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1.0 INTRODUCTION

Enbridge Energy, Limited Partnership (EELP) is proceeding with the execution of the inspection and improvement to the two twenty-inch crude oil pipelines crossing the Straits of Mackinac. The inspection of and improvement to these two fifty (50) year old pipelines is preliminary to the re-certification of the pipelines for extended life.

The original design was for a 1,200 psi hydrostatic test and an operating pressure of 600 psig. EELP is operating the system at a much-reduced pressure, approximately 33% of the original design operating pressure.

As a result of previous inspections and preliminary analyses completed for EELC by JP Kenny (JPK) in 2002 and 2003, it was determined that remediation work is required to maintain the safe operation of the Straits of Mackinac crossing pipelines. The initial analytical work performed by JPK for EELP recommended the acquisition of on-bottom current data in order to refine Vortex Induced Vibration (VIV) calculations into the fatigue equation analysis of spans. EELP acted on this recommendation in 2002, 2003, and 2004 and recording current meters were put in place and data accumulated.

A Remotely Operated Vehicle (ROV) made a visual inspection of the pipelines to identify and measure spans and assist in planning for the placement of span supports. A geo-pig with magnetic flux leakage capabilities was run through the pipelines recording heading and slope changes and measured the metal loss and any other anomalies within the pipelines. This data was analyzed and a stress assessment made by JPK in 2004.

EELP, at the end of 2004, has requested that JPK assess the current meter velocity data and prepare a corresponding allowable span evaluation.

2.0 SUMMARY AND RECOMMENDATIONS

This report is a summary of the analysis of the Straits of Mackinac crossings with respect to spanning and VIV effects. Previous studies assessed a wide range of spanning situations with conservative assumed velocities. This study attempts to provide, in an abbreviated fashion, a result that can be directly applied to inspection and remediation action. A simple computer model was created that provides the code stress analysis which was run numerous times over the range of recorded and possible current velocities with maximum in-line VIV amplitudes to identify the limiting spans. The model is one that essentially is a fixed – pinned beam. The fixed end of the model is a full anchor and the pinned end is embedded in a simulated dense sand soil that is anchored after 100' of length. The steady current velocities are used in the analysis and the wave effects are minor. The stresses were calculated per the AutoPipe 6.3 model and confirmed by JPK MathCAD programs in accordance with ASME B31.4 and the DNV 30.5 – 2000.

The results indicate the following:

- The allowable static load spans control over the VIV excited spans for all velocities greater than 2.75 ft/sec.
- All VIV is in-line type for all the analyzed spans.
- The reduced velocities, where this occurs, are in the range of 1 to 3.5.
- All cross flow VIV occurs above the range of the line's natural frequency, with reduced velocities between 4.8 and 12.
- Cross flow VIV is not likely to occur in these spans.

The maximum allowable span lengths for various steady current velocities per the above assumptions are shown in Table 2.1.

Steady Current Velocity **ft/sec**	**Maximum Allowable Span Length** **ft**
2.5	165
2.74 *	164
3	163
3.25	161
3.5	159
3.75	157
4	155
4.25	153

Table 2.1

* (per recorded maximum of report)

Recorded current velocities reached a maximum of 2.74 feet per second. Over time the maximum velocity will no doubt increase, but it is anticipated that it will not exceed 4.25 feet per second. That gives an upper bound that Enbridge can use as a guide to set the span length at which to take action in the the inspection and mitigation plan. Using a 140 foot span limit the plan would seem to provide a reasonable margin of safety with the modeled code stress limit of 153 feet shown above in table 2.1.

JPK has undertaken the task of modeling the pipeline in a way that, in our opinion, is a reasonably accurate recreation of the actual conditions of the pipeline crossings.

It is understood that many assumptions were made in the model and it is impossible to guarantee that all of those assumptions are conservative.
We attempted to make the assumptions slightly conservative but reasonably accurate.

Based on the results of the model, JPK calculated the stresses that will occur and have limited the stresses to those of the industry standard, B31.4 Code.

Enbridge suggested a span of 140 feet and we responded in the report - that 140 feet, in our opinion, seemed reasonable. This is based on our calculations that indicate that for all velocities less than 4.25 feet per second spans of 153 feet or less should be acceptable.

Enbridge must decide how much margin of safety it wishes to apply and how close to a 140 foot span the company wishes to go with its mitigation program.

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3.0 DESIGN DATA AND ASSUMPTIONS

Codes

The Michigan Public Service Commission requires that pipelines be constructed and maintained in accordance with the Minimum Federal Safety Standards which are Title 49—Transportation, Subtitle B—Other Regulations Relating to Transportation, Chapter 1--Research and Special Programs Administration, Department Of Transportation, CFR 195 Transport of hazardous liquids by pipeline. This regulation was formed from ASME/ANSI B31.4 "Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols".

B31.4 is the industry code to be used, with any overriding regulation requirements. In addition for any aspects, such as hydrodynamics, API Recommended Practice 1111, Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design), Pipeline Segment", is cited as an acceptable guide in the engineering calculations requirement.

Det Norske Veritas (DNV) 30.5, "Environmental Conditions and Environmental Loads" and Guidelines No. 14, "Free Spanning Pipelines" are also sources for these calculations.

Background

Pipeline Installed in 1953
Pipe is 2 @ 20" x 0.812" W.T. Grade A (30,000 Min Yield)
Floated across and then sank to conform to bottom
Hydrotested to approximately 600 PSI, Flow tested in 1972 to current 330 psi MAOP
Original Pipeline installed with 75 foot maximum span length

Assumptions Used in this Study

- corroded 10 percent reduced wall thickness, 0.731", from the original 0.812" design.
- operating full of oil
- product weight density 54.16 lb/cu ft
- pressure 300 psig
- tie-in temperature of 32 F rising to maximum of 40 F
- water depth 175', although results can apply to virtually all of the spans in the crossings
- pipeline centerline is assumed to be above the bottom 4', as per the assumed conditions (average of 2'-6') of the Lee Gordon Consulting current data report (ref 1)
- fictitious wave data was assumed simply to avoid modifying software

4.0 CURRENT DATA ASSESSMENT

The report "Pipeline Motion Measurement System and Current Profiler Data Analysis", October 11, 2004, by Lee Gordon Consulting (Ref. 1) provides a good summary of the data collection process used and relevant current data. This data was taken at an appropriate height above the bottom for direct application to the static and dynamic analyses and thus avoids inducing other extrapolation error that commonly occurs on other projects.

Figure 20 Max E/W currents found on page 17 of the report shows the month by month plot of current velocities. The range of velocities shown is 0.5 ft/sec to 2.75 ft/sec. The N/S currents, shown on figure 6 page 11 of the report, are much less, being under 1 ft/sec. This data appears reasonable and the maximum current velocity is probably slightly higher than 2.75 ft/sec and is anticipated to not exceed 4.25 ft/sec (Ref. 2 & 3).

Observed movement data presented in the report is also valuable in confirming predicted movement behaviour.

5.0 STATIC ANALYSIS CALCULATIONS

A JPK MathCAD program for static load allowable spans was used to check and compare with the AutoPipe model results (Ref. 4 & 5).

Static Stress Spans Analysis for 20" Enbridge Pipeline Crossings

Operation Case with Assumed Currents

This spreadsheet performs static stress calculations for a pipeline free span for restrained and unrestrained conditions. The span length is input and unity checks for longitudinal and Von Mises combined stresses are determined. Calculations are based on the following assumptions:

- All stresses are based on nominal wall thicknesses
- Lift force is conservatively neglected
- Lay tension is conservatively neglected
- Shear Stress along the span is negligable
- Positive forces and stresses are tensile

Definition of Units for MATHCAD:

$F := K$ N = newton kN = 1000·N s = sec

$psi := \frac{lbf}{in^2}$ kPa := 1000·Pa C = K $MPa := 10^6 \cdot Pa$

INPUT DATA

Pipeline Parameters

External Diameter:	De := 20·in	Steel Density:	ρst := 490·lbf·ft^-3
Wall Thickness:	WT := 0.731·in	Corrosion Coating Density:	ρcc := 70·lbf·ft^-3
Pipeline Length:	Lp := 1000·ft		
Corrosion Coating Thickness:	Tcc := 0.250·in	Poisson's Ratio:	ν := 0.3
Young's Modulus:	E := 30·10^6·psi	SMYS:	SMYS := 30000·psi
Coefficient of Thermal Expansion:	α := 6.5·10^-6·F^-1	Lay Radius:	r := 3770·ft

Environmental Parameters

Water Depth:	WD := 175·ft	Wave Height:	H := 13.12·ft
Density of Water:	ρwater := 62.431·lbf·ft^-3	Wave Period:	Tmax := 10·s
Clay Undrained Shear Strength:	Su := 40·lbf·ft^-2	Current Velocity:	Uc := 2.74·ft·s^-1
		Ref. Current Height:	yc := 4·ft
Percentage of Pipeline Circumference in Contact with Seabed	C% := 0.1·%	Kinematic Viscosity of Seawater:	υ := 1.625·10^-5·ft^2·s^-1

Hydrodynamic Coefficients

Inertia Coefficient: $CI := 2.05$

Drag Coefficient: $CD := 1$

Operating Parameters

Contents Density: $\rho cont := 54.16 \cdot lbf \cdot ft^{-3}$

Internal Pressure: $Pi := 300 \cdot psi$

Temperatures

Inlet Temperature: $Tin := 40 \cdot F$

Ambient Temperature for Temperature Profile: $Ta := 32 \cdot F$

Temperature at distance 'y' from inlet: $Ty := 40 \cdot F$ $y := 3730 \cdot ft$

Installation Temperature: $Tinst := 32 \cdot F$

Calculates Temperature at Distance 'z': $z := 0 \cdot ft$

PRELIMINARY CALCULATIONS

Total Outside Diameter:	$D := De + 2 \cdot (Tcc)$	$D = 20.5\,in$
Internal Diameter:	$Di := De - 2 \cdot WT$	$Di = 18.538\,in$
Linepipe External CSA:	$CSAlp := 0.25 \cdot \pi \cdot De^2$	$CSAlp = 314\,in^2$
Steel CSA:	$CSAst := 0.25 \cdot \pi \cdot (De^2 - Di^2)$	$CSAst = 44.251\,in^2$
Internal (bore) CSA:	$CSAi := 0.25 \cdot \pi \cdot Di^2$	$CSAi = 270\,in^2$

Submerged Weight = Steel Weight + Corrosion Coat Weight + Contents Weight - Buoyancy

$$Ws := \left[\left[\left[0.25 \cdot \pi \cdot \left(De^2 - Di^2\right)\right] \cdot \rho st\right] + \left[0.25 \cdot \pi \cdot \left[(De + 2 \cdot Tcc)^2 - De^2\right] \cdot \rho cc\right] + \left(0.25 \cdot \pi \cdot Di^2 \cdot \rho cont\right)\right] \cdot g - \left(0.25 \cdot \pi \cdot D^2 \cdot \rho water \cdot g\right)$$

$Ws = 3755.532\ ft \cdot s^{-2} lbf \cdot ft^{-1}$

Second Moment of Area	$I := \frac{\pi}{64} \cdot (De^4 - Di^4)$	$I = 2.057 \times 10^3\,in^4$
Min. External Pressure	$Po := (WD - 0.5 \cdot H) \cdot \rho water$	$Po = 73.027\,psi$
Axial Friction Coefficient	$\mu := \frac{Su \cdot C\% \cdot \pi \cdot D}{Ws}$	$\mu = 5.716 \times 10^{-5}\ ft^{-1} \cdot s^2$

TEMPERATURE PROFILE

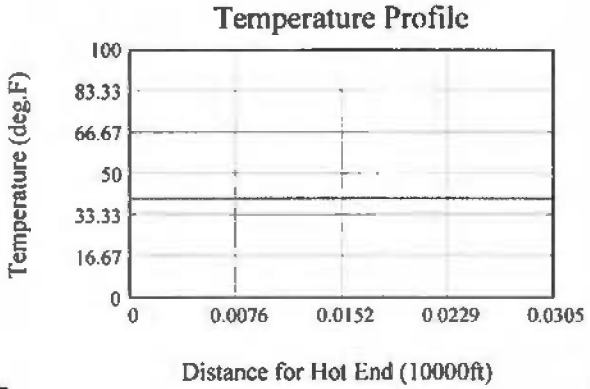
Heat Loss Coefficient $\beta := \left(\frac{1}{y}\right)\cdot\ln\left(\frac{Tin - Ta}{Ty - Ta}\right)$ $\beta = 0\ ft^{-1}$

$x := 0 .. 1000$ $T(x) := Ta + (Tin - Ta)\cdot e^{-\beta\cdot x}$

Temperature at specified distance:

$z = 0$

$T(z) = 40.0\,F$



MAGNITUDES OF STRESSES AND FORCES WITHIN PIPE

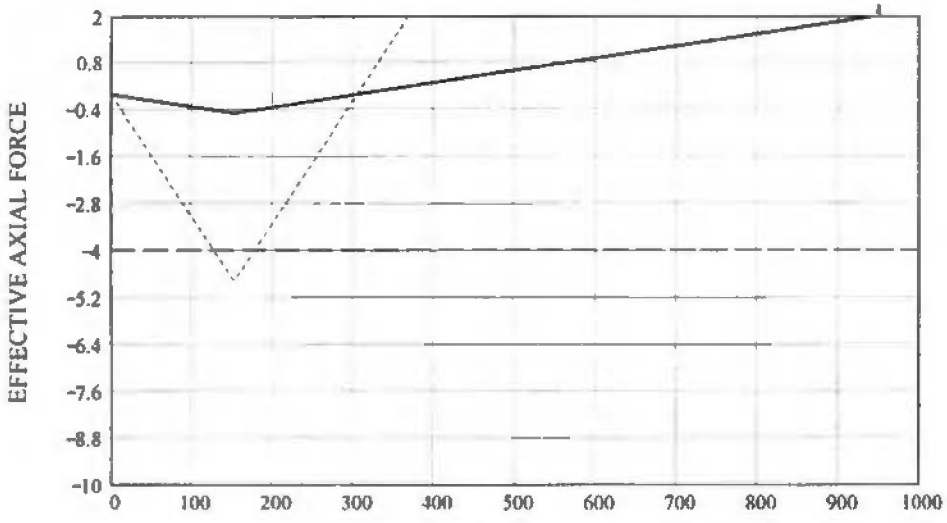
	Hoop	End Cap	Poisson's	Thermal
STRESS:	$\sigma h := \frac{(Pi - Po)\cdot De}{2\cdot WT}$	$\sigma ec := \frac{Di^2\cdot(Pi - Po)}{De^2 - Di^2}$	$\sigma v := \nu\cdot\sigma h$	$\sigma t(x) := \alpha\cdot(T(x) - Tinst)\cdot E$
	$\sigma h = 3.105\times 10^3\ psi$	$\sigma ec = 1.384\times 10^3\ psi$	$\sigma v = 931.5\ psi$	$\sigma t(0.5Lp) = 1.56\times 10^3\ psi$
FORCE:	$Fec := \sigma ec\cdot CSAst$	$Fv := \sigma v\cdot CSAst$	$Ft(x) := \sigma t(x)\cdot CSAst$	
	$Fec = 6.126\times 10^4\ lbf$	$Fv = 4.122\times 10^4\ lbf$	$Ft(0.5\cdot Lp) = 6.903\times 10^4\ lbf$	

EFFECTIVE AXIAL FORCE

(+ve Force is Tensile)

Effective Axial Force (fully restrained pipeline):	$Srestr(x) := Fv - Fec - Ft(x)$	$Srestr(0.5\cdot Lp) = -8.907\times 10^4\ lbf$
Effective Axial Force (hot end anchor length):	$Sh(x) := -\mu\cdot Ws\cdot x$	$Sh(0.5\cdot Lp) = -107.338\ lbf$
Effective Axial Force (cold end anchor length):	$Sc(x) := -\mu\cdot Ws\cdot(Lp - x)$	$Sc(0.5\cdot Lp) = -107.338\ lbf$
Effective Axial Force (hot & cold end anchor length):	$Shc(x) := if\left(0 \le x \le \frac{Lp}{2}, Sh(x), Sc(x)\right)$	
Effective Axial Force (whole pipeline):	$Seff(x) := max\left(\begin{pmatrix} Srestr(x) \\ Shc(x) \end{pmatrix}\right)$	

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Maximum Effective Axial Force Along Flowline

The maximum effective axial force occurs at the hot end anchor point where 'Srestr = Sh' for a 'long' pipeline and at 'Lp/2' for a short pipeline:

Location of hot end anchor point for a long pipeline: $a := 1 \cdot ft$ Given $Srestr(a) = Sh(a)$ $a := Find(a)$ $a = 414925\,ft$

Location of hot end anchor point for a long or short pipeline: $APh1 := if\left(Sh\left(\frac{Lp}{2}\right) > Srestr\left(\frac{Lp}{2}\right), \frac{Lp}{2}, a\right)$ $APh1 = 500\,ft$

Maximum (compressive) effective axial force: $Seffmax := if\left(Sh\left(\frac{Lp}{2}\right) > Srestr\left(\frac{Lp}{2}\right), Seff\left(\frac{Lp}{2}\right), Seff(a)\right)$ $Seffmax = -107\,lbf$

AXIAL STRESS ALONG FLOWLINE (+ve Stress is Tensile)

Axial Stress (fully restrained pipeline): $\sigma axrestr(x) := -\sigma t(x) + \sigma v$

Axial Stress (hot end anchor length): $\sigma axh(x) := \sigma ec - \frac{\mu \cdot Ws \cdot x}{CSAst}$

Axial Stress (cold end anchor length): $\sigma axc(x) := \sigma ec - \frac{\mu \cdot Ws \cdot (Lp - x)}{CSAst}$

Axial Stress (hot & cold end anchor length): $\sigma axhc(x) := if\left(0 \le x \le \frac{Lp}{2}, \sigma axh(x), \sigma axc(x)\right)$

Axial Stress (whole pipeline): $\sigma ax(x) := max\left(\sigma axrestr(x), \sigma axhc(x)\, \sigma ax\left(\frac{Lp}{2}\right)\right) = 1.382 \times 10^3\ psi$

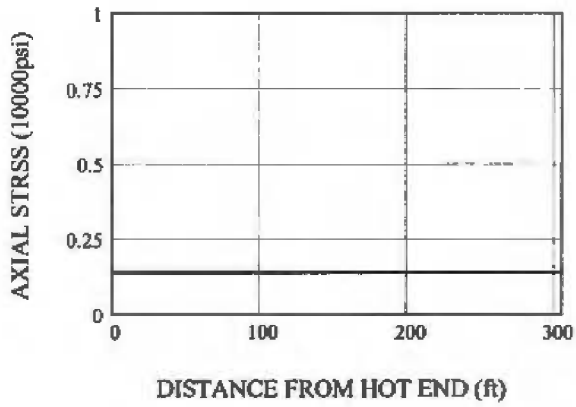
Location of maximum compressive axial stress (long pipeline):

$b := 5 \cdot ft$ Given $\sigma axrestr(b) = \sigma axh(b)$ $b_{AW} := Find(b)$ $b = 4.149 \times 10^5\ ft$

Location of maximum compressive axial stress (long or short pipeline):

$APh2 := if\left(\sigma axh\left(\frac{Lp}{2}\right) > \sigma axrestr\left(\frac{Lp}{2}\right), \frac{Lp}{2}, b\right)$

$APh2 = 500\ ft$



STEADY CURRENT VELOCITY (Ref. 3)

Steady Current Velocity at the top of the pipe is derived from the reference current velocity applied in Omnidirectionaly along the water depth column.

$Ucurr := if\left[y_c = 0, Uc, Uc \cdot \left[\left(\frac{\frac{D}{2} + y_c}{y_c}\right)^{\frac{1}{7}}\right]\right]$ $Ucurr = 2.817\ ft \cdot s^{-1}$

AIRY WAVE THEORY CALCULATIONS (Ref. 4)

Wavelength (λ)

First Approximation: $\lambda := 4 \cdot ft$ Given $\lambda = \left(\frac{g \cdot Tmax^2}{2 \cdot \pi} \cdot \tanh\left(\frac{2 \cdot \pi \cdot WD}{\lambda}\right)\right)$ $\lambda_{AW} := Find(\lambda)$ $\lambda = 499.66\ ft$

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Wave Induced Velocity and Acceleration

The maximum wave induced velocity and acceleration (over the wave cycle) is calculated at the top of pipe.

Maximum Velocity: $Uwavel := \left(\frac{H}{2}\right)\cdot\left(\frac{g\cdot Tmax}{\lambda}\right)\cdot\frac{\cosh\left[\frac{2\cdot\pi\cdot\left(\frac{D}{2}+y_c\right)}{\lambda}\right]}{\cosh\left(\frac{2\cdot\pi\cdot WD}{\lambda}\right)}$ $Uwavel = 0.926\ ft\cdot s^{-1}$

Maximum Acceleration: $Awavel := \frac{2\cdot\pi}{Tmax}\cdot Uwavel$ $Awavel = 0.582\ ft\cdot s^{-2}$

Functions describing Wave Induced Velocity and Acceleration with respect to Wave Phase Angle

$\theta := 0\cdot deg, 0.1\cdot deg .. 180\cdot deg$

Velocity $Uwave(\theta) := Uwavel\cdot\cos(\theta)$

Acceleration $Awave(\theta) := Awavel\cdot\sin(\theta)$

HYDRODYNAMIC LOADS

Functions describing Hydrodynamic Forces with respect to Wave Phase Angle

Drag Force $FD(\theta) := 0.5\cdot\frac{\rho water}{g}\cdot D\cdot CD\cdot(Uwave(\theta)+Ucurr)\cdot|Uwave(\theta)+Ucurr|$

Inertia Force $FI(\theta) := \pi\cdot 0.25\cdot\frac{\rho water}{g}\cdot D^2\cdot CI\cdot Awave(\theta)$

Horizontal Force (Drag + Inertia) $FH(\theta) := FD(\theta)+FI(\theta)$

Maximum Horizontal Hydrodynamic Force

The maximum horzontal hydrodynamic force occurs when the first derrivative is equal to zero.

First Approximation $\theta := 0\cdot deg$

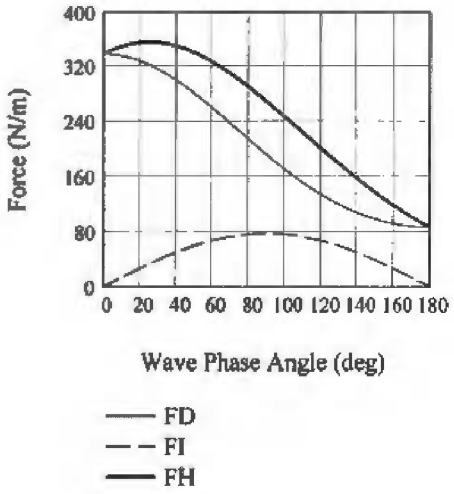
$\theta max := root\left(\frac{d}{d\theta}FH(\theta), \theta\right)$ $\theta max = 25.3\,deg$

Maximum Horzontal Hydrodynamic Force

$FH := FH(\theta max)$ $FH = 24.395\frac{lbf}{ft}$

$FH = 356.024\frac{N}{m}$

Drag Force, Inertial Force and Total Horizontal Force



STRESSES ALONG SPAN

Bending Stress due to Lay Radius: $\sigma rc := \frac{E \cdot De}{2 \cdot r}$ $\sigma rc = 6.631 \times 10^{3}\ psi$

Constant k: $K(x) := \sqrt{\frac{|Seff(x)|}{E \cdot I}}$ $K(0.5Lp) = 5.005 \times 10^{-4}\ ft^{-1}$

Maximum Bending Stress along Span
(based on average between fixed-fixed and pinned-pinned beam)

Bending stress due to submerged weight:

$$\sigma Ws(x, L) := \left[\frac{Ws \cdot L \cdot De}{2 \cdot K(x) \cdot I \cdot g} \cdot \frac{\tan(K(x) \cdot L) \cdot \left(\tan\left(\frac{K(x) \cdot L}{2} \right) - \frac{K(x) \cdot L}{2} \right)}{\tan(K(x) \cdot L) - (K(x) \cdot L)} \right]$$

Bending stress due to hydrodynamic load and lay radius:

$$\sigma hl(x, L) := \left[\frac{FH \cdot L \cdot De}{2 \cdot K(x) \cdot I} \cdot \frac{\tan(K(x) L) \cdot \left(\tan\left(\frac{K(x) \cdot L}{2} \right) - \frac{K(x) \cdot L}{2} \right)}{\tan(K(x) \cdot L) - (K(x) L)} + \sigma rc \right]$$

Resultant bending stress: $\sigma b(x, L) := \sqrt{\sigma Ws(x, L)^2 + \sigma hl(x, L)^2}$

Longitudinal Stress

$\sigma long1(x, L) := \sigma ax(x) + \sigma b(x, L)$

$\sigma long2(x, L) := \sigma ax(x) - \sigma b(x, L)$

Maximum Combined Stress (Von Mises)

$$\sigma VM1(x, L) := \left[\sigma h^2 + \sigma long1(x, L)^2 - (\sigma h \cdot \sigma long1(x, L)) \right]^{0.5}$$

$$\sigma VM2(x, L) := \left[\sigma h^2 + \sigma long2(x, L)^2 - (\sigma h \cdot \sigma long2(x, L)) \right]^{0.5}$$

ALLOWABLE STRESSES

Allowable Combined Stress	$\sigma VMallow := 0.9 \cdot SMYS$	$\sigma VMallow = 2.7 \times 10^{4}\ psi$
Allowable Longitudinal Stress	$\sigma Lallow := 0.8 \cdot SMYS$	$\sigma Lallow = 2.4 \times 10^{4}\ psi$

UNITY CHECKS $Ls := 1..250$

At location 1 (maximum effective axial force location - fully restrained)

Distance from hot end: $x1 := APh1$ $x1 = 500\ ft$

Longitudinal Stress Unity: $U1lg1(x1, Ls) := |\sigma long1(x1, Ls)| \cdot \sigma Lallow^{-1}$

$U1lg2(x1, Ls) := |\sigma long2(x1, Ls)| \cdot \sigma Lallow^{-1}$

Combined Stress Unity: $U1VM1(x1, Ls) := |\sigma VM1(x1, Ls)| \cdot \sigma VMallow^{-1}$

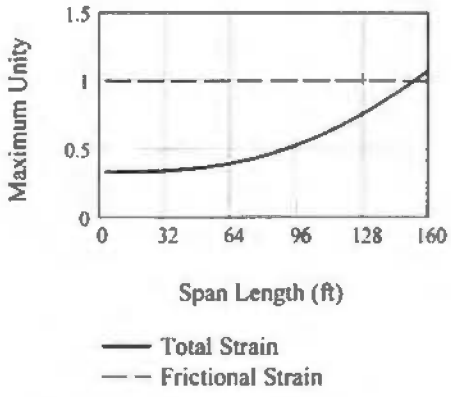
$U1VM2(x1, Ls) := |\sigma VM2(x1, Ls)| \cdot \sigma VMallow^{-1}$

Maximum Unity: $U1(x1, Ls) := \max\begin{pmatrix} U1lg1(x1, Ls) \\ U1lg2(x1, Ls) \\ U1VM1(x1, Ls) \\ U1VM2(x1, Ls) \end{pmatrix}$

$z := 65 \cdot ft$ Given $U1(x1, z) = 1$

Maximum Allowable Span: Find(z) = 152.803 ft

Note - This more conservative static span calc is for comparison with model results only. The AutoPipe model has axial restraint help from the anchor (pipeline) on the approximated pinned condition end. The model also includes input uniform loads to simulate the maximum amplitude of deflection due to dynamic (in-line VIV) loading.



At location 2 (at ends of pipe - unrestrained) Distance from hot end. $x2 := 1 \cdot ft$

Longitudinal Stress Unity: $U2lg1(x2, Ls) := |\sigma long1(x2, Ls)| \cdot \sigma Lallow^{-1}$

$U2lg2(x2, Ls) := |\sigma long2(x2, Ls)| \cdot \sigma Lallow^{-1}$

Combined Stress Unity: $U2VM1(x2, Ls) := |\sigma VM1(x2, Ls)| \cdot \sigma VMallow^{-1}$

$U2VM2(x2, Ls) := |\sigma VM2(x2, Ls)| \cdot \sigma VMallow^{-1}$

Maximum Unity: $U2(x2, Ls) := \max\begin{pmatrix} U2lg1(x2, Ls) \\ U2lg2(x2, Ls) \\ U2VM1(x2, Ls) \\ U2VM2(x2, Ls) \end{pmatrix}$ $z := 5 \cdot ft$ Given $U2(x2, z) = 1$

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Maximum Allowable Span: $Find(z) = 152.808\,ft$

Note - This more conservative static span calc is for comparison with model results only. The AutoPipe model has axial restraint help from the anchor (pipeline) on the approximated pinned condition end. The model also includes input uniform loads to simulate the maximum amplitude of deflection due to dynamic (in-line VIV) loading.

At location 3 Distance from hot end: $x3 := \frac{Lp}{2}$

Longitudinal Stress Unity:

$$U3lg1(x3, Ls) := |\sigma long1(x3, Ls)| \cdot \sigma L.allow^{-1}$$

$$U3lg2(x3, Ls) := |\sigma long2(x3, Ls)| \cdot \sigma L.allow^{-1}$$

Combined Stress Unity:

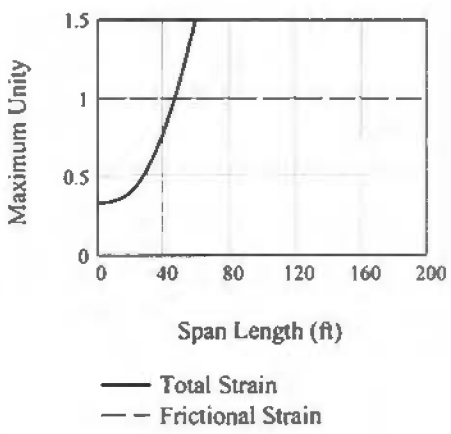
$$U3VM1(x3, Ls) := |\sigma VM1(x3, Ls)| \cdot \sigma VMallow^{-1}$$

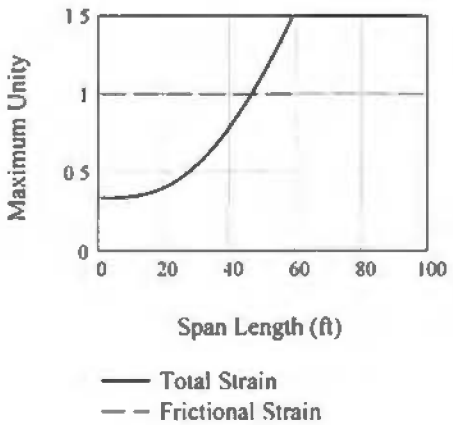
$$U3VM2(x3, Ls) := |\sigma VM2(x3, Ls)| \cdot \sigma VMallow^{-1}$$

Maximum Unity: $U3(x3, Ls) := max\begin{pmatrix} U3lg1(x3, Ls) \\ U3lg2(x3, Ls) \\ U3VM1(x3, Ls) \\ U3VM2(x3, Ls) \end{pmatrix}$ $z := 30 \cdot ft$ Given $U3(x3, z) = 1$

Maximum Allowable Span: $L(x3) := Find(z)$ $Lmax := min(L(x3))$ $Lmax = 152.803\,ft$

Note - This more conservative static span calc is for comparison with model results only. The AutoPipe model has axial restraint help from the anchor (pipeline) on the approximated pinned condition end. The model also includes input uniform loads to simulate the maximum amplitude of deflection due to dynamic (in-line VIV) loading.





M016SPAN06A84072 Spans Static Stress oper.xmcd Page 9 of 10 1/23/2005

REFERENCES

1. Project Design Basis
2. Ficticious assumed wave data
3. JP Kenny Design Guidelines. Determination of Design Steady Current Velocities. Doc. No. 00-9800-94-G-4-202, Rev, 0.3, 1:3:94
4. JP Kenny Design Guidelines. Wave Theories and Their Selection. Doc. No 00-9800-94-G-4-208 Rev. 05,1:3:94
5. JP Kenny. Structural analysis of Pipeline Systems, Design Guidelines Volume 4, Rev 01, 20/04/94. JPK Doc. No. 05-8050-94-Q-4-408.
6 JP Kenny. Pipeline Spans Design Guidelines, Design Guidelines Volume 4. Rev 01, 20/04/94. JPK Doc. No. 05-8050-94-Q-4-420.

6.0 DYNAMIC ANALYSIS CALCULATIONS

Calculations of the Vortex Induced Vibrations (VIV) were preformed on the range of spans and velocities indicated in the following summary.

