386
10.0	1269
12.5	1162
15.0	1064
20.0	892
25.0	748
30.0	627
35.0	588
40.0	588
45.0	588

Instantaneous three phase symmetrical fault current: 1805 (Amps)

Instantaneous line to neutral symmetrical fault current: 2788 (Amps)

Instantaneous line to line symmetrical fault current: 1625 (Amps)


MOTOR STARTING CURVE
FOR GENERATOR
Starting SKVA
8000
7000
6000
5000
4000
3000
2000
1000
0
3 5 8 10 13 15 18 20 23 25 28 30 33 35 38 40
Percent Voltage Dip (%)

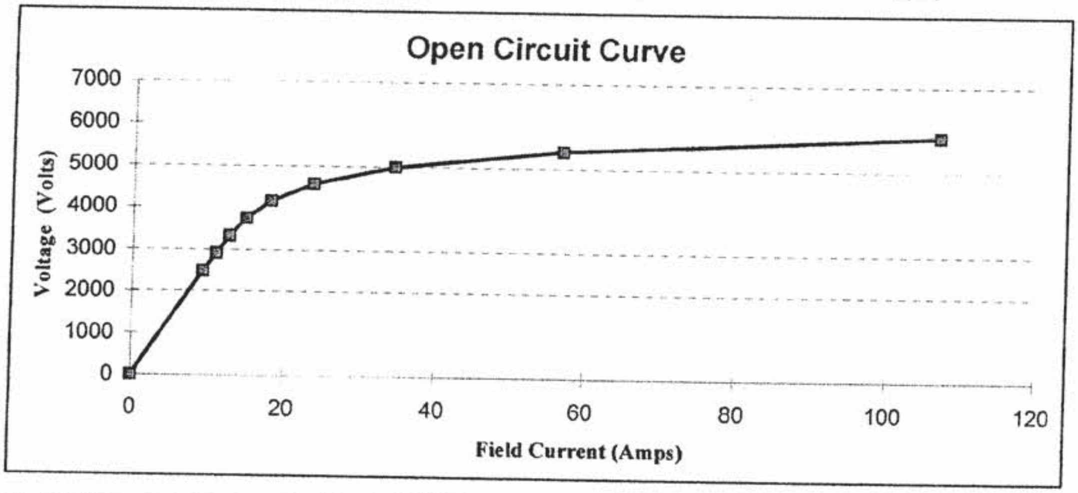

DECREMENT CURVE
FOR GENERATOR CURRENT
Current Decrement (Amps)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 5 10 15 20 25 30 35 40 45 50
Elapsed Time Cycle

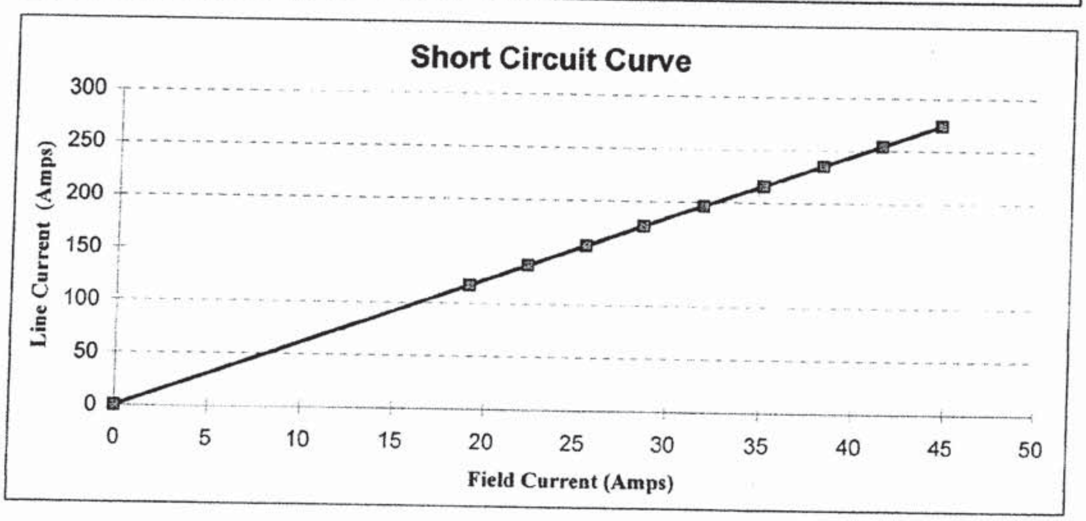
Open Circuit Curve

Field Current (Amps)	Voltage (Volts)
0.0	0
9.3	2496
11.0	2912
12.7	3328
14.9	3744
18.1	4160
23.7	4576
34.4	4992
57.0	5408
107.0	5824

Short Circuit Curve

Field Current (Amps)	Line Current (Amps)
0.0	0
19.1	118
22.3	137
25.5	157
28.6	176
31.8	196
35.0	216
38.2	235
41.4	255
44.6	274





LAFAYETTE POWER SYSTEMS

GENERATOR SPECIFICATIONS -- Arrangement No. 10004451

Completed by: MSR 17-Nov-04

Excitation	Volts	Kilowatt	Appl.	Frequency	Power Factor	Generator Frame
PM	4160	1640		60	0.80	825

Type	Pitch	Poles	Synchronous Speed	Number of Bearings	Winding Type	Enclosure Type
SR4B	0.6667	4	1800	2	Form	IP22

Connection	Number of Leads	Wires Per Lead	SAE Mounting Flywheel No.	SAE Mounting Housing No.
STAR	6	1	521	"00"

************ **Generator Efficiency at 0.80 Power Factor Per NEMA and IEC at 115 ° C** ************

Load Per Unit	Kilowatts	Efficiency (%)
0.00	0.0	0.0
0.25	410.0	94.3
0.50	820.0	96.4
0.75	1230.0	96.8
1.00	1640.0	96.8
1.25	2050.0	96.6

************ **Generator Resistances and Reactances** ************

Resistances at 25 ° C Stator (Ohms)	Field (Ohms)	Generator Impedance Base Ohms	Short Circuit Ratio
0.0545	1.01524	8.4418	0.3926

Reactances

		Per Unit	Ohms
Subtransient - Direct Axis	X"D	0.1577	1.3309
Subtransient - Quadrature Axis	X"Q	0.1329	1.1216
Transient - Saturated	X'D	0.2203	1.8595
Synchronous - Direct Axis	XD	3.1036	26.1994
Synchronous - Quadrature Axis	XQ	1.4587	12.3138
Negative Sequence	X2	0.1453	1.2262
Zero Sequence	X0	0.0032	0.0270

************ **Generator Time Constants** ************

		Seconds
Open Circuit Transient - Direct Axis	T'DO	6.66483
Short Circuit Transient - Direct Axis	T'D	0.47303
Open Circuit Subtransient - Direct Axis	T"DO	0.01576
Short Circuit Subtransient - Direct Axis	T"D	0.00203
Open Circuit Subtransient - Quadrature Axis	T"QO	0.01069
Short Circuit Subtransient - Quadrature Axis	T"Q	0.00004
Armature Short Circuit	TA	0.04433

************ **Excitation** ************

	No Load	0.8 PF
Excitation Voltage	8	29
Excitation Current	1.5	5.5

************ **Ratings** ************

Line-to-Line Voltage	4160 Volt
Line-to-Neutral Voltage	2402 Volt
KVA Rating	2050 kVA
Rated RMS Current (3 Phase)	285 Amps

************ **Voltage Regulation and Accuracy** ************

Voltage Level Adjustment	Constant Speed	With 3 Percent Speed Change
+/- 5 percent of rated	+/- 1 percent	+/- 2 percent

Waveform Deviation Line-to-Line No Load
Less Than 5 Percent

Telephone Influence Factor
Less Than 50

************ **Mechanical Information** ************

Center of Gravity

Dimension X	Dimension Y	Dimension Z
-1054.1 mm	0.0 mm	0.0 mm

Generator Weight	Rotor Weight	Stator Weight
4876 kg	1775 kg	3101 kg

Rotor Balance
0.025 mm Deflection
Peak-to-Peak

Overspeed Capacity
150 Percent of Synchronous Speed

************ **Generator Cooling Requirements** ************

Heat Dissipated	Airflow Required
54.40 KW	231.04 cu m/min

************ **Generator Temperature and Insulation Data** ************

Stator Rise (°C)	Rotor Rise (°C)	Insulation Class (°C)	Insulation Res. as Shipped
80	80	155	100.0 Megaohms min at 40°C

Generator Motor Starting Capability

Percent Voltage Dip	Across the Line Starting SKVA
2.5	262
5.0	537
7.5	827
10.0	1134
12.5	1458
15.0	1801
17.5	2165
20.0	2551
22.5	2962
25.0	3401
27.5	3871
30.0	4373
32.5	4913
35.0	5495
37.5	6122
40.0	6803

Generator Current Decrement Data

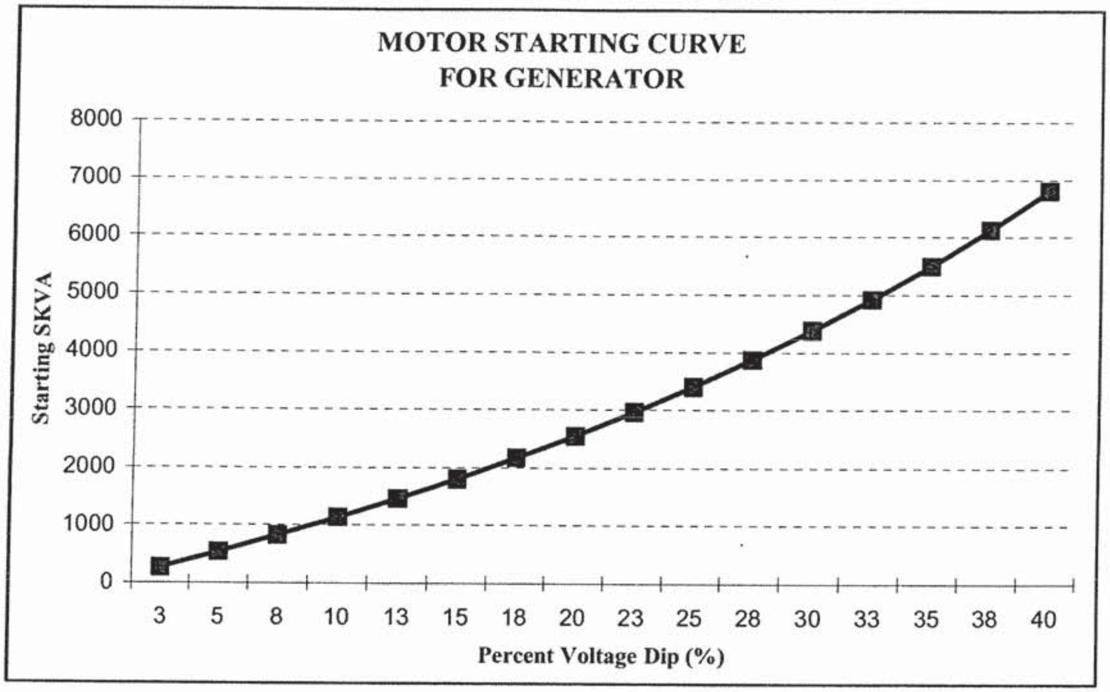
Base Voltage = 4160

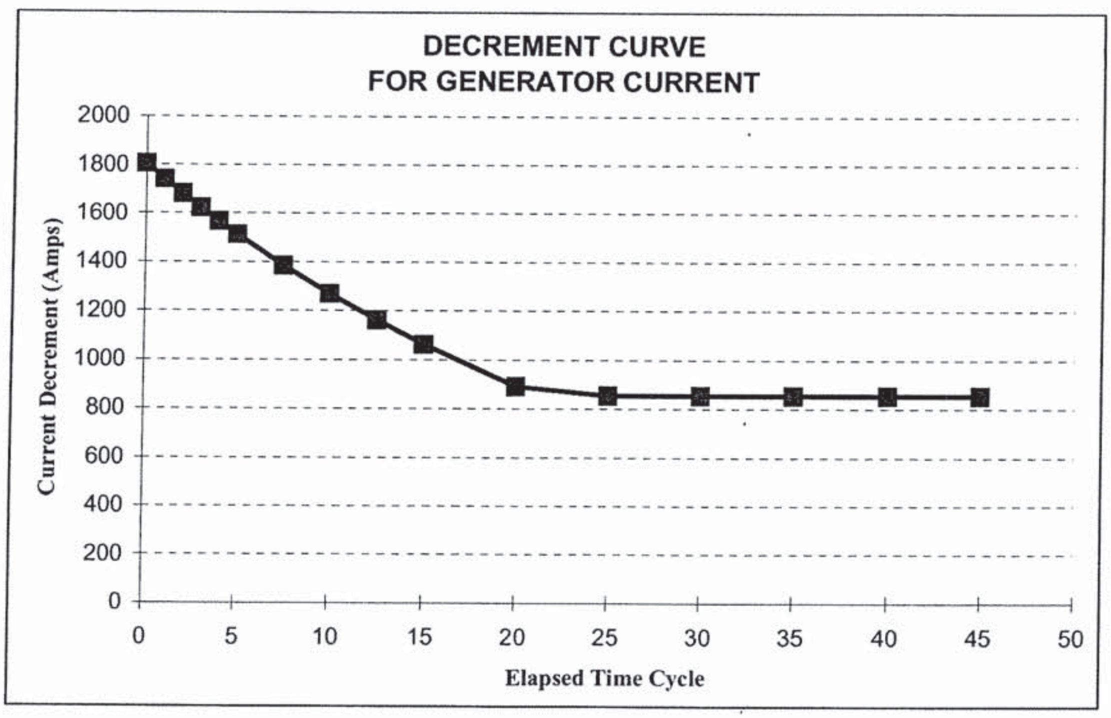
Elapsed Time (Cycles)	Decrement Current (Amps)
0.0	1805
1.0	1742
2.0	1682
3.0	1624
4.0	1567
5.0	1513
7.5	1386
10.0	1269
12.5	1162
15.0	1064
20.0	892
25.0	854
30.0	854
35.0	854
40.0	854
45.0	854

Instantaneous three phase symmetrical fault current: 1805 (Amps)

Instantaneous line to neutral symmetrical fault current: 2788 (Amps)

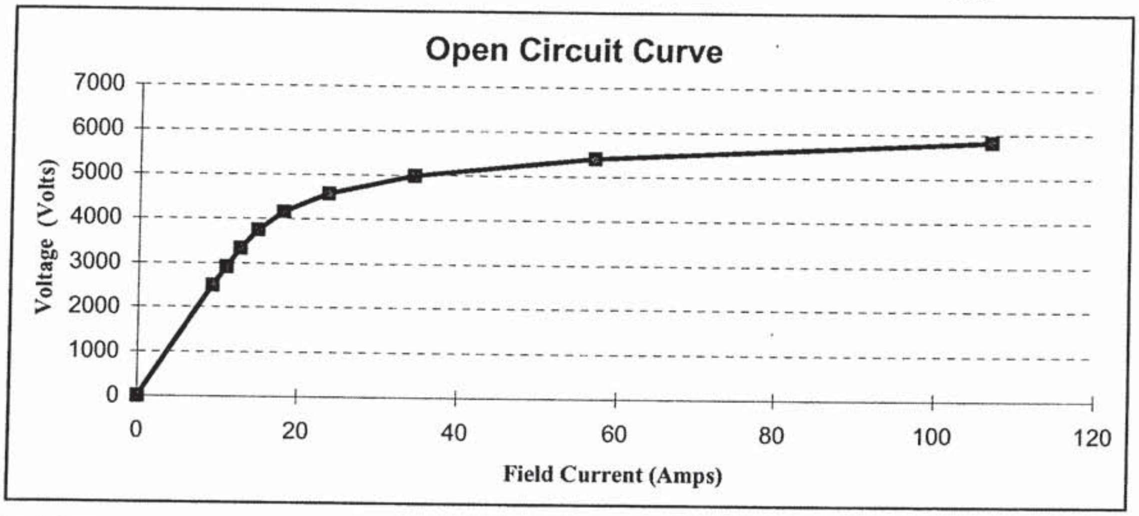
Instantaneous line to line symmetrical fault current: 1625 (Amps)

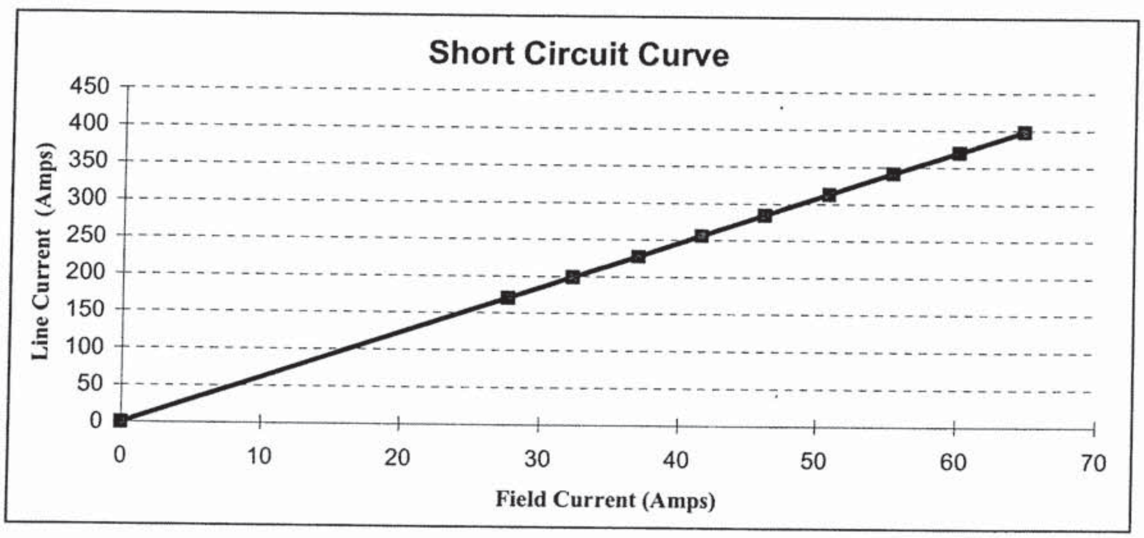

MOTOR STARTING CURVE
FOR GENERATOR
Starting SKVA
8000
7000
6000
5000
4000
3000
2000
1000
0
3 5 8 10 13 15 18 20 23 25 28 30 33 35 38 40
Percent Voltage Dip (%)


DECREMENT CURVE
FOR GENERATOR CURRENT
Current Decrement (Amps)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 5 10 15 20 25 30 35 40 45 50
Elapsed Time Cycle

Open Circuit Curve	
Field Current (Amps)	Voltage (Volts)
0.0	0
9.3	2496
11.0	2912
12.7	3328
14.9	3744
18.1	4160
23.7	4576
34.4	4992
57.0	5408
107.0	5824

Short Circuit Curve	
Field Current (Amps)	Line Current (Amps)
0.0	0
27.7	171
32.3	199
37.0	228
41.6	256
46.2	285
50.8	313
55.4	341
60.1	370
64.7	398





BUS NUMBER & NAME	DEVICE NUMBER & NAME DEVICE TYPE	MANUFACTURER DESCRIPTION	BUS VOLTS DEV. VOLTS	CT RATIO	SETTINGS
001 WATER PLNT	001-1 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 50 % (600A) VERY INV 1 INST 4.0 (4800A)
001 WATER PLNT	001-1_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 25 % (300A) MOD INV 1 INST 2.0 (2400A)
001 WATER PLNT	001-2 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 5 INST 4.0 (4800A)
001 WATER PLNT	001-2_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
001 WATER PLNT	001-3 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 20 % (240A) VERY INV 3 INST 4.0 (4800A)
001 WATER PLNT	001-3_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)

BUS NUMBER & NAME	DEVICE NUMBER & NAME DEVICE TYPE	MANUFACTURER DESCRIPTION	BUS VOLTS DEV. VOLTS	CT RATIO	SETTINGS
001 WATER PLNT	001-4 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 2 INST 4.0 (4800A)
001 WATER PLNT	001-4_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
001 WATER PLNT	001-5 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 2 INST 4.0 (4800A)
001 WATER PLNT	001-5_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
001 WATER PLNT	001-6 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 20 % (240A) VERY INV 3 INST 4.0 (4800A)
001 WATER PLNT	001-6_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 30 % (360A) VERY INV 2 INST 2.0 (2400A)

BUS NUMBER & NAME	DEVICE NUMBER & NAME DEVICE TYPE	MANUFACTURER DESCRIPTION	BUS VOLTS DEV. VOLTS	CT RATIO	SETTINGS
001 WATER PLNT	001-7 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 20 % (240A) VERY INV 3 INST 4.0 (4800A)
001 WATER PLNT	001-7_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
003 PWR PLNT-B	002 TIE Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 100 % (1200A) MOD INV 3
003 PWR PLNT-B	002 TIE_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2
002 PWR PLNT-A	002-1 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 5 INST 4.0 (4800A)
002 PWR PLNT-A	002-1_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)

BUS NUMBER & NAME	DEVICE NUMBER & NAME DEVICE TYPE	MANUFACTURER DESCRIPTION	BUS VOLTS DEV. VOLTS	CT RATIO	SETTINGS
002 PWR PLNT-A	002-2 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 5 INST 4.0 (4800A)
002 PWR PLNT-A	002-2_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
003 PWR PLNT-B	003-1 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 5 INST 4.0 (4800A)
003 PWR PLNT-B	003-1_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
003 PWR PLNT-B	003-2 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 30 % (360A) VERY INV 2 INST 4.0 (4800A)
003 PWR PLNT-B	003-2_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)

DEVICE SETTING TABLE
RELAYS

McMURDO STATION
ANTARTICA
REFER TO DWG ML - 04-255

BUS NUMBER & NAME	DEVICE NUMBER & NAME DEVICE TYPE	MANUFACTURER DESCRIPTION	BUS VOLTS DEV. VOLTS	CT RATIO	SETTINGS
003 PWR PLNT-B	003-3 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 20 % (240A) VERY INV 3 INST 4.0 (4800A)
003 PWR PLNT-B	003-3_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 15 % (180A) VERY INV 2 INST 2.0 (2400A)
003 PWR PLNT-B	003-4 Electronic	MULTILIN SR735/737 Feeder Relay 5A CT Sec	4160V	1200 / 5	Phase Pickup(Lo) 50 % (600A) VERY INV 1 INST 4.0 (4800A)
003 PWR PLNT-B	003-4_GF Electronic	MULTILIN SR735/737 Feeder Relay GF, 5A CT Sec	4160V	1200 / 5	Ground Pickup(Lo) 30 % (360A) VERY INV 2 INST 2.0 (2400A)

MERRICK & COMPANY

Technical Calculations

E002-Electrical

Calculation Title:
McMurdo Station Antarctica
Power Load Flow Analysis

Prepared For:
NSF/ASC

Prepared By:
Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, Co 80111-4703

COLORADO REGISTERED
R. ORLANDO TRUJILLO
46226
PROFESSIONAL ENGINEER

7-27-17

TABLE OF CONTENTS

SECTION 1 EXECUTIVE SUMMARY

McMurdo will experience multiple load fluctuations during construction as new buildings are completed and others demolished. Existing conditions include multiple low energy efficient buildings scheduled for replacement with larger and high-energy efficient facilities. As a result, final buildout will consume less energy once new construction is completed and old building removed. There is one phased construction scenario where the demand load will that will add burden to the distribution system that represents the system's worst-case system loading scenario.

Building-2 (Building services) will be the first building to be constructed. Construction of Building 2 will demo low energy buildings that exist within its construction footprint. The worst-case scenario will occur when Building-2 is constructed and commissioned. Onsite and construction support staff will be at its peak along with added energy to operate and maintain Building 2 during commissioning.

Feeder B and D will be removed from Building-2's footprint. The design package does not include construction phasing details as buildings are constructed and others removed; however, this calculation has consider the worst-case scenario where part of Feeder B will remain to support Building 155, B142, B182. Feeder B will required a back-feed to support existing buildings that are to remain during Building 2 construction. Merrick's recommendation is to install a temporary back-feed from a new 5kV J-Box installed adjacent to transformer XFE-C (Crary Building) to Pole B15. Building 155 is a high-energy use facility and will contribute to a peak demand prior to its relocation to Building 2. The decommissioning of Building 155 and its support functions will reduce the Peak KW demand once Building 2 is completed.

The design package has provided improved feeder loop capability over the existing radial 5kV distribution. The new feeder configuration provided loop capability between Feeder A and C, Feeder D and E, and Feeder A and D.

Calculation results indicated that all design feeders are within design capacity and service voltage. Merrick site investigation revealed system modifications not reflected in the as-built drawings. The power flow analysis included all findings unidentified during the site investigation. Building 166, B188, and B167 original overhead feeder was removed due to low clearance issues and their power source was relocated from Feeder B to Feeder D. A new 650-ft, #4, 600V cable was installed between pole D-35 and an existing pole located adjacent of B166. Secondary feeders to these buildings are excessive and subject to low service voltage. Low voltage conditions will occur when building occupancy increases during construction causing mechanical system failures. Building fault currents are too low and branch breakers are subject to long time trip delays. Failure to trip a breaker during a fault condition could lead to a building fire if not corrected. Corrective action is required for these facilities.

SECTION 2 INTRODUCTION

CODES, STANDARDS, REFERENCES:

UFC 3-501-01	(6 Oct 2015) Electrical Engineering
UFC 3-550-01	UFC 3-550-01 Exterior Electrical Power Distribution (1 September, 2-16)
NFPA 70E	Standard for Electrical Safety in the Work Place
NFPA 70	National Electrical Code 2014
IEEE	Std 399 Recommended Practices for Industrial and Commercial Power System Analysis.

Merrick conducted a load flow analysis for McMurdo based on building square footage, UFC 3-550-01 load flow analysis guidelines, and site visit of each building. A detail EasyPower™ model was developed reflecting existing conditions for each feeder and connected building/load. New building construction was incorporated into the model where multiple calculation were performed to analysis the performance of the overall system and identify the worst-case scenario. Building-2 (Building Services) will be the first building to be constructed. Construction of Building 2 will demo low energy buildings that exist within its construction footprint. The worst-case scenario will occur when Building-2 is constructed and commissioned while Building 155 remains in operation. The decommissioning of Building 155 and its support functions will reduce the Peak KW demand once Building 2 is completed. Power demand will continue to reduce as future buildings are construction and others removed.

Load Flow analysis performed by this calculation consist of feeder loading within McMurdo Station. System stability studies are outside of this scope but should be addressed when the overall site power demand drops lower than existing conditions. There will be several AIMS phased construction that will eventually drop the demand lower than existing conditions. A stability study should be conducted prior to reducing the overall demand load below the existing condition and/or the introduction of microturbines to McMurdo.

