ANALYSIS OF THE D-ZERO CRANE RAIL AS A SUPPORT FOR A HORIZONTAL LIFELINE

D-ZERO ENGINEERING NOTE # 3823.000 EN-519

Author: Herman Cease, PPD/ETT/D-Zero Mech.
March 2, 2000

Approved By:
PPD/ETT/D-Zero Project Mech. Support Leader

Summary:

The D-Zero crane rail is analyzed for use as an anchor support for a one person HorizonTM Horizontal Lifeline system that will span the pit area at D-Zero assembly hall. The lifeline will span 75 ft across the pit area, will be located out of the travel of the crane and above the concrete lenth wall.

Analysis:

The crane rail dimensions are 29.5 inches vertical height, 10.625 inch flange width and 0.875 inch flange thickness on the lower flange. The unsupported span is 25 feet. The maximum tension on the cable for the 75 ft span with a one person support system is 3,500 lbf total – data from MSA-ROSE mfg. The maximum lateral force at the Lifeline anchor positions on the crane rail then is 1,750 lbf. Assuming only the flange section contributes to strength and the anchor is attached at the midpoint of the rail, the expected stresses and deflections on the rail are:

$$S = -Wl/4Z$$
$$D = Wl^3/48EI$$

Where,

$$W = 1,750 \text{ lb}$$

$$L = 12.5 \text{ feet} = 150 \text{ inches}$$

$$E = \text{modulus of steel} = 28e6 \text{ psi}$$

$$Z = bh^2/3 = 0.875 * 10.625^2/3 = 32.9 \text{ in}^3$$

$$I = bh^3/12 = 0.875 * 10.625^3/12 = 87 \text{ in}^4$$

$$\text{Max stress at the loading point} = 1,995 \text{ psi}$$

$$\text{Max deflection at the loading point} = 0.047 \text{ inches}$$

The maximum allowable stress is 1/3 yield strength of the rail or $1/3 * 33,000 \text{ psi} = 11,000 \text{ psi}$. This would allow a maximum of five – one person lifeline support systems.

The minimum breaking strength of the 3/8" 7x19 galvanized wire rope is 14,400 lbf. The lateral load at the anchor position is then 7,200 lbf. Stress in the mounting rail, assuming only the flange section contributes is 8,200 psi indicating the rating for the steel rope is exceeded before exceeding the maximum allowable stresses in the crane rail.

Consideration of Crane loads:

The lifeline system puts a horizontal load on the crane rail. This load is perpendicular to any loads on the crane rail due to at the hook loads. Therefore, at the hook loads and loads occurring during a falling arrest are not additive on the crane support rails.

Conclusions:

The crane rail is a suitable anchor for a one person HorizonTM Horizontal Lifeline system. The expected stress on the rail is 1,995 psi which has a factor of safety of 5.5 on the allowable stress. The anchor position is located 18" away from the concrete lenth wall and out of the travel of the overhead crane.

MAX
TRAVEL
OF
CRANE
CARRIAGE

LOCATION OF LIFELINE ANCHOR

CRANE
RAIL

CONCRETE
LENTIL
WALL

COLLISION
HALL

WOOD RAILING

FIN. FLOOR
EL. 748'-0"

FIN FLOOR
EL. 731'-0"

FIN. FLOOR
EL. 722'-2"

PRE-CAST CONC. SLAB

REMOVABLE
GUARD RAILS
AT EDGE OF OPENING

EL. 720'-0"

EQUIP.
EXPRESS

STAIR
Nº 4

44'-6"

8

9

Rose

The Name in Safety at Heights And Confined Spaces

6-10-96
PRODUCT DATA SHEET

HORIZON™ Horizontal Lifeline Anchorage Connector Subsystem

BELOW BEAM MULTIPLE SPAN SUBSYSTEM

Lifeline Length	20 to 280 feet in spans up to 40 feet
Unsupported Span	40 feet maximum
Cable	3/8" 7x19 Galvanized wire rope - minimum breaking strength rated at 14,400 lbf
Compatibility	Fits most standard I-beams
Support Equipment	Requires the use of an energy absorbing lanyard that limits fall arrest forces to 900 lbf
Min Anchorage Strength	12,500 lbf lateral strength required for installation

PRODUCT DESCRIPTION: The Horizon™ Horizontal Lifeline, with integral in line shock absorber, provides complete freedom of movement for the entire length of the lifeline without having to detach the workers' personal fall arrest system. The Horizon™ Shock Absorber reduces line tension by up to 38% during a single fall condition (see Anchorage Loading Chart below).