VIV SPAN CALCULATION SUMMARY - ENBRIDGE 2004 STUDY JOB NO.: 84072 28-Dec 04

STRAITS OF MACKINAW, MICHIGAN

Span Length ft	Steady Current Velocity @ C.L. Pipe ft/sec	Steady Current Velocity @ Top of Pipe ft/sec	In-Line Reduced Velocity Vr il	Maximum Amplitude of In-Line Motion in	Cross Flow Reduced Velocity Vr xf	Maximum Amplitude Cross Flow in 1st mode Motion in	Maximum Amplitude Cross Flow in 2nd mode Motion in	Static AutoPipe Maximum Stress to Allowable Stress Ratio	In-Line VIV AutoPipe Maximum Stress to Allowable Stress Ratio
161	2 25	2.3117		2.6939		below	below		
162	2.25	2.3117		2.6939		below	below		
163	2.25	2 3117		2.6939		below	below		
164	2 25	2.3117		2.6939		below	below		
165	2.25	2.3117		2.6939		below	below		
166	2.25	2.3117	2.635	2.6939	2.635	below	below		
167	2.25	2.3117	2.667	2.6939	2.667	below	below		
168	2 25	2.3117	2.699	2.6939	2.699	below	below	0.99	1
169	2.25	2.3117	2.731	2.6939	2.731	below	below	1	
159	2.5	2.5685	2.686	2.6939	2.686	below	below		
160	2.5	2.5685	2.720	2.6939	2.720	below	below		
161	2 5	2.5685	2.754	2.6939	2.754	below	below		
162	2.5	2 5685	2.789	2.6939	2.789	below	below		
163	2.5	2.5685	2.823	2.6939	2.823	below	below		
164	2.5	2.5685	2.858	2.6939	2.858	below	below		0.98
165	2.5	2.5685	2.893	2.6939	2.893	below	below	0.98	0.99
166	2.5	2.5685	2.928	2.6939	2.928	below	below		1
167	2.5	2.5685	2.964	2.6939	2.964	below	below	1	
60	2.74	2.8150	0.419	below	0 419	below	below	0.28	
70	2.74	2.8150	0.571	below	0 571	below	below	0.31	
80	2.74	2.8150	0.745	below	0.745	below	below	0.36	
90	2.74	2.8150	0.943	below	0 943	below	below	0 41	
100	2.74	2.8150	1.165	2.6939	1.165	below	below	0 46	
110	2.74	2.8150	1.409	2.6939	1 409	below	below	0 53	
120	2.74	2.8150	1.677	2.6939	1.677	below	below	0.6	
130	2.74	2.8150	1.968	2.6939	1 968	below	below	0 68	
135	2.74	2.8150		2.6939		below	below		0 78
140	2.74	2.8150	2.283	2.6939	2 283	below	below	0 77	0 81
150	2.74	2.8150	2.620	2.6939	2 620	below	below	0.86	
160	2.74	2.8150	2.981	2.6939	2 981	below	below	0.95	
162	2.74	2.8150	3.056	2.6939	3 056	below	below	0.97	0 98
164	2.74	2.8150	3.132	2 6939	3.132	below	below	0.99	1
165	2.74	2.8150	3.171	2.6939	3.171	below	below	1	
166	2.74	2.8150	3.209	2.6939	3 209	below	below	1.01	
168	2.74	2.8150	3.287	2.6939	3.287	below	below	1.03	
170	2.74	2.8150	3.366	2.6939	3 366	below	below	1.06	
180	2.74	2.8150	3.773	above	3.773	below	below	1.16	
190	2.74	2.8150	4 204	above	4.204	below	below	1.28	
200	2.74	2.8150	4.658	above	4.658	28.529	29.267	1.4	
210	2.74	2.8150	5.136	above	5.136	28.529	29.267	1.52	
220	2.74	2.8150	5.637	above	5.637	28.529	29.267	1.65	
230	2.74	2.8150	6.161	above	6.161	28.529	29.267	1.79	
60	3	3.0822	0.459	below	0.459	below	below		
70	3	3.0822	0.625	below	0.625	below	below		
80	3	3.0822	0.816	below	0.816	below	below		
90	3	3.0822	1.033	2.6939	1.033	below	below		
100	3	3.0822	1.275	2.6939	1.275	below	below		
110	3	3 0822	1.543	2.6939	1.543	below	below		
120	3	3.0822	1.836	2.6939	1 836	below	below		
130	3	3.0822	2.155	2.6939	2.155	below	below		

VIV SPAN CALCULATION SUMMARY - 28-Dec 04
ENBRIDGE 2004 STUDY JOB NO.: 84072
STRAITS OF MACKINAW, MICHIGAN

Span Length ft	Steady Current Velocity @ C.L. Pipe ft/sec	Steady Current Velocity @ Top of Pipe ft/sec	In-Line Reduced Velocity Vr il	Maximum Amplitude of In-Line Motion in	Cross Flow Reduced Velocity Vr xf	Maximum Amplitude Cross Flow in 1st mode Motion in	Maximum Amplitude Cross Flow in 2nd mode Motion in	Static AutoPipe Maximum Stress to Allowable Stress Ratio	In-Line VIV AutoPipe Maximum Stress to Allowable Stress Ratio
135	3	3.0822	2.324	2.6939	2.324	below	below		0.78
140	3	3.0822	2.499	2.6939	2.499	below	below		0.81
150	3	3.0822	2.869	2.6939	2.869	below	below		
160	3	3.0822	3.264	2.6939	3.264	below	below	0.97	
162	3	3.0822	3.346	2.6939	3.346	below	below	0.99	0.98
163	3	3.0822	3.388	2.6939	3.388	below	below	1	
164	3	3.0822	3.430	2.6939	3.430	below	below		1
165	3	3.0822	3.472	2.6939	3.472	below	below		
166	3	3.0822	3.514	above	3.514	below	below		
168	3	3.0822	3.599	above	3.599	below	below		
170	3	3.0822	3.685	above	3.685	below	below		
180	3	3.0822	4.131	above	4.131	below	below		
190	3	3.0822		above		below	below		
200	3	3.0822		above		28.529	29.267		
210	3	3.0822		above		28.529	29.267		
220	3	3.0822		above		28.529	29.267		
230	3	3.0822		above		28.529	29.267		
60	3.25	3.3391	0.497	below	0.497	below	below		
70	3.25	3.3391	0.677	below	0.677	below	below		
80	3.25	3.3391	0.884	below	0.884	below	below		
90	3.25	3.3391	1.119	2.6939	1.119	below	below		
100	3.25	3.3391	1.381	2.6939	1.381	below	below		
110	3.25	3.3391	1.671	2.6939	1.671	below	below		
120	3.25	3.3391	1.989	2.6939	1.989	below	below		
130	3.25	3.3391	2.335	2.6939	2.335	below	below		
135	3.25	3.3391	2.518	2.6939	2.518	below	below		
140	3.25	3.3391	2.708	2.6939	2.708	below	below		
150	3.25	3.3391	3.108	2.6939	3.108	below	below		0.9
152	3.25	3.3391	3.192	2.6939	3.192	below	below		
154	3.25	3.3391	3.276	2.6939	3.276	below	below		
156	3.25	3.3391	3.362	2.6939	3.362	below	below		
158	3.25	3.3391	3.449	2.6939	3.449	below	below		0.97
159	3.25	3.3391	3.492	2.6939	3.492	below	below		0.98
160	3.25	3.3391	3.536	above	3.536	below	below	0.99	
161	3.25	3.3391	3.581	above	3.581	below	below	1	
162	3.25	3.3391	3.625	above	3.625	below	below		
163	3.25	3.3391	3.670	above	3.670	below	below		
164	3.25	3.3391	3.715	above	3.715	below	below		
165	3.25	3.3391	3.761	above	3.761	below	below		
166	3.25	3.3391	3.807	above	3.807	below	below		
168	3.25	3.3391	3.899	above	3.899	below	below		
170	3.25	3.3391	3.992	above	3.992	below	below		
180	3.25	3.3391	4.476	above	4.476	below	below		
190	3.25	3.3391	4.987	above	4.987	28.529	29.267		
200	3.25	3.3391	5.526	above	5.526	28.529	29.267		
210	3.25	3.3391	6.092	above	6.092	28.529	29.267		
220	3.25	3.3391	6.686	above	6.686	28.529	29.267		
230	3.25	3.3391		above		28.529	29.267		
140	3.5	3.5959		2.6939		below	below		
150	3.5	3.5959		2.6939		below	below		

VIV SPAN CALCULATION SUMMARY - ENBRIDGE 2004 STUDY JOB NO.: 84072 28-Dec 04

STRAITS OF MACKINAW, MICHIGAN

Span Length ft	Steady Current Velocity @ C.L. Pipe ft/sec	Steady Current Velocity @ Top of Pipe ft/sec	In-Line Reduced Velocity Vr il	Maximum Amplitude of In-Line Motion in	Cross Flow Reduced Velocity Vr xf	Maximum Amplitude Cross Flow in 1st mode Motion in	Maximum Amplitude Cross Flow in 2nd mode Motion in	Static AutoPipe Maximum Stress to Allowable Stress Ratio	In-Line VIV AutoPipe Maximum Stress to Allowable Stress Ratio
152	3 5	3.5959	3.437	2.6939	3.437	below	below		0.94
153	3 5	3 5959	3.482	2.6939	3.482	below	below		0.94
154	3 5	3.5959	3.528	above	3.528	below	below		
156	3 5	3.5959	3.620	above	3.620	below	below		
158	3 5	3 5959	3.714	above	3.714	below	below	0.99	
159	3 5	3 5959		above		below	below	1	
160	3 5	3 5959		above		below	below	1.01	
140	3.75	3 8528		2.6939		below	below		
148	3 75	3.8528	3.491	2.6939	3.491	below	below		0.92
149	3.75	3 8528	3.539	above	3.539	below	below		
150	3 75	3 8528	3.586	above	3.586	below	below		
151	3.75	3.8528	3.634	above	3.634	below	below		
152	3.75	3 8528	3.683	above	3.683	below	below		
153	3.75	3 8528	3.731	above	3.731	below	below		
154	3.75	3.8528	3.780	above	3.780	below	below		
155	3 75	3.8528	3.829	above	3.829	below	below		
156	3.75	3.8528	3.879	above	3.879	below	below		
157	3.75	3.8528	3.929	above	3.929	below	below	1	
158	3.75	3.8528	3.979	above	3.979	below	below		
159	3.75	3.8528	4.030	above	4.030	below	below		
160	3.75	3.8528		above		below	below		
140	4	4.1096	3.332	2.6939	3.332	below	below		
141	4	4.1096	3.380	2.6939	3.380	below	below		
142	4	4.1096	3.428	2.6939	3.428	below	below		
143	4	4.1096	3.477	2.6939	3.477	below	below		0.89
144	4	4.1096	3.525	above	3.525	below	below	0.88	
145	4	4.1096	3.575	above	3.575	below	below		
146	4	4.1096	3.624	above	3 624	below	below		
147	4	4.1096	3.674	above	3.674	below	below		
148	4	4.1096	3.724	above	3 724	below	below		
149	4	4.1096	3.775	above	3.775	below	below		
150	4	4.1096	3.825	above	3.825	below	below		
151	4	4.1096	3.877	above	3.877	below	below		
152	4	4.1096	3.928	above	3.928	below	below		
153	4	4.1096	3.980	above	3.980	below	below		
154	4	4.1096	4.032	above	4.032	below	below		
155	4	4.1096	4.085	above	4.085	below	below	1	
156	4	4.1096		above		below	below		
157	4	4.1096		above		below	below		
158	4	4.1096		above		below	below		
159	4	4.1096		above		below	below		
160	4	4.1096		above		below	below		
138	4.25	4.3665	3.440	2.6939	3.440	below	below		
139	4.25	4.3665	3.490	2.6939	3.490	below	below	0.85	0.87
140	4.25	4.3665	3.541	above	3.541	below	below		
141	4.25	4.3665	3.591	above	3.591	below	below		
142	4.25	4.3665	3.643	above	3.643	below	below		
143	4.25	4.3665	3.694	above	3.694	below	below		
144	4.25	4.3665	3.746	above	3.746	below	below		
145	4.25	4.3665	3.798	above	3.798	below	below		

ENBDNR0007390

VIV SPAN CALCULATION SUMMARY - ENBRIDGE 2004 STUDY JOB NO.: 84072 28-Dec 04

STRAITS OF MACKINAW, MICHIGAN

Span Length ft	Steady Current Velocity @ C L Pipe ft/sec	Steady Current Velocity @ Top of Pipe ft/sec	In-Line Reduced Velocity Vr il	Maximum Amplitude of In-Line Motion in	Cross Flow Reduced Velocity Vr xf	Maximum Amplitude Cross Flow in 1st mode Motion in	Maximum Amplitude Cross Flow in 2nd mode Motion in	Static AutoPipe Maximum Stress to Allowable Stress Ratio	In-Line VIV AutoPipe Maximum Stress to Allowable Stress Ratio
146	4.25	4 3665	3.851	above	3.851	below	below		
147	4.25	4.3665	3.904	above	3.904	below	below		
148	4.25	4.3665	3.957	above	3.957	below	below		
149	4.25	4.3665	4.010	above	4.010	below	below		
150	4.25	4 3665	4.064	above	4.064	below	below		
151	4.25	4.3665	4.119	above	4.119	below	below		
152	4.25	4 3665	4.174	above	4.174	below	below		
153	4.25	4.3665	4.229	above	4.229	below	below	1	
154	4.25	4 3665	4.284	above	4.284	below	below		
155	4.25	4.3665	4.340	above	4.340	below	below		

7.0 REFERENCES

1) "Pipeline Motion Measurement System and Current Profiler Data Analysis", October 11, 2004, Lee Gordon Consulting

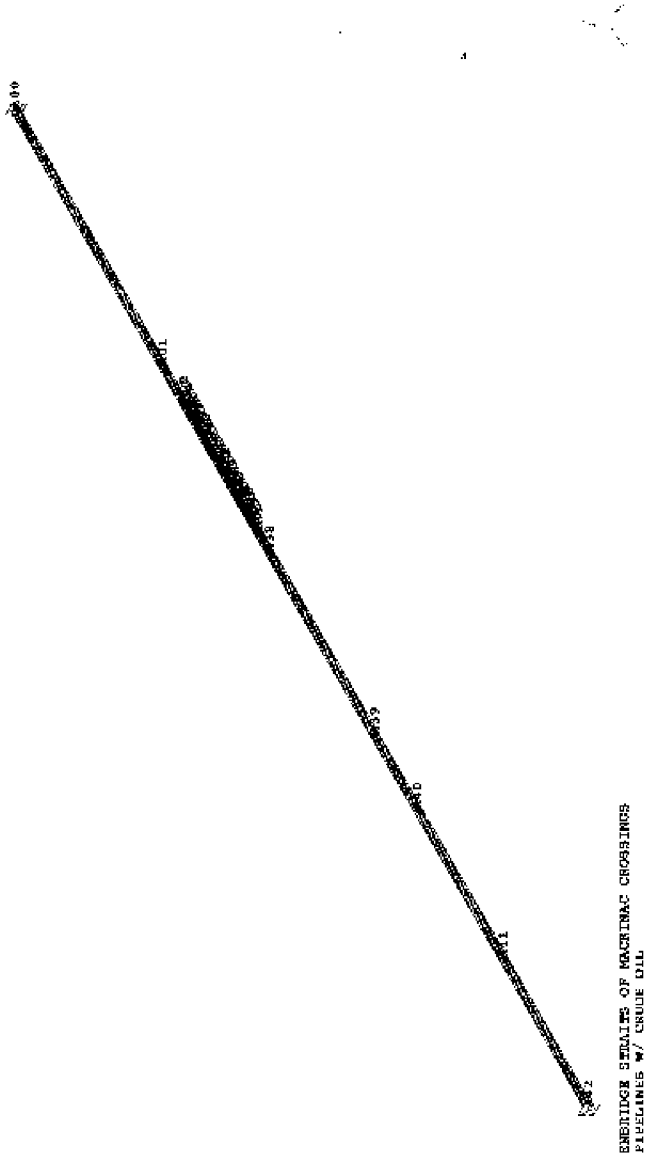
2) JP Kenny Design Guidelines "Determination of Design Steady Current Velocities" Doc. No. 00-9800-94-G-4-202, Rev, 0.3, 1:3:94