SECTION 3 GENERAL CRITERIA

The existing site will remain in operation during all AIMS phased construction. The modeling will be performed based on the following assumption:

1. Construction of Building 2 and partial removal of Feeder B will create the worst-case system loading.
2. Existing overhead feeders scheduled to remain will be modeled for system power flow and voltage drop.
3. Scott Base and Wind Turbines will not be considered as power generation into the system model. The study will focus on McMurdo feeder loading where the power source selection will have no impact to worst-case scenario. Only power generated from the power plant will be considered as part of the analysis.
4. Feeder selection and sizing is based on existing conditions in order to minimize cost. Conductor capacity will be evaluated based on feeder system loading, tie-breaker operation, and voltage drop to each primary service point. Modification will be made as required to support new construction and existing building to remain.
5. Existing building secondary conductors will be evaluated based on existing installed configuration. Any voltage violations identified by the results will be discussed but not resolved as part of the study and design.
6. Modification to existing overhead system will not be addressed as part of this design. Existing overhead pole jumpers are unreliable for long-term reliability due to high winds, vibrations, and mechanical failure due to cold climate application.
7. Excessive lengths on selected secondary distribution conductors provide limited power capacity within the service voltage criteria. Selected existing buildings may be problematic during construction with high occupancy causing mechanical equipment failure related to low voltage conditions. Design resolution to these building will not be provided in this design package.
8. McMurdo power plant is operating voltage at nominal voltage of 4.16kV.
9. Merrick was informed by McMurdo Site utilities that existing transformers do not have load tap changers. Therefore, load flow analysis will not be performed with adjusted tap settings on transformers for service voltage adjustment.

10. Transformer impedance data is not available. All calculations will be based on an assumed 5% impedance on transformers.
11. Previous McMurdo power system stability studies were conducted to maintain system stability based on existing power generation between McMurdo power plant, wind turbines, and Scott Base. The power flow analysis performed by this study will assume that no additional stability studies are required until the kW base loading drops below existing condition and there is no introduction of microturbines. .
12. EasyPower™ model generated by this study will be used for further system dynamic and stability studies as the system realizes a reduction of base loading and introduction of new power generation technology.

SECTION 4 DESIGN INPUT

1. Existing feeder conductors sizes, distances, and configuration provided by as-built drawings and field verification results gathered during Merrick's 2017 McMurdo deployment.
2. Existing transformers sizes and rated nominal voltage rating.
3. Individual transformer impedances are not available; therefore, an assumed input of 5% impedance.
4. Generation equipment will be modeled based on on-site data collection and data provided by the owner.
5. Individual kW demand data is not available for each building. Peak demand will be based on onsite survey of each building, building square footage, UFC standards, and available onsite power flow data.
6. Individual Generator impedance data will be incorporated into the model with an adjusted KW rating due to fuel source.
7. EasyPower™ Set points:
    a. Bus under voltage=0.95pu
    b. Bus over voltage= 1.05pu
    c. Overload Threshold= -10% of rating

SECTION 5 METHODOLOGY

An EasyPower™ electrical model for McMurdo Station will be developed that includes all system components of the existing 5kV distribution system. AIMS construction phasing will impose system load fluctuations as system loads are added or removed. The model will be created where future system modification can be analyzed and evaluate the performance of the system as construction progresses. The model will be available for further dynamic and stability analysis outside of this scope when system base loading drops below existing conditions or new power generation technology is introduced. This calculation will model the anticipated system loading worst-case scenario to calculate equipment loading and system losses. Loop feed breakers will be operated and system loading will be analyzed to overall system performance evaluation.

SECTION 6 REFERENCES

Refer to Section 2 Introduction.

SECTION 7 CONCLUSIONS

All service feeders are operating within their designed capability both in normal and back-up operation. Service entrance voltage for each facility is within 5% of the McMurdo power plant operating voltage for the exception of B166, B167, and B188. The new primary distribution system will support McMurdo long-term requirements. System upgrades for existing overhead lines that are to remain will require future upgrades to resolve system reliability issues related with these systems.

SECTION 8 CALCULATIONS

Power Flow Summary Report

Generator Summary Report

Generator			Scheduled			Limits		Solution							
Name	Type	Rated kVA	kW	kVAR	Vpu	kVAR Min	kVAR Max	kW	kVAR	kVA	Pf	Vpu	Deg	Eq'pu	Deg
GEN-1	Sw	1750			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
GEN-2	Sw	1750			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
GEN-4	Sw	1500			1.000			707	310	772	0.916	1.000	0.00	1.037	3.89
GEN-5	Sw	1750			1.000			707	310	772	0.916	1.000	0.00	1.046	4.80
GEN-6	Sw	1750			1.000			707	310	772	0.916	1.000	0.00	1.046	4.80
RTF-1	Sw	240000			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
RTF-1-SB G1	Sw	240000			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
RTF-1-SB G2	Sw	240000			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
RTF-2	Sw	240000			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
RTF-3	Sw	240000			1.000			0	0	0	0.000	1.000	0.00	1.000	0.00
SCOTT BASE G1	Sw	225			1.000			-0	0	0	0.000	1.000	0.00	1.000	-0.00
SCOTT BASE G2	Sw	225			1.000			-0	0	0	0.000	1.000	0.00	1.000	-0.00
WTG-01	Sw	330			1.000			-0	0	0	0.000	1.000	0.00	1.000	-0.00

Load Summary Report

Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
A-31	4.160	4.139	0.995	0.04	0	0	0	0.000
A20-1	0.208	0.202	0.970	-0.21	0	0	0	0.000
A22	0.208	0.204	0.980	-0.22	0	0	0	0.000
A22-2	0.208	0.203	0.975	-0.20	0	0	0	0.000
A22-3	0.208	0.203	0.974	-0.20	0	0	0	0.000
A23	0.208	0.202	0.974	-0.20	0	0	0	0.000
B-3	0.480	0.478	0.996	-1.10	243	61	250	0.970
B-5	0.480	0.478	0.996	-1.09	146	36	150	0.970
B-15-SEC	0.208	0.206	0.991	-0.04	0	0	0	0.000
B-15-SEC_A	0.208	0.204	0.981	0.24	0	0	0	0.000
B-15-SEC_B	0.208	0.205	0.988	0.05	0	0	0	0.000
B-155	0.208	0.205	0.985	-1.01	190	62	200	0.950
B-167	0.208	0.189	0.910	1.02	5	2	5	0.950
B-182 COM	0.208	0.203	0.974	0.47	16	12	20	0.800
B-188	0.208	0.189	0.910	1.05	4	2	5	0.900
B-221	0.208	0.207	0.993	-0.03	5	2	5	0.950
B4-LOUNGE	0.208	0.207	0.993	-0.00	1	1	1	0.800
B4-THEATER	0.208	0.207	0.993	-0.00	1	1	1	0.800
B7	0.208	0.207	0.995	-0.07	1	1	1	0.800
B10	0.208	0.207	0.995	-0.08	1	1	1	0.800
B18	4.160	4.146	0.997	0.02	0	0	0	0.000
B68	0.208	0.206	0.991	-0.11	32	24	40	0.800
B72	0.208	0.203	0.974	-0.20	1	0	1	0.981
B73	0.208	0.206	0.993	-0.07	2	1	2	0.950
B132	0.208	0.202	0.973	-0.19	5	1	5	0.981
B136A	0.208	0.207	0.996	0.02	2	1	2	0.800
B136C	0.208	0.207	0.996	0.02	2	1	2	0.800
B141	0.208	0.202	0.970	-0.18	5	1	5	0.981
B150	0.208	0.206	0.990	0.04	16	12	20	0.800
B160	0.208	0.206	0.993	-0.07	2	1	2	0.950
B166	0.208	0.192	0.921	0.82	5	2	5	0.950
B168	0.208	0.202	0.970	-0.21	5	1	5	0.981
B174	0.208	0.206	0.991	-0.25	5	1	5	0.981
B175	0.208	0.205	0.985	-0.24	10	2	10	0.981
B182 VEH HTRS 1	0.208	0.204	0.980	0.28	8	6	10	0.800
B182 VEH HTRS 2	0.208	0.205	0.987	0.07	8	6	10	0.800
B185	0.208	0.206	0.991	-0.25	5	1	5	0.981

Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
B191	0.208	0.206	0.991	-0.1	32	24	40	0.8
B192	0.208	0.204	0.98	-0.22	2	1	2	0.97
B341	0.208	0.206	0.991	-0.11	32	24	40	0.8
B344	0.208	0.205	0.988	-0.31	1	0	1	1
BLDG 10	0.48	0.477	0.993	-0.53	143	47	150	0.95
BUILDING 4	0.208	0.206	0.989	-0.04	32	24	40	0.8
BUS-1	4.16	4.159	1	0	0	0	0	0
BUS-2	4.16	4.158	0.999	-0.01	0	0	0	0
BUS-3	4.16	4.158	1	-0.01	0	0	0	0
BUS-4	4.16	4.158	1	-0.01	0	0	0	0
BUS-5	4.16	4.158	1	-0.01	0	0	0	0
BUS-6	4.16	4.158	1	-0.01	0	0	0	0
BUS-8	4.16	4.158	1	-0.01	0	0	0	0
BUS-9	0.208	0.189	0.91	1.02	0	0	0	0
BUS-9_C	4.16	4.159	1	0	0	0	0	0
BUS-15	4.16	4.138	0.995	0.05	0	0	0	0
BUS-27	4.16	4.137	0.995	0.05	0	0	0	0
CORE FREEZER PRI	4.16	4.152	0.998	-0.03	0	0	0	0
CORE FREEZER SEC	0.48	0.478	0.997	-0.16	38	12	40	0.95
D-17	4.16	4.14	0.995	0.04	0	0	0	0
D-17-1	4.16	4.14	0.995	0.04	0	0	0	0
D-17-1_A	4.16	4.137	0.994	0.05	0	0	0	0
D-29	4.16	4.137	0.995	0.05	0	0	0	0
D-30	4.16	4.137	0.994	0.05	0	0	0	0
D-31	4.16	4.137	0.994	0.05	0	0	0	0
D-33	4.16	4.137	0.994	0.05	0	0	0	0
D-34	4.16	4.137	0.994	0.05	0	0	0	0
D-35	4.16	4.137	0.994	0.05	0	0	0	0
D-38	4.16	4.149	0.997	0	0	0	0	0
D-40 SEC	0.208	0.202	0.97	-0.18	1	0	1	0.9
D-41	4.16	4.148	0.997	0.01	0	0	0	0
D-42	4.16	4.148	0.997	0.01	0	0	0	0
D-43	4.16	4.148	0.997	0.01	0	0	0	0
D-44	4.16	4.148	0.997	0.01	0	0	0	0
D10	4.16	4.144	0.996	0.02	0	0	0	0
D11	4.16	4.143	0.996	0.03	0	0	0	0
D12	4.16	4.142	0.996	0.03	0	0	0	0
D13	4.16	4.141	0.996	0.04	0	0	0	0
D14	4.16	4.141	0.995	0.04	0	0	0	0
D15	4.16	4.141	0.995	0.04	0	0	0	0

Bus		Solution						
Name	**Base kV**	**kV**	**Vpu**	**Deg**	**kW**	**kVar**	**kVA**	**Pf**
D16	4.16	4.14	0.995	0.04	0	0	0	0
D17-2	4.16	4.14	0.995	0.04	0	0	0	0
D17-2_A	4.16	4.137	0.994	0.05	0	0	0	0
D18	4.16	4.141	0.995	0.04	0	0	0	0
D19	4.16	4.14	0.995	0.04	0	0	0	0
D20	4.16	4.139	0.995	0.04	0	0	0	0
D21	4.16	4.139	0.995	0.04	0	0	0	0
D22	4.16	4.138	0.995	0.05	0	0	0	0
D23	4.16	4.138	0.995	0.05	0	0	0	0
D24	4.16	4.138	0.995	0.05	0	0	0	0
D26	4.16	4.138	0.995	0.05	0	0	0	0
D28	4.16	4.137	0.995	0.05	0	0	0	0
D39 SEC	0.208	0.204	0.98	-0.21	0	0	0	0
D40 SEC	0.208	0.204	0.98	-0.21	1	0	1	0.9
GEN 1	4.16	4.16	1	0	0	0	0	0
GEN 2	4.16	4.16	1	0	0	0	0	0
GEN 5	4.16	4.16	1	0	0	0	0	0
GEN 6	4.16	4.16	1	0	0	0	0	0
GEN-4	4.16	4.16	1	0	0	0	0	0
HTA	0.48	0.477	0.993	-0.9	20	0	20	1
HTA_A	0.48	0.477	0.993	-0.9	20	0	20	1
HTA_B	0.48	0.477	0.993	-0.9	20	0	20	1
HTP-5	0.48	0.477	0.993	-0.9	3	0	3	1
HTP4	0.48	0.477	0.993	-0.9	10	0	10	1
HTP6	0.48	0.477	0.993	-0.9	0	0	0	0
JB	4.16	4.156	0.999	-0.01	0	0	0	0
JB-1A	4.16	4.157	0.999	-0.01	0	0	0	0
JB-3	4.16	4.146	0.997	0.02	0	0	0	0
JB-3A	4.16	4.158	0.999	-0.01	0	0	0	0
JB-4	4.16	4.146	0.997	0.02	0	0	0	0
JB-5	4.16	4.137	0.994	0.04	0	0	0	0
JB-6B	4.16	4.159	1	0	0	0	0	0
JB-36D	4.16	4.137	0.995	0.05	0	0	0	0
JB-A2	4.16	4.14	0.995	0.03	0	0	0	0
JB-C1	4.16	4.157	0.999	-0.01	0	0	0	0
JB-E1	4.16	4.152	0.998	-0.03	0	0	0	0
JB-TSPG	4.16	4.158	1	-0.01	0	0	0	0
JB-WP	4.16	4.159	1	0	0	0	0	0
KIWI	4.16	4.144	0.996	0.02	16	12	20	0.8
LDB HE COMPRESS	0.208	0.206	0.991	0	18	13	22	0.8

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Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
LOAD BANKS	0.48	0.48	1	0	0	0	0	0
P-35 SEC	0.208	0.207	0.993	-0.06	0	0	0	0
P-A2	4.16	4.158	0.999	-0.01	0	0	0	0
P-A3	4.16	4.155	0.999	0	0	0	0	0
P-A4	4.16	4.153	0.998	0	0	0	0	0
P-A5	4.16	4.151	0.998	0.01	0	0	0	0
P-A6	4.16	4.148	0.997	0.02	0	0	0	0
P-A7	4.16	4.147	0.997	0.02	0	0	0	0
P-A8	4.16	4.145	0.996	0.03	0	0	0	0
P-A9	4.16	4.145	0.996	0.03	0	0	0	0
P-A9_A	4.16	4.144	0.996	0.03	0	0	0	0
P-A10	4.16	4.144	0.996	0.03	0	0	0	0
P-A10 COMMON D	4.16	4.151	0.998	-0.01	0	0	0	0
P-A18	4.16	4.142	0.996	0.03	0	0	0	0
P-A19	4.16	4.141	0.995	0.04	0	0	0	0
P-A20	4.16	4.141	0.995	0.04	0	0	0	0
P-A20-1	0.208	0.206	0.989	-0.25	0	0	0	0
P-A21	4.16	4.141	0.995	0.04	0	0	0	0
P-A22	4.16	4.14	0.995	0.04	0	0	0	0
P-A22 - D COMMON	4.16	4.149	0.997	0	0	0	0	0
P-A22.	4.16	4.148	0.997	0.01	0	0	0	0
P-A23	4.16	4.14	0.995	0.04	0	0	0	0
P-A24	4.16	4.139	0.995	0.04	0	0	0	0
P-A25	4.16	4.139	0.995	0.04	0	0	0	0
P-A26	4.16	4.139	0.995	0.04	0	0	0	0
P-A26 LITE SOUTH	0.208	0.205	0.988	-0.34	0	0	0	1
P-A26 SEC	0.208	0.205	0.988	-0.34	3	0	3	1
P-A27	0.208	0.205	0.985	-0.35	3	0	3	1
P-A28	4.16	4.139	0.995	0.04	0	0	0	0
P-A29	4.16	4.139	0.995	0.04	0	0	0	0
P-A30	4.16	4.139	0.995	0.04	0	0	0	0
P-A30-SEC	0.208	0.206	0.991	-0.28	0	0	0	0
P-A31 (SEC)	0.208	0.206	0.991	-0.28	0	0	0	0
P-A31 SEC WEST	0.208	0.206	0.989	-0.31	0	0	0	0
P-A32	4.16	4.139	0.995	0.04	0	0	0	0
P-A33	4.16	4.139	0.995	0.04	0	0	0	0
P-B	4.16	4.157	0.999	-0.01	0	0	0	0
P-B1	0.208	0.207	0.996	-0.08	0	0	0	0
P-B2	4.16	4.157	0.999	-0.01	0	0	0	0
P-B3	4.16	4.155	0.999	0	0	0	0	0

Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
P-B3-SEC	0.208	0.207	0.996	-0.08	0	0	0	0
P-B4	4.16	4.154	0.999	0	0	0	0	0
P-B5	4.16	4.152	0.998	0	0	0	0	0
P-B5-SEC	0.208	0.207	0.994	-0.02	0	0	0	0
P-B6	4.16	4.151	0.998	0.01	0	0	0	0
P-B8	4.16	4.15	0.998	0.01	0	0	0	0
P-B9	4.16	4.149	0.997	0.01	0	0	0	0
P-B10	4.16	4.147	0.997	0.02	0	0	0	0
P-B11	4.16	4.147	0.997	0.02	0	0	0	0
P-B12	4.16	4.147	0.997	0.02	0	0	0	0
P-B13	4.16	4.147	0.997	0.02	0	0	0	0
P-B14	4.16	4.147	0.997	0.02	0	0	0	0
P-B15	4.16	4.147	0.997	0.02	0	0	0	0
P-B16	4.16	4.147	0.997	0.02	0	0	0	0
P-B17	4.16	4.146	0.997	0.02	0	0	0	0
P-B20	4.16	4.147	0.997	0.02	0	0	0	0
P-B82	0.208	0.207	0.995	-0.06	0	0	0	0
P-B82_A	0.208	0.207	0.994	-0.05	1	1	1	0.8
P-C1	4.16	4.158	0.999	-0.01	0	0	0	0
P-D9	4.16	4.145	0.996	0.02	0	0	0	0
P-D33	4.16	4.147	0.997	0.01	0	0	0	0
P-D36	4.16	4.137	0.995	0.05	0	0	0	0
P-D37NC	4.16	4.146	0.997	0.01	0	0	0	0
P-D39	4.16	4.149	0.997	0	0	0	0	0
P-D40	4.16	4.148	0.997	0	0	0	0	0
POLE - B166	0.208	0.192	0.924	0.78	0	0	0	0
POLE 167	0.208	0.19	0.913	0.98	0	0	0	0
POWER PLANT A	4.16	4.159	1	0	0	0	0	0
POWER PLANT A_A	4.16	4.158	1	-0.01	0	0	0	0
PUMP HOUSE PRI	4.16	4.157	0.999	-0.01	0	0	0	0
PUMP HOUSE-SEC	0.48	0.475	0.99	-0.58	29	9	30	0.95
RWE POWERSTORE	4.16	4.137	0.995	0.05	0	0	0	0
SCOTT BASE G1	0.4	0.4	1	0	0	0	0	0
SCOTT BASE G2	0.4	0.4	1	0	0	0	0	0
SW-1	4.16	4.158	1	-0.01	0	0	0	0
SW-2	4.16	4.158	1	-0.01	0	0	0	0
SW-3	4.16	4.158	1	-0.01	0	0	0	0
SW-4	4.16	4.158	1	-0.01	0	0	0	0
SW-5	4.16	4.159	1	0	0	0	0	0
SW-6	4.16	4.159	1	0	0	0	0	0

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Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
SWA-01	4.16	4.141	0.995	0.03	0	0	0	0
SWC-01	4.16	4.158	0.999	-0.01	0	0	0	0
SWE-01	4.16	4.152	0.998	-0.03	0	0	0	0
T-L (XFE-A)	4.16	4.159	1	0	0	0	0	0
T-PH-1	4.16	4.159	1	0	0	0	0	0
T-PH-1 SEC	0.48	0.479	0.998	-0.18	67	33	75	0.9
T-W-1 SEC	0.208	0.207	0.998	-0.18	67	33	75	0.9
T-W-2 SEC	0.48	0.479	0.998	-0.18	67	33	75	0.9
T-W-2 SEC_A	0.208	0.207	0.998	-0.18	67	33	75	0.9
TW-1 PRI	4.16	4.159	1	0	0	0	0	0
TW-2 PRI	4.16	4.159	1	0	0	0	0	0
TW-2 PRI_A	4.16	4.159	1	0	0	0	0	0
USAP B70	0.208	0.207	0.994	0.03	1	0	1	0.95
VEOC	0.48	0.474	0.987	-0.72	143	47	150	0.95
WTG- SOURCE-1	0.4	0.4	1	0	0	0	0	0
WTG-1	0.4	0.4	1	0	0	0	0	0
WTG-1_C	0.4	0.4	1	0	0	0	0	0
WTG-2	0.4	0.4	1	0	0	0	0	0
XFA-4 PRI	4.16	4.153	0.998	0	0	0	0	0
XFA-4 SEC	0.48	0.477	0.993	-0.9	0	0	0	0
XFA-5-PRI	4.16	4.151	0.998	0.01	0	0	0	0
XFA-5-SEC	0.208	0.207	0.994	-0.17	40	30	50	0.8
XFA-6-PRI	4.16	4.148	0.997	0.02	0	0	0	0
XFA-6-SEC	0.208	0.207	0.997	0	3	2	4	0.8
XFA-9-A-SEC	0.208	0.207	0.994	-0.08	24	18	30	0.8
XFA-9-B-SEC	0.208	0.207	0.994	-0.08	24	18	30	0.8
XFA-9A-PRI	4.16	4.145	0.996	0.03	0	0	0	0
XFA-9B-PRI	4.16	4.144	0.996	0.03	0	0	0	0
XFA-10B-PRI	4.16	4.14	0.995	0.03	0	0	0	0
XFA-10B-SEC	0.208	0.207	0.994	-0.02	12	9	15	0.8
XFA-19-PRI	4.16	4.141	0.995	0.04	0	0	0	0
XFA-19-SEC	0.208	0.207	0.994	-0.12	0	0	0	0
XFA-25-A-SEC	0.208	0.207	0.994	0.01	8	6	10	0.8
XFA-25-PRI	4.16	4.139	0.995	0.04	0	0	0	0
XFA-25-SEC	0.208	0.206	0.991	-0.14	40	30	50	0.8
XFA-25A-PRI	4.16	4.139	0.995	0.04	0	0	0	0
XFA-32-PRI	4.16	4.139	0.995	0.04	0	0	0	0
XFA-32-SEC	0.208	0.206	0.992	-0.26	0	0	0	0
XFA-VEOC PRI	4.16	4.139	0.995	0.03	0	0	0	0
XFB-3-PRI	4.16	4.155	0.999	0	0	0	0	0

Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
XFB-3-SEC	0.208	0.207	0.996	-0.08	0	0	0	0
XFB-11 SEC	0.208	0.207	0.995	-0.06	16	12	20	0.8
XFB-11-PRI	4.16	4.147	0.997	0.02	0	0	0	0
XFB-12 SEC	0.208	0.207	0.993	-0.13	16	12	20	0.8
XFB-12-PRI	4.16	4.147	0.997	0.02	0	0	0	0
XFB-15 SEC	0.208	0.207	0.994	-0.13	0	0	0	0
XFB-15-PRI	4.16	4.147	0.997	0.02	0	0	0	0
XFB-15A SEC	0.48	0.478	0.996	-0.01	3	2	4	0.8
XFB-15A-PRI	4.16	4.147	0.997	0.02	0	0	0	0
XFB-17 SEC	0.208	0.205	0.986	-0.96	0	0	0	0
XFB-17-PRI	4.16	4.145	0.996	0.02	0	0	0	0
XFB-20 SEC	0.208	0.207	0.997	0	0	0	0	0
XFB-20-PRI	4.16	4.147	0.997	0.02	0	0	0	0
XFC-8A PRI	4.16	4.156	0.999	-0.01	0	0	0	0
XFC-8B SEC	0.208	0.207	0.997	-0.12	24	18	30	0.8
XFC-8C PRI	4.16	4.156	0.999	-0.01	0	0	0	0
XFC-8C SEC	0.208	0.207	0.997	-0.12	24	18	30	0.8
XFC-B2B5 PRI	4.16	4.149	0.997	-0.03	0	0	0	0
XFC-B2B5-SEC	0.48	0.478	0.996	-1.07	0	0	0	0
XFD-17 PRI	4.16	4.14	0.995	0.04	0	0	0	0
XFD-17 PRI_B	4.16	4.141	0.995	0.04	0	0	0	0
XFD-17 SEC	0.208	0.206	0.992	-0.1	32	24	40	0.8
XFD-17-1 PRI	4.16	4.14	0.995	0.04	0	0	0	0
XFD-17-1 PRI_A	4.16	4.137	0.994	0.05	0	0	0	0
XFD-17-1 SEC	0.208	0.206	0.992	-0.1	0	0	0	0
XFD-18 PRI	4.16	4.141	0.995	0.04	0	0	0	0
XFD-18-SEC	0.208	0.206	0.992	-0.11	0	0	0	0
XFD-19 SEC	0.208	0.206	0.992	-0.11	0	0	0	0
XFD-25 PRI	4.16	4.138	0.995	0.05	0	0	0	0
XFD-25-SEC	0.208	0.206	0.992	-0.1	0	0	0	0
XFD-35 PRI	4.16	4.137	0.994	0.05	0	0	0	0
XFD-35 SEC	0.208	0.207	0.993	-0.05	0	0	0	0
XFD-36-D1	4.16	4.137	0.994	0.04	0	0	0	0
XFD-36-D2	4.16	4.137	0.994	0.04	0	0	0	0
XFD-36A SEC	0.208	0.207	0.993	-0.02	0	0	0	0
XFD-36A SEC_A	0.208	0.206	0.993	-0.03	0	0	0	0
XFD-42-B PRI	4.16	4.146	0.997	0.02	0	0	0	0
XFD-42A SEC	0.208	0.207	0.995	-0.06	16	12	20	0.8
XFD-42A SEC_A	0.208	0.207	0.995	-0.06	16	12	20	0.8
XFD-42A-PRI	4.16	4.146	0.997	0.02	0	0	0	0