Horizon™ Horizontal Lifeline
Anchorage Loading Chart
(140 ft Length - 20 ft Span)

Horizon™ Shock Absorber
Load Chart
(140 ft Length - 20 ft Span)

Table 1

Input Force (F1)	Anchorage Load (F2)	Anchorage Load (F3)	Change of Elevation (h)
1 Person	1,860 lbf	2,280 lbf	37.75 inches
2 Person	3,000 lbf	3,840 lbf	38.00 inches
3 Person	3,460 lbf	4,480 lbf	41.50 inches
4 Person	4,000 lbf	6,880 lbf	42.00 inches
5 Person	4,720 lbf	7,640 lbf	48.00 inches

Based on 140 ft length with supported spans of 20 ft
 F1 - Lanyard Energy Absorber rated at 900 lbf
 F2 - With Horizon™ Shock Absorber
 F3 - Without Horizon™ Shock Absorber

Rose Manufacturing Company • 2250 South Tejon Street • Englewood, CO 80110-1000 • USA
 Phone 303-922-6246 • Toll free phone 1-800-722-1231 • Fax 303-934-9960

HORIZON™ Horizontal Lifeline Subsystem

COMPONENT SPECIFICATIONS- HORIZONTAL LIFELINE SUBSYSTEM

12" Turnbuckle with Plate - Part Number 506662

Material	High tensile alloy steel
Thread	Course, 1/2 inch
Range	Up to 12 inch adjustment
Use	Line tensioning

3/8" Open Wedge Socket - Part Number 506563

Use	Secures one end of HLL
Strength	12,500 lbf
Features	Adjustable for line length positioning

3/8" Wire Rope Clip - Part Number 506649

Use	Secures wire rope end
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3/8" Galvanized Wire Rope with jaw end - Part Number 605548

Type	7x19 Galvanized steel cable
Strength	14,400 lbf tension
Length	20 feet minimum depending on application

3/8" Snatch Block Pulley - Part Number 506663

Use	Connects Rose Dyna-Locks & Dynaevals to 3/8" dia horizontal lifeline. Can be use only on single span systems.
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HORIZON™ Horizontal Lifeline Subsystem

COMPONENT SPECIFICATIONS - HORIZONTAL LIFELINE SUBSYSTEM

Horizon™ HLL Shock Absorber with Integral Turnbuckle
P/N 506475

The Horizon™ Shock Absorber assembly offers easy tensioning adjustment and constant load energy absorption to provide lower anchorage forces.

Material	High tensile alloy & stainless steel
Strength	12,500 lbf minimum
Adjustment	6 inches nominal
Length	24 inches nominal

BeamGrip™ Anchor
P/N 506635

The BeamGrip™ Anchor assembly allows quick and easy installation to standard beam sizes while offering over 12,500 lbf of lateral anchorage strength.

Material	Carbon steel, yellow zinc plated
Strength	12,500 lbf
I Beam Compatibility	Wide range of sizes to accommodate most beams
System Compatibility	BeamGrip™ End Fitting, Part Number 506637 BeamGrip™ Bypass Fitting, Part Number 506636

BeamGrip™ End Fitting
P/N 506637

The BeamGrip™ End Fitting is used in conjunction with the BeamGrip™ Anchor, pictured above, and is designed to allow orientation for anchorage loading in 3 directions.

Material	Carbon steel, yellow zinc plated
Strength	12,500 lbf minimum
Compatibility	BeamGrip™ Anchor assembly, Part Number 506635

Note: (Must use linkage components approved for use with the Horizon™ Horizontal Lifeline only.)

BeamGrip™ Bypass
Fitting
P/N 506636

The BeamGrip™ Bypass Fitting allows a worker to bypass an intermediate span support without disconnecting from the horizontal lifeline.