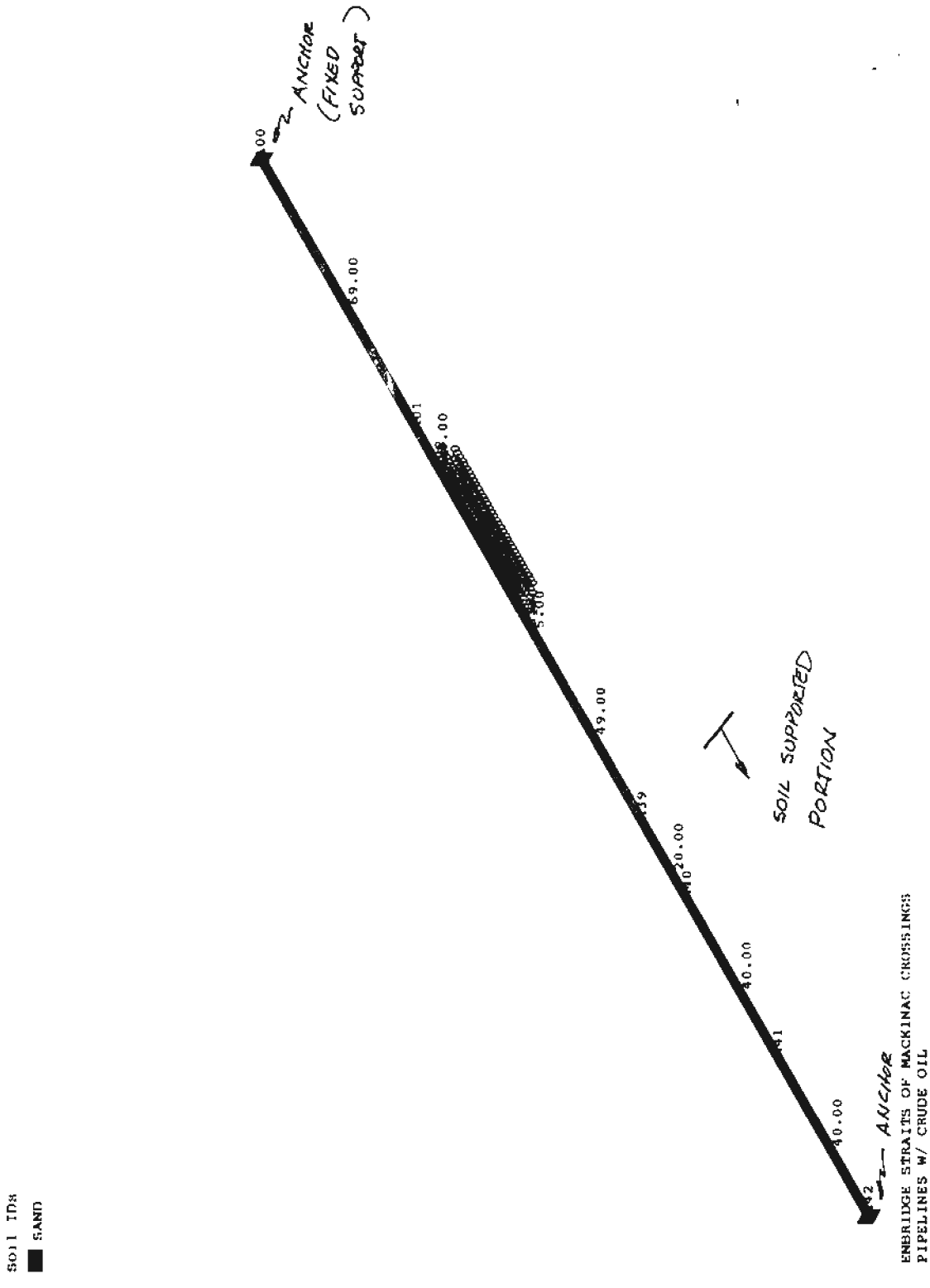
3) JP Kenny Design Guidelines "Wave Theories and Their Selection", Doc. No. 00-9800-94-G-4-208 Rev. 05, 1:3:94

4) JP Kenny Design Guidelines "Structural Analysis of Pipeline Systems", Volume 4. Rev 01, 20/04/94.

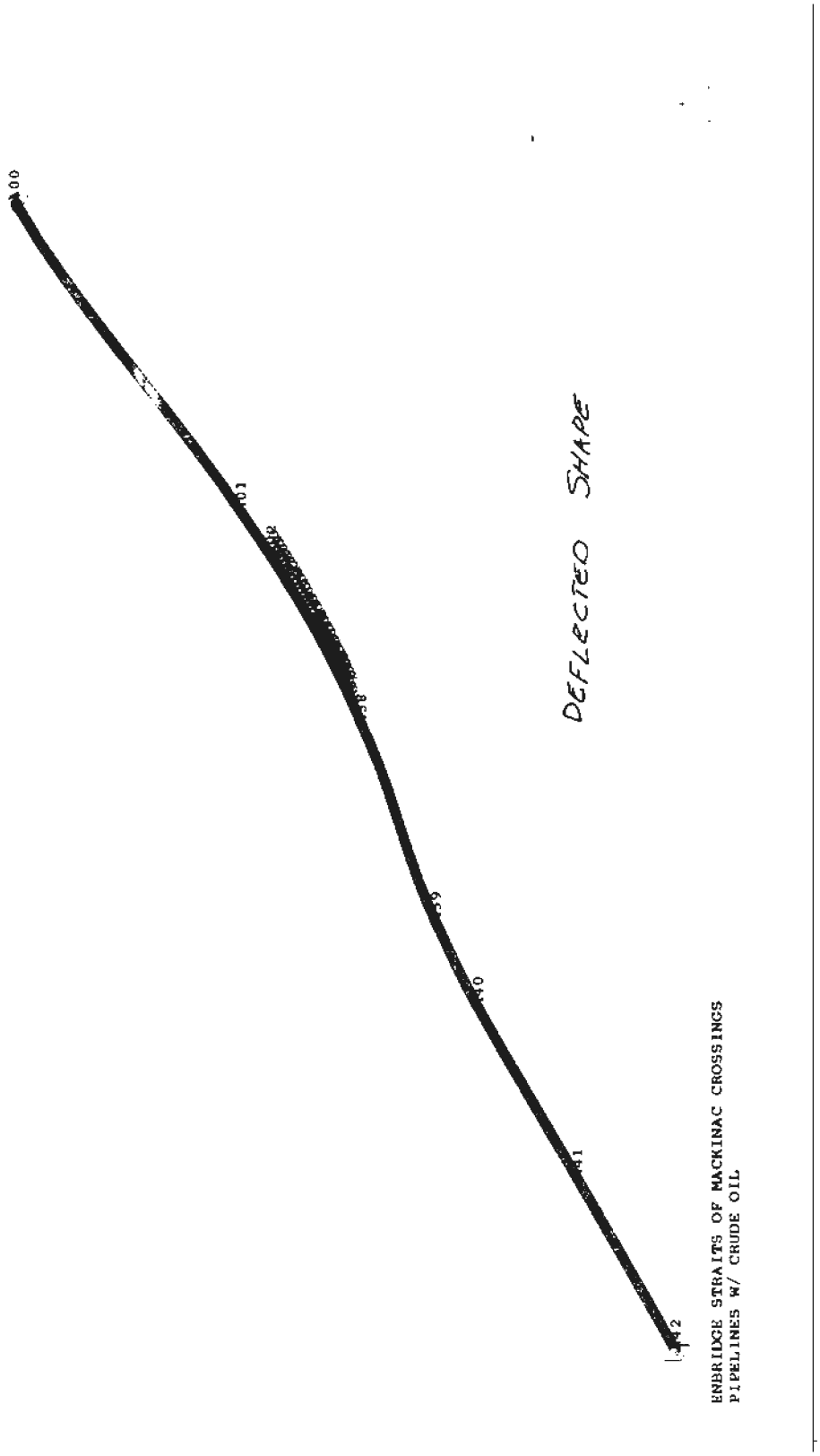
5) JP Kenny Design Guidelines "Pipeline Spans Design Guidelines" Volume 4 Rev 01, 20/04/94 Doc. No. 05-8050-94-Q-4-420.

APPENDIX A: AUTOPIPE MODEL


ENBRIDGE STRAITS OF MACKINAC CROSSINGS
PIPELINES W/ CRUDE OIL



ENBDNR0007395



ENBDNR0007396

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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   1
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          *                              *******   **  *******   *******
         ***               **            **    **  **  **    **  **
        ** **             ******         **    **  **  **    **  **
       **   **    **   **  **   *****    *******   **  *******   *****
      *********   **   **  **  **   **   **        **  **        **
     **       **  **   **  **  **   **   **        **  **        **
    **         **  *****   **   *****    **        **  **        *******
```

Pipe Stress Analysis and Design Program

Version: 6.30.11

Edition: Plus-Win

Developed and Maintained by

BENTLEY SYSTEMS, INCORPORATED
1600 Riviera Ave., Suite 300
Walnut Creek, CA 94596

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------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   2
------------------------------------------------------------------------------
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**************************************************************
**                                                          **
**              AUTOPIPE SYSTEM INFORMATION                 **
**                                                          **
**************************************************************

SYSTEM NAME : ENB2004I

PROJECT ID  : ENBRIDGE STRAITS OF MACKINAC CROSSINGS
              PIPELINES W/ CRUDE OIL

DESCRIPTION : PINNED-FIXED END SPAN MODELING TO
              FIND  STRESS TO
              DEFLECTION RELATIONSHIP FOR A UNIFORMLY
              LOADED PIPE BEAM

PREPARED BY : _____________________________
              CRAIG KILMER

CHECKED BY  : _____________________________

PIPING CODE            : B31.4

VERTICAL AXIS          : Z

AMBIENT TEMPERATURE    :   32.0 deg F

COMPONENT LIBRARY      : AUTOPIPE

MATERIAL LIBRARY       : AUTOB314

MODEL REVISION NUMBER  :    29
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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   3
-------------------------------------------------------------------------------
                 C O M P O N E N T   D A T A   L I S T I N G
-------------------------------------------------------------------------------
 *** SEGMENT A
 -----------------------------------------------------------------------------
 From A00 to A01, DX= 69.00 ft                                          Run

 PIPE DATA:
   Pipe Id= CORR10, Material= CS, Poisson= 0.300, Nom Size= 20 inch,
   OD= 20.000 inch, Sch= NS, Wall Thk= 0.731 inch, Mill= 0.091 inch,
   Cor= 0 inch, Pipe Density= 489.00 lb/cu.ft, Pipe Unit Wgt= 150.27 lb/ft,
   Content Sp Gr= 0.868, Content Unit Wgt= 101.52 lb/ft,
   Insul Thk= 0.010 inch, Insul Material= OTHER,
   Insul Density= 70.00 lb/cu.ft, Insul Unit Wgt= 0.31 lb/ft,
   Lining Thk= 0 inch, Long Weld factor= 1.00, Circ Weld factor= 1.00,
   Long Modulus= 29.65920 E6 psi, Hoop Modulus= 29.65920 E6 psi,
   Shear Modulus= 11.40738 E6 psi, Syc= 30000.0 psi

 OPERATING DATA:
   P1= 300.00 psi, T1= 40.00 deg F, Exp1= 0.05760 in/100ft,
   E1= 29.62400 E6 psi, Sy1= 30000.00 psi

 POINT DATA:
   A00, Coordinates, X= 0.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A00, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 SUPPORT DATA:
   A00, Anchor, KTX= Rigid, KTY= Rigid, KTZ= Rigid, KRX= Rigid, KRY= Rigid,
   KRZ= Rigid

 -----------------------------------------------------------------------------
 From A01 to A02, DX= 10.00 ft                                          Run

 POINT DATA:
   A01, Coordinates, X= 69.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A01, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A02 to A03, DX= 1.00 ft                                           Run

 POINT DATA:
   A02, Coordinates, X= 79.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A02, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A03 to A04, DX= 1.00 ft                                           Run

 POINT DATA:
   A03, Coordinates, X= 80.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A03, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A04 to A05, DX= 1.00 ft                                           Run
  POINT DATA:
   A04, Coordinates, X= 81.00 ft, Y= 0.00 ft, Z= -170.00 ft
```

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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   4
-------------------------------------------------------------------------------
                 C O M P O N E N T   D A T A   L I S T I N G
   A04, Dist Load= GR, Id= 29, DLY= -17 lb/ft
  -----------------------------------------------------------------------------
 From A05 to A06, DX= 1.00 ft                                            Run

 POINT DATA:
   A05, Coordinates, X= 82.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A05, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A06 to A07, DX= 1.00 ft                                            Run

 POINT DATA:
   A06, Coordinates, X= 83.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A06, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A07 to A08, DX= 1.00 ft                                            Run

 POINT DATA:
   A07, Coordinates, X= 84.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A07, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A08 to A09, DX= 1.00 ft                                            Run

 POINT DATA:
   A08, Coordinates, X= 85.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A08, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A09 to A10, DX= 1.00 ft                                            Run

 POINT DATA:
   A09, Coordinates, X= 86.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A09, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A10 to A11, DX= 1.00 ft                                            Run

 POINT DATA:
   A10, Coordinates, X= 87.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A10, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A11 to A12, DX= 1.00 ft                                            Run

 POINT DATA:
   A11, Coordinates, X= 88.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A11, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -----------------------------------------------------------------------------
 From A12 to A13, DX= 1.00 ft                                            Run
POINT DATA:
```


ENBDNR0007400

```
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   5
-------------------------------------------------------------------------------
                 C O M P O N E N T   D A T A   L I S T I N G
   A12, Coordinates, X= 89.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A12, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A13 to A14, DX= 1.00 ft                                              Run

 POINT DATA:
   A13, Coordinates, X= 90.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A13, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A14 to A15, DX= 1.00 ft                                              Run

 POINT DATA:
   A14, Coordinates, X= 91.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A14, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A15 to A16, DX= 1.00 ft                                              Run

 POINT DATA:
   A15, Coordinates, X= 92.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A15, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A16 to A17, DX= 1.00 ft                                              Run

 POINT DATA:
   A16, Coordinates, X= 93.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A16, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A17 to A18, DX= 1.00 ft                                              Run

 POINT DATA:
   A17, Coordinates, X= 94.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A17, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A18 to A19, DX= 1.00 ft                                              Run

 POINT DATA:
   A18, Coordinates, X= 95.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A18, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A19 to A20, DX= 1.00 ft                                              Run

 POINT DATA:
   A19, Coordinates, X= 96.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A19, Dist Load= GR, Id= 29, DLY= -17 lb/ft
  ------------------------------------------------------------------------------
 From A20 to A21, DX= 1.00 ft                                              Run
```


ENBDNR0007401

```
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   6
-------------------------------------------------------------------------------
                C O M P O N E N T   D A T A   L I S T I N G
  POINT DATA:
   A20, Coordinates, X= 97.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A20, Dist Load= GR, Id= 29, DLY= -17 lb/ft
 -------------------------------------------------------------------------------
 From A21 to A22, DX= 1.00 ft                                              Run

 POINT DATA:
   A21, Coordinates, X= 98.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A21, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A22 to A23, DX= 1.00 ft                                              Run

 POINT DATA:
   A22, Coordinates, X= 99.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A22, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A23 to A24, DX= 1.00 ft                                              Run

 POINT DATA:
   A23, Coordinates, X= 100.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A23, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A24 to A25, DX= 1.00 ft                                              Run

 POINT DATA:
   A24, Coordinates, X= 101.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A24, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A25 to A26, DX= 1.00 ft                                              Run

 POINT DATA:
   A25, Coordinates, X= 102.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A25, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A26 to A27, DX= 1.00 ft                                              Run

 POINT DATA:
   A26, Coordinates, X= 103.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A26, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A27 to A28, DX= 1.00 ft                                              Run

 POINT DATA:
   A27, Coordinates, X= 104.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A27, Dist Load= GR, Id= 29, DLY= -17 lb/ft
 -------------------------------------------------------------------------------
 From A28 to A29, DX= 1.00 ft                                              Run
```


ENBDNR0007402

```
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   7
-------------------------------------------------------------------------------
                C O M P O N E N T   D A T A   L I S T I N G
POINT DATA:
   A28, Coordinates, X= 105.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A28, Dist Load= GR, Id= 29, DLY= -17 lb/ft
 -------------------------------------------------------------------------------
 From A29 to A30, DX= 1.00 ft                                              Run

 POINT DATA:
   A29, Coordinates, X= 106.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A29, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A30 to A31, DX= 1.00 ft                                              Run

 POINT DATA:
   A30, Coordinates, X= 107.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A30, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A31 to A32, DX= 1.00 ft                                              Run

 POINT DATA:
   A31, Coordinates, X= 108.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A31, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A32 to A33, DX= 1.00 ft                                              Run

 POINT DATA:
   A32, Coordinates, X= 109.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A32, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A33 to A34, DX= 1.00 ft                                              Run

 POINT DATA:
   A33, Coordinates, X= 110.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A33, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A34 to A35, DX= 1.00 ft                                              Run