Bus		Solution						
Name	Base kV	kV	Vpu	Deg	kW	kVar	kVA	Pf
XFD-44	4.16	4.148	0.997	0.01	0	0	0	0
XFD-44-SEC	0.208	0.207	0.997	0	2	1	2	0.8
XFD-45-PRI	4.16	4.148	0.997	0.01	0	0	0	0
XFD-45-SEC	0.208	0.207	0.997	0	1	1	1	0.8
XFE-A PRI	4.16	4.151	0.998	-0.03	0	0	0	0
XFE-B PRI	4.16	4.152	0.998	-0.03	0	0	0	0
XFE-B SEC	0.208	0.206	0.992	-0.5	180	87	200	0.9
XFF-D-PRI	4.16	4.159	1	0	0	0	0	0
XFF-D-SEC	0.48	0.479	0.998	-0.18	67	33	75	0.9

System Summary Report

Total	kW	kVAR	kVA	PF
Generation in System	2122	929	2317	0.916
Load in System	2108	931	2305	0.915
Shunt Load in System	0	0		
Losses in System	14	-2		
Check of Balance	0	0		

Voltage Violation Report

Limits (MAX: 1.05, Min: 0.95)

Bus Name	Base kV	Vpu	kV
B-167	0.208	0.91	0.189
B-188	0.208	0.91	0.189
B166	0.208	0.921	0.192
BUS-176	0.208	0.91	0.189
POLE - B166	0.208	0.924	0.192
POLE 167	0.208	0.913	0.19

Transformer Tap Report

Transformer	Connection		Base kV		Tap kV		LTC Description							
Name	From Bus Name	To Bus Name	From	To	From	To	Type	LTC	LTC Type	Control Side	LTC Side	Control Value pu	Limits Min kV	Limits Max kV
T-PH-1	T-PH-1	T-PH-1 SEC	4.16	0.48	4.16	0.48	2Wnd	No						
T-W-2	TW-2 PRI	T-W-2 SEC	4.16	0.48	4.16	0.48	2Wnd	No						
TX-1	T-L (XFE-A)	LOAD BANKS	4.16	0.48	4.16	0.48	2Wnd	No						
TX-1_A	TW-1 PRI	T-W-1 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
TX-2	XFD-36-D1	B-221	4.16	0.208	4.16	0.208	2Wnd	No						
TX-2_A	XFD-36-D2	USAP B70	4.16	0.208	4.16	0.208	2Wnd	No						
TX-3	PUMP HOUSE	PUMP HOUSE-SEC	4.16	0.48	4.16	0.48	2Wnd	No						
TX-4	XFA-VEOC PRI	VEOC	4.16	0.48	4.16	0.48	2Wnd	No						
XFA-4	XFA-4 PRI	XFA-4 SEC	4.16	0.48	4.16	0.48	2Wnd	No						
XFA-5	XFA-5-PRI	XFA-5-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-6	XFA-6-PRI	XFA-6-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-9-A	XFA-9A-PRI	XFA-9-A-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-9-B	XFA-9B-PRI	XFA-9-B-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-10B	XFA-10B-PRI	XFA-10B-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-19	XFA-19-PRI	XFA-19-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-25	XFA-25-PRI	XFA-25-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-25A	XFA-25A-PRI	XFA-25-A-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFA-32	XFA-32-PRI	XFA-32-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-3	XFB-3-PRI	XFB-3-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-11	XFB-11-PRI	XFB-11 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-12	XFB-12-PRI	XFB-12 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-15	XFB-15-PRI	XFB-15 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-15A	XFB-15A-PRI	XFB-15A SEC	4.16	0.48	4.16	0.48	2Wnd	No						
XFB-17	XFB-17-PRI	XFB-17 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFB-20	XFB-20-PRI	XFB-20 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFC-8-C	XFC-8C PRI	XFC-8C SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFC-8B	XFC-8A PRI	XFC-8B SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFC-B2-B5	XFC-B2B5 PRI	XFC-B2B5-SEC	4.16	0.48	4.13	0.48	2Wnd	Yes	kV	To	From	1	0.1	1500
XFD-17	XFD-17 PRI	XFD-17 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-17-1	XFD-17-1 PRI	XFD-17-1 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-18	XFD-18 PRI	XFD-18-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-19	XFD-17 PRI_B	XFD-19 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-25	XFD-25 PRI	XFD-25-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-35	XFD-35 PRI	XFD-35 SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-36-A	XFD-17-	XFD-36A SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-36-B	D17-2_A	XFD-36A SEC_A	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-42_A	XFD-42A-PRI	XFD-42A SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-42_B	XFD-42-B PRI	XFD-42A SEC_A	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-44	XFD-44	XFD-44-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFD-45	XFD-45-PRI	XFD-45-SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFE-A.	XFE-A PRI	BLDG 10	4.16	0.48	4.16	0.48	2Wnd	No						
XFE-B	XFE-B PRI	XFE-B SEC	4.16	0.208	4.16	0.208	2Wnd	No						
XFE-C.	CORE FREEZE	CORE FREEZER SEC	4.16	0.48	4.16	0.48	2Wnd	No						
XFF-B	TW-2 PRI_A	T-W-2 SEC_A	4.16	0.208	4.16	0.208	2Wnd	No						
XFF-D	XFF-D-PRI	XFF-D-SEC	4.16	0.48	4.16	0.48	2Wnd	No						

Line Overload Report

Overload Threshold = 10.00 %

Line				Load			
From Bus Name	To Bus Name	Branch Name	Rated Amps	Load Amps	Loaded%	OverLoaded%	Comment
A-31	P-A32	C-3_AG	190	2.4	1.30%	-98.70%	
A20-1	B168	C-4_K	115	14.6	12.70%	-87.30%	
A22	A22-2	C-4_D	170	49.4	29.10%	-70.90%	
A22	D39 SEC	C-4_AF	115	2.8	2.50%	-97.50%	
A22	B192	C-4_C	115	5.8	5.10%	-94.90%	
A22-2	A23	C-4_H	170	46.5	27.40%	-72.60%	
A22-2	A22-3	C-4_F	170	2.9	1.70%	-98.30%	
A22-3	B72	C-4_E	170	2.9	1.70%	-98.30%	
A23	B132	C-4_G	170	31.9	18.80%	-81.20%	
A23	A20-1	C-4_J	115	14.6	12.70%	-87.30%	
B-15-SEC	B-15-SEC_A	C-10_A	170	85.3	50.20%	-49.80%	
B-15-SEC	B-15-SEC_B	C-10_D	170	28.1	16.50%	-83.50%	
B-15-SEC_A	B182 VEH HT	C-10_C	170	28.3	16.70%	-83.30%	
B-15-SEC_A	B-182 COM	C-10_B	170	57	33.50%	-66.50%	
B-15-SEC_B	B182 VEH HT	C-10_E	170	28.1	16.50%	-83.50%	
B-167	BUS-9	C-37	25	0	0.00%	-100.00%	
B-167	POLE 167	C-1_CU	125	15.3	12.20%	-87.80%	
B-188	POLE 167	C-1_CV	125	15.2	12.20%	-87.80%	
B18	P-B17	C-1_CL	190	0	0.00%	-100.00%	
B73	P-35 SEC	C-1_CS	620	5.6	0.90%	-99.10%	
B132	B141	C-4_I	170	17.4	10.20%	-89.80%	
B141	D-40 SEC	C-4_AE	170	2.9	1.70%	-98.30%	
B150	XFD-36A SEC	C-1_CJ	130	56.1	43.20%	-56.80%	
B160	P-35 SEC	C-1_CR	620	5.6	0.90%	-99.10%	
B166	POLE - B166	C-1_CT	125	15.1	12.10%	-87.90%	
BUILDING 4	XFD-17-1 SEC	C-1_CC	130	112.3	86.40%	-13.60%	
BUS-1	SW-6	C-1_L	765	88.4	11.60%	-88.40%	
BUS-2	P-C1	C-20	255	68.1	26.70%	-73.30%	
BUS-2	SWC-01	C-19	255	68.1	26.70%	-73.30%	
BUS-3	BUS-4	C-1_A	765	0.1	0.00%	-100.00%	
BUS-4	BUS-5	C-1_B	765	0.1	0.00%	-100.00%	
BUS-5	BUS-6	C-1_C	765	0.1	0.00%	-100.00%	
BUS-6	JB-TSPG	C-1_D	765	0.1	0.00%	-100.00%	
BUS-8	JB-TSPG	C-1_E	765	0	0.00%	-100.00%	
BUS-27	D28	C-11_T	190	2.8	1.50%	-98.50%	
D-17	D-17-1	C-11_I	190	5.6	3.00%	-97.00%	
D-17-1	D17-2	C-11_J	190	0	0.00%	-100.00%	
D-17-1_A	D17-2_A	C-11_CK	400	3.1	0.80%	-99.20%	
D-29	D-30	C-11_V	190	2.8	1.50%	-98.50%	
D-30	D-31	C-11_W	190	2.8	1.50%	-98.50%	
D-31	D-33	C-11_X	190	2.8	1.50%	-98.50%	
D-33	D-34	C-11_Z	190	2.8	1.50%	-98.50%	
D-34	D-35	C-11_AA	190	2.8	1.50%	-98.50%	

Line Overload Report

Overload Threshold = 10.00 %

D-38	P-A22.	C-1_BR	190	36.5	19.20%	-80.80%	
D-41	P-D40	C-1_CO	190	8.5	4.50%	-95.50%	
D-42	D-41	C-1_BT	190	8.5	4.50%	-95.50%	
D-43	D-42	C-1_BU	190	0.4	0.20%	-99.80%	
D-44	XFD-44	C-3_AO	130	0.3	0.20%	-99.80%	
D-44	D-43	C-1_BV	190	0.4	0.20%	-99.80%	
D-44	XFD-45-PRI	C-3_AP	130	0.1	0.10%	-99.90%	
D10	D11	C-11_A	190	36.5	19.20%	-80.80%	
D11	D12	C-11_B	190	36.5	19.20%	-80.80%	
D12	D13	C-11_C	190	11.2	5.90%	-94.10%	
D12	D18	C-11_K	190	25.4	13.40%	-86.60%	
D13	D14	C-11_D	190	11.2	5.90%	-94.10%	
D14	D15	C-11_F	190	11.2	5.90%	-94.10%	
D15	D16	C-11_G	190	11.2	5.90%	-94.10%	
D16	D-17	C-11_H	190	11.2	5.90%	-94.10%	
D18	D19	C-11_L	190	14.3	7.50%	-92.50%	
D19	D20	C-11_M	190	14.3	7.50%	-92.50%	
D20	D21	C-11_N	190	14.3	7.50%	-92.50%	
D21	D22	C-11_O	190	14.3	7.50%	-92.50%	
D22	D23	C-11_P	190	14.3	7.50%	-92.50%	
D23	D24	C-11_Q	190	5.6	2.90%	-97.10%	
D23	D26	C-11_R	190	8.8	4.60%	-95.40%	
D26	BUS-27	C-11_S	190	2.8	1.50%	-98.50%	
D26	P-D36	C-11_AB	190	6	3.20%	-96.80%	
D28	D-29	C-11_U	190	2.8	1.50%	-98.50%	
D39 SEC	D40 SEC	C-4_AG	115	2.8	2.50%	-97.50%	
JB	XFC-8A PRI	195	255	4.2	1.60%	-98.40%	
JB	XFC-8C PRI	195_A	255	4.1	1.60%	-98.40%	
JB-1A	SW-1	C-1_T	765	85.4	11.20%	-88.80%	
JB-3	D-42	C-1_BW	190	5.6	2.90%	-97.10%	
JB-3A	SW-3	C-1_AV	765	54.3	7.10%	-92.90%	
JB-4	JB-3	C-1_BX	130	2.8	2.10%	-97.90%	
JB-5	XFD-36-D1	C-33	280	0.7	0.20%	-99.80%	
JB-5	XFD-36-D2	C-33_A	280	0.2	0.10%	-99.90%	
JB-6B	SW-6	C-1_BB	765	31.3	4.10%	-95.90%	
JB-36D	D-17-1_A	C-11_AF	400	5.9	1.50%	-98.50%	
JB-A2	XFA-10B-PRI	C-3_AM	280	2.1	0.70%	-99.30%	
JB-A2	XFA-VEOC PRI	C-27	165	21.1	12.80%	-87.20%	
JB-C1	JB	C-5_C	255	8.2	3.20%	-96.80%	
JB-E1	JB-3A	C-1_AW	255	54.4	21.30%	-78.70%	
JB-E1	XFE-B PRI	C-1_CP	255	28	11.00%	-89.00%	
JB-E1	SWE-01	C-1_CQ	255	26.5	10.40%	-89.60%	
JB-WP	SW-6	C-1_AY	765	20.9	2.70%	-97.30%	
KIWI	D-42	C-1_BZ	130	2.8	2.10%	-97.90%	
LDB HE COMPRES	XFD-	C-1_CK	130	63	48.50%	-51.50%	

MERRICK & COMPANY

Subject:	McMurdo Station Load Flow Study				
Project No.:	**6401748177**	Calculation No.:	E002	Rev:	0

Line Overload Report

Overload Threshold = 10.00 %

P-35 SEC	POLE - B166	C-31	95	45.5	47.90%	-52.10%	
P-35 SEC	XFD-35 SEC	C-1_CH	620	56.7	9.10%	-90.90%	
P-A2	P-A3	C-3	152	62.6	41.20%	-58.80%	
P-A2	SW-2	C-1_N	255	62.6	24.50%	-75.50%	
P-A3	P-A4	C-3_A	190	62.6	32.90%	-67.10%	
P-A4	P-A5	C-3_C	190	53.2	28.00%	-72.00%	
P-A4	XFA-4 PRI	C-3_B	130	10.2	7.80%	-92.20%	
P-A5	P-A6	C-3_E	190	46.4	24.40%	-75.60%	
P-A5	XFA-5-PRI	C-3_D	130	7	5.40%	-94.60%	
P-A6	P-A7	C-3_G	190	45.9	24.10%	-75.90%	
P-A6	XFA-6-PRI	C-3_F	130	0.6	0.40%	-99.60%	
P-A7	P-A8	C-3_H	190	45.9	24.10%	-75.90%	
P-A8	P-A9_A	C-3_N	280	4.2	1.50%	-98.50%	
P-A8	P-A9	C-3_K	280	4.2	1.50%	-98.50%	
P-A8	P-A10	C-3_L	190	37.7	19.90%	-80.10%	
P-A9	XFA-9A-PRI	C-3_J	130	4.2	3.20%	-96.80%	
P-A9_A	XFA-9B-PRI	C-3_M	130	4.2	3.20%	-96.80%	
P-A10	P-A18	C-3_O	190	37.7	19.90%	-80.10%	
P-	JB-1A	C-15	285	45	15.80%	-84.20%	
P-	D-38	C-29	190	45	23.70%	-76.30%	
P-A18	P-A19	C-3_P	190	37.7	19.90%	-80.10%	
P-A19	XFA-19-PRI	C-3_T	130	4.3	3.30%	-96.70%	
P-A19	P-A20	C-3_R	190	10.5	5.50%	-94.50%	
P-A20	P-A21	C-3_S	190	0	0.00%	-100.00%	
P-A20	P-A22	C-3_U	190	10.5	5.50%	-94.50%	
P-A20-1	B175	C-4_A	170	28.7	16.90%	-83.10%	
P-A20-1	A22	C-4_B	170	58	34.10%	-65.90%	
P-A22	P-A23	C-3_V	190	10.5	5.50%	-94.50%	
P-A22 -	D-38	C-1_BS	190	8.5	4.50%	-95.50%	
P-A22.	P-D33	C-1_BQ	400	36.5	9.10%	-90.90%	
P-A23	P-A24	C-3_W	190	10.5	5.50%	-94.50%	
P-A24	P-A25	C-3_Y	190	8.4	4.40%	-95.60%	
P-A24	P-A26	C-3_AA	130	2.4	1.90%	-98.10%	
P-A25	XFA-25-PRI	C-3_Z	130	7	5.40%	-94.60%	
P-A25	XFA-25A-PRI	C-3_X	130	1.4	1.10%	-98.90%	
P-A26	P-A28	C-3_AC	190	2.4	1.30%	-98.70%	
P-A26 SEC	P-A27	C-4_Q	135	8.5	6.30%	-93.70%	
P-A26 SEC	P-	C-4_R	135	0.3	0.20%	-99.80%	
P-A28	P-A29	C-3_AD	190	2.4	1.30%	-98.70%	
P-A29	P-A30	C-3_AE	190	2.4	1.30%	-98.70%	
P-A30	A-31	C-3_AF	190	2.4	1.30%	-98.70%	
P-A30-SEC	B344	C-3_AN	100	2.8	2.80%	-97.20%	
P-A31 (SEC)	P-A30-SEC	C-4_S	280	2.8	1.00%	-99.00%	
P-A31 (SEC)	P-	C-4_O	280	17.2	6.10%	-93.90%	
P-A31 SEC WEST	P-A26 SEC	C-4_P	280	17.2	6.10%	-93.90%	

Line Overload Report

Overload Threshold = 10.00 %

P-A32	P-A33	C-3_AH	190	0	0.00%	-100.00%	
P-A32	XFA-32-PRI	C-3_AI	130	2.4	1.90%	-98.10%	
P-B	JB-1A	C-1_V	765	40.8	5.30%	-94.70%	
P-B1	B10	C-4_V	85	2.8	3.30%	-96.70%	
P-B1	B7	C-4_W	85	2.8	3.30%	-96.70%	
P-B1	P-B82	C-4_X	85	2.8	3.30%	-96.70%	
P-B2	P-B	C-1_W	400	40.8	10.20%	-89.80%	
P-B3	P-B2	C-1_X	190	40.8	21.50%	-78.50%	
P-B3-SEC	P-B5-SEC	C-4_Z	85	5.6	6.60%	-93.40%	
P-B3-SEC	P-B1	C-4_U	230	8.4	3.60%	-96.40%	
P-B4	P-B3	C-1_Z	190	40.1	21.10%	-78.90%	
P-B5	P-B4	C-1_AA	190	40.1	21.10%	-78.90%	
P-B5-SEC	B4-LOUNGE	C-4_AA	85	2.8	3.30%	-96.70%	
P-B5-SEC	B4-THEATER	C-4_AB	85	2.8	3.30%	-96.70%	
P-B6	P-B5	C-1_AB	190	40.1	21.10%	-78.90%	
P-B8	P-B6	C-1_AC	190	40.1	21.10%	-78.90%	
P-B9	P-B8	C-1_AD	190	40.1	21.10%	-78.90%	
P-B10	P-B9	C-1_AE	190	40.1	21.10%	-78.90%	
P-B11	P-B10	C-1_AK	400	11.8	2.90%	-97.10%	
P-B12	P-B11	C-1_AM	190	9	4.70%	-95.30%	
P-B13	P-B12	C-1_AO	190	6.2	3.30%	-96.70%	
P-B14	P-B13	C-1_AP	190	6.2	3.30%	-96.70%	
P-B15	P-B14	C-1_AQ	190	6.2	3.30%	-96.70%	
P-B16	P-B10	C-1_AF	190	28.2	14.80%	-85.20%	
P-B17	P-B16	C-1_AG	190	28.2	14.80%	-85.20%	
P-B20	P-B10	C-1_AI	130	0.6	0.40%	-99.60%	
P-B82	P-B82_A	C-4_Y	85	2.8	3.30%	-96.70%	
P-C1	SW-4	C-1_AT	855	68.1	8.00%	-92.00%	
P-D9	D10	C-11	190	36.5	19.20%	-80.80%	
P-D33	P-D37NC	C-1_BO	190	36.5	19.20%	-80.80%	
P-D36	JB-36D	C-11_AD	400	5.9	1.50%	-98.50%	
P-D36	JB-5	C-32	280	0.9	0.30%	-99.70%	
P-D36	RWE POWERS	C-11_AC	400	0.7	0.20%	-99.80%	
P-D37NC	P-D9	C-1_BN	190	36.5	19.20%	-80.80%	
P-D39	P-A22 -	C-1_CM	190	8.5	4.50%	-95.50%	
P-D40	P-D39	C-1_CN	190	8.5	4.50%	-95.50%	
POLE 167	POLE - B166	DIST	125	30.4	24.30%	-75.70%	
POWER PLANT A	SW-2	C-1_H	285	42	14.70%	-85.30%	
POWER PLANT A	BUS-9_C	C-2_C	280	0	0.00%	-100.00%	
POWER PLANT A	GEN 5	C-2_A	280	107.2	38.30%	-61.70%	
POWER PLANT A	GEN 6	C-2_B	280	107.2	38.30%	-61.70%	
POWER PLANT A	SW-1	C-1_F	285	52.5	18.40%	-81.60%	
POWER PLANT A	SW-5	C-1_K	765	39.3	5.10%	-94.90%	
POWER PLANT A	SW-4	C-1_J	285	54.8	19.20%	-80.80%	
POWER PLANT A	GEN-4	C-2	280	107.2	38.30%	-61.70%	

Line Overload Report

Overload Threshold = 10.00 %

POWER PLANT A	SW-3	C-1_I	765	44.8	5.90%	-94.10%	
POWER PLANT A_	SW-2	C-1_O	765	20.6	2.70%	-97.30%	
POWER PLANT A_	SW-1	C-1_M	855	33	3.90%	-96.10%	
POWER PLANT A_	SW-5	C-1_R	765	39.3	5.10%	-94.90%	
POWER PLANT A_	SW-3	C-1_P	855	9.5	1.10%	-98.90%	
POWER PLANT A_	SW-4	C-1_Q	285	13.5	4.70%	-95.30%	
POWER PLANT A_	SW-6	C-1_U	765	36.3	4.70%	-95.30%	
RWE POWERSTO	BUS-15	C-34	280	0.7	0.30%	-99.70%	
SW-1	BUS-3	C-1	765	0.1	0.00%	-100.00%	
SWA-01	JB-A2	C-17	155	23.1	14.90%	-85.10%	
SWA-01	P-A19	C-16	280	23.1	8.20%	-91.80%	
SWC-01	PUMP HOUSE	C-26	140	4.2	3.00%	-97.00%	
SWC-01	JB-C1	C-21	280	8.2	2.90%	-97.10%	
SWC-01	XFC-B2B5 PRI	C-24	155	56.1	36.20%	-63.80%	
SWE-01	CORE FREEZE	C-30_A	155	5.6	3.60%	-96.40%	
SWE-01	XFE-A PRI	C-30	140	21	15.00%	-85.00%	
T-L (XFE-A)	SW-5	C-1_G	765	0	0.00%	-100.00%	
T-PH-1	JB-6B	C-1_BC	765	10.4	1.40%	-98.60%	
TW-1 PRI	JB-WP	C-1_AZ	765	10.4	1.40%	-98.60%	
TW-2 PRI	JB-WP	C-1_BA	765	10.4	1.40%	-98.60%	
TW-2 PRI_A	JB-6B	C-1_BD	765	10.4	1.40%	-98.60%	
WTG-1	WTG-	C-36	760	0	0.00%	-100.00%	
WTG-1_C	SCOTT BASE G	C-36_C	760	0	0.00%	-100.00%	
WTG-2	SCOTT BASE G	C-36_D	760	0	0.00%	-100.00%	
XFA-4 SEC	HTA_B	C-6_G	175	24.2	13.80%	-86.20%	
XFA-4 SEC	HTA_A	C-6_F	175	24.2	13.80%	-86.20%	
XFA-4 SEC	HTA	C-6_E	175	24.2	13.80%	-86.20%	
XFA-4 SEC	HTP4	C-6_J	175	12.1	6.90%	-93.10%	
XFA-4 SEC	HTP-5	C-6_I	175	3.6	2.10%	-97.90%	
XFA-4 SEC	HTP6	C-6_H	175	0	0.00%	-100.00%	
XFA-19-SEC	P-A20-1	C-4	230	86.7	37.70%	-62.30%	
XFA-32-SEC	B185	C-4_M	170	14.3	8.40%	-91.60%	
XFA-32-SEC	P-A31 (SEC)	C-4_N	280	20	7.10%	-92.90%	
XFA-32-SEC	B174	C-4_L	170	14.3	8.40%	-91.60%	
XFB-3-PRI	P-B3	C-1_Y	125	0.7	0.60%	-99.40%	
XFB-3-SEC	P-B3-SEC	C-4_T	230	14	6.10%	-93.90%	
XFB-11-PRI	P-B11	C-1_AL	130	2.8	2.10%	-97.90%	
XFB-12-PRI	P-B12	C-1_AN	130	2.8	2.10%	-97.90%	
XFB-15 SEC	B-15-SEC	C-10	170	113.5	66.70%	-33.30%	
XFB-15-PRI	P-B15	C-1_AS	130	5.7	4.40%	-95.60%	
XFB-15A-PRI	P-B15	C-1_AR	130	0.6	0.40%	-99.60%	
XFB-17 SEC	B-155	C-13	1520	563.7	37.10%	-62.90%	
XFB-17-PRI	P-B17	C-1_AH	130	28.2	21.70%	-78.30%	
XFB-20 SEC	B136A	C-4_AC	115	5.6	4.80%	-95.20%	
XFB-20 SEC	B136C	C-4_AD	115	5.6	4.80%	-95.20%	

Line Overload Report

Overload Threshold = 10.00 %

XFB-20-PRI	P-B20	C-1_AJ	130	0.6	0.40%	-99.60%	
XFC-B2B5-SEC	B-3	C-25	1520	302	19.90%	-80.10%	
XFC-B2B5-SEC	B-5	C-25_A	1140	181.1	15.90%	-84.10%	
XFD-17 PRI	D-17	C-1_CA	130	5.6	4.30%	-95.70%	
XFD-17 PRI_B	D18	C-1_CE	130	5.6	4.30%	-95.70%	
XFD-17-1 PRI	D-17-1	C-1_CB	130	5.6	4.30%	-95.70%	
XFD-17-1 PRI_A	D-17-1_A	C-1_CI	130	2.8	2.20%	-97.80%	
XFD-18 PRI	D18	C-1_CD	130	5.6	4.30%	-95.70%	
XFD-18-SEC	B341	C-12	230	112	48.70%	-51.30%	
XFD-19 SEC	B68	C-12_A	230	112	48.70%	-51.30%	
XFD-25 PRI	D24	C-1_CF	130	5.6	4.30%	-95.70%	
XFD-25-SEC	B191	C-12_B	230	112	48.70%	-51.30%	
XFD-35 PRI	D-35	C-1_CG	130	2.8	2.20%	-97.80%	
XFD-42-B PRI	JB-4	C-1_BY	130	2.8	2.10%	-97.90%	
XFD-42A-PRI	JB-3	C-1_BG	130	2.8	2.10%	-97.90%	
XFF-D-PRI	JB-6B	C-1_BE	765	10.4	1.40%	-98.60%	