Material	Carbon steel, yellow zinc plated
Strength	5,000 lbf vertical 3,600 lbf lateral
Compatibility	BeamGrip™ Anchor assembly, Part Number 506635

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HORIZON™ Horizontal Lifeline Subsystem

COMPONENT SPECIFICATIONS - PERSONNEL FALL ARREST SUBSYSTEM

**Full Body Harness
P/N 502733**

Full Body Harness - Part Number 502733

Sizes	x-small, standard, x-large, super x-large
System Usage	Fall arrest, controlled descent, ladder climbing, confined space entry and exit and worker positioning
D-ring locations	Back, chest and 2 hip
Weight	3.5 lbs
Standards	Meets ANSI Z359.1, ANSI A10.14, CSA Z259.10, OSHA
Capacity	310 lbs including clothes, tools and other user borne objects
Material	Nylon (polyester 502734)

**Self
Retracting
Lanyard**

**20'
Backpacker
P/N 506615**

Self Retracting Lanyard - Part Numbers

506208 - 30 Meter Dyna-Lock
506204 - 16 Meter Dyna-Lock

Usage	Single span systems
Max. Arrest Distance	24 inches
Capacity	310 lbs including clothes, tools and other user borne objects
Standards	Meets ANSI Z359.1, ANSI A10.14, OSHA

Self Retracting Lanyard - Part Numbers

506615 - 20' Anchorage Mount
506619 - 20' Backpacker™

Usage	Single span systems
Max. Arrest Distance	24 inches
Capacity	310 lbs including clothes, tools and other user borne objects
Standards	Meets ANSI Z359.1, ANSI A10.14, OSHA

**Carabiner
P/N 506572**

Carabiner - Part Number 506572

Material	High tensile alloy steel
Strength	5,000 lbf
Proof Load	3,600 lbf
Throat Opening	.675 inch minimum
Length	3.7 nominal
Weight	0.6 lbs

**Lanyard Shock Absorber
P/N 501226-006**

Lanyard Shock Absorber - Part Number - 501226-006

Max. Arrest Distance	42 inches
Max. Arrest Force	900 lbf
Capacity	130 to 310 lbs including clothes, tools and other user borne objects
Material	Nylon or polyester
Compatibility	Equipped with snaphook or webbed loop
Standards	Meets ANSI Z359.1, ANSI A10.14, OSHA

F A X

To: Delmar Miller
Company:
Fax number: +1 (630) 840-8481
Business phone:

From: Steve Eaton
Fax number: +1 (708) 482-9045
Business phone:
Home phone:

Date & Time: 2/24/2000 4:12:12 PM
Pages: 5
Re: Horizontal Lifeline Info

Rose Manufacturing Co.
2250 S. Tejon St.
Englewood, CO
80110-1000

Phone [303] 922-6246
Fax [303] 934-9960
<http://www.rosemfg.com>

TELEFAX TRANSMISSION

To: Dalmar or Herman @ Fermi From: Mark Blake
Fax: 630 840 8481 Pages: 2
Phone: _____ Date: _____
Re: HLL Specs. CC: _____

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Fermi Lab
Delmar Miller / Herman Sites
630-840-8481 fax

Rose Manufacturing Co.
2250 S. Tejon St.
Englewood, CO
80110-1000

Phone [303] 922-6246
Fax [303] 934-9960
<http://www.rosemfg.com>

From Mark Blake
Phone 303-975-2315
Fax 303-934-9960
E-Mail Mark.Blake@MSAnet.com
Date 1-Mar-00
Re Calculations for a 75 foot Horizontal Lifeline

Dear Sirs,

In response to a request made by Steve Eaton of Elliott sales here are the specifications for the horizontal lifeline system outlined below.

System Length – 75 feet
No. on Spans – 1
No. of Workers – 1
Force per Person – 900 lbs.
MSA Rose HLL Shock Absorber – Yes

Specification for unloaded system

Initial line tension – 514 lbs.
Sag Distance for horizontal – 4"

Specification for loaded system

Workers arrested – 1
Maximum Cable Tension – 3,500 lbs.
Maximum Cable Drop – 5.0 feet
Total Fall Distance based on use of self-retracting lanyard and Full Body Harness – 8.0 feet

Please feel free to call me with any additional questions that you may have.

Regards,

A handwritten signature in black ink that reads "Mark Blake".

Mark Blake

ADDENDUM TO:

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SUPPORT FOR A HORIZONTAL LIFELINE

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March 3, 2000

Approved By:
PPD/ETT/D-Zero Project Mech. Support Leader

Addendum:

The crane rail is a suitable anchor for a one person Horizon™ Horizontal Lifeline system. The expected stress on the rail is 1,995 psi which has a factor of safety of 5.5 on the allowable stress. If a multi-person system is required, 4 additional one person Horizon™ Horizontal Lifeline systems can be attached to the crane rail without exceeding the maximum allowable stress. Each additional system should be attached to the crane rail in a location out of the travel of the crane.