 POINT DATA:
   A34, Coordinates, X= 111.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A34, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A35 to A36, DX= 1.00 ft                                              Run

 POINT DATA:
   A35, Coordinates, X= 112.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A35, Dist Load= GR, Id= 29, DLY= -17 lb/ft
  ------------------------------------------------------------------------------
 From A36 to A37, DX= 1.00 ft                                              Run
```

```
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   8
-------------------------------------------------------------------------------
                C O M P O N E N T   D A T A   L I S T I N G
POINT DATA:
   A36, Coordinates, X= 113.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A36, Dist Load= GR, Id= 29, DLY= -17 lb/ft
 -------------------------------------------------------------------------------
 From A37 to A38, DX= 5.00 ft                                              Run

 POINT DATA:
   A37, Coordinates, X= 114.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A37, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A38 to A39, DX= 49.00 ft                                             Run

 POINT DATA:
   A38, Coordinates, X= 119.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A38, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 -------------------------------------------------------------------------------
 From A39 to A40, DX= 20.00 ft                                             Run

 POINT DATA:
   A39, Coordinates, X= 168.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A39, Dist Load= GR, Id= 29, DLY= -17 lb/ft

 SOIL DATA:
   Soil Id= SAND, 7 point(s) at 31.00 inch
   Horz K1= 12640.000 lb/in/ft, Horz P1= 920.000 lb/ft,
   Horz K2= 0.000 lb/in/ft, Long K1= 480.000 lb/in/ft,
   Long P1= 180.000 lb/ft, Long k2= 0.000 lb/in/ft,
   Vert Up K1= 1200.000 lb/in/ft, Vert Up P1= 220.000 lb/ft,
   Vert Up K2= 0.000 lb/in/ft, Vert Dn K1= 3420.000 lb/in/ft,
   Vert Dn P1= 8760.000 lb/ft, Vert Dn K2= 0.000 lb/in/ft

 -------------------------------------------------------------------------------
 From A40 to A41, DX= 40.00 ft                                             Run

 POINT DATA:
   A40, Coordinates, X= 188.00 ft, Y= 0.00 ft, Z= -170.00 ft

 SOIL DATA:
   Soil Id= SAND, 4 point(s) at 100.00 inch

 -------------------------------------------------------------------------------
 From A41 to A42, DX= 40.00 ft                                             Run

 POINT DATA:
   A41, Coordinates, X= 228.00 ft, Y= 0.00 ft, Z= -170.00 ft
   A42, Coordinates, X= 268.00 ft, Y= 0.00 ft, Z= -170.00 ft

 SUPPORT DATA:
   A42, Anchor, KTX= Rigid, KTY= Rigid, KTZ= Rigid, KRX= Rigid, KRY= Rigid,
   KRZ= Rigid
  SOIL DATA:
```


ENBDNR0007404

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE   9
------------------------------------------------------------------------------

                C O M P O N E N T   D A T A   L I S T I N G

   Soil Id= SAND, 1 point(s) at 410.00 inch
   Soil Id= SAND, End at A42

 ------------------------------------------------------------------------------


 Number of points in the system: 55


 Weight of Empty Pipes + Weight of Contents = Total Weight of System
        40354.3 lb     +     27207.7 lb     =       67562.0 lb
```

```
--------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  10
--------------------------------------------------------------------------------
```

C O O R D I N A T E S D A T A L I S T I N G

POINT NAME	COORDINATE (ft) X	Y	Z
*** SEGMENT A			
A00	0.00	0.00	-170.00
A01	69.00	0.00	-170.00
A02	79.00	0.00	-170.00
A03	80.00	0.00	-170.00
A04	81.00	0.00	-170.00
A05	82.00	0.00	-170.00
A06	83.00	0.00	-170.00
A07	84.00	0.00	-170.00
A08	85.00	0.00	-170.00
A09	86.00	0.00	-170.00
A10	87.00	0.00	-170.00
A11	88.00	0.00	-170.00
A12	89.00	0.00	-170.00
A13	90.00	0.00	-170.00
A14	91.00	0.00	-170.00
A15	92.00	0.00	-170.00
A16	93.00	0.00	-170.00
A17	94.00	0.00	-170.00
A18	95.00	0.00	-170.00
A19	96.00	0.00	-170.00
A20	97.00	0.00	-170.00
A21	98.00	0.00	-170.00
A22	99.00	0.00	-170.00
A23	100.00	0.00	-170.00
A24	101.00	0.00	-170.00
A25	102.00	0.00	-170.00
A26	103.00	0.00	-170.00
A27	104.00	0.00	-170.00
A28	105.00	0.00	-170.00
A29	106.00	0.00	-170.00
A30	107.00	0.00	-170.00
A31	108.00	0.00	-170.00
A32	109.00	0.00	-170.00
A33	110.00	0.00	-170.00
A34	111.00	0.00	-170.00
A35	112.00	0.00	-170.00
A36	113.00	0.00	-170.00
A37	114.00	0.00	-170.00
A38	119.00	0.00	-170.00
A39	168.00	0.00	-170.00
A40	188.00	0.00	-170.00
A41	228.00	0.00	-170.00
A42	268.00	0.00	-170.00

ENBDNR0007406

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  11
------------------------------------------------------------------------------

                    P I P E   D A T A   L I S T I N G

 Pipe ID/     Nom/ O.D.  -----Thickness(inch)-----  Spec   Weight(lb/ft )    ZL/
 Material     Sch  inch  W.Th. Corr Mill Insu Ling  Grav  Pipe  Other Total  ZC
 ------------ ---- ----- ----- ---- ---- ---- ----  ----  ----- ----- ----- ----
 CORR10        20 20.000 0.731    0 0.09 0.01    0  0.87    150  0.31   252 1.00
 CS           NS                                                            1.00
```

```
--------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  12
--------------------------------------------------------------------------------

              M A T E R I A L   D A T A   L I S T I N G

  Material            Density  Pois. Temper.       Modulus E6 psi       Expans.
    Name     Pipe ID  lb/cu.ft Ratio deg F    Axial     Hoop    Shear   in/100ft
------------ -------- -------- ----- ------- -------- -------- -------- --------
 CS          CORR10      489.0  0.30    32.0   29.659   29.659   11.407
                                        40.0   29.624                     0.0576
```

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  13
------------------------------------------------------------------------------

        M A T E R I A L   A L L O W A B L E   D A T A   L I S T I N G

  Material            Temper. Yield
    Name     Pipe ID  deg F   psi
------------ -------- ------- --------
 CS          CORR10      32.0  30000.0
```

```
--------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  14
--------------------------------------------------------------------------------

                        TEMPERATURE AND PRESSURE DATA
      -----C A S E   1------  -----C A S E   2------  -----C A S E   3------
 POINT PRESS. TEMPER  EXPAN.   PRESS. TEMPER  EXPAN.   PRESS. TEMPER  EXPAN.
 NAME  psi    deg F  in/100ft  psi    deg F  in/100ft  psi    deg F  in/100ft
 ----- ------ ------ --------  ------ ------ --------  ------ ------ --------

 *** SEGMENT A
 A00       300  40.00    0.058
 A42       300  40.00    0.058
```

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  15
------------------------------------------------------------------------------

     H O T   M O D U L U S  (E6 psi  )

 POINT
 NAME     CASE 1      CASE 2      CASE 3
 -----  ----------  ----------  ----------

 *** SEGMENT A
 A00        29.624
 A42        29.624


*  Non-standard material
```

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  16
------------------------------------------------------------------------------

                       H O T   A L L O W A B L E S  (psi   )
      ------C A S E  1------   ------C A S E  2------   ------C A S E  3------
 POINT         NOT     NOT              NOT     NOT              NOT     NOT
 NAME  YIELD   USED    USED     YIELD   USED    USED     YIELD   USED    USED
 ----- ------  ------  ------   ------  ------  ------   ------  ------  ------

 *** SEGMENT A
 A00    30000*
 A42    30000*
*  Non-code material
```

ENB2004I 12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS BENTLEY
04:52 PM PIPELINES W/ CRUDE OIL AutoPIPE+6.30 MODEL PAGE 17

FORCES AND DISPLACEMENTS

(Force - lb , Moment - ft-lb , Tran. - in , Rot. - deg , Line - lb/ft)

POINT NAME	LOAD CASE	TYPE	X	Y	Z	XX	YY	ZZ
A00	GR	LINE	0	-17	0			
A01	GR	LINE	0	-17	0			
A02	GR	LINE	0	-17	0			
A03	GR	LINE	0	-17	0			
A04	GR	LINE	0	-17	0			
A05	GR	LINE	0	-17	0			
A06	GR	LINE	0	-17	0			
A07	GR	LINE	0	-17	0			
A08	GR	LINE	0	-17	0			
A09	GR	LINE	0	-17	0			
A10	GR	LINE	0	-17	0			
A11	GR	LINE	0	-17	0			
A12	GR	LINE	0	-17	0			
A13	GR	LINE	0	-17	0			
A14	GR	LINE	0	-17	0			
A15	GR	LINE	0	-17	0			
A16	GR	LINE	0	-17	0			
A17	GR	LINE	0	-17	0			
A18	GR	LINE	0	-17	0			
A19	GR	LINE	0	-17	0			
A20	GR	LINE	0	-17	0			
A21	GR	LINE	0	-17	0			
A22	GR	LINE	0	-17	0			
A23	GR	LINE	0	-17	0			
A24	GR	LINE	0	-17	0			
A25	GR	LINE	0	-17	0			

ENBDNR0007413

```
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  18
```

FORCES AND DISPLACEMENTS

(Force - lb , Moment - ft-lb , Tran. - in , Rot. - deg , Line - lb/ft)

POINT NAME	LOAD CASE	TYPE	X	Y	Z	XX	YY	ZZ
A26	GR	LINE	0	-17	0			
A27	GR	LINE	0	-17	0			
A28	GR	LINE	0	-17	0			
A29	GR	LINE	0	-17	0			
A30	GR	LINE	0	-17	0			
A31	GR	LINE	0	-17	0			
A32	GR	LINE	0	-17	0			
A33	GR	LINE	0	-17	0			
A34	GR	LINE	0	-17	0			
A35	GR	LINE	0	-17	0			
A36	GR	LINE	0	-17	0			
A37	GR	LINE	0	-17	0			
A38	GR	LINE	0	-17	0			
A39	GR	LINE	0	-17	0			

ENBDNR0007414

```
--------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 MODEL  PAGE  19
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SOIL PROPERTIES

Soil ID	Dirn	Initial K (lb/in/ft)	Yield P (lb/ft)	Final K (lb/in/ft)	Yield disp (in)
SAND	Horiz.	12640.000	920.000	0.000	0.0728
	Long	480.000	180.000	0.000	0.3750
	Vert Up	1200.000	220.000	0.000	0.1833
	Vert Dn	3420.000	8760.000	0.000	2.5614

ENBDNR0007415

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 RESULT PAGE   1
------------------------------------------------------------------------------
```

A N A L Y S I S S U M M A R Y

Current model revision number : 29

```
  Static - Date and Time of analysis ..... Dec 28, 2004   4:33 PM
           Model Revision Number ......... 29
           Number of load cases .......... 4
           Load cases analyzed ........... GR T1 P1 U1
           Gaps/Friction/Soil considered ..... Yes
           Tolerance - Force, Displacement ..... 10.00 lb   0.0162 in
           Friction - Scale Factor, Tolerance .... 1.00   0.10
           Ignore friction for cases E1,E2,E3 .... No
           Hanger design run ..... No
           Cut short included ..... No
           Include Bourdon rotational effect ..... No
           Pipe radius for Bourdon calculation ... Mean
           Occasional load analysis type ..... Nonlinear
           Non-linear analysis summary file ..... ENB2004I.LOG
           Use default load sequence ..... Yes
           Base load cases for nonlinear analysis
                                                GR = None
                                                T1 = GR
                                                P1 = T1
                                                U1 = GR
           Weight of contents included ..... Yes
           Pressure stiffening case ..... 0
           Water elevation for buoyancy loads .... 0.000 ft
           Specific gravity of water ..... 1.000
           Hot modulus case used in analysis ..... 0
           Use corroded thickness in analysis .... No
           Rigid stiffness factor ..... 1000.0
```


ENBDNR0007416

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------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 RESULT PAGE   2
------------------------------------------------------------------------------
```

CODE COMPLIANCE COMBINATIONS

Combination	Category	Method	Load	Factor	M/S	Allowable	Remarks
GR + Max P	Sustain	Sum	Gravity	1.00		24000 psi	Def
			Max Long	1.00			
Cold to T1	Expansion	Sum	Thermal 1	1.00		Automatic	Default
SUS. + U1	Occasion	Sum	User 1	1.00		Automatic	User
			Max Sus	1.00			
Max P	Hoop		Max Hoop	1.00		Automatic	Default
Max Equiv.	Tensile	Sum	Max Long	1.00		Automatic	Default
			Max Hoop	1.00			
			Gravity	1.00			
			Max Exp	1.00			
OPER	Combined	Sum	SUS. + U1	1.00	S	27000 psi	Use
			Max Exp	1.00			

ENBDNR0007417

```
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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 RESULT PAGE   3
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```

OTHER USER COMBINATIONS

Combination	Method	Load	Factor	Remarks
GR	Sum	Gravity	1.00	Default
T1	Sum	Thermal 1	1.00	Default
P1	Sum	Press 1	1.00	Default
U1	Sum	User 1	1.00	Default
OPER	Sum	Gravity	1.00	User
		Thermal 1	1.00	
		Press 1	1.00	
		User 1	1.00	