Transformer Overload Report

Overload Threshold = 10.00 %

Transformer				Load			
Name	From Bus N...	To Bus Name	Rated Amps	Load Amps	Loaded%	OverLoaded%	Comment
T-PH-1	T-PH-1	T-PH-1 SEC	300.7	90.4	30.10%	-69.90%	
T-W-2	TW-2 PRI	T-W-2 SEC	270.6	90.4	33.40%	-66.60%	
TX-1	T-L (XFE-A)	LOAD BANKS	1202.8	0	0.00%	-100.00%	
TX-1_A	TW-1 PRI	T-W-1 SEC	832.7	208.7	25.10%	-74.90%	
TX-2	XFD-36-D1	B-221	416.4	14	3.40%	-96.60%	
TX-2_A	XFD-36-D2	USAP B70	208.2	2.8	1.30%	-98.70%	
TX-3	PUMP HOUSE	PUMP HOUSE-SEC	135.3	36.4	26.90%	-73.10%	
TX-4	XFA-VEOC PRI	VEOC	601.4	182.8	30.40%	-69.60%	
XFA-4	XFA-4 PRI	XFA-4 SEC	270.6	88.4	32.70%	-67.30%	
XFA-5	XFA-5-PRI	XFA-5-SEC	1387.9	139.6	10.10%	-89.90%	
XFA-6	XFA-6-PRI	XFA-6-SEC	1387.9	11.1	0.80%	-99.20%	
XFA-9-A	XFA-9A-PRI	XFA-9-A-SEC	277.6	83.8	30.20%	-69.80%	
XFA-9-B	XFA-9B-PRI	XFA-9-B-SEC	416.4	83.8	20.10%	-79.90%	
XFA-10B	XFA-10B-PRI	XFA-10B-SEC	416.4	41.9	10.10%	-89.90%	
XFA-19	XFA-19-PRI	XFA-19-SEC	416.4	86.7	20.80%	-79.20%	
XFA-25	XFA-25-PRI	XFA-25-SEC	1387.9	140	10.10%	-89.90%	
XFA-25A	XFA-25A-PRI	XFA-25-A-SEC	277.6	27.9	10.10%	-89.90%	
XFA-32	XFA-32-PRI	XFA-32-SEC	416.4	48.3	11.60%	-88.40%	
XFB-3	XFB-3-PRI	XFB-3-SEC	208.2	14	6.70%	-93.30%	
XFB-11	XFB-11-PRI	XFB-11 SEC	624.5	55.8	8.90%	-91.10%	
XFB-12	XFB-12-PRI	XFB-12 SEC	624.5	55.9	8.90%	-91.10%	
XFB-15	XFB-15-PRI	XFB-15 SEC	832.7	113.5	13.60%	-86.40%	
XFB-15A	XFB-15A-PRI	XFB-15A SEC	270.6	4.8	1.80%	-98.20%	
XFB-17	XFB-17-PRI	XFB-17 SEC	2775.7	563.7	20.30%	-79.70%	
XFB-20	XFB-20-PRI	XFB-20 SEC	208.2	11.1	5.40%	-94.60%	
XFC-8-C	XFC-8C PRI	XFC-8C SEC	624.5	83.5	13.40%	-86.60%	
XFC-8B	XFC-8A PRI	XFC-8B SEC	208.2	83.5	40.10%	-59.90%	
XFC-B2-B5	XFC-B2B5 PRI	XFC-B2B5-SEC	601.4	483.1	80.30%	-19.70%	
XFD-17	XFD-17 PRI	XFD-17 SEC	208.2	111.9	53.80%	-46.20%	
XFD-17-1	XFD-17-1 PRI	XFD-17-1 SEC	416.4	112.3	27.00%	-73.00%	
XFD-18	XFD-18 PRI	XFD-18-SEC	208.2	112	53.80%	-46.20%	
XFD-19	XFD-17 PRI_B	XFD-19 SEC	277.6	112	40.40%	-59.60%	
XFD-25	XFD-25 PRI	XFD-25-SEC	277.6	112	40.40%	-59.60%	
XFD-35	XFD-35 PRI	XFD-35 SEC	624.5	56.7	9.10%	-90.90%	
XFD-36-A	XFD-17-	XFD-36A SEC	277.6	56.1	20.20%	-79.80%	
XFD-36-B	D17-2_A	XFD-36A SEC_A	416.4	63	15.10%	-84.90%	
XFD-42_A	XFD-42A-PRI	XFD-42A SEC	208.2	55.8	26.80%	-73.20%	
XFD-42_B	XFD-42-B PRI	XFD-42A SEC_A	208.2	55.8	26.80%	-73.20%	
XFD-44	XFD-44	XFD-44-SEC	1387.9	5.6	0.40%	-99.60%	
XFD-45	XFD-45-PRI	XFD-45-SEC	208.2	2.8	1.30%	-98.70%	
XFE-A.	XFE-A PRI	BLDG 10	601.4	181.7	30.20%	-69.80%	
XFE-B	XFE-B PRI	XFE-B SEC	2775.7	559.5	20.20%	-79.80%	
XFE-C.	CORE FREEZE	CORE FREEZER SEC	270.6	48.3	17.80%	-82.20%	
XFF-B	TW-2 PRI_A	T-W-2 SEC_A	832.7	208.7	25.10%	-74.90%	
XFF-D	XFF-D-PRI	XFF-D-SEC	360.8	90.4	25.10%	-74.90%	

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
A-31	4.16	P-A32	4.16	0	-0.1
A20-1	0.208	B168	0.208	0	0
A22	0.208	D39 SEC	0.208	0	0
A22	0.208	A22-2	0.208	0.1	0
A22	0.208	B192	0.208	0	0
A22-2	0.208	A22-3	0.208	0	0
A22-2	0.208	A23	0.208	0	0
A22-3	0.208	B72	0.208	0	0
A23	0.208	B132	0.208	0	0
A23	0.208	A20-1	0.208	0	0
B-15-SEC	0.208	B-15-SEC_B	0.208	0	0
B-15-SEC	0.208	B-15-SEC_A	0.208	0.3	0.1
B-15-SEC_A	0.208	B-182 COM	0.208	0.2	0
B-15-SEC_A	0.208	B182 VEH HTRS 1	0.208	0	0
B-15-SEC_B	0.208	B182 VEH HTRS 2	0.208	0	0
B-167	0.208	POLE 167	0.208	0	0
B-167	0.208	BUS-9	0.208	0	0
B-188	0.208	POLE 167	0.208	0	0
B18	4.16	P-B17	4.16	0	-0.1
B73	0.208	P-35 SEC	0.208	0	0
B132	0.208	B141	0.208	0	0
B141	0.208	D-40 SEC	0.208	0	0
B150	0.208	XFD-36A SEC	0.208	0.1	0
B160	0.208	P-35 SEC	0.208	0	0
B166	0.208	POLE - B166	0.208	0	0
BUILDING 4	0.208	XFD-17-1 SEC	0.208	0.1	0
BUS-1	4.16	SW-6	4.16	0	0
BUS-2	4.16	P-C1	4.16	0	0
BUS-2	4.16	SWC-01	4.16	0	0
BUS-3	4.16	BUS-4	4.16	0	0
BUS-4	4.16	BUS-5	4.16	0	0
BUS-5	4.16	BUS-6	4.16	0	0
BUS-6	4.16	JB-TSPG	4.16	0	-0.6
BUS-8	4.16	JB-TSPG	4.16	0	0
BUS-27	4.16	D28	4.16	0	-0.1
CORE FREEZER PR	4.16	CORE FREEZER SEC	0.48	0	0.1
D-17	4.16	D-17-1	4.16	0	0
D-17-1	4.16	D17-2	4.16	0	0
D-17-1_A	4.16	D17-2_A	4.16	0	0
D-29	4.16	D-30	4.16	0	-0.1
D-30	4.16	D-31	4.16	0	-0.1
D-31	4.16	D-33	4.16	0	0
D-33	4.16	D-34	4.16	0	-0.1
D-34	4.16	D-35	4.16	0	0
D-38	4.16	P-A22.	4.16	0.1	-0.1
D-41	4.16	P-D40	4.16	0	0
D-42	4.16	D-41	4.16	0	0
D-43	4.16	D-42	4.16	0	0

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
D-44	4.16	D-43	4.16	0	0
D-44	4.16	XFD-44	4.16	0	-0.2
D-44	4.16	XFD-45-PRI	4.16	0	-0.1
D10	4.16	D11	4.16	0.1	0
D11	4.16	D12	4.16	0.1	0
D12	4.16	D18	4.16	0	-0.1
D12	4.16	D13	4.16	0	-0.1
D13	4.16	D14	4.16	0	-0.1
D14	4.16	D15	4.16	0	0
D15	4.16	D16	4.16	0	0
D16	4.16	D-17	4.16	0	0
D17-2_A	4.16	XFD-36A SEC_A	0.208	0	0
D18	4.16	D19	4.16	0	-0.1
D19	4.16	D20	4.16	0	-0.1
D20	4.16	D21	4.16	0	-0.1
D21	4.16	D22	4.16	0	-0.1
D22	4.16	D23	4.16	0	-0.1
D23	4.16	D26	4.16	0	-0.1
D23	4.16	D24	4.16	0	-0.1
D26	4.16	BUS-27	4.16	0	-0.1
D26	4.16	P-D36	4.16	0	-0.1
D28	4.16	D-29	4.16	0	0
D39 SEC	0.208	D40 SEC	0.208	0	0
JB	4.16	XFC-8C PRI	4.16	0	-0.8
JB	4.16	XFC-8A PRI	4.16	0	-0.2
JB-1A	4.16	SW-1	4.16	0.1	0
JB-3	4.16	D-42	4.16	0	-0.5
JB-3A	4.16	SW-3	4.16	0	0
JB-4	4.16	JB-3	4.16	0	0
JB-5	4.16	XFD-36-D1	4.16	0	-0.3
JB-5	4.16	XFD-36-D2	4.16	0	-1.2
JB-6B	4.16	SW-6	4.16	0	-0.2
JB-36D	4.16	D-17-1_A	4.16	0	-0.7
JB-A2	4.16	XFA-10B-PRI	4.16	0	0
JB-A2	4.16	XFA-VEOC PRI	4.16	0	-0.2
JB-C1	4.16	JB	4.16	0	-0.6
JB-E1	4.16	XFE-B PRI	4.16	0	0
JB-E1	4.16	SWE-01	4.16	0	0
JB-E1	4.16	JB-3A	4.16	0.4	-0.4
JB-WP	4.16	SW-6	4.16	0	-0.4
KIWI	4.16	D-42	4.16	0	-2.4
LDB HE COMPRES	0.208	XFD-36A SEC_A	0.208	0	0
P-35 SEC	0.208	POLE - B166	0.208	1.1	0.2
P-35 SEC	0.208	XFD-35 SEC	0.208	0	0
P-A2	4.16	P-A3	4.16	0.3	0
P-A2	4.16	SW-2	4.16	0	0
P-A3	4.16	P-A4	4.16	0.1	0

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
P-A4	4.16	P-A5	4.16	0.2	0
P-A4	4.16	XFA-4 PRI	4.16	0	0
P-A5	4.16	P-A6	4.16	0.2	-0.1
P-A5	4.16	XFA-5-PRI	4.16	0	0
P-A6	4.16	P-A7	4.16	0.1	0
P-A6	4.16	XFA-6-PRI	4.16	0	-0.1
P-A7	4.16	P-A8	4.16	0.2	0
P-A8	4.16	P-A10	4.16	0.1	0
P-A8	4.16	P-A9_A	4.16	0	-0.2
P-A8	4.16	P-A9	4.16	0	-0.1
P-A9	4.16	XFA-9A-PRI	4.16	0	0
P-A9_A	4.16	XFA-9B-PRI	4.16	0	0
P-A10	4.16	P-A18	4.16	0.1	0
P-	4.16	JB-1A	4.16	0.4	-0.6
P-	4.16	D-38	4.16	0.2	0
P-A18	4.16	P-A19	4.16	0.1	0
P-A19	4.16	P-A20	4.16	0	0
P-A19	4.16	XFA-19-PRI	4.16	0	0
P-A20	4.16	P-A22	4.16	0	-0.1
P-A20	4.16	P-A21	4.16	0	-0.1
P-A20-1	0.208	A22	0.208	0.2	0
P-A20-1	0.208	B175	0.208	0	0
P-A22	4.16	P-A23	4.16	0	-0.1
P-A22 -	4.16	D-38	4.16	0	-0.1
P-A22.	4.16	P-D33	4.16	0	-0.1
P-A23	4.16	P-A24	4.16	0	-0.1
P-A24	4.16	P-A26	4.16	0	-0.1
P-A24	4.16	P-A25	4.16	0	-0.1
P-A25	4.16	XFA-25A-PRI	4.16	0	0
P-A25	4.16	XFA-25-PRI	4.16	0	0
P-A26	4.16	P-A28	4.16	0	-0.1
P-A26 SEC	0.208	P-A26 LITE SOUTH	0.208	0	0
P-A26 SEC	0.208	P-A27	0.208	0	0
P-A28	4.16	P-A29	4.16	0	0
P-A29	4.16	P-A30	4.16	0	-0.1
P-A30	4.16	A-31	4.16	0	-0.1
P-A30-SEC	0.208	B344	0.208	0	0
P-A31 (SEC)	0.208	P-A30-SEC	0.208	0	0
P-A31 (SEC)	0.208	P-A31 SEC WEST	0.208	0	0
P-A31 SEC WEST	0.208	P-A26 SEC	0.208	0	0
P-A32	4.16	P-A33	4.16	0	0
P-A32	4.16	XFA-32-PRI	4.16	0	0
P-B	4.16	JB-1A	4.16	0	0
P-B1	0.208	B10	0.208	0	0
P-B1	0.208	B7	0.208	0	0
P-B1	0.208	P-B82	0.208	0	0
P-B2	4.16	P-B	4.16	0	0
P-B3	4.16	P-B2	4.16	0.1	0

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
P-B3-SEC	0.208	P-B5-SEC	0.208	0	0
P-B3-SEC	0.208	P-B1	0.208	0	0
P-B4	4.16	P-B3	4.16	0.1	0
P-B5	4.16	P-B4	4.16	0.1	0
P-B5-SEC	0.208	B4-LOUNGE	0.208	0	0
P-B5-SEC	0.208	B4-THEATER	0.208	0	0
P-B6	4.16	P-B5	4.16	0.1	0
P-B8	4.16	P-B6	4.16	0.1	0
P-B9	4.16	P-B8	4.16	0.1	0
P-B10	4.16	P-B9	4.16	0.1	0
P-B11	4.16	P-B10	4.16	0	-0.1
P-B12	4.16	P-B11	4.16	0	0
P-B13	4.16	P-B12	4.16	0	0
P-B14	4.16	P-B13	4.16	0	-0.1
P-B15	4.16	P-B14	4.16	0	-0.1
P-B16	4.16	P-B10	4.16	0	0
P-B17	4.16	P-B16	4.16	0.1	-0.1
P-B20	4.16	P-B10	4.16	0	-0.1
P-B82	0.208	P-B82_A	0.208	0	0
P-C1	4.16	SW-4	4.16	0	-0.1
P-D9	4.16	D10	4.16	0.1	0
P-D33	4.16	P-D37NC	4.16	0.1	0
P-D36	4.16	JB-5	4.16	0	-3.5
P-D36	4.16	JB-36D	4.16	0	0
P-D36	4.16	RWE POWERSTORE	4.16	0	-0.1
P-D37NC	4.16	P-D9	4.16	0.1	0
P-D39	4.16	P-A22 - D COMMON	4.16	0	-0.1
P-D40	4.16	P-D39	4.16	0	-0.1
POLE 167	0.208	POLE - B166	0.208	0.1	0
POWER PLANT A	4.16	SW-4	4.16	0.1	-0.1
POWER PLANT A	4.16	SW-5	4.16	0	0
POWER PLANT A	4.16	GEN-4	4.16	0.1	0.1
POWER PLANT A	4.16	GEN 6	4.16	0.1	0.1
POWER PLANT A	4.16	GEN 5	4.16	0.1	0.1
POWER PLANT A	4.16	SW-1	4.16	0.1	-0.1
POWER PLANT A	4.16	SW-3	4.16	0.1	-0.1
POWER PLANT A	4.16	SW-2	4.16	0.1	-0.1
POWER PLANT A	4.16	BUS-9_C	4.16	0	0
POWER PLANT A_	4.16	SW-6	4.16	0	-0.1
POWER PLANT A_	4.16	SW-1	4.16	0	-0.5
POWER PLANT A_	4.16	SW-3	4.16	0	-0.5
POWER PLANT A_	4.16	SW-5	4.16	0.1	-0.1
POWER PLANT A_	4.16	SW-4	4.16	0	-0.2
POWER PLANT A_	4.16	SW-2	4.16	0	0
PUMP HOUSE PRI	4.16	PUMP HOUSE-SEC	0.48	0.2	0.4

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
RWE POWERSTO RE	4.16	BUS-15	4.16	0	-5
SCOTT BASE G1	0.4	SCOTT BASE G1	0.4	0	0
SCOTT BASE G2	0.4	SCOTT BASE G2	0.4	0	0
SW-1	4.16	BUS-3	4.16	0	0
SWA-01	4.16	JB-A2	4.16	0	0
SWA-01	4.16	P-A19	4.16	0	0
SWC-01	4.16	JB-C1	4.16	0	-0.3
SWC-01	4.16	PUMP HOUSE PRI	4.16	0	-0.1
SWC-01	4.16	XFC-B2B5 PRI	4.16	0.7	0
SWE-01	4.16	CORE FREEZER PRI	4.16	0	0
SWE-01	4.16	XFE-A PRI	4.16	0	-0.1
T-L (XFE-A)	4.16	LOAD BANKS	0.48	0	0
T-L (XFE-A)	4.16	SW-5	4.16	0	0
T-PH-1	4.16	JB-6B	4.16	0	-0.2
T-PH-1	4.16	T-PH-1 SEC	0.48	0	0.3
TW-1 PRI	4.16	T-W-1 SEC	0.208	0	0.3
TW-1 PRI	4.16	JB-WP	4.16	0	-0.1
TW-2 PRI	4.16	T-W-2 SEC	0.48	0	0.3
TW-2 PRI	4.16	JB-WP	4.16	0	-0.1
TW-2 PRI_A	4.16	JB-6B	4.16	0	-0.2
TW-2 PRI_A	4.16	T-W-2 SEC_A	0.208	0	0.3
WTG-SOURCE-1	0.4	WTG-SOURCE-1	0.4	0	0
WTG-1	0.4	WTG-SOURCE-1	0.4	0	0
WTG-1_C	0.4	SCOTT BASE G1	0.4	0	0
WTG-2	0.4	SCOTT BASE G2	0.4	0	0
XFA-4 PRI	4.16	XFA-4 SEC	0.48	0.3	1.1
XFA-4 SEC	0.48	HTA_B	0.48	0	0
XFA-4 SEC	0.48	HTP4	0.48	0	0
XFA-4 SEC	0.48	HTP6	0.48	0	0
XFA-4 SEC	0.48	HTA_A	0.48	0	0
XFA-4 SEC	0.48	HTA	0.48	0	0
XFA-4 SEC	0.48	HTP-5	0.48	0	0
XFA-5-PRI	4.16	XFA-5-SEC	0.208	0.1	0.2
XFA-6-PRI	4.16	XFA-6-SEC	0.208	0	0
XFA-9A-PRI	4.16	XFA-9-A-SEC	0.208	0	0.1
XFA-9B-PRI	4.16	XFA-9-B-SEC	0.208	0	0.1
XFA-10B-PRI	4.16	XFA-10B-SEC	0.208	0	0
XFA-19-PRI	4.16	XFA-19-SEC	0.208	0	0.1
XFA-19-SEC	0.208	P-A20-1	0.208	0.1	0.1
XFA-25-PRI	4.16	XFA-25-SEC	0.208	0.1	0.2
XFA-25A-PRI	4.16	XFA-25-A-SEC	0.208	0	0
XFA-32-PRI	4.16	XFA-32-SEC	0.208	0	0.1
XFA-32-SEC	0.208	B185	0.208	0	0
XFA-32-SEC	0.208	B174	0.208	0	0

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
XFA-VEOC PRI	4.16	VEOC	0.48	0.5	2.3
XFB-3-PRI	4.16	XFB-3-SEC	0.208	0	0
XFB-3-PRI	4.16	P-B3	4.16	0	0
XFB-3-SEC	0.208	P-B3-SEC	0.208	0	0
XFB-11-PRI	4.16	P-B11	4.16	0	0
XFB-11-PRI	4.16	XFB-11 SEC	0.208	0	0
XFB-12-PRI	4.16	XFB-12 SEC	0.208	0	0.1
XFB-12-PRI	4.16	P-B12	4.16	0	0
XFB-15 SEC	0.208	B-15-SEC	0.208	0.1	0
XFB-15-PRI	4.16	P-B15	4.16	0	0
XFB-15-PRI	4.16	XFB-15 SEC	0.208	0	0.2
XFB-15A-PRI	4.16	XFB-15A SEC	0.48	0	0
XFB-15A-PRI	4.16	P-B15	4.16	0	0
XFB-17 SEC	0.208	B-155	0.208	0.2	0.3
XFB-17-PRI	4.16	P-B17	4.16	0.1	0
XFB-17-PRI	4.16	XFB-17 SEC	0.208	0.9	3.9
XFB-20 SEC	0.208	B136A	0.208	0	0
XFB-20 SEC	0.208	B136C	0.208	0	0
XFB-20-PRI	4.16	XFB-20 SEC	0.208	0	0
XFB-20-PRI	4.16	P-B20	4.16	0	0
XFC-8A PRI	4.16	XFC-8B SEC	0.208	0	0.1
XFC-8C PRI	4.16	XFC-8C SEC	0.208	0	0.1
XFC-B2B5 PRI	4.16	XFC-B2B5-SEC	0.48	1.4	7.9
XFC-B2B5-SEC	0.48	B-3	0.48	0.1	0.1
XFC-B2B5-SEC	0.48	B-5	0.48	0	0
XFD-17 PRI	4.16	XFD-17 SEC	0.208	0	0.2
XFD-17 PRI	4.16	D-17	4.16	0	0
XFD-17 PRI_B	4.16	XFD-19 SEC	0.208	0	0.2
XFD-17 PRI_B	4.16	D18	4.16	0	0
XFD-17-1 PRI	4.16	XFD-17-1 SEC	0.208	0	0.2
XFD-17-1 PRI	4.16	D-17-1	4.16	0	-0.1
XFD-17-1 PRI_A	4.16	D-17-1_A	4.16	0	-0.1
XFD-17-1 PRI_A	4.16	XFD-36A SEC	0.208	0	0
XFD-18 PRI	4.16	XFD-18-SEC	0.208	0	0.2
XFD-18 PRI	4.16	D18	4.16	0	0
XFD-18-SEC	0.208	B341	0.208	0	0
XFD-19 SEC	0.208	B68	0.208	0	0
XFD-25 PRI	4.16	D24	4.16	0	0
XFD-25 PRI	4.16	XFD-25-SEC	0.208	0	0.2
XFD-25-SEC	0.208	B191	0.208	0	0
XFD-35 PRI	4.16	D-35	4.16	0	0
XFD-35 PRI	4.16	XFD-35 SEC	0.208	0	0
XFD-36-D1	4.16	B-221	0.208	0	0
XFD-36-D2	4.16	USAP B70	0.208	0	0
XFD-42-B PRI	4.16	XFD-42A SEC_A	0.208	0	0
XFD-42-B PRI	4.16	JB-4	4.16	0	0

Branch Losses Report

From Bus		To Bus		Losses	
Name	Base kV	Name	Base kV	kW	kVAR
XFD-42A-PRI	4.16	XFD-42A SEC	0.208	0	0
XFD-42A-PRI	4.16	JB-3	4.16	0	0
XFD-44	4.16	XFD-44-SEC	0.208	0	0
XFD-45-PRI	4.16	XFD-45-SEC	0.208	0	0
XFE-A PRI	4.16	BLDG 10	0.48	0.3	1.5
XFE-B PRI	4.16	XFE-B SEC	0.208	0.4	2
XFF-D-PRI	4.16	JB-6B	4.16	0	-0.2
XFF-D-PRI	4.16	XFF-D-SEC	0.48	0	0.3
Total System Los				13.9	2.2