ENBDNR0007418

```
------------------------------------------------------------------------------
ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 RESULT PAGE   4
------------------------------------------------------------------------------
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CODE COMPLIANCE

Y - Factor	0.00
Weld efficiency factor	1.00
Range reduction factor	1.00
Design Pressure Factor	1.00
Minimum stress ratio used in reports	0.00
Number of stress points per span	0
Include corrosion in stress calcs.	Y
Include torsion in code stress	Y
Include axial force in code stress	Y
Set sustained SIF to 1.00	N
Total stress	Octahedral
Direct shear	None
Longitudinal pressure calculation	PD/4t
Include rigorous pressure	N

ENBDNR0007419

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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
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     WAVE LOAD : 100YR

     Wave Type : Airy         Load case : User 1

            Depth  (d)     :  175.00000  ft
            Height (H)     :   13.12000  ft
            Period (T)     :   10.00000  sec
            Length (L)     :  500.02527  ft

     Plot parameters for wave theory regions (Shore Protection Manual,1977)
            X= d/(g*T**2)  :     0.05435  (0.0155 < Transitional water < 0.0792 )
            Y= H/(g*T**2)  :     0.00407
               H/d         :     0.07497  (Breaking limit: H/d=0.78)
               L**2*H/d**3 :     0.61207  (Max=26 for Airy and Stokes)
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ENBDNR0007420

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ENB2004I
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]

Explanation of the Results:

A point name
B load combination name
C translation in the global X direction
D translation in the global Y direction
E translation in the global Z direction
F rotation about the global X direction
G rotation about the global Y direction
H rotation about the global Z direction

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12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS BENTLEY
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
*** Segment A begin ***							
A00	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.000	0.000	0.000	0.000	0.000
	OPER	0.000	0.000	0.000	0.000	0.000	0.000
A01	GR	-0.005	-1.145	-8.425	0.000	0.458	-0.058
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.233	-0.012	0.000	0.001	-0.065
	OPER	-0.005	-2.377	-8.437	0.000	0.458	-0.123
A02	GR	-0.006	-1.239	-9.187	0.000	0.265	-0.031
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.339	-0.013	0.000	0.000	-0.036
	OPER	-0.006	-2.578	-9.200	0.000	0.265	-0.066
A03	GR	-0.006	-1.245	-9.241	0.000	0.244	-0.028
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.346	-0.013	0.000	0.000	-0.033
	OPER	-0.006	-2.591	-9.254	0.000	0.245	-0.060
A04	GR	-0.006	-1.250	-9.290	0.000	0.223	-0.025
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.353	-0.013	0.000	0.000	-0.030
	OPER	-0.006	-2.603	-9.303	0.000	0.224	-0.054
A05	GR	-0.006	-1.255	-9.334	0.000	0.202	-0.022
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.359	-0.013	0.000	0.000	-0.027
	OPER	-0.006	-2.614	-9.348	0.000	0.203	-0.048
A06	GR	-0.007	-1.259	-9.375	0.000	0.181	-0.019
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.364	-0.013	0.000	0.000	-0.023
	OPER	-0.007	-2.623	-9.388	0.000	0.182	-0.042
A07	GR	-0.007	-1.263	-9.410	0.000	0.160	-0.016
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.368	-0.013	0.000	0.000	-0.020
	OPER	-0.007	-2.631	-9.424	0.000	0.160	-0.036

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ENB2004I
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
A08	GR	-0.007	-1.266	-9.442	0.000	0.139	-0.013
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.372	-0.013	0.000	0.000	-0.017
	OPER	-0.007	-2.638	-9.455	0.000	0.139	-0.030
A09	GR	-0.007	-1.268	-9.469	0.000	0.117	-0.010
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.376	-0.014	0.000	0.000	-0.014
	OPER	-0.007	-2.644	-9.482	0.000	0.117	-0.024
A10	GR	-0.007	-1.270	-9.491	0.000	0.096	-0.007
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.378	-0.014	0.000	0.000	-0.011
	OPER	-0.007	-2.648	-9.504	0.000	0.096	-0.017
A11	GR	-0.007	-1.271	-9.509	0.000	0.074	-0.004
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.380	-0.014	0.000	0.000	-0.007
	OPER	-0.007	-2.651	-9.522	0.000	0.074	-0.011
A12	GR	-0.007	-1.271	-9.522	0.000	0.053	-0.001
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.381	-0.014	0.000	0.000	-0.004
	OPER	-0.007	-2.653	-9.536	0.000	0.053	-0.005
A13	GR	-0.007	-1.271	-9.531	0.000	0.031	0.002
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.382	-0.014	0.000	0.000	-0.001
	OPER	-0.007	-2.653	-9.544	0.000	0.031	0.002
A14	GR	-0.007	-1.270	-9.535	0.000	0.009	0.006
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.382	-0.014	0.000	0.000	0.002
	OPER	-0.007	-2.652	-9.549	0.000	0.009	0.008
A15	GR	-0.007	-1.269	-9.535	0.000	-0.012	0.009
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.381	-0.014	0.000	0.000	0.005
	OPER	-0.007	-2.650	-9.548	0.000	-0.013	0.014

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ENB2004I
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
A16	GR	-0.007	-1.267	-9.530	0.000	-0.034	0.012
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.379	-0.014	0.000	0.000	0.009
	OPER	-0.007	-2.646	-9.543	0.000	-0.034	0.020
A17	GR	-0.007	-1.264	-9.520	0.000	-0.056	0.015
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.377	-0.014	0.000	0.000	0.012
	OPER	-0.007	-2.641	-9.534	0.000	-0.056	0.027
A18	GR	-0.007	-1.261	-9.506	0.000	-0.077	0.018
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.374	-0.014	0.000	0.000	0.015
	OPER	-0.007	-2.635	-9.520	0.000	-0.078	0.033
A19	GR	-0.008	-1.257	-9.488	0.000	-0.099	0.021
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.371	-0.014	0.000	0.000	0.018
	OPER	-0.008	-2.628	-9.501	0.000	-0.099	0.039
A20	GR	-0.008	-1.252	-9.465	0.000	-0.121	0.024
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.367	-0.013	0.000	0.000	0.021
	OPER	-0.008	-2.619	-9.478	0.000	-0.121	0.045
A21	GR	-0.008	-1.247	-9.437	0.000	-0.142	0.027
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.362	-0.013	0.000	0.000	0.025
	OPER	-0.008	-2.609	-9.451	0.000	-0.142	0.051
A22	GR	-0.008	-1.241	-9.405	0.000	-0.163	0.029
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.356	-0.013	0.000	0.000	0.028
	OPER	-0.008	-2.597	-9.419	0.000	-0.163	0.057
A23	GR	-0.008	-1.234	-9.369	0.000	-0.184	0.032
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.350	-0.013	0.000	0.000	0.031
	OPER	-0.008	-2.585	-9.382	0.000	-0.185	0.063

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ENB2004I
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
A24	GR	-0.008	-1.227	-9.328	0.000	-0.205	0.035
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.343	-0.013	0.000	0.000	0.034
	OPER	-0.008	-2.571	-9.341	0.000	-0.206	0.069
A25	GR	-0.008	-1.220	-9.283	0.000	-0.226	0.038
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.336	-0.013	0.000	0.000	0.037
	OPER	-0.008	-2.556	-9.296	0.000	-0.227	0.075
A26	GR	-0.008	-1.211	-9.233	0.000	-0.247	0.041
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.328	-0.013	0.000	0.000	0.040
	OPER	-0.008	-2.539	-9.246	0.000	-0.247	0.081
A27	GR	-0.008	-1.202	-9.179	0.000	-0.268	0.044
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.319	-0.013	0.000	0.000	0.043
	OPER	-0.008	-2.522	-9.192	0.000	-0.268	0.087
A28	GR	-0.008	-1.193	-9.121	0.000	-0.288	0.047
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.310	-0.013	0.000	0.000	0.046
	OPER	-0.008	-2.503	-9.134	0.000	-0.288	0.093
A29	GR	-0.008	-1.183	-9.058	0.000	-0.308	0.049
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.300	-0.013	0.000	0.000	0.049
	OPER	-0.008	-2.483	-9.071	0.000	-0.308	0.098
A30	GR	-0.008	-1.172	-8.992	0.000	-0.328	0.052
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.289	-0.013	0.000	0.000	0.052
	OPER	-0.008	-2.462	-9.005	0.000	-0.328	0.104
A31	GR	-0.008	-1.161	-8.921	0.000	-0.348	0.055
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.278	-0.013	0.000	0.000	0.055
	OPER	-0.008	-2.439	-8.934	0.000	-0.348	0.110

ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS BENTLEY
04:52 PM PIPELINES W/ CRUDE OIL AutoPIPE+6.30 RESULT PAGE 11

D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
A32	GR	-0.009	-1.149	-8.846	0.000	-0.367	0.057
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.266	-0.013	0.000	-0.001	0.058
	OPER	-0.009	-2.416	-8.859	0.000	-0.367	0.115
A33	GR	-0.009	-1.137	-8.767	0.000	-0.386	0.060
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.254	-0.013	0.000	-0.001	0.060
	OPER	-0.009	-2.391	-8.780	0.000	-0.387	0.120
A34	GR	-0.009	-1.124	-8.684	0.000	-0.405	0.062
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.241	-0.012	0.000	-0.001	0.063
	OPER	-0.009	-2.365	-8.697	0.000	-0.405	0.126
A35	GR	-0.009	-1.111	-8.597	0.000	-0.423	0.065
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.227	-0.012	0.000	-0.001	0.066
	OPER	-0.009	-2.338	-8.610	0.000	-0.424	0.131
A36	GR	-0.009	-1.097	-8.507	0.000	-0.441	0.067
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.213	-0.012	0.000	-0.001	0.069
	OPER	-0.009	-2.310	-8.519	0.000	-0.442	0.136
A37	GR	-0.009	-1.083	-8.412	0.000	-0.459	0.070
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.199	-0.012	0.000	-0.001	0.071
	OPER	-0.009	-2.281	-8.424	0.000	-0.460	0.141
A38	GR	-0.009	-1.004	-7.886	0.000	-0.543	0.081
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-1.118	-0.011	0.000	-0.001	0.083
	OPER	-0.009	-2.121	-7.897	0.000	-0.544	0.164
A39	GR	-0.013	-0.066	-0.924	0.000	-0.484	0.052
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.100	-0.001	0.000	-0.001	0.064
	OPER	-0.013	-0.165	-0.925	0.000	-0.485	0.116

ENBDNR0007426

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ENB2004I
12/28/2004 ENBRIDGE STRAITS OF MACKINAC CROSSINGS  BENTLEY
04:52 PM   PIPELINES W/ CRUDE OIL                  AutoPIPE+6.30 RESULT PAGE  12
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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
+ 1	GR	-0.013	-0.041	-0.686	0.000	-0.421	0.041
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.069	-0.001	0.000	-0.001	0.054
	OPER	-0.013	-0.110	-0.687	0.000	-0.422	0.095
+ 2	GR	-0.013	-0.022	-0.483	0.000	-0.356	0.031
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.043	-0.001	0.000	-0.001	0.043
	OPER	-0.013	-0.066	-0.483	0.000	-0.356	0.074
+ 3	GR	-0.012	-0.009	-0.314	0.000	-0.292	0.022
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.024	0.000	0.000	0.000	0.032
	OPER	-0.012	-0.033	-0.314	0.000	-0.293	0.054
+ 4	GR	-0.012	0.000	-0.177	0.000	-0.233	0.014
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.010	0.000	0.000	0.000	0.023
	OPER	-0.012	-0.010	-0.177	0.000	-0.234	0.037
+ 5	GR	-0.012	0.006	-0.070	0.000	-0.180	0.008
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.001	0.000	0.000	0.000	0.015
	OPER	-0.012	0.006	-0.070	0.000	-0.181	0.023
+ 6	GR	-0.011	0.009	0.011	0.000	-0.134	0.004
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.005	0.000	0.000	0.000	0.008
	OPER	-0.011	0.014	0.011	0.000	-0.134	0.012
+ 7	GR	-0.011	0.010	0.069	0.000	-0.095	0.001
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.008	0.000	0.000	0.000	0.004
	OPER	-0.011	0.018	0.070	0.000	-0.095	0.005
A40	GR	-0.011	0.010	0.109	0.000	-0.062	-0.001
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.009	0.000	0.000	0.000	0.001
	OPER	-0.011	0.019	0.109	0.000	-0.062	0.000

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D I S P L A C E M E N T S

Point name	Load combination	TRANSLATIONS (in) X	Y	Z	ROTATIONS (deg) X	Y	Z
+ 1	GR	-0.009	0.005	0.145	0.000	0.007	-0.003
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.006	0.000	0.000	0.000	-0.003
	OPER	-0.009	0.011	0.145	0.000	0.007	-0.006
+ 2	GR	-0.008	0.001	0.105	0.000	0.033	-0.002
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.001	0.000	0.000	0.000	-0.002
	OPER	-0.008	0.002	0.105	0.000	0.034	-0.004
+ 3	GR	-0.007	0.000	0.045	0.000	0.034	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.001	0.000	0.000	0.000	-0.001
	OPER	-0.007	-0.002	0.045	0.000	0.034	-0.001
+ 4	GR	-0.006	-0.001	-0.005	0.000	0.024	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.002	0.000	0.000	0.000	0.000
	OPER	-0.006	-0.002	-0.005	0.000	0.024	0.000
A41	GR	-0.005	0.000	-0.034	0.000	0.011	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.002	0.000	0.000	0.000	0.000
	OPER	-0.005	-0.002	-0.034	0.000	0.011	0.000
+ 1	GR	-0.003	0.000	-0.033	0.000	-0.009	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	-0.001	0.000	0.000	0.000	0.000
	OPER	-0.003	-0.001	-0.033	0.000	-0.009	0.000
A42	GR	0.000	0.000	0.000	0.000	0.000	0.000
	T1	0.000	0.000	0.000	0.000	0.000	0.000
	P1	0.000	0.000	0.000	0.000	0.000	0.000
	U1	0.000	0.000	0.000	0.000	0.000	0.000
	OPER	0.000	0.000	0.000	0.000	0.000	0.000

*** Segment A end   ***

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R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
[A]	[B] [C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]

Explanation of the Results:

A point name
B restraint type
C load combination name
D force acting on the restraint in the global X direction
E force acting on the restraint in the global Y direction
F force acting on the restraint in the global Z direction
G resultant force acting on the restraint
H moment acting on the restraint about the global X direction
I moment acting on the restraint about the global Y direction
J moment acting on the restraint about the global Z direction
K resultant moment acting on the restraint

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R E S T R A I N T R E A C T I O N S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A00	Anchor								
	GR	14614	-1515	-10561	18094	0	321566	-45031	324703
	T1	-62993	0	0	62993	0	0	0	0
	P1	-30471	0	0	30471	0	0	0	0
	U1	0	-1587	-15	1587	0	459	-47747	47749
	OPER	-78850	-3102	-10576	79616	0	322024	-92778	335123
A42	Anchor								
	GR	-14299	1	-1524	14380	0	-10661	-31	10661
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-154	-2	155	0	-15	458	459
	OPER	79165	-153	-1526	79179	0	-10676	428	10685

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              G L O B A L   F O R C E S   &   M O M E N T S

 Point     Load           FORCES (lb    )             MOMENTS (ft-lb  )
 name    combination   X      Y      Z    Result    X       Y       Z    Result
 ------ ------------ ------ ------ ------ ------ -------- ------- ------- -------

  [A]     [B]          [C]    [D]    [E]    [F]     [G]     [H]     [I]     [J]


 Explanation of the Results:

 A  point name
 B  load combination name
 C  force acting on the pipe cross section in the global X direction
 D  force acting on the pipe cross section in the global Y direction
 E  force acting on the pipe cross section in the global Z direction
 F  resultant force acting on the pipe cross section
 G  moment acting on the pipe cross section about the global X direction
 H  moment acting on the pipe cross section about the global Y direction
 I  moment acting on the pipe cross section about the global Z direction
 J  resultant moment acting on the pipe cross section
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G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
*** Segment A begin ***									
A00	GR	-14614	1515	10561	18094	0 -321566	45031	324703	
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	1587	15	1587	0	-459	47747	47749
	OPER	78850	3102	10576	79616	0 -322024	92778	335123	
A01 -	GR	-14614	342	2578	14843	0	131715	-19054	133086
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	373	4	373	0	188	-19886	19886
	OPER	78850	716	2582	78895	0	131903	-38939	137531
A01 +	GR	-14614	342	2578	14843	0	131715	-19054	133086
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	373	4	373	0	188	-19886	19886
	OPER	78850	716	2582	78895	0	131903	-38939	137531
A02 -	GR	-14614	172	1421	14684	0	151711	-21627	153245
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	197	2	197	0	216	-22740	22741
	OPER	78850	370	1423	78863	0	151927	-44366	158273
A02 +	GR	-14614	172	1421	14684	0	151711	-21627	153245
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	197	2	197	0	216	-22740	22741
	OPER	78850	370	1423	78863	0	151927	-44366	158273
A03 -	GR	-14614	155	1305	14673	0	153074	-21790	154617
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	180	2	180	0	218	-22928	22929
	OPER	78850	335	1307	78861	0	153293	-44719	159682
A03 +	GR	-14614	155	1305	14673	0	153074	-21790	154617
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	180	2	180	0	218	-22928	22929
	OPER	78850	335	1307	78861	0	153293	-44719	159682
A04 -	GR	-14614	138	1190	14663	0	154322	-21937	155873
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	162	2	162	0	220	-23100	23101
	OPER	78850	301	1191	78859	0	154542	-45037	160970

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A04	+	GR	-14614	138	1190	14663	0	154322	-21937	155873
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	162	2	162	0	220	-23100	23101
		OPER	78850	301	1191	78859	0	154542	-45037	160970
A05	-	GR	-14614	121	1074	14654	0	155454	-22067	157012
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	145	2	145	0	222	-23253	23254
		OPER	78850	266	1076	78858	0	155675	-45320	162138
A05	+	GR	-14614	121	1074	14654	0	155454	-22067	157012
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	145	2	145	0	222	-23253	23254
		OPER	78850	266	1076	78858	0	155675	-45320	162138
A06	-	GR	-14614	104	958	14646	0	156470	-22180	158034
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	127	1	127	0	223	-23389	23390
		OPER	78850	231	960	78856	0	156693	-45569	163185
A06	+	GR	-14614	104	958	14646	0	156470	-22180	158034
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	127	1	127	0	223	-23389	23390
		OPER	78850	231	960	78856	0	156693	-45569	163185
A07	-	GR	-14614	87	843	14638	0	157370	-22275	158939
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	110	1	110	0	224	-23507	23508
		OPER	78850	197	844	78855	0	157595	-45783	164110
A07	+	GR	-14614	87	843	14638	0	157370	-22275	158939
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	110	1	110	0	224	-23507	23508
		OPER	78850	197	844	78855	0	157595	-45783	164110
A08	-	GR	-14614	70	727	14632	0	158155	-22354	159727
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	92	1	92	0	226	-23608	23609
		OPER	78850	162	728	78853	0	158381	-45962	164915

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A08	+	GR	-14614	70	727	14632	0	158155	-22354	159727
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	92	1	92	0	226	-23608	23609
		OPER	78850	162	728	78853	0	158381	-45962	164915
A09	-	GR	-14614	53	611	14627	0	158824	-22416	160398
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	74	1	74	0	227	-23691	23692
		OPER	78850	128	612	78852	0	159051	-46107	165599
A09	+	GR	-14614	53	611	14627	0	158824	-22416	160398
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	74	1	74	0	227	-23691	23692
		OPER	78850	128	612	78852	0	159051	-46107	165599
A10	-	GR	-14614	36	496	14622	0	159378	-22461	160953
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	57	1	57	0	227	-23757	23758
		OPER	78850	93	496	78851	0	159605	-46218	166162
A10	+	GR	-14614	36	496	14622	0	159378	-22461	160953
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	57	1	57	0	227	-23757	23758
		OPER	78850	93	496	78851	0	159605	-46218	166162
A11	-	GR	-14614	19	380	14619	0	159816	-22489	161390
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	39	1	39	0	228	-23805	23806
		OPER	78850	58	380	78851	0	160044	-46293	166604
A11	+	GR	-14614	19	380	14619	0	159816	-22489	161390
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	39	1	39	0	228	-23805	23806
		OPER	78850	58	380	78851	0	160044	-46293	166604
A12	-	GR	-14614	2	264	14616	0	160138	-22499	161711
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	22	0	22	0	228	-23835	23836
		OPER	78850	24	265	78850	0	160366	-46334	166926

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A12	+	GR	-14614	2	264	14616	0	160138	-22499	161711
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	22	0	22	0	228	-23835	23836
		OPER	78850	24	265	78850	0	160366	-46334	166926
A13	-	GR	-14614	-15	149	14615	0	160344	-22493	161914
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	4	0	4	0	229	-23848	23849
		OPER	78850	-11	149	78850	0	160573	-46341	167126
A13	+	GR	-14614	-15	149	14615	0	160344	-22493	161914
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	4	0	4	0	229	-23848	23849
		OPER	78850	-11	149	78850	0	160573	-46341	167126
A14	-	GR	-14614	-32	33	14614	0	160435	-22470	162001
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-14	0	14	0	229	-23843	23844
		OPER	78850	-45	33	78850	0	160664	-46313	167206
A14	+	GR	-14614	-32	33	14614	0	160435	-22470	162001
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-14	0	14	0	229	-23843	23844
		OPER	78850	-45	33	78850	0	160664	-46313	167206
A15	-	GR	-14614	-49	-83	14614	0	160410	-22430	161970
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-31	0	31	0	229	-23821	23822
		OPER	78850	-80	-83	78850	0	160639	-46250	167164
A15	+	GR	-14614	-49	-83	14614	0	160410	-22430	161970
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-31	0	31	0	229	-23821	23822
		OPER	78850	-80	-83	78850	0	160639	-46250	167164
A16	-	GR	-14614	-66	-199	14615	0	160269	-22372	161823
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-49	0	49	0	229	-23781	23782
		OPER	78850	-114	-199	78850	0	160498	-46153	167002

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A16	+	GR	-14614	-66	-199	14615	0	160269	-22372	161823
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-49	0	49	0	229	-23781	23782
		OPER	78850	-114	-199	78850	0	160498	-46153	167002
A17	-	GR	-14614	-83	-314	14617	0	160013	-22298	161559
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-66	0	66	0	228	-23723	23724
		OPER	78850	-149	-315	78851	0	160241	-46021	166719
A17	+	GR	-14614	-83	-314	14617	0	160013	-22298	161559
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-66	0	66	0	228	-23723	23724
		OPER	78850	-149	-315	78851	0	160241	-46021	166719
A18	-	GR	-14614	-100	-430	14621	0	159641	-22207	161178
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-84	-1	84	0	228	-23648	23649
		OPER	78850	-184	-431	78851	0	159868	-45855	166315
A18	+	GR	-14614	-100	-430	14621	0	159641	-22207	161178
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-84	-1	84	0	228	-23648	23649
		OPER	78850	-184	-431	78851	0	159868	-45855	166315
A19	-	GR	-14614	-117	-546	14624	0	159153	-22099	160680
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-102	-1	102	0	227	-23555	23556
		OPER	78850	-218	-546	78852	0	159380	-45654	165790
A19	+	GR	-14614	-117	-546	14624	0	159153	-22099	160680
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-102	-1	102	0	227	-23555	23556
		OPER	78850	-218	-546	78852	0	159380	-45654	165790
A20	-	GR	-14614	-134	-661	14629	0	158550	-21973	160065
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-119	-1	119	0	226	-23445	23446
		OPER	78850	-253	-662	78853	0	158776	-45418	165144

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A20	+	GR	-14614	-134	-661	14629	0	158550	-21973	160065
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-119	-1	119	0	226	-23445	23446
		OPER	78850	-253	-662	78853	0	158776	-45418	165144
A21	-	GR	-14614	-151	-777	14635	0	157830	-21831	159333
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-137	-1	137	0	225	-23317	23318
		OPER	78850	-287	-778	78854	0	158056	-45148	164377
A21	+	GR	-14614	-151	-777	14635	0	157830	-21831	159333
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-137	-1	137	0	225	-23317	23318
		OPER	78850	-287	-778	78854	0	158056	-45148	164377
A22	-	GR	-14614	-168	-893	14642	0	156996	-21672	158484
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-154	-1	154	0	224	-23172	23173
		OPER	78850	-322	-894	78856	0	157220	-44844	163490
A22	+	GR	-14614	-168	-893	14642	0	156996	-21672	158484
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-154	-1	154	0	224	-23172	23173
		OPER	78850	-322	-894	78856	0	157220	-44844	163490
A23	-	GR	-14614	-185	-1008	14650	0	156045	-21496	157519
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-172	-1	172	0	223	-23008	23010
		OPER	78850	-357	-1010	78857	0	156268	-44504	162481
A23	+	GR	-14614	-185	-1008	14650	0	156045	-21496	157519
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-172	-1	172	0	223	-23008	23010
		OPER	78850	-357	-1010	78857	0	156268	-44504	162481
A24	-	GR	-14614	-202	-1124	14658	0	154979	-21303	156436
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-189	-2	189	0	221	-22828	22829
		OPER	78850	-391	-1126	78859	0	155200	-44130	161352

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A24	+	GR	-14614	-202	-1124	14658	0	154979	-21303	156436
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-189	-2	189	0	221	-22828	22829
		OPER	78850	-391	-1126	78859	0	155200	-44130	161352
A25	-	GR	-14614	-219	-1240	14668	0	153797	-21092	155237
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-207	-2	207	0	219	-22629	22631
		OPER	78850	-426	-1241	78861	0	154016	-43722	160102
A25	+	GR	-14614	-219	-1240	14668	0	153797	-21092	155237
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-207	-2	207	0	219	-22629	22631
		OPER	78850	-426	-1241	78861	0	154016	-43722	160102
A26	-	GR	-14614	-236	-1355	14678	0	152499	-20865	153920
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-225	-2	225	0	218	-22414	22415
		OPER	78850	-460	-1357	78863	0	152717	-43279	158731
A26	+	GR	-14614	-236	-1355	14678	0	152499	-20865	153920
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-225	-2	225	0	218	-22414	22415
		OPER	78850	-460	-1357	78863	0	152717	-43279	158731
A27	-	GR	-14614	-253	-1471	14690	0	151086	-20621	152487
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-242	-2	242	0	215	-22180	22181
		OPER	78850	-495	-1473	78865	0	151302	-42801	157239
A27	+	GR	-14614	-253	-1471	14690	0	151086	-20621	152487
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-242	-2	242	0	215	-22180	22181
		OPER	78850	-495	-1473	78865	0	151302	-42801	157239
A28	-	GR	-14614	-270	-1587	14702	0	149557	-20360	150937
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-260	-2	260	0	213	-21929	21930
		OPER	78850	-530	-1589	78868	0	149771	-42289	155626

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A28	+	GR	-14614	-270	-1587	14702	0	149557	-20360	150937
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-260	-2	260	0	213	-21929	21930
		OPER	78850	-530	-1589	78868	0	149771	-42289	155626
A29	-	GR	-14614	-287	-1702	14715	0	147913	-20081	149270
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-277	-2	277	0	211	-21661	21662
		OPER	78850	-564	-1705	78870	0	148124	-41742	153893
A29	+	GR	-14614	-287	-1702	14715	0	147913	-20081	149270
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-277	-2	277	0	211	-21661	21662
		OPER	78850	-564	-1705	78870	0	148124	-41742	153893
A30	-	GR	-14614	-304	-1818	14730	0	146152	-19786	147486
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-295	-3	295	0	208	-21374	21375
		OPER	78850	-599	-1821	78873	0	146361	-41160	152038
A30	+	GR	-14614	-304	-1818	14730	0	146152	-19786	147486
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-295	-3	295	0	208	-21374	21375
		OPER	78850	-599	-1821	78873	0	146361	-41160	152038
A31	-	GR	-14614	-321	-1934	14745	0	144276	-19474	145585
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-313	-3	313	0	206	-21070	21071
		OPER	78850	-633	-1937	78876	0	144482	-40544	150063
A31	+	GR	-14614	-321	-1934	14745	0	144276	-19474	145585
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-313	-3	313	0	206	-21070	21071
		OPER	78850	-633	-1937	78876	0	144482	-40544	150063
A32	-	GR	-14614	-338	-2050	14761	0	142285	-19145	143567
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-330	-3	330	0	203	-20749	20750
		OPER	78850	-668	-2052	78879	0	142488	-39894	147967

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G L O B A L F O R C E S & M O M E N T S

Point name		Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A32	+	GR	-14614	-338	-2050	14761	0	142285	-19145	143567
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-330	-3	330	0	203	-20749	20750
		OPER	78850	-668	-2052	78879	0	142488	-39894	147967
A33	-	GR	-14614	-355	-2165	14778	0	140177	-18798	141432
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-348	-3	348	0	200	-20410	20411
		OPER	78850	-703	-2168	78883	0	140377	-39209	145750
A33	+	GR	-14614	-355	-2165	14778	0	140177	-18798	141432
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-348	-3	348	0	200	-20410	20411
		OPER	78850	-703	-2168	78883	0	140377	-39209	145750
A34	-	GR	-14614	-372	-2281	14795	0	137954	-18435	139180
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-365	-3	365	0	197	-20054	20055
		OPER	78850	-737	-2284	78886	0	138151	-38489	143412
A34	+	GR	-14614	-372	-2281	14795	0	137954	-18435	139180
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-365	-3	365	0	197	-20054	20055
		OPER	78850	-737	-2284	78886	0	138151	-38489	143412
A35	-	GR	-14614	-389	-2397	14814	0	135615	-18055	136812
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-383	-3	383	0	193	-19679	19680
		OPER	78850	-772	-2400	78890	0	135809	-37734	140954
A35	+	GR	-14614	-389	-2397	14814	0	135615	-18055	136812
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-383	-3	383	0	193	-19679	19680
		OPER	78850	-772	-2400	78890	0	135809	-37734	140954
A36	-	GR	-14614	-406	-2512	14834	0	133161	-17658	134327
		T1	62993	0	0	62993	0	0	0	0
		P1	30471	0	0	30471	0	0	0	0
		U1	0	-401	-4	401	0	190	-19288	19289
		OPER	78850	-806	-2516	78894	0	133351	-36945	138374

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G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
A36 +	GR	-14614	-406	-2512	14834	0	133161	-17658	134327
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-401	-4	401	0	190	-19288	19289
	OPER	78850	-806	-2516	78894	0	133351	-36945	138374
A37 -	GR	-14614	-423	-2628	14854	0	130591	-17244	131724
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-418	-4	418	0	186	-18878	18879
	OPER	78850	-841	-2632	78898	0	130777	-36122	135674
A37 +	GR	-14614	-423	-2628	14854	0	130591	-17244	131724
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-418	-4	418	0	186	-18878	18879
	OPER	78850	-841	-2632	78898	0	130777	-36122	135674
A38 -	GR	-14614	-508	-3206	14970	0	116005	-14917	116960
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-506	-5	506	0	165	-16568	16569
	OPER	78850	-1014	-3211	78922	0	116170	-31485	120361
A38 +	GR	-14614	-508	-3206	14970	0	116005	-14917	116960
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-506	-5	506	0	165	-16568	16569
	OPER	78850	-1014	-3211	78922	0	116170	-31485	120361
A39 -	GR	-14614	-1341	-8875	17150	0	-179995	30370	182540
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-1368	-13	1368	0	-257	29346	29347
	OPER	78850	-2709	-8888	79395	0	-180252	59715	189886
A39 +	GR	-14606	-430	-5409	15581	0	-179995	30370	182540
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-1150	-8	1150	0	-257	29346	29347
	OPER	78858	-1581	-5417	79059	0	-180252	59715	189886
+ 1	GR	-14591	905	217	14620	0	-193518	31445	196056
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-229	0	229	0	-276	32222	32223
	OPER	78873	675	217	78876	0	-193794	63667	203984

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G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
+ 2	GR	-14576	1642	4104	15231	0	-192975	29184	195169
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	1006	6	1006	0	-275	32795	32796
	OPER	78888	2647	4110	79039	0	-193250	61979	202946
+ 3	GR	-14561	1943	6544	16082	0	-182715	25080	184428
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	1747	9	1747	0	-261	30281	30282
	OPER	78903	3690	6553	79260	0	-182975	55361	191167
+ 4	GR	-14547	1949	7812	16626	0	-166355	20222	167579
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	2041	11	2041	0	-237	25914	25915
	OPER	78917	3990	7823	79404	0	-166592	46137	172863
+ 5	GR	-14533	1773	8160	16761	0	-146825	15349	147625
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	2032	12	2032	0	-209	20812	20814
	OPER	78931	3805	8172	79444	0	-147034	36162	151416
+ 6	GR	-14520	1501	7894	16595	0	-126425	10917	126896
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	1838	11	1838	0	-180	15731	15732
	OPER	78944	3339	7906	79409	0	-126605	26648	129379
+ 7	GR	-14507	1194	7406	16331	0	-106689	7165	106929
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	1546	11	1546	0	-152	11136	11137
	OPER	78957	2740	7417	79352	0	-106841	18301	108397
A40	GR	-14481	625	6073	15715	0	-88174	4181	88273
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	908	9	908	0	-126	7270	7271
	OPER	78983	1533	6082	79232	0	-88299	11451	89039
+ 1	GR	-14444	84	3877	14956	0	-39588	-819	39597
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	206	6	207	0	-56	8	57