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
A-31	4.16	P-A32	4.16	0.00%
A20-1	0.208	B168	0.208	0.10%
A22	0.208	B192	0.208	0.10%
A22	0.208	A22-2	0.208	0.50%
A22	0.208	D39 SEC	0.208	0.00%
A22-2	0.208	A22-3	0.208	0.00%
A22-2	0.208	A23	0.208	0.10%
A22-3	0.208	B72	0.208	0.00%
A23	0.208	B132	0.208	0.10%
A23	0.208	A20-1	0.208	0.30%
B-15-SEC	0.208	B-15-SEC_A	0.208	0.90%
B-15-SEC	0.208	B-15-SEC_B	0.208	0.30%
B-15-SEC_A	0.208	B-182 COM	0.208	0.80%
B-15-SEC_A	0.208	B182 VEH HTRS 1	0.208	0.20%
B-15-SEC_B	0.208	B182 VEH HTRS 2	0.208	0.10%
B-167	0.208	BUS-9	0.208	0.00%
B-167	0.208	POLE 167	0.208	-0.30%
B-188	0.208	POLE 167	0.208	-0.30%
B18	4.16	P-B17	4.16	0.00%
B73	0.208	P-35 SEC	0.208	0.00%
B132	0.208	B141	0.208	0.20%
B141	0.208	D-40 SEC	0.208	0.00%
B150	0.208	XFD-36A SEC	0.208	-0.30%
B160	0.208	P-35 SEC	0.208	0.00%
B166	0.208	POLE - B166	0.208	-0.30%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
BUILDING 4	0.208	XFD-17-1 SEC	0.208	-0.30%
BUS-1	4.16	SW-6	4.16	0.00%
BUS-2	4.16	SWC-01	4.16	0.00%
BUS-2	4.16	P-C1	4.16	0.00%
BUS-3	4.16	BUS-4	4.16	0.00%
BUS-4	4.16	BUS-5	4.16	0.00%
BUS-5	4.16	BUS-6	4.16	0.00%
BUS-6	4.16	JB-TSPG	4.16	0.00%
BUS-8	4.16	JB-TSPG	4.16	0.00%
BUS-27	4.16	D28	4.16	0.00%
CORE FREEZER PR	4.16	CORE FREEZER SEC	0.48	0.10%
D-17	4.16	D-17-1	4.16	0.00%
D-17-1	4.16	D17-2	4.16	0.00%
D-17-1_A	4.16	D17-2_A	4.16	0.00%
D-29	4.16	D-30	4.16	0.00%
D-30	4.16	D-31	4.16	0.00%
D-31	4.16	D-33	4.16	0.00%
D-33	4.16	D-34	4.16	0.00%
D-34	4.16	D-35	4.16	0.00%
D-38	4.16	P-A22.	4.16	0.00%
D-41	4.16	P-D40	4.16	0.00%
D-42	4.16	D-41	4.16	0.00%
D-43	4.16	D-42	4.16	0.00%
D-44	4.16	D-43	4.16	0.00%
D-44	4.16	XFD-44	4.16	0.00%
D-44	4.16	XFD-45-PRI	4.16	0.00%
D10	4.16	D11	4.16	0.00%
D11	4.16	D12	4.16	0.00%
D12	4.16	D13	4.16	0.00%
D12	4.16	D18	4.16	0.00%
D13	4.16	D14	4.16	0.00%
D14	4.16	D15	4.16	0.00%
D15	4.16	D16	4.16	0.00%
D16	4.16	D-17	4.16	0.00%
D17-2_A	4.16	XFD-36A SEC_A	0.208	0.20%
D18	4.16	D19	4.16	0.00%
D19	4.16	D20	4.16	0.00%
D20	4.16	D21	4.16	0.00%
D21	4.16	D22	4.16	0.00%
D22	4.16	D23	4.16	0.00%
D23	4.16	D24	4.16	0.00%
D23	4.16	D26	4.16	0.00%
D26	4.16	BUS-27	4.16	0.00%
D26	4.16	P-D36	4.16	0.00%
D28	4.16	D-29	4.16	0.00%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
D39 SEC	0.208	D40 SEC	0.208	0.00%
JB	4.16	XFC-8A PRI	4.16	0.00%
JB	4.16	XFC-8C PRI	4.16	0.00%
JB-1A	4.16	SW-1	4.16	0.00%
JB-3	4.16	D-42	4.16	0.00%
JB-3A	4.16	SW-3	4.16	0.00%
JB-4	4.16	JB-3	4.16	0.00%
JB-5	4.16	XFD-36-D1	4.16	0.00%
JB-5	4.16	XFD-36-D2	4.16	0.00%
JB-6B	4.16	SW-6	4.16	0.00%
JB-36D	4.16	D-17-1_A	4.16	0.00%
JB-A2	4.16	XFA-10B-PRI	4.16	0.00%
JB-A2	4.16	XFA-VEOC PRI	4.16	0.00%
JB-C1	4.16	JB	4.16	0.00%
JB-E1	4.16	JB-3A	4.16	-0.10%
JB-E1	4.16	XFE-B PRI	4.16	0.00%
JB-E1	4.16	SWE-01	4.16	0.00%
JB-WP	4.16	SW-6	4.16	0.00%
KIWI	4.16	D-42	4.16	-0.10%
LDB HE COMPRES	0.208	XFD-36A SEC_A	0.208	-0.20%
P-35 SEC	0.208	XFD-35 SEC	0.208	0.00%
P-35 SEC	0.208	POLE - B166	0.208	6.90%
P-A2	4.16	P-A3	4.16	0.10%
P-A2	4.16	SW-2	4.16	0.00%
P-A3	4.16	P-A4	4.16	0.00%
P-A4	4.16	XFA-4 PRI	4.16	0.00%
P-A4	4.16	P-A5	4.16	0.10%
P-A5	4.16	XFA-5-PRI	4.16	0.00%
P-A5	4.16	P-A6	4.16	0.10%
P-A6	4.16	XFA-6-PRI	4.16	0.00%
P-A6	4.16	P-A7	4.16	0.00%
P-A7	4.16	P-A8	4.16	0.00%
P-A8	4.16	P-A9	4.16	0.00%
P-A8	4.16	P-A9_A	4.16	0.00%
P-A8	4.16	P-A10	4.16	0.00%
P-A9	4.16	XFA-9A-PRI	4.16	0.00%
P-A9_A	4.16	XFA-9B-PRI	4.16	0.00%
P-A10	4.16	P-A18	4.16	0.00%
P-	4.16	JB-1A	4.16	-0.10%
P-	4.16	D-38	4.16	0.10%
P-A18	4.16	P-A19	4.16	0.00%
P-A19	4.16	P-A20	4.16	0.00%
P-A19	4.16	XFA-19-PRI	4.16	0.00%
P-A20	4.16	P-A21	4.16	0.00%
P-A20	4.16	P-A22	4.16	0.00%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
P-A20-1	0.208	B175	0.208	0.50%
P-A20-1	0.208	A22	0.208	0.90%
P-A22	4.16	P-A23	4.16	0.00%
P-A22 -	4.16	D-38	4.16	0.00%
P-A22.	4.16	P-D33	4.16	0.00%
P-A23	4.16	P-A24	4.16	0.00%
P-A24	4.16	P-A25	4.16	0.00%
P-A24	4.16	P-A26	4.16	0.00%
P-A25	4.16	XFA-25A-PRI	4.16	0.00%
P-A25	4.16	XFA-25-PRI	4.16	0.00%
P-A26	4.16	P-A28	4.16	0.00%
P-A26 SEC	0.208	P-A27	0.208	0.20%
P-A26 SEC	0.208	P-A26 LITE SOUTH	0.208	0.00%
P-A28	4.16	P-A29	4.16	0.00%
P-A29	4.16	P-A30	4.16	0.00%
P-A30	4.16	A-31	4.16	0.00%
P-A30-SEC	0.208	B344	0.208	0.30%
P-A31 (SEC)	0.208	P-A31 SEC WEST	0.208	0.20%
P-A31 (SEC)	0.208	P-A30-SEC	0.208	0.00%
P-A31 SEC WEST	0.208	P-A26 SEC	0.208	0.10%
P-A32	4.16	P-A33	4.16	0.00%
P-A32	4.16	XFA-32-PRI	4.16	0.00%
P-B	4.16	JB-1A	4.16	0.00%
P-B1	0.208	B10	0.208	0.00%
P-B1	0.208	B7	0.208	0.10%
P-B1	0.208	P-B82	0.208	0.10%
P-B2	4.16	P-B	4.16	0.00%
P-B3	4.16	P-B2	4.16	0.00%
P-B3-SEC	0.208	P-B1	0.208	0.00%
P-B3-SEC	0.208	P-B5-SEC	0.208	0.20%
P-B4	4.16	P-B3	4.16	0.00%
P-B5	4.16	P-B4	4.16	0.00%
P-B5-SEC	0.208	B4-LOUNGE	0.208	0.10%
P-B5-SEC	0.208	B4-THEATER	0.208	0.10%
P-B6	4.16	P-B5	4.16	0.00%
P-B8	4.16	P-B6	4.16	0.00%
P-B9	4.16	P-B8	4.16	0.00%
P-B10	4.16	P-B9	4.16	0.00%
P-B11	4.16	P-B10	4.16	0.00%
P-B12	4.16	P-B11	4.16	0.00%
P-B13	4.16	P-B12	4.16	0.00%
P-B14	4.16	P-B13	4.16	0.00%
P-B15	4.16	P-B14	4.16	0.00%
P-B16	4.16	P-B10	4.16	0.00%
P-B17	4.16	P-B16	4.16	0.00%
P-B20	4.16	P-B10	4.16	0.00%
P-B82	0.208	P-B82_A	0.208	0.10%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
P-C1	4.16	SW-4	4.16	0.00%
P-D9	4.16	D10	4.16	0.00%
P-D33	4.16	P-D37NC	4.16	0.00%
P-D36	4.16	RWE POWERSTORE	4.16	0.00%
P-D36	4.16	JB-36D	4.16	0.00%
P-D36	4.16	JB-5	4.16	0.00%
P-D37NC	4.16	P-D9	4.16	0.00%
P-D39	4.16	P-A22 - D COMMON	4.16	0.00%
P-D40	4.16	P-D39	4.16	0.00%
POLE 167	0.208	POLE - B166	0.208	-1.10%
POWER PLANT A	4.16	GEN 5	4.16	0.00%
POWER PLANT A	4.16	GEN 6	4.16	0.00%
POWER PLANT A	4.16	GEN-4	4.16	0.00%
POWER PLANT A	4.16	SW-1	4.16	0.00%
POWER PLANT A	4.16	BUS-9_C	4.16	0.00%
POWER PLANT A	4.16	SW-2	4.16	0.00%
POWER PLANT A	4.16	SW-3	4.16	0.00%
POWER PLANT A	4.16	SW-4	4.16	0.00%
POWER PLANT A	4.16	SW-5	4.16	0.00%
POWER PLANT A_	4.16	SW-1	4.16	0.00%
POWER PLANT A_	4.16	SW-2	4.16	0.00%
POWER PLANT A_	4.16	SW-3	4.16	0.00%
POWER PLANT A_	4.16	SW-4	4.16	0.00%
POWER PLANT A_	4.16	SW-5	4.16	0.00%
POWER PLANT A_	4.16	SW-6	4.16	0.00%
PUMP HOUSE PRI	4.16	PUMP HOUSE-SEC	0.48	0.90%
RWE POWERSTO	4.16	BUS-15	4.16	0.00%
SCOTT BASE G1	0.4	SCOTT BASE G1	0.4	0.00%
SCOTT BASE G2	0.4	SCOTT BASE G2	0.4	0.00%
SW-1	4.16	BUS-3	4.16	0.00%
SWA-01	4.16	P-A19	4.16	0.00%
SWA-01	4.16	JB-A2	4.16	0.00%
SWC-01	4.16	JB-C1	4.16	0.00%
SWC-01	4.16	XFC-B2B5 PRI	4.16	0.20%
SWC-01	4.16	PUMP HOUSE PRI	4.16	0.00%
SWE-01	4.16	XFE-A PRI	4.16	0.00%
SWE-01	4.16	CORE FREEZER PRI	4.16	0.00%
T-L (XFE-A)	4.16	LOAD BANKS	0.48	0.00%
T-L (XFE-A)	4.16	SW-5	4.16	0.00%
T-PH-1	4.16	T-PH-1 SEC	0.48	0.20%
T-PH-1	4.16	JB-6B	4.16	0.00%
TW-1 PRI	4.16	T-W-1 SEC	0.208	0.20%
TW-1 PRI	4.16	JB-WP	4.16	0.00%
TW-2 PRI	4.16	T-W-2 SEC	0.48	0.20%
TW-2 PRI	4.16	JB-WP	4.16	0.00%
TW-2 PRI_A	4.16	T-W-2 SEC_A	0.208	0.20%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
TW-2 PRI_A	4.16	JB-6B	4.16	0.00%
WTG-SOURCE-1	0.4	WTG-SOURCE-1	0.4	0.00%
WTG-1	0.4	WTG-SOURCE-1	0.4	0.00%
WTG-1_C	0.4	SCOTT BASE G1	0.4	0.00%
WTG-2	0.4	SCOTT BASE G2	0.4	0.00%
XFA-4 PRI	4.16	XFA-4 SEC	0.48	0.50%
XFA-4 SEC	0.48	HTA	0.48	0.00%
XFA-4 SEC	0.48	HTA_A	0.48	0.00%
XFA-4 SEC	0.48	HTA_B	0.48	0.00%
XFA-4 SEC	0.48	HTP6	0.48	0.00%
XFA-4 SEC	0.48	HTP-5	0.48	0.00%
XFA-4 SEC	0.48	HTP4	0.48	0.00%
XFA-5-PRI	4.16	XFA-5-SEC	0.208	0.40%
XFA-6-PRI	4.16	XFA-6-SEC	0.208	0.00%
XFA-9A-PRI	4.16	XFA-9-A-SEC	0.208	0.20%
XFA-9B-PRI	4.16	XFA-9-B-SEC	0.208	0.20%
XFA-10B-PRI	4.16	XFA-10B-SEC	0.208	0.10%
XFA-19-PRI	4.16	XFA-19-SEC	0.208	0.10%
XFA-19-SEC	0.208	P-A20-1	0.208	0.50%
XFA-25-PRI	4.16	XFA-25-SEC	0.208	0.40%
XFA-25A-PRI	4.16	XFA-25-A-SEC	0.208	0.10%
XFA-32-PRI	4.16	XFA-32-SEC	0.208	0.30%
XFA-32-SEC	0.208	B174	0.208	0.10%
XFA-32-SEC	0.208	B185	0.208	0.10%
XFA-32-SEC	0.208	P-A31 (SEC)	0.208	0.10%
XFA-VEOC PRI	4.16	VEOC	0.48	0.80%
XFB-3-PRI	4.16	XFB-3-SEC	0.208	0.30%
XFB-3-PRI	4.16	P-B3	4.16	0.00%
XFB-3-SEC	0.208	P-B3-SEC	0.208	0.00%
XFB-11-PRI	4.16	XFB-11 SEC	0.208	0.10%
XFB-11-PRI	4.16	P-B11	4.16	0.00%
XFB-12-PRI	4.16	XFB-12 SEC	0.208	0.40%
XFB-12-PRI	4.16	P-B12	4.16	0.00%
XFB-15 SEC	0.208	B-15-SEC	0.208	0.30%
XFB-15-PRI	4.16	XFB-15 SEC	0.208	0.30%
XFB-15-PRI	4.16	P-B15	4.16	0.00%
XFB-15A-PRI	4.16	XFB-15A SEC	0.48	0.10%
XFB-15A-PRI	4.16	P-B15	4.16	0.00%
XFB-17 SEC	0.208	B-155	0.208	0.10%
XFB-17-PRI	4.16	XFB-17 SEC	0.208	1.00%
XFB-17-PRI	4.16	P-B17	4.16	0.00%
XFB-20 SEC	0.208	B136A	0.208	0.10%
XFB-20 SEC	0.208	B136C	0.208	0.10%
XFB-20-PRI	4.16	XFB-20 SEC	0.208	0.00%

Voltage Drop Report

From Bus		To Bus		Drop
Name	Base kV	Name	Base kV	%
XFB-20-PRI	4.16	P-B20	4.16	0.00%
XFC-8A PRI	4.16	XFC-8B SEC	0.208	0.20%
XFC-8C PRI	4.16	XFC-8C SEC	0.208	0.20%
XFC-B2B5 PRI	4.16	XFC-B2B5-SEC	0.48	0.10%
XFC-B2B5-SEC	0.48	B-3	0.48	0.10%
XFC-B2B5-SEC	0.48	B-5	0.48	0.00%
XFD-17 PRI	4.16	XFD-17 SEC	0.208	0.30%
XFD-17 PRI	4.16	D-17	4.16	0.00%
XFD-17 PRI_B	4.16	XFD-19 SEC	0.208	0.30%
XFD-17 PRI_B	4.16	D18	4.16	0.00%
XFD-17-1 PRI	4.16	XFD-17-1 SEC	0.208	0.30%
XFD-17-1 PRI	4.16	D-17-1	4.16	0.00%
XFD-17-1 PRI_A	4.16	XFD-36A SEC	0.208	0.10%
XFD-17-1 PRI_A	4.16	D-17-1_A	4.16	0.00%
XFD-18 PRI	4.16	XFD-18-SEC	0.208	0.30%
XFD-18 PRI	4.16	D18	4.16	0.00%
XFD-18-SEC	0.208	B341	0.208	0.10%
XFD-19 SEC	0.208	B68	0.208	0.10%
XFD-25 PRI	4.16	XFD-25-SEC	0.208	0.30%
XFD-25 PRI	4.16	D24	4.16	0.00%
XFD-25-SEC	0.208	B191	0.208	0.10%
XFD-35 PRI	4.16	XFD-35 SEC	0.208	0.10%
XFD-35 PRI	4.16	D-35	4.16	0.00%
XFD-36-D1	4.16	B-221	0.208	0.10%
XFD-36-D2	4.16	USAP B70	0.208	0.00%
XFD-42-B PRI	4.16	XFD-42A SEC_A	0.208	0.10%
XFD-42-B PRI	4.16	JB-4	4.16	0.00%
XFD-42A-PRI	4.16	XFD-42A SEC	0.208	0.10%
XFD-42A-PRI	4.16	JB-3	4.16	0.00%
XFD-44	4.16	XFD-44-SEC	0.208	0.00%
XFD-45-PRI	4.16	XFD-45-SEC	0.208	0.00%
XFE-A PRI	4.16	BLDG 10	0.48	0.50%
XFE-B PRI	4.16	XFE-B SEC	0.208	0.60%
XFF-D-PRI	4.16	XFF-D-SEC	0.48	0.20%
XFF-D-PRI	4.16	JB-6B	4.16	0.00%

Technical Calculations

E003-Electrical

Calculation Title:

McMurdo Station Antarctica

Short-Circuit Calculations

July 19, 2017

Prepared For:

NSF/ASC

Prepared By:

Merrick & Company

5970 Greenwood Plaza Blvd.

Greenwood Village, Co 80111-4703

TABLE OF CONTENTS

SECTION 1 EXECUTIVE SUMMARY

An EasyPower™ model was created for McMurdo Station for the existing electrical system to analyze existing fault conditions. The electrical system consists of a 4.16kV micro-grid with multiple power generation sources. The system was modeled with three reciprocating generators online assuming this operating scenario will generate the highest fault currents imposed onto the system. It is anticipated that the site will likely not operate more than three units based on the forecasted load.

Tabulated results are provided at the end of this report. Results generally indicate low fault currents in comparison to typical equipment available interrupting ratings (AIC). Equipment verification of existing equipment is outside of this scope; however, there does not appear to be a problem with existing equipment ratings against the available short-circuit currents.

Building 166, B188, and B167 original overhead feeder was removed due to low clearance issues and their power source was relocate from Feeder B to Feeder D. A new 650-ft, #4, 600V cable was installed between pole D-35 and an existing pole located adjacent of B166. Secondary feeders to these buildings are excessive and subject to low service voltage. Low voltage conditions will occur when building occupancy increases during construction causing mechanical system failures. Building fault currents are too low and branch breakers are subject to long time trip delays. Failure to trip a breaker during a fault condition could lead to a building fire if not corrected. Corrective action is required for these facilities.

SECTION 2 INTRODUCTION

CODES, STANDARDS, REFERENCES:

UFC 3-501-01 (6 Oct 2015) Electrical Engineering

UFC 3-550-01 Exterior Electrical Power Distribution (1 September, 2-16)

NFPA 70E Standard for Electrical Safety in the Work Place

NFPA 70 National Electrical Code 2017

IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems.

This study assesses the existing fault current associated with McMurdo's existing 4.16kV power generation and distribution system. Fault currents will vary depending on the number of generator running on line. This study will assume that a maximum of three generators will be operating on a single event. Two generators will typically be running under normal condition but the highest fault currents will occur on rare occasions when three are running. Therefore, the calculation will evaluate the worst-case condition and size the equipment accordingly. Reciprocating generators produce higher fault currents than inverter base technologies as used by microturbines and wind turbines. Reciprocating engines will be used for fault calculations in order to calculate the highest fault currents.

AIMS will include a number of construction phases and the fault currents results will vary slightly as feeders are reconfigured. The EasyPower™ model is configured to evaluate each construction phase to recalculate the fault currents as system modifications occur. The calculated results will provide guidance in properly specifying AIC ratings for each electrical equipment and adjusting overcurrent protective device settings to achieve system protective coordination. Coordination studies will be provided on a separate report.

SECTION 3 GENERAL CRITERIA

The existing site will remain in operation during all AIMS phased construction. The modeling will be performed based on the following assumption:

1. Existing overhead feeders scheduled to remain will be modeled based on as-built data provided that indicates feeder size and distances. Adjustments to the data was made based on Merrick's findings from 2017 Deployment.
2. Scott Base and Wind Turbines will not be considered as power generation source into the system model for the purpose of this study. The study will focus on McMurdo feeder fault conditions from the existing power plant with a maximum of three generators in operation which will generate the worst case fault condition..
3. Existing building secondary conductors will be evaluated based on existing installed configuration. Conductors distance will be calculated from existing AutoCAD site drawings.
4. McMurdo power plant operating output voltage at nominal voltage of 4.16kV (1.0 p.u)
5. Merrick was informed by McMurdo Site utilities that existing transformers do not have load tap changers. Therefore, calculations will be based without adjusted tap settings on transformers.
6. Transformer impedance data is not available. All calculations will be based on an assumed 5% impedance on transformers.

SECTION 4 DESIGN INPUT

1. Existing feeder conductors sizes, distances, and configuration provided by as-built drawings and field verification results gathered during Merrick's 2017 McMurdo deployment.
2. Existing transformers sizes and rated nominal voltage rating.
3. Individual transformer impedances are not available; therefore, an assumed input of 5% impedance.
4. Generation equipment will be modeled based on on-site data collection and data provided by the owner.
5. Individual Generator impedance data will be incorporated into the model with an adjusted KW rating due to fuel source.
6. EasyPower™ Set points:
    a. Bus under voltage=0.95pu
    b. Bus over voltage= 1.05pu
    c. Overload Threshold= -10% of rating
    d. X/R ANSI Calculation Method
    e. 3-phase Fault

SECTION 5 METHODOLOGY

An EasyPower™ electrical model for McMurdo Station was developed that includes all system components of the existing 5kV distribution system. AIMS construction phasing will impose system modifications where feeder configurations will change the available fault currents at various site locations. Multiple calculations will be conducted and compared to the worst-case scenario to determine if fault currents reach an undesirable level.

The model will provide future support in analyzing future system modifications as construction progresses. The model will be available for further dynamic and stability analysis outside of this scope when system base loading drops below existing conditions or new power generation technology is introduced. Loop feed breakers will be operated and system loading will be analyzed to overall system performance evaluation.

SECTION 6 REFERENCES

Refer to Section 1 Introduction.

SECTION 7 CONCLUSIONS

Modifications to the existing overhead system had no significant change in fault currents between the existing and the new proposed feeder modifications. No further action is required in existing electrical equipment to support the new primary installation. AIMS is required to conduct individual fault studies for all new structures based on the service entrance equipment specified.

SECTION 8 CALCULATIONS

HV Momentary Report

EasyPower 9.8.1.490 07/19/17 19:05:40 C:\...\McM Primary Distribution.dez
EasyPower LLC.
Comments :

Vpu=1.0

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
A-31	4.16	3361.5	3430.7	8739.8	5	3361.5
					8	3361.5
					12	3361.5
					15	3361.5
B18	4.16	4145.6	4529.8	10778.4	5	4145.6
					8	4145.6
					12	4145.6
					15	4145.6
BUS-1	4.16	4981.5	7932.6	12952	5	6247.7
					8	5700.4
					12	5348.7
					15	5199.7
BUS-2	4.16	4919.8	7614.6	12791.5	5	5997.3
					8	5472
					12	5134.3
					15	4991.3
BUS-3	4.16	4944	7736.4	12854.5	5	6093.2
					8	5559.5
					12	5216.4
					15	5071.2
BUS-4	4.16	4938.7	7709.6	12840.7	5	6072.1
					8	5540.2
					12	5198.3
					15	5053.6
BUS-5	4.16	4933.5	7682.9	12827	5	6051.1
					8	5521
					12	5180.4
					15	5036.1
BUS-6	4.16	4928.2	7656.5	12813.3	5	6030.2
					8	5502
					12	5162.5
					15	5018.7
BUS-7	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
BUS-8	4.16	4888.5	7462.6	12710	5	5877.6
					8	5362.7
					12	5031.8
					15	4891.7
BUS-9_C	4.16	4947.5	7782.5	12863.6	5	6129.5
					8	5592.6
					12	5247.5
					15	5101.3
BUS-9_G	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
BUS-15	4.16	1930.5	1954	5019.2	5	1930.5
					8	1930.5
					12	1930.5
					15	1930.5

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
BUS-27	4.16	3231.2	3309	8401	5	3231.2
					8	3231.2
					12	3231.2
					15	3231.2
CORE FREEZER PRI	4.16	4484.8	5891	11660.5	5	4639.7
					8	4484.8
					12	4484.8
					15	4484.8
D-17	4.16	3554.2	3719.4	9241	5	3554.2
					8	3554.2
					12	3554.2
					15	3554.2
D-17-1	4.16	3537.5	3696.4	9197.5	5	3537.5
					8	3537.5
					12	3537.5
					15	3537.5
D-17-1_A	4.16	3009.9	3067.9	7825.9	5	3009.9
					8	3009.9
					12	3009.9
					15	3009.9
D-29	4.16	3107.3	3165.1	8078.9	5	3107.3
					8	3107.3
					12	3107.3
					15	3107.3
D-30	4.16	2981.9	3024.4	7753	5	2981.9
					8	2981.9
					12	2981.9
					15	2981.9
D-31	4.16	2915.6	2951.6	7580.7	5	2915.6
					8	2915.6
					12	2915.6
					15	2915.6
D-33	4.16	2877.5	2910.1	7481.4	5	2877.5
					8	2877.5
					12	2877.5
					15	2877.5
D-34	4.16	2826.2	2854.8	7348.1	5	2826.2
					8	2826.2
					12	2826.2
					15	2826.2
D-35	4.16	2782.5	2808	7234.5	5	2782.5
					8	2782.5
					12	2782.5
					15	2782.5
D-38	4.16	4360.2	5428.4	11336.5	5	4360.2
					8	4360.2
					12	4360.2
					15	4360.2

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
D-41	4.16	4015.5	4467.9	10440.4	5	4015.5
					8	4015.5
					12	4015.5
					15	4015.5
D-42	4.16	3959.6	4356.6	10294.9	5	3959.6
					8	3959.6
					12	3959.6
					15	3959.6
D-43	4.16	3901.6	4248.7	10144.1	5	3901.6
					8	3901.6
					12	3901.6
					15	3901.6
D-44	4.16	3845.7	4151	9998.8	5	3845.7
					8	3845.7
					12	3845.7
					15	3845.7
D10	4.16	4035.4	4538.5	10492.1	5	4035.4
					8	4035.4
					12	4035.4
					15	4035.4
D11	4.16	3958.9	4378.6	10293.2	5	3958.9
					8	3958.9
					12	3958.9
					15	3958.9
D12	4.16	3882.2	4233	10093.7	5	3882.2
					8	3882.2
					12	3882.2
					15	3882.2
D13	4.16	3794.2	4080.5	9864.9	5	3794.2
					8	3794.2
					12	3794.2
					15	3794.2
D14	4.16	3716.8	3956.5	9663.7	5	3716.8
					8	3716.8
					12	3716.8
					15	3716.8
D15	4.16	3653.3	3860.6	9498.6	5	3653.3
					8	3653.3
					12	3653.3
					15	3653.3
D16	4.16	3602.9	3787.5	9367.5	5	3602.9
					8	3602.9
					12	3602.9
					15	3602.9
D17-2	4.16	3502.3	3648.8	9105.9	5	3502.3
					8	3502.3
					12	3502.3
					15	3502.3

D17-2_A	4.16	2997.3	3054.3	7792.9	5	2997.3
					8	2997.3
					12	2997.3
					15	2997.3
D18	4.16	3791.5	4076	9857.9	5	3791.5
					8	3791.5
					12	3791.5
					15	3791.5
D19	4.16	3695.6	3923.9	9608.5	5	3695.6
					8	3695.6
					12	3695.6
					15	3695.6
D20	4.16	3610.7	3798.7	9387.9	5	3610.7
					8	3610.7
					12	3610.7
					15	3610.7
D21	4.16	3532.3	3689.4	9184.1	5	3532.3
					8	3532.3
					12	3532.3
					15	3532.3
D22	4.16	3452.8	3583.6	8977.4	5	3452.8
					8	3452.8
					12	3452.8
					15	3452.8
D23	4.16	3380.5	3491.1	8789.4	5	3380.5
					8	3380.5
					12	3380.5
					15	3380.5
D24	4.16	3312.8	3407.2	8613.2	5	3312.8
					8	3312.8
					12	3312.8
					15	3312.8
D26	4.16	3292.3	3382.3	8560	5	3292.3
					8	3292.3
					12	3292.3
					15	3292.3
D28	4.16	3138.2	3200.6	8159.4	5	3138.2
					8	3138.2
					12	3138.2
					15	3138.2
GEN 1	4.16	1538.8	2460.8	4001	5	1938.1
					8	1768.4
					12	1659.2
					15	1613
GEN 2	4.16	1538.8	2460.8	4001	5	1938.1
					8	1768.4
					12	1659.2
					15	1613

GEN 5	4.16	4968.5	7874.6	12918	5	6202.1
					8	5658.8
					12	5309.6
					15	5161.7
GEN 6	4.16	4968.5	7874.6	12918	5	6202.1
					8	5658.8
					12	5309.6
					15	5161.7
GEN-4	4.16	4973.6	7897.4	12931.3	5	6220
					8	5675.1
					12	5325
					15	5176.7
GEN-155	4.16	1387.8	2371.4	3608.4	5	1867.7
					8	1704.1
					12	1598.9
					15	1554.4
JB	4.16	4359.3	5661.7	11334.2	5	4459.2
					8	4359.3
					12	4359.3
					15	4359.3
JB-1A	4.16	4922.9	7630.2	12799.6	5	6009.5
					8	5483.1
					12	5144.8
					15	5001.5
JB-3	4.16	3375.7	3480	8776.9	5	3375.7
					8	3375.7
					12	3375.7
					15	3375.7
JB-3A	4.16	4912	7576.1	12771.1	5	5966.9
					8	5444.2
					12	5108.3
					15	4966
JB-4	4.16	3338.8	3435.9	8680.8	5	3338.8
					8	3338.8
					12	3338.8
					15	3338.8
JB-5	4.16	2213.8	2245.5	5755.8	5	2213.8
					8	2213.8
					12	2213.8
					15	2213.8
JB-6B	4.16	4961.8	7828.1	12900.6	5	6165.4
					8	5625.4
					12	5278.3
					15	5131.2
JB-36D	4.16	3220.6	3297	8373.6	5	3220.6
					8	3220.6
					12	3220.6
					15	3220.6

JB-A1	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
JB-A2	4.16	4061.2	4385.6	10559.2	5	4061.2
					8	4061.2
					12	4061.2
					15	4061.2
JB-C1	4.16	4669.8	6681.9	12141.5	5	5262.7
					8	4801.7
					12	4669.8
					15	4669.8
JB-E1	4.16	4545.8	6131.9	11819.1	5	4829.5
					8	4545.8
					12	4545.8
					15	4545.8
JB-TSPG	4.16	4890.2	7470.9	12714.6	5	5884.1
					8	5368.7
					12	5037.4
					15	4897.1
JB-WP	4.16	4953	7782.4	12877.7	5	6129.4
					8	5592.5
					12	5247.4
					15	5101.3
KIWI	4.16	1808.7	1811.8	4702.5	5	1808.7
					8	1808.7
					12	1808.7
					15	1808.7
P-A1	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-A2	4.16	4936	7695.6	12833.5	5	6061
					8	5530.1
					12	5188.9
					15	5044.4
P-A3	4.16	4844.6	6908.3	12596	5	5441
					8	4964.4
					12	4844.6
					15	4844.6
P-A4	4.16	4801.8	6607	12484.7	5	5203.7
					8	4801.8
					12	4801.8
					15	4801.8
P-A5	4.16	4705.6	6076.4	12234.7	5	4785.8
					8	4705.6
					12	4705.6
					15	4705.6

P-A6	4.16	4559.3	5500.6	11854.2	5	4559.3
					8	4559.3
					12	4559.3
					15	4559.3
P-A7	4.16	4488.1	5281.3	11669	5	4488.1
					8	4488.1
					12	4488.1
					15	4488.1
P-A8	4.16	4383.5	5006.3	11397.2	5	4383.5
					8	4383.5
					12	4383.5
					15	4383.5
P-A9	4.16	4331.6	4926	11262.3	5	4331.6
					8	4331.6
					12	4331.6
					15	4331.6
P-A9_A	4.16	4273.5	4837.4	11111.2	5	4273.5
					8	4273.5
					12	4273.5
					15	4273.5
P-A10	4.16	4327.1	4875.4	11250.4	5	4327.1
					8	4327.1
					12	4327.1
					15	4327.1
P-A10 COMMON D	4.16	4456.5	5860.9	11586.8	5	4616
					8	4456.5
					12	4456.5
					15	4456.5
P-A18	4.16	4237.1	4686.4	11016.6	5	4237.1
					8	4237.1
					12	4237.1
					15	4237.1
P-A19	4.16	4135.4	4495.3	10752	5	4135.4
					8	4135.4
					12	4135.4
					15	4135.4
P-A20	4.16	4106.1	4444	10675.9	5	4106.1
					8	4106.1
					12	4106.1
					15	4106.1
P-A21	4.16	3980.5	4238.5	10349.4	5	3980.5
					8	3980.5
					12	3980.5
					15	3980.5
P-A22	4.16	3980.5	4238.5	10349.4	5	3980.5
					8	3980.5
					12	3980.5
					15	3980.5

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
P-A22 - D COMMON	4.16	4272.7	5120.2	11109	5	4272.7
					8	4272.7
					12	4272.7
					15	4272.7
P-A22.	4.16	4274.6	5126.4	11114	5	4274.6
					8	4274.6
					12	4274.6
					15	4274.6
P-A23	4.16	3881.5	4090.2	10091.9	5	3881.5
					8	3881.5
					12	3881.5
					15	3881.5
P-A24	4.16	3752.6	3910.9	9756.7	5	3752.6
					8	3752.6
					12	3752.6
					15	3752.6
P-A25	4.16	3652.2	3779.6	9495.7	5	3652.2
					8	3652.2
					12	3652.2
					15	3652.2
P-A26	4.16	3663.7	3798.6	9525.6	5	3663.7
					8	3663.7
					12	3663.7
					15	3663.7
P-A28	4.16	3586.2	3700.2	9324.1	5	3586.2
					8	3586.2
					12	3586.2
					15	3586.2
P-A29	4.16	3530.9	3631.8	9180.3	5	3530.9
					8	3530.9
					12	3530.9
					15	3530.9
P-A30	4.16	3430.3	3511.1	8918.8	5	3430.3
					8	3430.3
					12	3430.3
					15	3430.3
P-A32	4.16	3277.9	3335.2	8522.7	5	3277.9
					8	3277.9
					12	3277.9
					15	3277.9
P-A33	4.16	3264.2	3319.7	8486.9	5	3264.2
					8	3264.2
					12	3264.2
					15	3264.2
P-B	4.16	4905.4	7544	12754	5	5941.7
					8	5421.2
					12	5086.7
					15	4945

P-B2	4.16	4890	7462.7	12713.9	5	5877.6
					8	5362.7
					12	5031.8
					15	4891.7
P-B3	4.16	4816.8	6821.6	12523.8	5	5372.7
					8	4902.1
					12	4816.8
					15	4816.8
P-B3.	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-B4	4.16	4741.5	6361.9	12327.9	5	5010.6
					8	4741.5
					12	4741.5
					15	4741.5
P-B5	4.16	4666.6	5980	12133	5	4709.8
					8	4666.6
					12	4666.6
					15	4666.6
P-B6	4.16	4606.5	5727.7	11976.8	5	4606.5
					8	4606.5
					12	4606.5
					15	4606.5
P-B8	4.16	4527.9	5448.7	11772.6	5	4527.9
					8	4527.9
					12	4527.9
					15	4527.9
P-B9	4.16	4449.2	5211.3	11567.9	5	4449.2
					8	4449.2
					12	4449.2
					15	4449.2
P-B10	4.16	4378.5	5025	11384.2	5	4378.5
					8	4378.5
					12	4378.5
					15	4378.5
P-B11	4.16	4314.2	4910	11216.8	5	4314.2
					8	4314.2
					12	4314.2
					15	4314.2
P-B12	4.16	4294.8	4864.9	11166.6	5	4294.8
					8	4294.8
					12	4294.8
					15	4294.8
P-B13	4.16	4234.3	4731.5	11009.3	5	4234.3
					8	4234.3
					12	4234.3
					15	4234.3

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
P-B14	4.16	4163	4587.1	10823.9	5	4163
					8	4163
					12	4163
					15	4163
P-B15	4.16	4087.9	4447.2	10628.5	5	4087.9
					8	4087.9
					12	4087.9
					15	4087.9
P-B16	4.16	4328.1	4904.4	11253.1	5	4328.1
					8	4328.1
					12	4328.1
					15	4328.1
P-B17	4.16	4237.1	4707	11016.4	5	4237.1
					8	4237.1
					12	4237.1
					15	4237.1
P-B20	4.16	4233.5	4727.5	11007.2	5	4233.5
					8	4233.5
					12	4233.5
					15	4233.5
P-C1	4.16	4924.2	7636.4	12802.9	5	6014.4
					8	5487.6
					12	5149
					15	5005.6
P-C2	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C3	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C4	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C5	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C6	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C7	4.16	0	0	0	5	0
					8	0
					12	0
					15	0

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
P-C8	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-C9	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D2	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D4	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D5	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D6	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D7	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D8	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
P-D9	4.16	4098.7	4684.8	10656.7	5	4098.7
					8	4098.7
					12	4098.7
					15	4098.7
P-D33	4.16	4216.5	5002.4	10963	5	4216.5
					8	4216.5
					12	4216.5
					15	4216.5
P-D36	4.16	3225.9	3302.8	8387.3	5	3225.9
					8	3225.9
					12	3225.9
					15	3225.9
P-D37NC	4.16	4158.1	4836.2	10811	5	4158.1
					8	4158.1
					12	4158.1
					15	4158.1

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
P-D39	4.16	4184.1	4862.2	10878.7	5	4184.1
					8	4184.1
					12	4184.1
					15	4184.1
P-D40	4.16	4073.3	4591.8	10590.5	5	4073.3
					8	4073.3
					12	4073.3
					15	4073.3
POWER PLANT A	4.16	4981.5	7932.6	12952	5	6247.7
					8	5700.4
					12	5348.7
					15	5199.7
POWER PLANT A_A	4.16	4963.4	7836.6	12904.9	5	6172.1
					8	5631.5
					12	5284
					15	5136.8
PUMP HOUSE PRI	4.16	4814	6848	12516.5	5	5393.5
					8	4921
					12	4814
					15	4814
RWE POWERSTORE	4.16	3196.7	3270.7	8311.4	5	3196.7
					8	3196.7
					12	3196.7
					15	3196.7
SW-1	4.16	4949.3	7763.5	12868.2	5	6114.5
					8	5578.9
					12	5234.7
					15	5088.9
SW-2	4.16	4962.4	7831.3	12902.2	5	6167.9
					8	5627.6
					12	5280.4
					15	5133.3
SW-3	4.16	4949.3	7763.5	12868.2	5	6114.5
					8	5578.9
					12	5234.7
					15	5088.9
SW-4	4.16	4933	7680.4	12825.7	5	6049.1
					8	5519.2
					12	5178.6
					15	5034.4
SW-5	4.16	4976.5	7905.6	12938.8	5	6226.5
					8	5681
					12	5330.5
					15	5182
SW-6	4.16	4976.5	7905.6	12938.8	5	6226.4
					8	5681
					12	5330.5
					15	5182

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
SWA-01	4.16	4115.4	4469.2	10700	5	4115.4
					8	4115.4
					12	4115.4
					15	4115.4
SWC-01	4.16	4915.5	7593	12780.2	5	5980.3
					8	5456.4
					12	5119.8
					15	4977.2
SWE-01	4.16	4539.6	6112.3	11803	5	4814.1
					8	4539.6
					12	4539.6
					15	4539.6
T-L (XFE-A)	4.16	4974.7	7896.2	12934.2	5	6219.1
					8	5674.3
					12	5324.2
					15	5175.9
T-PH-1	4.16	4947.1	7752.2	12862.5	5	6105.6
					8	5570.8
					12	5227.1
					15	5081.5
TIE SWITCH AC	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
TW-1 PRI	4.16	4944.2	7737.2	12854.8	5	6093.8
					8	5560
					12	5216.9
					15	5071.6
TW-2 PRI	4.16	4944.2	7737.2	12854.8	5	6093.8
					8	5560
					12	5216.9
					15	5071.6
TW-2 PRI_A	4.16	4947.1	7752.2	12862.5	5	6105.6
					8	5570.8
					12	5227.1
					15	5081.5
XFA-4 PRI	4.16	4743.4	6324.4	12332.9	5	4981.1
					8	4743.4
					12	4743.4
					15	4743.4
XFA-5-PRI	4.16	4633	5810.4	12045.9	5	4633
					8	4633
					12	4633
					15	4633
XFA-6-PRI	4.16	4472	5266.8	11627.2	5	4472
					8	4472
					12	4472
					15	4472

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
XFA-6-PRI_A	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFA-9A-PRI	4.16	4313.6	4888.3	11215.4	5	4313.6
					8	4313.6
					12	4313.6
					15	4313.6
XFA-9B-PRI	4.16	4255.8	4801.3	11065.2	5	4255.8
					8	4255.8
					12	4255.8
					15	4255.8
XFA-10A PRI	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFA-10B-PRI	4.16	4051.5	4373.2	10534	5	4051.5
					8	4051.5
					12	4051.5
					15	4051.5
XFA-19-PRI	4.16	4117.3	4465.8	10705	5	4117.3
					8	4117.3
					12	4117.3
					15	4117.3
XFA-25-PRI	4.16	3636	3759.8	9453.6	5	3636
					8	3636
					12	3636
					15	3636
XFA-25A-PRI	4.16	3636	3759.8	9453.6	5	3636
					8	3636
					12	3636
					15	3636
XFA-32-PRI	4.16	3264	3319.7	8486.3	5	3264
					8	3264
					12	3264
					15	3264
XFA-B3B4 PRI	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFA-HT PRI	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFA-VEOC PRI	4.16	3883.1	4123.4	10096.1	5	3883.1
					8	3883.1
					12	3883.1
					15	3883.1

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
XFB-3-PRI	4.16	4803.8	6734.4	12489.9	5	5304
					8	4839.4
					12	4803.8
					15	4803.8
XFB-11-PRI	4.16	4296.3	4872.6	11170.4	5	4296.3
					8	4296.3
					12	4296.3
					15	4296.3
XFB-12-PRI	4.16	4277	4828.4	11120.1	5	4277
					8	4277
					12	4277
					15	4277
XFB-15-PRI	4.16	4070.3	4418.3	10582.7	5	4070.3
					8	4070.3
					12	4070.3
					15	4070.3
XFB-15A-PRI	4.16	4070.3	4418.3	10582.7	5	4070.3
					8	4070.3
					12	4070.3
					15	4070.3
XFB-17-PRI	4.16	4129.3	4515.7	10736.2	5	4129.3
					8	4129.3
					12	4129.3
					15	4129.3
XFB-20-PRI	4.16	4215.7	4693.7	10960.8	5	4215.7
					8	4215.7
					12	4215.7
					15	4215.7
XFC-8 -XFC-8 PRI	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFC-8A PRI	4.16	4284.3	5460.1	11139.2	5	4300.4
					8	4284.3
					12	4284.3
					15	4284.3
XFC-8C PRI	4.16	3994.5	4790.1	10385.8	5	3994.5
					8	3994.5
					12	3994.5
					15	3994.5
XFC-B2B5 PRI	4.16	4514.1	5686.3	11736.6	5	4514.1
					8	4514.1
					12	4514.1
					15	4514.1
XFD-6-PRI	4.16	0	0	0	5	0
					8	0
					12	0
					15	0

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
XFD-17 PRI	4.16	3539.5	3700	9202.6	5	3539.5
					8	3539.5
					12	3539.5
					15	3539.5
XFD-17 PRI_B	4.16	3775.9	4052.1	9817.4	5	3775.9
					8	3775.9
					12	3775.9
					15	3775.9
XFD-17-1 PRI	4.16	3464.8	3603	9008.4	5	3464.8
					8	3464.8
					12	3464.8
					15	3464.8
XFD-17-1 PRI_A	4.16	2952.2	3003.6	7675.8	5	2952.2
					8	2952.2
					12	2952.2
					15	2952.2
XFD-18 PRI	4.16	3775.9	4052.1	9817.4	5	3775.9
					8	3775.9
					12	3775.9
					15	3775.9
XFD-25 PRI	4.16	3299.2	3391.1	8577.8	5	3299.2
					8	3299.2
					12	3299.2
					15	3299.2
XFD-35 PRI	4.16	2771.9	2796.9	7207	5	2771.9
					8	2771.9
					12	2771.9
					15	2771.9
XFD-36-D1	4.16	2153.4	2183.3	5598.9	5	2153.4
					8	2153.4
					12	2153.4
					15	2153.4
XFD-36-D2	4.16	2003.1	2028.7	5208	5	2003.1
					8	2003.1
					12	2003.1
					15	2003.1
XFD-42-B PRI	4.16	3325	3419.5	8644.9	5	3325
					8	3325
					12	3325
					15	3325
XFD-42A-PRI	4.16	3361.7	3463.2	8740.4	5	3361.7
					8	3361.7
					12	3361.7
					15	3361.7
XFD-44	4.16	3620.6	3819.6	9413.6	5	3620.6
					8	3620.6
					12	3620.6
					15	3620.6

3 PHASE Fault		Total Fault Currents			Fuse Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	2.6*Sym Amps	Test X/R	Duty Amps
XFD-45-PRI	4.16	3769.2	4033.2	9799.8	5	3769.2
					8	3769.2
					12	3769.2
					15	3769.2
XFE-A PRI	4.16	4400.5	5530.5	11441.3	5	4400.5
					8	4400.5
					12	4400.5
					15	4400.5
XFE-B PRI	4.16	4539.6	6112.3	11803	5	4814.1
					8	4539.6
					12	4539.6
					15	4539.6
XFE-C	4.16	0	0	0	5	0
					8	0
					12	0
					15	0
XFF-D-PRI	4.16	4947.1	7752.2	12862.5	5	6105.6
					8	5570.8
					12	5227.1
					15	5081.5

LV Momentary Report

Vpu = 1.00

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
A20-1	0.208	1703.4	1703.4	LVPCB	1703.4
				Fuse X/R = 1.73	1703.4
				Fuse X/R = 4.9	1703.4
				MCCB 10-20 kA	1703.4
				MCCB > 20 kA	1703.4
A22	0.208	4128.6	4128.8	LVPCB	4128.6
				Fuse X/R = 1.73	4128.6
				Fuse X/R = 4.9	4128.6
				MCCB 10-20 kA	4128.6
				MCCB > 20 kA	4128.6
A22-2	0.208	2904.4	2904.4	LVPCB	2904.4
				Fuse X/R = 1.73	2904.4
				Fuse X/R = 4.9	2904.4
				MCCB 10-20 kA	2904.4
				MCCB > 20 kA	2904.4
A22-3	0.208	2000.2	2000.2	LVPCB	2000.2
				Fuse X/R = 1.73	2000.2
				Fuse X/R = 4.9	2000.2
				MCCB 10-20 kA	2000.2
				MCCB > 20 kA	2000.2
A23	0.208	2675.2	2675.2	LVPCB	2675.2
				Fuse X/R = 1.73	2675.2
				Fuse X/R = 4.9	2675.2
				MCCB 10-20 kA	2675.2
				MCCB > 20 kA	2675.2
B-3	0.48	14383.6	18180.9	LVPCB	14383.6
				Fuse X/R = 1.73	18433.2
				Fuse X/R = 4.9	14383.6
				MCCB 10-20 kA	15815
				MCCB > 20 kA	14383.6
B-3 AND B-4	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
B-5	0.48	14383.6	18180.9	LVPCB	14383.6
				Fuse X/R = 1.73	18433.2
				Fuse X/R = 4.9	14383.6
				MCCB 10-20 kA	15815
				MCCB > 20 kA	14383.6
B-15-SEC	0.208	15234.7	15414.6	LVPCB	15234.7
				Fuse X/R = 1.73	15234.7
				Fuse X/R = 4.9	15234.7
				MCCB 10-20 kA	15234.7
				MCCB > 20 kA	15234.7

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
B-15-SEC_A	0.208	5608.4	5608.4	LVPCB	5608.4
				Fuse X/R = 1.73	5608.4
				Fuse X/R = 4.9	5608.4
				MCCB 10-20 kA	5608.4
				MCCB > 20 kA	5608.4
B-15-SEC_B	0.208	5608.4	5608.4	LVPCB	5608.4
				Fuse X/R = 1.73	5608.4
				Fuse X/R = 4.9	5608.4
				MCCB 10-20 kA	5608.4
				MCCB > 20 kA	5608.4
B-155	0.208	20136.4	23654.4	LVPCB	20136.4
				Fuse X/R = 1.73	23956.7
				Fuse X/R = 4.9	20136.4
				MCCB 10-20 kA	20553.9
				MCCB > 20 kA	20136.4
B-167	0.208	464.8	464.8	LVPCB	464.8
				Fuse X/R = 1.73	464.8
				Fuse X/R = 4.9	464.8
				MCCB 10-20 kA	464.8
				MCCB > 20 kA	464.8
B-182 COM	0.208	3064.3	3064.3	LVPCB	3064.3
				Fuse X/R = 1.73	3064.3
				Fuse X/R = 4.9	3064.3
				MCCB 10-20 kA	3064.3
				MCCB > 20 kA	3064.3
B-188	0.208	464.8	464.8	LVPCB	464.8
				Fuse X/R = 1.73	464.8
				Fuse X/R = 4.9	464.8
				MCCB 10-20 kA	464.8
				MCCB > 20 kA	464.8
B-221	0.208	7025	7617.3	LVPCB	7025
				Fuse X/R = 1.73	7546.2
				Fuse X/R = 4.9	7025
				MCCB 10-20 kA	7025
				MCCB > 20 kA	7025
B4-LOUNGE	0.208	1198.2	1198.2	LVPCB	1198.2
				Fuse X/R = 1.73	1198.2
				Fuse X/R = 4.9	1198.2
				MCCB 10-20 kA	1198.2
				MCCB > 20 kA	1198.2
B4-THEATER	0.208	1198.2	1198.2	LVPCB	1198.2
				Fuse X/R = 1.73	1198.2
				Fuse X/R = 4.9	1198.2
				MCCB 10-20 kA	1198.2
				MCCB > 20 kA	1198.2
B7	0.208	2264.9	2267.5	LVPCB	2264.9
				Fuse X/R = 1.73	2264.9
				Fuse X/R = 4.9	2264.9
				MCCB 10-20 kA	2264.9
				MCCB > 20 kA	2264.9

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
B10	0.208	3288.5	3341.5	LVPCB	3288.5
				Fuse X/R = 1.73	3288.5
				Fuse X/R = 4.9	3288.5
				MCCB 10-20 kA	3288.5
				MCCB > 20 kA	3288.5
B68	0.208	17488.3	19047.6	LVPCB	17488.3
				Fuse X/R = 1.73	18912.8
				Fuse X/R = 4.9	17488.3
				MCCB 10-20 kA	17488.3
				MCCB > 20 kA	17488.3
B72	0.208	1671.1	1671.1	LVPCB	1671.1
				Fuse X/R = 1.73	1671.1
				Fuse X/R = 4.9	1671.1
				MCCB 10-20 kA	1671.1
				MCCB > 20 kA	1671.1
B73	0.208	10707.4	11074	LVPCB	10707.4
				Fuse X/R = 1.73	10707.4
				Fuse X/R = 4.9	10707.4
				MCCB 10-20 kA	10707.4
				MCCB > 20 kA	10707.4
B75	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
B129	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
B132	0.208	2479	2479	LVPCB	2479
				Fuse X/R = 1.73	2479
				Fuse X/R = 4.9	2479
				MCCB 10-20 kA	2479
				MCCB > 20 kA	2479
B136A	0.208	6651.6	6652.5	LVPCB	6651.6
				Fuse X/R = 1.73	6651.6
				Fuse X/R = 4.9	6651.6
				MCCB 10-20 kA	6651.6
				MCCB > 20 kA	6651.6
B136C	0.208	6651.6	6652.5	LVPCB	6651.6
				Fuse X/R = 1.73	6651.6
				Fuse X/R = 4.9	6651.6
				MCCB 10-20 kA	6651.6
				MCCB > 20 kA	6651.6
B141	0.208	1887.7	1887.7	LVPCB	1887.7
				Fuse X/R = 1.73	1887.7
				Fuse X/R = 4.9	1887.7
				MCCB 10-20 kA	1887.7
				MCCB > 20 kA	1887.7

B150	0.208	9713	9739.8	LVPCB	9713
				Fuse X/R = 1.73	9713
				Fuse X/R = 4.9	9713
				MCCB 10-20 kA	9713
				MCCB > 20 kA	9713
B159	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
B160	0.208	10707.4	11074	LVPCB	10707.4
				Fuse X/R = 1.73	10707.4
				Fuse X/R = 4.9	10707.4
				MCCB 10-20 kA	10707.4
				MCCB > 20 kA	10707.4
B166	0.208	563.9	563.9	LVPCB	563.9
				Fuse X/R = 1.73	563.9
				Fuse X/R = 4.9	563.9
				MCCB 10-20 kA	563.9
				MCCB > 20 kA	563.9
B168	0.208	1580.2	1580.2	LVPCB	1580.2
				Fuse X/R = 1.73	1580.2
				Fuse X/R = 4.9	1580.2
				MCCB 10-20 kA	1580.2
				MCCB > 20 kA	1580.2
B174	0.208	5736	5806.4	LVPCB	5736
				Fuse X/R = 1.73	5736
				Fuse X/R = 4.9	5736
				MCCB 10-20 kA	5736
				MCCB > 20 kA	5736
B175	0.208	4128.6	4128.8	LVPCB	4128.6
				Fuse X/R = 1.73	4128.6
				Fuse X/R = 4.9	4128.6
				MCCB 10-20 kA	4128.6
				MCCB > 20 kA	4128.6
B182 VEH HTRS 1	0.208	4216.7	4216.7	LVPCB	4216.7
				Fuse X/R = 1.73	4216.7
				Fuse X/R = 4.9	4216.7
				MCCB 10-20 kA	4216.7
				MCCB > 20 kA	4216.7
B182 VEH HTRS 2	0.208	4816.1	4816.1	LVPCB	4816.1
				Fuse X/R = 1.73	4816.1
				Fuse X/R = 4.9	4816.1
				MCCB 10-20 kA	4816.1
				MCCB > 20 kA	4816.1
B185	0.208	5736	5806.4	LVPCB	5736
				Fuse X/R = 1.73	5736
				Fuse X/R = 4.9	5736
				MCCB 10-20 kA	5736
				MCCB > 20 kA	5736

B191	0.208	18488.3	20270.8	LVPCB	18488.3
				Fuse X/R = 1.73	20189
				Fuse X/R = 4.9	18488.3
				MCCB 10-20 kA	18488.3
				MCCB > 20 kA	18488.3
B192	0.208	2928.4	2928.5	LVPCB	2928.4
				Fuse X/R = 1.73	2928.4
				Fuse X/R = 4.9	2928.4
				MCCB 10-20 kA	2928.4
				MCCB > 20 kA	2928.4
B341	0.208	17488.3	19047.6	LVPCB	17488.3
				Fuse X/R = 1.73	18912.8
				Fuse X/R = 4.9	17488.3
				MCCB 10-20 kA	17488.3
				MCCB > 20 kA	17488.3
B344	0.208	806.6	806.6	LVPCB	806.6
				Fuse X/R = 1.73	806.6
				Fuse X/R = 4.9	806.6
				MCCB 10-20 kA	806.6
				MCCB > 20 kA	806.6
BLDG 10	0.48	12248.3	15593.4	LVPCB	12248.3
				Fuse X/R = 1.73	15802.9
				Fuse X/R = 4.9	12328.5
				MCCB 10-20 kA	13558.3
				MCCB > 20 kA	12328.5
BUILDING 4	0.208	13842	14054.4	LVPCB	13842
				Fuse X/R = 1.73	13842
				Fuse X/R = 4.9	13842
				MCCB 10-20 kA	13842
				MCCB > 20 kA	13842
BUS-9	0.208	273.2	273.2	LVPCB	273.2
				Fuse X/R = 1.73	273.2
				Fuse X/R = 4.9	273.2
				MCCB 10-20 kA	273.2
				MCCB > 20 kA	273.2
BUS-10	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
CORE FREEZER SEC	0.48	12322.9	15909.6	LVPCB	12322.9
				Fuse X/R = 1.73	16106.3
				Fuse X/R = 4.9	12565.1
				MCCB 10-20 kA	13818.6
				MCCB > 20 kA	12565.1
D-40 SEC	0.208	1522.8	1522.8	LVPCB	1522.8
				Fuse X/R = 1.73	1522.8
				Fuse X/R = 4.9	1522.8
				MCCB 10-20 kA	1522.8
				MCCB > 20 kA	1522.8

D39 SEC	0.208	2928.4	2928.5	LVPCB	2928.4
				Fuse X/R = 1.73	2928.4
				Fuse X/R = 4.9	2928.4
				MCCB 10-20 kA	2928.4
				MCCB > 20 kA	2928.4
D40 SEC	0.208	2265	2265	LVPCB	2265
				Fuse X/R = 1.73	2265
				Fuse X/R = 4.9	2265
				MCCB 10-20 kA	2265
				MCCB > 20 kA	2265
HT-165	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
HTA	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
HTA_A	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
HTA_B	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
HTP#1	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
HTP#2	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
HTP-5	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
HTP3	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0

HTP4	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
HTP6	0.48	4684.6	5408.8	LVPCB	4684.6
				Fuse X/R = 1.73	5465.7
				Fuse X/R = 4.9	4684.6
				MCCB 10-20 kA	4689.3
				MCCB > 20 kA	4684.6
LDB HE COMPRESS	0.208	13400	13576	LVPCB	13400
				Fuse X/R = 1.73	13400
				Fuse X/R = 4.9	13400
				MCCB 10-20 kA	13400
				MCCB > 20 kA	13400
LOAD BANKS	0.48	15470.7	21420	LVPCB	15880.3
				Fuse X/R = 1.73	21498.5
				Fuse X/R = 4.9	16771.8
				MCCB 10-20 kA	18444.9
				MCCB > 20 kA	16771.8
P-35 SEC	0.208	16748	17944.8	LVPCB	16748
				Fuse X/R = 1.73	17652.3
				Fuse X/R = 4.9	16748
				MCCB 10-20 kA	16748
				MCCB > 20 kA	16748
P-A20-1	0.208	9794.5	9971.1	LVPCB	9794.5
				Fuse X/R = 1.73	9794.5
				Fuse X/R = 4.9	9794.5
				MCCB 10-20 kA	9794.5
				MCCB > 20 kA	9794.5
P-A26 LITE SOUTH	0.208	1744.5	1744.5	LVPCB	1744.5
				Fuse X/R = 1.73	1744.5
				Fuse X/R = 4.9	1744.5
				MCCB 10-20 kA	1744.5
				MCCB > 20 kA	1744.5
P-A26 SEC	0.208	2715.1	2716.1	LVPCB	2715.1
				Fuse X/R = 1.73	2715.1
				Fuse X/R = 4.9	2715.1
				MCCB 10-20 kA	2715.1
				MCCB > 20 kA	2715.1
P-A27	0.208	1612.3	1612.3	LVPCB	1612.3
				Fuse X/R = 1.73	1612.3
				Fuse X/R = 4.9	1612.3
				MCCB 10-20 kA	1612.3
				MCCB > 20 kA	1612.3
P-A30-SEC	0.208	3507.8	3512.6	LVPCB	3507.8
				Fuse X/R = 1.73	3507.8
				Fuse X/R = 4.9	3507.8
				MCCB 10-20 kA	3507.8
				MCCB > 20 kA	3507.8

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
P-A31 (SEC)	0.208	5295.8	5359.8	LVPCB	5295.8
				Fuse X/R = 1.73	5295.8
				Fuse X/R = 4.9	5295.8
				MCCB 10-20 kA	5295.8
				MCCB > 20 kA	5295.8
P-A31 SEC WEST	0.208	3507.8	3512.6	LVPCB	3507.8
				Fuse X/R = 1.73	3507.8
				Fuse X/R = 4.9	3507.8
				MCCB 10-20 kA	3507.8
				MCCB > 20 kA	3507.8
P-B1	0.208	3689	3831.6	LVPCB	3689
				Fuse X/R = 1.73	3689
				Fuse X/R = 4.9	3689
				MCCB 10-20 kA	3689
				MCCB > 20 kA	3689
P-B3-SEC	0.208	3840.3	4006.5	LVPCB	3840.3
				Fuse X/R = 1.73	3851.2
				Fuse X/R = 4.9	3840.3
				MCCB 10-20 kA	3840.3
				MCCB > 20 kA	3840.3
P-B5-SEC	0.208	1651.7	1651.9	LVPCB	1651.7
				Fuse X/R = 1.73	1651.7
				Fuse X/R = 4.9	1651.7
				MCCB 10-20 kA	1651.7
				MCCB > 20 kA	1651.7
P-B82	0.208	2161	2162.7	LVPCB	2161
				Fuse X/R = 1.73	2161
				Fuse X/R = 4.9	2161
				MCCB 10-20 kA	2161
				MCCB > 20 kA	2161
P-B82_A	0.208	1460.1	1460.1	LVPCB	1460.1
				Fuse X/R = 1.73	1460.1
				Fuse X/R = 4.9	1460.1
				MCCB 10-20 kA	1460.1
				MCCB > 20 kA	1460.1
P-C4 SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C4-1	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C5 SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
P-C6 SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C6-1	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C6-2	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C7 SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
P-C8 SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
POLE - B166	0.208	631.2	631.2	LVPCB	631.2
				Fuse X/R = 1.73	631.2
				Fuse X/R = 4.9	631.2
				MCCB 10-20 kA	631.2
				MCCB > 20 kA	631.2
POLE 167	0.208	509.6	509.6	LVPCB	509.6
				Fuse X/R = 1.73	509.6
				Fuse X/R = 4.9	509.6
				MCCB 10-20 kA	509.6
				MCCB > 20 kA	509.6
PUMP HOUSE-SEC	0.48	2548.9	2765.9	LVPCB	2548.9
				Fuse X/R = 1.73	2741.3
				Fuse X/R = 4.9	2548.9
				MCCB 10-20 kA	2548.9
				MCCB > 20 kA	2548.9
SCOTT BASE G1	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
SCOTT BASE G2	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
T-PH-1 SEC	0.48	15436.8	21302.7	LVPCB	15801.5
				Fuse X/R = 1.73	21391.8
				Fuse X/R = 4.9	16688.5
				MCCB 10-20 kA	18353.3
				MCCB > 20 kA	16688.5
T-W-1 SEC	0.208	35615	49131.6	LVPCB	36445.7
				Fuse X/R = 1.73	49339.5
				Fuse X/R = 4.9	38491.6
				MCCB 10-20 kA	42331.4
				MCCB > 20 kA	38491.6
T-W-2 SEC	0.48	15433.2	21290.4	LVPCB	15793.1
				Fuse X/R = 1.73	21380.5
				Fuse X/R = 4.9	16679.7
				MCCB 10-20 kA	18343.6
				MCCB > 20 kA	16679.7
T-W-2 SEC_A	0.208	35623.3	49160.2	LVPCB	36464.9
				Fuse X/R = 1.73	49365.6
				Fuse X/R = 4.9	38511.9
				MCCB 10-20 kA	42353.7
				MCCB > 20 kA	38511.9
USAP B70	0.208	6946	7515.4	LVPCB	6946
				Fuse X/R = 1.73	7436.5
				Fuse X/R = 4.9	6946
				MCCB 10-20 kA	6946
				MCCB > 20 kA	6946
VEHICLE HTRS	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
VEOC	0.48	8914.1	10474.8	LVPCB	8914.1
				Fuse X/R = 1.73	10609
				Fuse X/R = 4.9	8914.1
				MCCB 10-20 kA	9102.1
				MCCB > 20 kA	8914.1
WTG-SOURCE-1	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-SOURCE-2	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-SOURCE-3	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
WTG-1	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-1_A	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-1_B	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-1_C	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
WTG-2	0.4	80	80	LVPCB	80
				Fuse X/R = 1.73	80
				Fuse X/R = 4.9	80
				MCCB 10-20 kA	80
				MCCB > 20 kA	80
XFA-4 SEC	0.48	4787.6	5634.6	LVPCB	4787.6
				Fuse X/R = 1.73	5707.7
				Fuse X/R = 4.9	4787.6
				MCCB 10-20 kA	4897
				MCCB > 20 kA	4787.6
XFA-5-SEC	0.208	21829.4	27241.5	LVPCB	21829.4
				Fuse X/R = 1.73	27635.5
				Fuse X/R = 4.9	21829.4
				MCCB 10-20 kA	23710.1
				MCCB > 20 kA	21829.4
XFA-6-SEC	0.208	21653.4	26581.7	LVPCB	21653.4
				Fuse X/R = 1.73	26975
				Fuse X/R = 4.9	21653.4
				MCCB 10-20 kA	23143.5
				MCCB > 20 kA	21653.4
XFA-6-SEC_A	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFA-9-A-SEC	0.208	21481.8	26035.3	LVPCB	21481.8
				Fuse X/R = 1.73	26417.6
				Fuse X/R = 4.9	21481.8
				MCCB 10-20 kA	22665.3
				MCCB > 20 kA	21481.8

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
XFA-9-B-SEC	0.208	21413.1	25903.6	LVPCB	21413.1
				Fuse X/R = 1.73	26282.8
				Fuse X/R = 4.9	21413.1
				MCCB 10-20 kA	22549.6
				MCCB > 20 kA	21413.1
XFA-10A-SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFA-10B-SEC	0.208	21202.3	25144.4	LVPCB	21202.3
				Fuse X/R = 1.73	25487.3
				Fuse X/R = 4.9	21202.3
				MCCB 10-20 kA	21867.1
				MCCB > 20 kA	21202.3
XFA-19-SEC	0.208	21281.4	25310.2	LVPCB	21281.4
				Fuse X/R = 1.73	25660.5
				Fuse X/R = 4.9	21281.4
				MCCB 10-20 kA	22015.7
				MCCB > 20 kA	21281.4
XFA-25-A-SEC	0.208	20746.4	23834.9	LVPCB	20746.4
				Fuse X/R = 1.73	24065.1
				Fuse X/R = 4.9	20746.4
				MCCB 10-20 kA	20746.4
				MCCB > 20 kA	20746.4
XFA-25-SEC	0.208	20746.4	23834.9	LVPCB	20746.4
				Fuse X/R = 1.73	24065.1
				Fuse X/R = 4.9	20746.4
				MCCB 10-20 kA	20746.4
				MCCB > 20 kA	20746.4
XFA-32-SEC	0.208	7415.9	8110.9	LVPCB	7415.9
				Fuse X/R = 1.73	8069.3
				Fuse X/R = 4.9	7415.9
				MCCB 10-20 kA	7415.9
				MCCB > 20 kA	7415.9
XFA-B3B4 SEC.	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFA-HT-SEC	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFB-3-SEC	0.208	4003.1	4198.6	LVPCB	4003.1
				Fuse X/R = 1.73	4058.8
				Fuse X/R = 4.9	4003.1
				MCCB 10-20 kA	4003.1
				MCCB > 20 kA	4003.1

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
XFB-11 SEC	0.208	21459.8	26013.8	LVPCB	21459.8
				Fuse X/R = 1.73	26395.9
				Fuse X/R = 4.9	21459.8
				MCCB 10-20 kA	22646.7
				MCCB > 20 kA	21459.8
XFB-12 SEC	0.208	11173.3	12934.4	LVPCB	11173.3
				Fuse X/R = 1.73	13075.6
				Fuse X/R = 4.9	11173.3
				MCCB 10-20 kA	11218.3
				MCCB > 20 kA	11173.3
XFB-15 SEC	0.208	21217.3	25234.3	LVPCB	21217.3
				Fuse X/R = 1.73	25583.6
				Fuse X/R = 4.9	21217.3
				MCCB 10-20 kA	21949.7
				MCCB > 20 kA	21217.3
XFB-15A SEC	0.48	4813.1	5531.5	LVPCB	4813.1
				Fuse X/R = 1.73	5585.3
				Fuse X/R = 4.9	4813.1
				MCCB 10-20 kA	4813.1
				MCCB > 20 kA	4813.1
XFB-17 SEC	0.208	21284.1	25410.4	LVPCB	21284.1
				Fuse X/R = 1.73	25768.3
				Fuse X/R = 4.9	21284.1
				MCCB 10-20 kA	22108.2
				MCCB > 20 kA	21284.1
XFB-20 SEC	0.208	21374	25722.9	LVPCB	21374
				Fuse X/R = 1.73	26095.1
				Fuse X/R = 4.9	21374
				MCCB 10-20 kA	22388.6
				MCCB > 20 kA	21374
XFC-8-SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFC-8A SEC	0.48	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFC-8B SEC	0.208	21419.5	26835.9	LVPCB	21419.5
				Fuse X/R = 1.73	27219.9
				Fuse X/R = 4.9	21419.5
				MCCB 10-20 kA	23353.6
				MCCB > 20 kA	21419.5
XFC-8C SEC	0.208	21040.5	25938.8	LVPCB	21040.5
				Fuse X/R = 1.73	26321.5
				Fuse X/R = 4.9	21040.5
				MCCB 10-20 kA	22582.8
				MCCB > 20 kA	21040.5

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
XFC-B2B5-SEC	0.48	14898	19159.2	LVPCB	14898
				Fuse X/R = 1.73	19402.3
				Fuse X/R = 4.9	15136.5
				MCCB 10-20 kA	16646.4
				MCCB > 20 kA	15136.5
XFD-5-SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFD-17 SEC	0.208	20533	23764.5	LVPCB	20533
				Fuse X/R = 1.73	24023.1
				Fuse X/R = 4.9	20533
				MCCB 10-20 kA	20610.9
				MCCB > 20 kA	20533
XFD-17-1 SEC	0.208	20433.6	23531.6	LVPCB	20433.6
				Fuse X/R = 1.73	23768.7
				Fuse X/R = 4.9	20433.6
				MCCB 10-20 kA	20433.6
				MCCB > 20 kA	20433.6
XFD-18-SEC	0.208	20821.6	24560	LVPCB	20821.6
				Fuse X/R = 1.73	24883.7
				Fuse X/R = 4.9	20821.6
				MCCB 10-20 kA	21349.3
				MCCB > 20 kA	20821.6
XFD-19 SEC	0.208	20821.6	24560	LVPCB	20821.6
				Fuse X/R = 1.73	24883.7
				Fuse X/R = 4.9	20821.6
				MCCB 10-20 kA	21349.3
				MCCB > 20 kA	20821.6
XFD-25-SEC	0.208	20219.3	22987.4	LVPCB	20219.3
				Fuse X/R = 1.73	23160.8
				Fuse X/R = 4.9	20219.3
				MCCB 10-20 kA	20219.3
				MCCB > 20 kA	20219.3
XFD-35 SEC	0.208	19413.4	21296.1	LVPCB	19413.4
				Fuse X/R = 1.73	21214.8
				Fuse X/R = 4.9	19413.4
				MCCB 10-20 kA	19413.4
				MCCB > 20 kA	19413.4
XFD-36A SEC	0.208	19648.1	21938.2	LVPCB	19648.1
				Fuse X/R = 1.73	21997.7
				Fuse X/R = 4.9	19648.1
				MCCB 10-20 kA	19648.1
				MCCB > 20 kA	19648.1
XFD-36A SEC_A	0.208	19721.3	22085.9	LVPCB	19721.3
				Fuse X/R = 1.73	22166
				Fuse X/R = 4.9	19721.3
				MCCB 10-20 kA	19721.3
				MCCB > 20 kA	19721.3

3 PHASE Fault		Total Fault Currents		Equipment Duties	
Bus Name	Bus kV	Sym Amps	Asym Amps	Equip Type	Duty Amps
XFD-42A SEC	0.208	20313.7	23168.6	LVPCB	20313.7
				Fuse X/R = 1.73	23359.4
				Fuse X/R = 4.9	20313.7
				MCCB 10-20 kA	20313.7
				MCCB > 20 kA	20313.7
XFD-42A SEC_A	0.208	20261.4	23057.4	LVPCB	20261.4
				Fuse X/R = 1.73	23236.2
				Fuse X/R = 4.9	20261.4
				MCCB 10-20 kA	20261.4
				MCCB > 20 kA	20261.4
XFD-44-SEC	0.208	20628.7	24050	LVPCB	20628.7
				Fuse X/R = 1.73	24336.3
				Fuse X/R = 4.9	20628.7
				MCCB 10-20 kA	20879.6
				MCCB > 20 kA	20628.7
XFD-45-SEC	0.208	20818.1	24515.9	LVPCB	20818.1
				Fuse X/R = 1.73	24835.3
				Fuse X/R = 4.9	20818.1
				MCCB 10-20 kA	21307.7
				MCCB > 20 kA	20818.1
XFE-B SEC	0.208	34452.8	45447.3	LVPCB	34452.8
				Fuse X/R = 1.73	45912.2
				Fuse X/R = 4.9	35817.8
				MCCB 10-20 kA	39390.9
				MCCB > 20 kA	35817.8
XFE-C SEC	0.208	0	0	LVPCB	0
				Fuse X/R = 1.73	0
				Fuse X/R = 4.9	0
				MCCB 10-20 kA	0
				MCCB > 20 kA	0
XFF-D-SEC	0.48	15436.8	21302.7	LVPCB	15801.5
				Fuse X/R = 1.73	21391.8
				Fuse X/R = 4.9	16688.5
				MCCB 10-20 kA	18353.3
				MCCB > 20 kA	16688.5

HV Interrupting Report

Vpu = 1.00

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
A-31	4.16	3361.5	1.71	0	Sym	5	3	1	3361.5	24
B18	4.16	4145.6	2.6	0	Sym	5	3	1	4145.6	30
BUS-1	4.16	4981.5	23.33	0	Sym	5	3	1	4981.5	36
BUS-2	4.16	4919.8	17.13	0	Sym	5	3	1	4919.8	35
BUS-3	4.16	4944	19.11	0	Sym	5	3	1	4944	36
BUS-4	4.16	4938.7	18.64	0	Sym	5	3	1	4938.7	36
BUS-5	4.16	4933.5	18.19	0	Sym	5	3	1	4933.5	36
BUS-6	4.16	4928.2	17.77	0	Sym	5	3	1	4928.2	36
BUS-7	4.16	0	0	0	Sym	5	3	1	0	0
BUS-8	4.16	4888.5	15.12	0	Sym	5	3	1	4888.5	35
BUS-9_C	4.16	4947.5	20.21	0	Sym	5	3	1	4947.5	36
BUS-9_G	4.16	0	0	0	Sym	5	3	1.25	0	0
BUS-15	4.16	1930.5	1.57	0.039	Sym	5	3	1	1930.5	14
BUS-27	4.16	3231.2	1.76	0	Sym	5	3	1	3231.2	23
CORE FREEZER PRI	4.16	4484.8	5.98	0	Sym	5	3	1	4484.8	32
D-17	4.16	3554.2	2.05	0	Sym	5	3	1	3554.2	26
D-17-1	4.16	3537.5	2.04	0	Sym	5	3	1	3537.5	25
D-17-1_A	4.16	3009.9	1.69	0	Sym	5	3	1	3009.9	22
D-29	4.16	3107.3	1.68	0	Sym	5	3	1	3107.3	22
D-30	4.16	2981.9	1.61	0	Sym	5	3	1	2981.9	21
D-31	4.16	2915.6	1.57	0	Sym	5	3	1	2915.6	21
D-33	4.16	2877.5	1.55	0	Sym	5	3	1	2877.5	21
D-34	4.16	2826.2	1.53	0	Sym	5	3	1	2826.2	20
D-35	4.16	2782.5	1.51	0	Sym	5	3	1	2782.5	20
D-38	4.16	4360.2	4.67	0	Sym	5	3	1	4360.2	31
D-41	4.16	4015.5	2.83	0	Sym	5	3	1	4015.5	29
D-42	4.16	3959.6	2.69	0	Sym	5	3	1	3959.6	29
D-43	4.16	3901.6	2.55	0	Sym	5	3	1	3901.6	28
D-44	4.16	3845.7	2.44	0	Sym	5	3	1	3845.7	28
D10	4.16	4035.4	2.97	0	Sym	5	3	1	4035.4	29
D11	4.16	3958.9	2.75	0	Sym	5	3	1	3958.9	29
D12	4.16	3882.2	2.57	0	Sym	5	3	1	3882.2	28
D13	4.16	3794.2	2.4	0	Sym	5	3	1	3794.2	27
D14	4.16	3716.8	2.27	0	Sym	5	3	1	3716.8	27
D15	4.16	3653.3	2.18	0	Sym	5	3	1	3653.3	26
D16	4.16	3602.9	2.11	0	Sym	5	3	1	3602.9	26

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
D17-2	4.16	3502.3	2	0	Sym	5	3	1	3502.3	25
D17-2_A	4.16	2997.3	1.68	0	Sym	5	3	1	2997.3	22
D18	4.16	3791.5	2.39	0	Sym	5	3	1	3791.5	27
D19	4.16	3695.6	2.24	0	Sym	5	3	1	3695.6	27
D20	4.16	3610.7	2.12	0	Sym	5	3	1	3610.7	26
D21	4.16	3532.3	2.03	0	Sym	5	3	1	3532.3	25
D22	4.16	3452.8	1.95	0	Sym	5	3	1	3452.8	25
D23	4.16	3380.5	1.88	0	Sym	5	3	1	3380.5	24
D24	4.16	3312.8	1.82	0	Sym	5	3	1	3312.8	24
D26	4.16	3292.3	1.81	0	Sym	5	3	1	3292.3	24
D28	4.16	3138.2	1.7	0	Sym	5	3	1	3138.2	23
GEN 1	4.16	1538.8	24.62	0	Sym	5	3	1	1538.8	11
GEN 2	4.16	1538.8	24.62	0	Sym	5	3	1	1538.8	11
GEN 5	4.16	4968.5	22.15	0	Sym	5	3	1	4968.5	36
GEN 6	4.16	4968.5	22.15	0	Sym	5	3	1	4968.5	36
GEN-4	4.16	4973.6	22.63	0	Sym	5	3	1	4973.6	36
GEN-155	4.16	1387.8	150	0	Sym	5	3	1.25	1741.1	13
JB	4.16	4359.3	5.67	0	Sym	5	3	1	4359.3	31
JB-1A	4.16	4922.9	17.36	0	Sym	5	3	1	4922.9	35
JB-3	4.16	3375.7	1.86	0	Sym	5	3	1	3375.7	24
JB-3A	4.16	4912	16.58	0	Sym	5	3	1	4912	35
JB-4	4.16	3338.8	1.83	0	Sym	5	3	1	3338.8	24
JB-5	4.16	2213.8	1.61	0	Sym	5	3	1	2213.8	16
JB-6B	4.16	4961.8	20.89	0	Sym	5	3	1	4961.8	36
JB-36D	4.16	3220.6	1.76	0	Sym	5	3	1	3220.6	23
JB-A1	4.16	0	0	0	Sym	5	3	1	0	0
JB-A2	4.16	4061.2	2.45	0	Sym	5	3	1	4061.2	29
JB-C1	4.16	4669.8	9.49	0	Sym	5	3	1	4669.8	34
JB-E1	4.16	4545.8	6.83	0	Sym	5	3	1	4545.8	33
JB-TSPG	4.16	4890.2	15.22	0	Sym	5	3	1	4890.2	35
JB-WP	4.16	4953	19.97	0	Sym	5	3	1	4953	36
KIWI	4.16	1808.7	1.29	0.113	Sym	5	3	1	1808.7	13
P-A1	4.16	0	0	0	Sym	5	3	1.25	0	0
P-A2	4.16	4936	18.4	0	Sym	5	3	1	4936	36
P-A3	4.16	4844.6	9.29	0	Sym	5	3	1	4844.6	35
P-A4	4.16	4801.8	7.58	0	Sym	5	3	1	4801.8	35

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
P-A5	4.16	4705.6	5.51	0	Sym	5	3	1	4705.6	34
P-A6	4.16	4559.3	4.06	0	Sym	5	3	1	4559.3	33
P-A7	4.16	4488.1	3.64	0	Sym	5	3	1	4488.1	32
P-A8	4.16	4383.5	3.19	0	Sym	5	3	1	4383.5	32
P-A9	4.16	4331.6	3.13	0	Sym	5	3	1	4331.6	31
P-A9_A	4.16	4273.5	3.06	0	Sym	5	3	1	4273.5	31
P-A10	4.16	4327.1	3	0	Sym	5	3	1	4327.1	31
P-A10 COMMON D	4.16	4456.5	6.02	0	Sym	5	3	1	4456.5	32
P-A18	4.16	4237.1	2.75	0	Sym	5	3	1	4237.1	31
P-A19	4.16	4135.4	2.53	0	Sym	5	3	1	4135.4	30
P-A20	4.16	4106.1	2.48	0	Sym	5	3	1	4106.1	30
P-A21	4.16	3980.5	2.27	0	Sym	5	3	1	3980.5	29
P-A22	4.16	3980.5	2.27	0	Sym	5	3	1	3980.5	29
P-A22 - D COMMON	4.16	4272.7	3.94	0	Sym	5	3	1	4272.7	31
P-A22.	4.16	4274.6	3.95	0	Sym	5	3	1	4274.6	31
P-A23	4.16	3881.5	2.14	0	Sym	5	3	1	3881.5	28
P-A24	4.16	3752.6	2	0	Sym	5	3	1	3752.6	27
P-A25	4.16	3652.2	1.91	0	Sym	5	3	1	3652.2	26
P-A26	4.16	3663.7	1.93	0	Sym	5	3	1	3663.7	26
P-A28	4.16	3586.2	1.87	0	Sym	5	3	1	3586.2	26
P-A29	4.16	3530.9	1.82	0	Sym	5	3	1	3530.9	25
P-A30	4.16	3430.3	1.75	0	Sym	5	3	1	3430.3	25
P-A32	4.16	3277.9	1.66	0	Sym	5	3	1	3277.9	24
P-A33	4.16	3264.2	1.65	0	Sym	5	3	1	3264.2	24
P-B	4.16	4905.4	16.14	0	Sym	5	3	1	4905.4	35
P-B2	4.16	4890	15.08	0	Sym	5	3	1	4890	35
P-B3	4.16	4816.8	8.92	0	Sym	5	3	1	4816.8	35
P-B3.	4.16	0	0	0	Sym	5	3	1	0	0
P-B4	4.16	4741.5	6.64	0	Sym	5	3	1	4741.5	34
P-B5	4.16	4666.6	5.32	0	Sym	5	3	1	4666.6	34
P-B6	4.16	4606.5	4.64	0	Sym	5	3	1	4606.5	33
P-B8	4.16	4527.9	4.01	0	Sym	5	3	1	4527.9	33
P-B9	4.16	4449.2	3.56	0	Sym	5	3	1	4449.2	32
P-B10	4.16	4378.5	3.26	0	Sym	5	3	1	4378.5	32
P-B11	4.16	4314.2	3.14	0	Sym	5	3	1	4314.2	31
P-B12	4.16	4294.8	3.07	0	Sym	5	3	1	4294.8	31

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
P-B13	4.16	4234.3	2.89	0	Sym	5	3	1	4234.3	31
P-B14	4.16	4163	2.7	0	Sym	5	3	1	4163	30
P-B15	4.16	4087.9	2.54	0	Sym	5	3	1	4087.9	29
P-B16	4.16	4328.1	3.08	0	Sym	5	3	1	4328.1	31
P-B17	4.16	4237.1	2.81	0	Sym	5	3	1	4237.1	31
P-B20	4.16	4233.5	2.88	0	Sym	5	3	1	4233.5	31
P-C1	4.16	4924.2	17.46	0	Sym	5	3	1	4924.2	35
P-C2	4.16	0	0	0	Sym	5	3	1	0	0
P-C3	4.16	0	0	0	Sym	5	3	1	0	0
P-C4	4.16	0	0	0	Sym	5	3	1	0	0
P-C5	4.16	0	0	0	Sym	5	3	1	0	0
P-C6	4.16	0	0	0	Sym	5	3	1	0	0
P-C7	4.16	0	0	0	Sym	5	3	1	0	0
P-C8	4.16	0	0	0	Sym	5	3	1	0	0
P-C9	4.16	0	0	0	Sym	5	3	1	0	0
P-D2	4.16	0	0	0	Sym	5	3	1.25	0	0
P-D4	4.16	0	0	0	Sym	5	3	1	0	0
P-D5	4.16	0	0	0	Sym	5	3	1	0	0
P-D6	4.16	0	0	0	Sym	5	3	1	0	0
P-D7	4.16	0	0	0	Sym	5	3	1	0	0
P-D8	4.16	0	0	0	Sym	5	3	1	0	0
P-D9	4.16	4098.7	3.2	0	Sym	5	3	1	4098.7	30
P-D33	4.16	4216.5	3.77	0	Sym	5	3	1	4216.5	30
P-D36	4.16	3225.9	1.76	0	Sym	5	3	1	3225.9	23
P-D37NC	4.16	4158.1	3.46	0	Sym	5	3	1	4158.1	30
P-D39	4.16	4184.1	3.44	0	Sym	5	3	1	4184.1	30
P-D40	4.16	4073.3	3.01	0	Sym	5	3	1	4073.3	29
POWER PLANT A	4.16	4981.5	23.33	0	Sym	5	3	1	4981.5	36
POWER PLANT A_A	4.16	4963.4	21.08	0	Sym	5	3	1	4963.4	36
PUMP HOUSE PRI	4.16	4814	9.16	0	Sym	5	3	1	4814	35
RWE POWERSTORE	4.16	3196.7	1.75	0	Sym	5	3	1	3196.7	23
SW-1	4.16	4949.3	19.61	0	Sym	5	3	1	4949.3	36
SW-2	4.16	4962.4	20.96	0	Sym	5	3	1	4962.4	36
SW-3	4.16	4949.3	19.61	0	Sym	5	3	1	4949.3	36
SW-4	4.16	4933	18.15	0	Sym	5	3	1	4933	36
SW-5	4.16	4976.5	22.65	0	Sym	5	3	1	4976.5	36

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
SW-6	4.16	4976.5	22.65	0	Sym	5	3	1	4976.5	36
SWA-01	4.16	4115.4	2.52	0	Sym	5	3	1	4115.4	30
SWC-01	4.16	4915.5	16.81	0	Sym	5	3	1	4915.5	35
SWE-01	4.16	4539.6	6.76	0	Sym	5	3	1	4539.6	33
T-L (XFE-A)	4.16	4974.7	22.43	0	Sym	5	3	1	4974.7	36
T-PH-1	4.16	4947.1	19.4	0	Sym	5	3	1	4947.1	36
TIE SWITCH AC	4.16	0	0	0	Sym	5	3	1.25	0	0
TW-1 PRI	4.16	4944.2	19.12	0	Sym	5	3	1	4944.2	36
TW-2 PRI	4.16	4944.2	19.12	0	Sym	5	3	1	4944.2	36
TW-2 PRI_A	4.16	4947.1	19.4	0	Sym	5	3	1	4947.1	36
XFA-4 PRI	4.16	4743.4	6.44	0	Sym	5	3	1	4743.4	34
XFA-5-PRI	4.16	4633	4.82	0	Sym	5	3	1	4633	33
XFA-6-PRI	4.16	4472	3.65	0	Sym	5	3	1	4472	32
XFA-6-PRI_A	4.16	0	0	0	Sym	5	3	1	0	0
XFA-9A-PRI	4.16	4313.6	3.08	0	Sym	5	3	1	4313.6	31
XFA-9B-PRI	4.16	4255.8	3.02	0	Sym	5	3	1	4255.8	31
XFA-10A PRI	4.16	0	0	0	Sym	5	3	1	0	0
XFA-10B-PRI	4.16	4051.5	2.44	0	Sym	5	3	1	4051.5	29
XFA-19-PRI	4.16	4117.3	2.5	0	Sym	5	3	1	4117.3	30
XFA-25-PRI	4.16	3636	1.9	0	Sym	5	3	1	3636	26
XFA-25A-PRI	4.16	3636	1.9	0	Sym	5	3	1	3636	26
XFA-32-PRI	4.16	3264	1.65	0	Sym	5	3	1	3264	24
XFA-B3B4 PRI	4.16	0	0	0	Sym	5	3	1	0	0
XFA-HT PRI	4.16	0	0	0	Sym	5	3	1	0	0
XFA-VEOC PRI	4.16	3883.1	2.24	0	Sym	5	3	1	3883.1	28
XFB-3-PRI	4.16	4803.8	8.41	0	Sym	5	3	1	4803.8	35
XFB-11-PRI	4.16	4296.3	3.09	0	Sym	5	3	1	4296.3	31
XFB-12-PRI	4.16	4277	3.03	0	Sym	5	3	1	4277	31
XFB-15-PRI	4.16	4070.3	2.51	0	Sym	5	3	1	4070.3	29
XFB-15A-PRI	4.16	4070.3	2.51	0	Sym	5	3	1	4070.3	29
XFB-17-PRI	4.16	4129.3	2.61	0	Sym	5	3	1	4129.3	30
XFB-20-PRI	4.16	4215.7	2.84	0	Sym	5	3	1	4215.7	30
XFC-8 -XFC-8 PRI	4.16	0	0	0	Sym	5	3	1	0	0
XFC-8A PRI	4.16	4284.3	5.19	0	Sym	5	3	1	4284.3	31
XFC-8C PRI	4.16	3994.5	3.95	0	Sym	5	3	1	3994.5	29
XFC-B2B5 PRI	4.16	4514.1	4.92	0	Sym	5	3	1	4514.1	33

3 PHASE Fault		Total Fault Currents								
Bus Name	Bus kV	Sym Amps	X/R Ratio	NACD	Breaker Type	Int Time Cyc	Part Time Cyc	Adj Fact	Bkr Duty Amps	Bkr Duty MVA
XFD-6-PRI	4.16	0	0	0	Sym	5	3	1	0	0
XFD-17 PRI	4.16	3539.5	2.04	0	Sym	5	3	1	3539.5	26
XFD-17 PRI_B	4.16	3775.9	2.37	0	Sym	5	3	1	3775.9	27
XFD-17-1 PRI	4.16	3464.8	1.97	0	Sym	5	3	1	3464.8	25
XFD-17-1 PRI_A	4.16	2952.2	1.66	0	Sym	5	3	1	2952.2	21
XFD-18 PRI	4.16	3775.9	2.37	0	Sym	5	3	1	3775.9	27
XFD-25 PRI	4.16	3299.2	1.81	0	Sym	5	3	1	3299.2	24
XFD-35 PRI	4.16	2771.9	1.51	0	Sym	5	3	1	2771.9	20
XFD-36-D1	4.16	2153.4	1.6	0	Sym	5	3	1	2153.4	16
XFD-36-D2	4.16	2003.1	1.58	0	Sym	5	3	1	2003.1	14
XFD-42-B PRI	4.16	3325	1.82	0	Sym	5	3	1	3325	24
XFD-42A-PRI	4.16	3361.7	1.85	0	Sym	5	3	1	3361.7	24
XFD-44	4.16	3620.6	2.16	0	Sym	5	3	1	3620.6	26
XFD-45-PRI	4.16	3769.2	2.33	0	Sym	5	3	1	3769.2	27
XFE-A PRI	4.16	4400.5	4.87	0	Sym	5	3	1	4400.5	32
XFE-B PRI	4.16	4539.6	6.76	0	Sym	5	3	1	4539.6	33
XFE-C	4.16	0	0	0	Sym	5	3	1.25	0	0
XFF-D-PRI	4.16	4947.1	19.4	0	Sym	5	3	1	4947.1	36

30 Cycle Report

Vpu = 1.00

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
A-31	4.16	2597.5
A20-1	0.208	1698.3
A22	0.208	4087.4
A22-2	0.208	2887.3
A22-3	0.208	1993.3
A23	0.208	2661.3
B-3	0.48	12353.3
B-3 AND B-4	0.48	0
B-5	0.48	12353.3
B-15-SEC	0.208	14351.6
B-15-SEC_A	0.208	5539.3
B-15-SEC_B	0.208	5539.3
B-155	0.208	18335.9
B-167	0.208	464.5
B-182 COM	0.208	3048.6
B-188	0.208	464.5
B-221	0.208	6801.5
B4-LOUNGE	0.208	1195.1
B4-THEATER	0.208	1195.1
B7	0.208	2248.6
B10	0.208	3244.7
B18	4.16	2968
B68	0.208	16157.7
B72	0.208	1666.6
B73	0.208	10226.5
B75	0.208	0
B129	0.208	0
B132	0.208	2467.4
B136A	0.208	6533.1
B136C	0.208	6533.1
B141	0.208	1881.7
B150	0.208	9390.8
B159	0.208	0
B160	0.208	10226.5
B166	0.208	563.6
B168	0.208	1575.8
B174	0.208	5607
B175	0.208	4087.4
B182 VEH HTRS 1	0.208	4182.6
B182 VEH HTRS 2	0.208	4768.8
B185	0.208	5607
B191	0.208	17000.9
B192	0.208	2910.1
B341	0.208	16157.7
B344	0.208	805.6

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
BLDG 10	0.48	10743.7
BUILDING 4	0.208	13094.6
BUS-1	4.16	3323.6
BUS-2	4.16	3296.1
BUS-3	4.16	3306.9
BUS-4	4.16	3304.5
BUS-5	4.16	3302.2
BUS-6	4.16	3299.8
BUS-7	4.16	0
BUS-8	4.16	3282.1
BUS-9	0.208	273.1
BUS-9_C	4.16	3308.4
BUS-9_G	4.16	0
BUS-10	0.208	0
BUS-15	4.16	1664.6
BUS-27	4.16	2514.1
CORE FREEZER PRI	4.16	3100.2
CORE FREEZER SEC	0.48	10798.9
D-17	4.16	2677.5
D-17-1	4.16	2669.4
D-17-1_A	4.16	2386.5
D-29	4.16	2447.9
D-30	4.16	2379
D-31	4.16	2341.6
D-33	4.16	2319.8
D-34	4.16	2290.2
D-35	4.16	2264.6
D-38	4.16	3044.9
D-40 SEC	0.208	1519.2
D-41	4.16	2894.2
D-42	4.16	2869.1
D-43	4.16	2842.9
D-44	4.16	2817.3
D10	4.16	2901.1
D11	4.16	2866.9
D12	4.16	2832.1
D13	4.16	2791.6
D14	4.16	2755.4
D15	4.16	2725.3
D16	4.16	2701.1
D17-2	4.16	2652.1
D17-2_A	4.16	2379.1
D18	4.16	2790.3
D19	4.16	2745.4
D20	4.16	2704.9
D21	4.16	2666.8
D22	4.16	2627.5
D23	4.16	2591.2
D24	4.16	2556.5

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
D26	4.16	2546
D28	4.16	2464.7
D39 SEC	0.208	2910.1
D40 SEC	0.208	2254.8
GEN 1	4.16	1025.9
GEN 2	4.16	1025.9
GEN 5	4.16	3317.8
GEN 6	4.16	3317.8
GEN-4	4.16	3320
GEN-155	4.16	925.2
HT-165	0.48	0
HTA	0.48	4451.5
HTA_A	0.48	4451.5
HTA_B	0.48	4451.5
HTP#1	0.48	0
HTP#2	0.48	0
HTP-5	0.48	4451.5
HTP3	0.48	0
HTP4	0.48	4451.5
HTP6	0.48	4451.5
JB	4.16	3040.6
JB-1A	4.16	3297.5
JB-3	4.16	2590.5
JB-3A	4.16	3292.6
JB-4	4.16	2571.1
JB-5	4.16	1866.3
JB-6B	4.16	3314.8
JB-36D	4.16	2508.3
JB-A1	4.16	0
JB-A2	4.16	2930.4
JB-C1	4.16	3183.3
JB-E1	4.16	3127.6
JB-TSPG	4.16	3282.9
JB-WP	4.16	3310.9
KIWI	4.16	1602.8
LDB HE COMPRESS	0.208	12707.3
LOAD BANKS	0.48	13131
P-35 SEC	0.208	15539.5
P-A1	4.16	0
P-A2	4.16	3303.3
P-A3	4.16	3263.7
P-A4	4.16	3245.6
P-A5	4.16	3205.5
P-A6	4.16	3144.8
P-A7	4.16	3115.2
P-A8	4.16	3071.5
P-A9	4.16	3047.2
P-A9_A	4.16	3019.7
P-A10	4.16	3047.6

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
P-A10 COMMON D	4.16	3086.6
P-A18	4.16	3009.3
P-A19	4.16	2965.2
P-A20	4.16	2952.4
P-A20-1	0.208	9410.6
P-A21	4.16	2896.6
P-A22	4.16	2896.6
P-A22 - D COMMON	4.16	3007.1
P-A22.	4.16	3007.9
P-A23	4.16	2851.6
P-A24	4.16	2791.6
P-A25	4.16	2743.7
P-A26	4.16	2748
P-A26 LITE SOUTH	0.208	1738
P-A26 SEC	0.208	2693.6
P-A27	0.208	1607
P-A28	4.16	2710.4
P-A29	4.16	2683.1
P-A30	4.16	2632.7
P-A30-SEC	0.208	3467.8
P-A31 (SEC)	0.208	5185.8
P-A31 SEC WEST	0.208	3467.8
P-A32	4.16	2553.9
P-A33	4.16	2546.7
P-B	4.16	3289.7
P-B1	0.208	3629.9
P-B2	4.16	3282.8
P-B3	4.16	3251.3
P-B3-SEC	0.208	3775.7
P-B3.	4.16	0
P-B4	4.16	3219.3
P-B5	4.16	3188
P-B5-SEC	0.208	1644.6
P-B6	4.16	3163
P-B8	4.16	3130.3
P-B9	4.16	3097.5
P-B10	4.16	3067.8
P-B11	4.16	3038.3
P-B12	4.16	3030.1
P-B13	4.16	3004.2
P-B14	4.16	2973.4
P-B15	4.16	2940.5
P-B16	4.16	3046.5
P-B17	4.16	3007.6
P-B20	4.16	3004
P-B82	0.208	2146.5
P-B82_A	0.208	1454.8
P-C1	4.16	3298
P-C2	4.16	0

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
P-C3	4.16	0
P-C4	4.16	0
P-C4 SEC	0.208	0
P-C4-1	0.208	0
P-C5	4.16	0
P-C5 SEC	0.208	0
P-C6	4.16	0
P-C6 SEC	0.208	0
P-C6-1	0.208	0
P-C6-2	0.208	0
P-C7	4.16	0
P-C7 SEC	0.208	0
P-C8	4.16	0
P-C8 SEC	0.208	0
P-C9	4.16	0
P-D2	4.16	0
P-D4	4.16	0
P-D5	4.16	0
P-D6	4.16	0
P-D7	4.16	0
P-D8	4.16	0
P-D9	4.16	2929.2
P-D33	4.16	2980.8
P-D36	4.16	2511.3
P-D37NC	4.16	2955.3
P-D39	4.16	2968.6
P-D40	4.16	2919.9
POLE - B166	0.208	630.8
POLE 167	0.208	509.3
POWER PLANT A	4.16	3323.6
POWER PLANT A_A	4.16	3315.5
PUMP HOUSE PRI	4.16	3249.9
PUMP HOUSE-SEC	0.48	2480.6
RWE POWERSTORE	4.16	2494.7
SCOTT BASE G1	0.4	80
SCOTT BASE G2	0.4	80
SW-1	4.16	3309.2
SW-2	4.16	3315.1
SW-3	4.16	3309.2
SW-4	4.16	3302
SW-5	4.16	3321.3
SW-6	4.16	3321.3
SWA-01	4.16	2955.4
SWC-01	4.16	3294.2
SWE-01	4.16	3124.8
T-L (XFE-A)	4.16	3320.5
T-PH-1	4.16	3308.3
T-PH-1 SEC	0.48	13106.9
T-W-1 SEC	0.208	30240.8

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
T-W-2 SEC	0.48	13104.4
T-W-2 SEC_A	0.208	30246.8
TIE SWITCH AC	4.16	0
TW-1 PRI	4.16	3307
TW-2 PRI	4.16	3307
TW-2 PRI_A	4.16	3308.3
USAP B70	0.208	6727.8
VEHICLE HTRS	0.208	0
VEOC	0.48	8101.3
WTG-SOURCE-1	0.4	80
WTG-SOURCE-2	0.4	80
WTG-SOURCE-3	0.4	80
WTG-1	0.4	80
WTG-1_A	0.4	80
WTG-1_B	0.4	80
WTG-1_C	0.4	80
WTG-2	0.4	80
XFA-4 PRI	4.16	3220.6
XFA-4 SEC	0.48	4543
XFA-5-PRI	4.16	3174.5
XFA-5-SEC	0.208	19704.7
XFA-6-PRI	4.16	3107.4
XFA-6-PRI_A	4.16	0
XFA-6-SEC	0.208	19566.4
XFA-6-SEC_A	0.208	0
XFA-9-A-SEC	0.208	19430.8
XFA-9-B-SEC	0.208	19375.2
XFA-9A-PRI	4.16	3039.3
XFA-9B-PRI	4.16	3011.9
XFA-10A PRI	4.16	0
XFA-10A-SEC	0.208	0
XFA-10B-PRI	4.16	2925.6
XFA-10B-SEC	0.208	19210.8
XFA-19-PRI	4.16	2957
XFA-19-SEC	0.208	19274.4
XFA-25-A-SEC	0.208	18852.4
XFA-25-PRI	4.16	2735.7
XFA-25-SEC	0.208	18852.4
XFA-25A-PRI	4.16	2735.7
XFA-32-PRI	4.16	2546.4
XFA-32-SEC	0.208	7165.7
XFA-B3B4 PRI	4.16	0
XFA-B3B4 SEC.	0.48	0
XFA-HT PRI	4.16	0
XFA-HT-SEC	0.48	0
XFA-VEOC PRI	4.16	2846.8
XFB-3-PRI	4.16	3245.7
XFB-3-SEC	0.208	3932.3
XFB-11 SEC	0.208	19412.7

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
XFB-11-PRI	4.16	3030.5
XFB-12 SEC	0.208	10599.1
XFB-12-PRI	4.16	3022.2
XFB-15 SEC	0.208	19221.8
XFB-15-PRI	4.16	2932.4
XFB-15A SEC	0.48	4567.8
XFB-15A-PRI	4.16	2932.4
XFB-17 SEC	0.208	19274.9
XFB-17-PRI	4.16	2959.3
XFB-20 SEC	0.208	19345.3
XFB-20-PRI	4.16	2996.1
XFC-8 -XFC-8 PRI	4.16	0
XFC-8-SEC	0.208	0
XFC-8A PRI	4.16	3005.5
XFC-8A SEC	0.48	0
XFC-8B SEC	0.208	19369.1
XFC-8C PRI	4.16	2866.7
XFC-8C SEC	0.208	19063.3
XFC-B2B5 PRI	4.16	3117.8
XFC-B2B5-SEC	0.48	12726.9
XFD-5-SEC	0.208	0
XFD-6-PRI	4.16	0
XFD-17 PRI	4.16	2670.1
XFD-17 PRI_B	4.16	2782.9
XFD-17 SEC	0.208	18671.8
XFD-17-1 PRI	4.16	2632.5
XFD-17-1 PRI_A	4.16	2353.7
XFD-17-1 SEC	0.208	18592.4
XFD-18 PRI	4.16	2782.9
XFD-18-SEC	0.208	18900.3
XFD-19 SEC	0.208	18900.3
XFD-25 PRI	4.16	2549.3
XFD-25-SEC	0.208	18422.8
XFD-35 PRI	4.16	2258.3
XFD-35 SEC	0.208	17779.2
XFD-36-D1	4.16	1824.1
XFD-36-D2	4.16	1717.1
XFD-36A SEC	0.208	17960.2
XFD-36A SEC_A	0.208	18019
XFD-42-B PRI	4.16	2563.8
XFD-42A SEC	0.208	18499
XFD-42A SEC_A	0.208	18457.1
XFD-42A-PRI	4.16	2583.2
XFD-44	4.16	2708.4
XFD-44-SEC	0.208	18746.9
XFD-45-PRI	4.16	2780.8
XFD-45-SEC	0.208	18898.2
XFE-A PRI	4.16	3063.5
XFE-B PRI	4.16	3124.8

3 PHASE Fault		Total Fault Currents
Name	Bus kV	Sym Amps
XFE-B SEC	0.208	29412.2
XFE-C	4.16	0
XFE-C SEC	0.208	0
XFF-D-PRI	4.16	3308.3
XFF-D-SEC	0.48	13106.9

Equipment Duty Report

EasyPower 9.8.1.490 07/19/17 19:05:40 C:\...\McM Primary Distribution.dez
EasyPower LLC.
Comments :

Fault Type: 3 PHASE Vpu: 1.00

Bus		Equipment				Ratings			Duties				Comments
Name	Base kV	ID	Manufacturer	Style	Test Standard	1/2 Cycle (kA)	Int (kA)	Int Cycles	1/2 Cycle (kA)	1/2 Cycle Percent	Int (kA)	Int Percent	
BUS-1	4.160	BH-2_I	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.932	-89.8%	5.070	-89.2%	
POWER PLANT A	4.160	BH-2_A	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	4.891	-93.7%	3.126	-93.3%	
		BH-2_B	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	5.487	-93.0%	3.507	-92.5%	
		BH-2_C	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	5.487	-93.0%	3.507	-92.5%	
		BH-2	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_D	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_E	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_F	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_G	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_H	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.933	-89.8%	5.070	-89.2%	
		BH-2_I	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.932	-89.8%	5.070	-89.2%	
POWER PLANT A_A	4.160	BH-2_M	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	6.629	-91.5%	4.199	-91.1%	
		BH-2_O	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	6.258	-92.0%	3.964	-91.6%	
		BH-2_P	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	6.629	-91.5%	4.199	-91.1%	
		BH-2_Q	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	7.032	-91.0%	4.454	-90.5%	
		BH-2_R	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	6.318	-91.9%	4.001	-91.5%	
		BH-2_T	SQD	VR-05035-12	ANSI-SYM	78.000	46.914	3	6.318	-91.9%	4.001	-91.5%	
SW-1	4.160	FS-1	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.089	-89.8%			
SW-2	4.160	FS-1_A	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.133	-89.7%			
SW-3	4.160	FS-1_B	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.089	-89.8%			
SW-4	4.160	FS-1_C	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.034	-89.9%			
SW-5	4.160	FS-1_D	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.182	-89.6%			
SW-6	4.160	FS-1_E	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.182	-89.6%			
		FS-2	Cutler-Hammer	CLE	ANSI-SYM	50.000			5.182	-89.6%			
SWA-01	4.160	FS-1_F	Cutler-Hammer	CLE	ANSI-SYM	50.000			4.115	-91.8%			
SWE-01	4.160	FS-42	Cutler-Hammer	CLE	ANSI-SYM	50.000			4.540	-90.9%			
		FS-43	Cutler-Hammer	CLE	ANSI-SYM	50.000			4.540	-90.9%			
XFA-4 PRI	4.160	FS-15_B	Cooper	NX	ANSI-SYM	50.000			4.743	-90.5%			
XFA-5-PRI	4.160	FS-15_C	Cooper	NX	ANSI-SYM	50.000			4.633	-90.7%			