	OPER	79019	291	3883	79115	0	-39645	-811	39653

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G L O B A L F O R C E S & M O M E N T S

Point name	Load combination	FORCES (lb) X	Y	Z	Result	MOMENTS (ft-lb) X	Y	Z	Result
+ 2	GR	-14412	-86	1978	14548	0	-8572	-1492	8700
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-71	3	71	0	-12	-1643	1644
	OPER	79051	-158	1981	79076	0	-8584	-3135	9138
+ 3	GR	-14384	-77	606	14397	0	7253	-800	7297
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-96	1	96	0	10	-1072	1072
	OPER	79080	-173	607	79082	0	7263	-1872	7501
+ 4	GR	-14360	-33	-180	14361	0	12100	-186	12101
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-47	0	47	0	17	-303	303
	OPER	79104	-80	-180	79104	0	12117	-489	12127
A41	GR	-14328	2	-322	14332	0	10662	76	10663
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	15	0	15	0	15	74	76
	OPER	79135	17	-323	79136	0	10678	150	10679
+ 1	GR	-14303	3	-744	14322	0	4218	35	4218
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-35	-1	35	0	6	-232	232
	OPER	79160	-31	-745	79164	0	4224	-197	4229
A42	GR	-14303	3	-744	14322	0	-10661	-31	10661
	T1	62993	0	0	62993	0	0	0	0
	P1	30471	0	0	30471	0	0	0	0
	U1	0	-35	-1	35	0	-15	458	459
	OPER	79160	-31	-745	79164	0	-10676	428	10685

*** Segment A end ***

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
*** Segment A begin ***									
A00	SIFI= 1.00	SIFO= 1.00							
	GR	0	19275	-18614	0	19275	-18614	19275	352
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	2786	-2786	0	2786	-2786	2786	271
	OPER	4688	19601	-19505	0	19601	-19505	22222	164
A01	SIFI= 1.00	SIFO= 1.00							
	GR	0	8095	-7435	0	8095	-7435	8095	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1160	-1160	0	1160	-1160	1160	91
	OPER	4688	8072	-7976	0	8072	-7976	11090	344
A02	SIFI= 1.00	SIFO= 1.00							
	GR	0	9271	-8611	0	9271	-8611	9271	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1327	-1327	0	1327	-1327	1327	91
	OPER	4688	9282	-9186	0	9282	-9186	12224	344
A03	SIFI= 1.00	SIFO= 1.00							
	GR	0	9351	-8691	0	9351	-8691	9351	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1338	-1338	0	1338	-1338	1338	91
	OPER	4688	9365	-9269	0	9365	-9269	12302	344
A04	SIFI= 1.00	SIFO= 1.00							
	GR	0	9425	-8764	0	9425	-8764	9425	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1348	-1348	0	1348	-1348	1348	91
	OPER	4688	9440	-9344	0	9440	-9344	12372	344
A05	SIFI= 1.00	SIFO= 1.00							
	GR	0	9491	-8831	0	9491	-8831	9491	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1357	-1357	0	1357	-1357	1357	91
	OPER	4688	9508	-9412	0	9508	-9412	12437	344
A06	SIFI= 1.00	SIFO= 1.00							
	GR	0	9551	-8890	0	9551	-8890	9551	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1365	-1365	0	1365	-1365	1365	91
	OPER	4688	9569	-9473	0	9569	-9473	12495	344

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
A07	SIFI= 1.00	SIFO= 1.00							
	GR	0	9604	-8943	0	9604	-8943	9604	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1372	-1372	0	1372	-1372	1372	91
	OPER	4688	9623	-9527	0	9623	-9527	12546	344
A08	SIFI= 1.00	SIFO= 1.00							
	GR	0	9649	-8989	0	9649	-8989	9649	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1377	-1377	0	1377	-1377	1377	91
	OPER	4688	9670	-9574	0	9670	-9574	12590	344
A09	SIFI= 1.00	SIFO= 1.00							
	GR	0	9689	-9028	0	9689	-9028	9689	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1382	-1382	0	1382	-1382	1382	91
	OPER	4688	9710	-9614	0	9710	-9614	12628	344
A10	SIFI= 1.00	SIFO= 1.00							
	GR	0	9721	-9061	0	9721	-9061	9721	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1386	-1386	0	1386	-1386	1386	91
	OPER	4688	9743	-9647	0	9743	-9647	12659	344
A11	SIFI= 1.00	SIFO= 1.00							
	GR	0	9747	-9086	0	9747	-9086	9747	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1389	-1389	0	1389	-1389	1389	91
	OPER	4688	9768	-9673	0	9768	-9673	12683	344
A12	SIFI= 1.00	SIFO= 1.00							
	GR	0	9765	-9105	0	9765	-9105	9765	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1391	-1391	0	1391	-1391	1391	91
	OPER	4688	9787	-9691	0	9787	-9691	12701	344
A13	SIFI= 1.00	SIFO= 1.00							
	GR	0	9777	-9117	0	9777	-9117	9777	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1391	-1391	0	1391	-1391	1391	91
	OPER	4688	9799	-9703	0	9799	-9703	12712	344

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
A14	SIFI= 1.00	SIFO= 1.00							
	GR	0	9782	-9122	0	9782	-9122	9782	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1391	-1391	0	1391	-1391	1391	91
	OPER	4688	9804	-9708	0	9804	-9708	12717	344
A15	SIFI= 1.00	SIFO= 1.00							
	GR	0	9780	-9120	0	9780	-9120	9780	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1390	-1390	0	1390	-1390	1390	91
	OPER	4688	9801	-9705	0	9801	-9705	12714	344
A16	SIFI= 1.00	SIFO= 1.00							
	GR	0	9772	-9111	0	9772	-9111	9772	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1388	-1388	0	1388	-1388	1388	91
	OPER	4688	9792	-9696	0	9792	-9696	12705	344
A17	SIFI= 1.00	SIFO= 1.00							
	GR	0	9756	-9096	0	9756	-9096	9756	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1384	-1384	0	1384	-1384	1384	91
	OPER	4688	9775	-9679	0	9775	-9679	12690	344
A18	SIFI= 1.00	SIFO= 1.00							
	GR	0	9734	-9074	0	9734	-9074	9734	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1380	-1380	0	1380	-1380	1380	91
	OPER	4688	9752	-9656	0	9752	-9656	12667	344
A19	SIFI= 1.00	SIFO= 1.00							
	GR	0	9705	-9045	0	9705	-9045	9705	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1374	-1374	0	1374	-1374	1374	91
	OPER	4688	9721	-9625	0	9721	-9625	12638	344
A20	SIFI= 1.00	SIFO= 1.00							
	GR	0	9669	-9009	0	9669	-9009	9669	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1368	-1368	0	1368	-1368	1368	91
	OPER	4688	9683	-9587	0	9683	-9587	12603	344

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
A21	SIFI= 1.00	SIFO= 1.00							
	GR	0	9626	-8966	0	9626	-8966	9626	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1360	-1360	0	1360	-1360	1360	91
	OPER	4688	9639	-9543	0	9639	-9543	12560	344
A22	SIFI= 1.00	SIFO= 1.00							
	GR	0	9577	-8916	0	9577	-8916	9577	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1352	-1352	0	1352	-1352	1352	91
	OPER	4688	9587	-9491	0	9587	-9491	12511	344
A23	SIFI= 1.00	SIFO= 1.00							
	GR	0	9521	-8860	0	9521	-8860	9521	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1342	-1342	0	1342	-1342	1342	91
	OPER	4688	9528	-9432	0	9528	-9432	12456	344
A24	SIFI= 1.00	SIFO= 1.00							
	GR	0	9457	-8797	0	9457	-8797	9457	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1332	-1332	0	1332	-1332	1332	91
	OPER	4688	9462	-9366	0	9462	-9366	12394	344
A25	SIFI= 1.00	SIFO= 1.00							
	GR	0	9387	-8727	0	9387	-8727	9387	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1320	-1320	0	1320	-1320	1320	91
	OPER	4688	9389	-9293	0	9389	-9293	12325	344
A26	SIFI= 1.00	SIFO= 1.00							
	GR	0	9311	-8650	0	9311	-8650	9311	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1308	-1308	0	1308	-1308	1308	91
	OPER	4688	9309	-9213	0	9309	-9213	12249	344
A27	SIFI= 1.00	SIFO= 1.00							
	GR	0	9227	-8567	0	9227	-8567	9227	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1294	-1294	0	1294	-1294	1294	91
	OPER	4688	9222	-9126	0	9222	-9126	12167	344

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
A28	SIFI= 1.00	SIFO= 1.00							
	GR	0	9137	-8476	0	9137	-8476	9137	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1280	-1280	0	1280	-1280	1280	91
	OPER	4688	9128	-9032	0	9128	-9032	12078	344
A29	SIFI= 1.00	SIFO= 1.00							
	GR	0	9039	-8379	0	9039	-8379	9039	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1264	-1264	0	1264	-1264	1264	91
	OPER	4688	9027	-8931	0	9027	-8931	11983	344
A30	SIFI= 1.00	SIFO= 1.00							
	GR	0	8935	-8275	0	8935	-8275	8935	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1247	-1247	0	1247	-1247	1247	91
	OPER	4688	8919	-8823	0	8919	-8823	11881	344
A31	SIFI= 1.00	SIFO= 1.00							
	GR	0	8824	-8164	0	8824	-8164	8824	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1229	-1229	0	1229	-1229	1229	91
	OPER	4688	8803	-8707	0	8803	-8707	11773	344
A32	SIFI= 1.00	SIFO= 1.00							
	GR	0	8707	-8046	0	8707	-8046	8707	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1211	-1211	0	1211	-1211	1211	91
	OPER	4688	8681	-8585	0	8681	-8585	11658	344
A33	SIFI= 1.00	SIFO= 1.00							
	GR	0	8582	-7922	0	8582	-7922	8582	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1191	-1191	0	1191	-1191	1191	91
	OPER	4688	8552	-8456	0	8552	-8456	11537	344
A34	SIFI= 1.00	SIFO= 1.00							
	GR	0	8451	-7790	0	8451	-7790	8451	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1170	-1170	0	1170	-1170	1170	91
	OPER	4688	8415	-8319	0	8415	-8319	11410	344

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
A35	SIFI= 1.00	SIFO= 1.00							
	GR	0	8313	-7652	0	8313	-7652	8313	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1148	-1148	0	1148	-1148	1148	91
	OPER	4688	8272	-8176	0	8272	-8176	11276	344
A36	SIFI= 1.00	SIFO= 1.00							
	GR	0	8167	-7507	0	8167	-7507	8167	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1125	-1125	0	1125	-1125	1125	91
	OPER	4688	8121	-8025	0	8121	-8025	11136	345
A37	SIFI= 1.00	SIFO= 1.00							
	GR	0	8016	-7355	0	8016	-7355	8016	172
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1102	-1102	0	1102	-1102	1102	91
	OPER	4688	7964	-7868	0	7964	-7868	10989	345
A38	SIFI= 1.00	SIFO= 1.00							
	GR	0	7154	-6494	0	7154	-6494	7154	173
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	967	-967	0	967	-967	967	91
	OPER	4688	7070	-6974	0	7070	-6974	10164	345
A39	SIFI= 1.00	SIFO= 1.00							
	GR	0	10980	-10320	0	10980	-10320	10980	350
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1712	-1712	0	1712	-1712	1712	271
	OPER	4688	11127	-11031	0	11127	-11031	13977	162
+ 1	SIFI= 1.00	SIFO= 1.00							
	GR	0	11769	-11109	0	11769	-11109	11769	351
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1880	-1880	0	1880	-1880	1880	270
	OPER	4688	11949	-11854	0	11949	-11854	14767	162
+ 2	SIFI= 1.00	SIFO= 1.00							
	GR	0	11716	-11058	0	11716	-11058	11716	351
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1913	-1913	0	1913	-1913	1913	270
	OPER	4688	11888	-11794	0	11888	-11794	14709	162

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
+ 3	SIFI= 1.00	SIFO= 1.00							
	GR	0	11089	-10431	0	11089	-10431	11089	352
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1767	-1767	0	1767	-1767	1767	270
	OPER	4688	11200	-11107	0	11200	-11107	14050	163
+ 4	SIFI= 1.00	SIFO= 1.00							
	GR	0	10106	-9449	0	10106	-9449	10106	353
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1512	-1512	0	1512	-1512	1512	271
	OPER	4688	10132	-10039	0	10132	-10039	13031	165
+ 5	SIFI= 1.00	SIFO= 1.00							
	GR	0	8942	-8285	0	8942	-8285	8942	354
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	1214	-1214	0	1214	-1214	1214	271
	OPER	4688	8880	-8788	0	8880	-8788	11849	166
+ 6	SIFI= 1.00	SIFO= 1.00							
	GR	0	7732	-7076	0	7732	-7076	7732	355
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	918	-918	0	918	-918	918	271
	OPER	4688	7594	-7503	0	7594	-7503	10651	168
+ 7	SIFI= 1.00	SIFO= 1.00							
	GR	0	6567	-5911	0	6567	-5911	6567	356
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	650	-650	0	650	-650	650	271
	OPER	4688	6370	-6279	0	6370	-6279	9530	170
A40	SIFI= 1.00	SIFO= 1.00							
	GR	0	5477	-4823	0	5477	-4823	5477	357
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	424	-424	0	424	-424	424	271
	OPER	4688	5240	-5150	0	5240	-5150	8523	173
+ 1	SIFI= 1.00	SIFO= 1.00							
	GR	0	2637	-1984	0	2637	-1984	2637	1
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	3	-3	0	3	-3	3	352
	OPER	4688	2358	-2269	0	4688	-2269	6145	181

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G E N E R A L P I P E S T R E S S R E P O R T
(Stress in psi)

Point name	Load combination	Hoop Stress	Longitudinal Max	Longitudinal Min	Shear Stress	Principal Max	Principal Min	Total Stress	Loc
+ 2	SIFI= 1.00	SIFO= 1.00							
	GR	0	833	-182	0	833	-182	833	10
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	96	-96	0	96	-96	96	90
	OPER	4688	577	-490	0	4688	-490	4951	200
+ 3	SIFI= 1.00	SIFO= 1.00							
	GR	0	751	-101	0	751	-101	751	174
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	63	-63	0	63	-63	63	91
	OPER	4688	480	-395	0	4688	-395	4897	346
+ 4	SIFI= 1.00	SIFO= 1.00							
	GR	0	1031	-382	0	1031	-382	1031	179
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	18	-18	0	18	-18	18	93
	OPER	4688	750	-665	0	4688	-665	5053	358
A41	SIFI= 1.00	SIFO= 1.00							
	GR	0	946	-298	0	946	-298	946	180
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	4	-4	0	4	-4	4	258
	OPER	4688	665	-582	0	4688	-582	5004	1
+ 1	SIFI= 1.00	SIFO= 1.00							
	GR	0	569	77	0	569	0	569	180
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	14	-14	0	14	-14	14	91
	OPER	4688	288	-206	0	4688	-206	4794	357
A42	SIFI= 1.00	SIFO= 1.00							
	GR	0	945	-299	0	945	-299	945	0
	T1	0	-1424	-1424	0	0	-1424	1424	270
	P1	4688	1141	1141	0	4688	1141	4234	270
	U1	0	27	-27	0	27	-27	27	272
	OPER	4688	664	-582	0	4688	-582	5004	178

*** Segment A end ***

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                      ASME B31.4 (1998)  CODE COMPLIANCE
                       (Moments in ft-lb  )             (Stress in psi     )
 Point     Load      In-Pl. Out-Pl. Torsion   S.I.F    Eq. Load   Code   Code
 name   combination  Moment  Moment  Moment  In  Out   no. type  Stress Allow.
 ------ ----------- ------- ------- ------- ---- ---- ---- ----  ------ ------

  [A]    [B]          [C]     [D]     [E]   [F]  [G]  [H]  [I]    [J]    [K]


 Explanation of the Results:

 A  point name
 B  load combination name
 C  in-plane moment
 D  out-of-plane moment
 E  torsional moment or axial force when applicable
 F  in-plane stress intensification factor
 G  out-of-plane stress intensification factor
 H  equation number according to the design code when applicable
 I  load type
 J  calculated code stress
 K  code allowable
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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
A00	Max P							HOOP	4104	21600
	GR + Max P	321566	45031	0	1.00	1.00		SUST	21327	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	322024	92778	0	1.00	1.00		OCC	24113	24000**
	OPER	322024	92778	0	1.00	1.00		COMB	25536	27000
	Max Equiv.	321566	45031	0	1.00	1.00	Trsc	EQTN	22312	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A14	Max P							HOOP	4104	21600
	GR + Max P	160435	22470	0	1.00	1.00		SUST	11834	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160664	46313	0	1.00	1.00		OCC	13225	24000
	OPER	160664	46313	0	1.00	1.00		COMB	14649	27000
	Max Equiv.	160435	22470	0	1.00	1.00	Trsc	EQTN	12819	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (ft-lb)	Out-Pl. Moment (ft-lb)	Torsion Moment (ft-lb)	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (psi)	Code Allow. (psi)
A15	Max P							HOOP	4104	21600
	GR + Max P	160410	22430	0	1.00	1.00		SUST	11832	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160639	46250	0	1.00	1.00		OCC	13222	24000
	OPER	160639	46250	0	1.00	1.00		COMB	14646	27000
	Max Equiv.	160410	22430	0	1.00	1.00	Trsc	EQTN	12818	27000
A13	Max P							HOOP	4104	21600
	GR + Max P	160344	22493	0	1.00	1.00		SUST	11829	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160573	46341	0	1.00	1.00		OCC	13221	24000
	OPER	160573	46341	0	1.00	1.00		COMB	14644	27000
	Max Equiv.	160344	22493	0	1.00	1.00	Trsc	EQTN	12814	27000
A16	Max P							HOOP	4104	21600
	GR + Max P	160269	22372	0	1.00	1.00		SUST	11824	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160498	46153	0	1.00	1.00		OCC	13211	24000
	OPER	160498	46153	0	1.00	1.00		COMB	14635	27000
	Max Equiv.	160269	22372	0	1.00	1.00	Trsc	EQTN	12809	27000
A12	Max P							HOOP	4104	21600
	GR + Max P	160138	22499	0	1.00	1.00		SUST	11817	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160366	46334	0	1.00	1.00		OCC	13208	24000
	OPER	160366	46334	0	1.00	1.00		COMB	14631	27000
	Max Equiv.	160138	22499	0	1.00	1.00	Trsc	EQTN	12802	27000
A17	Max P							HOOP	4104	21600
	GR + Max P	160013	22298	0	1.00	1.00		SUST	11808	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160241	46021	0	1.00	1.00		OCC	13193	24000
	OPER	160241	46021	0	1.00	1.00		COMB	14616	27000
	Max Equiv.	160013	22298	0	1.00	1.00	Trsc	EQTN	12794	27000
A11	Max P							HOOP	4104	21600
	GR + Max P	159816	22489	0	1.00	1.00		SUST	11798	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	160044	46293	0	1.00	1.00		OCC	13187	24000
	OPER	160044	46293	0	1.00	1.00		COMB	14611	27000
	Max Equiv.	159816	22489	0	1.00	1.00	Trsc	EQTN	12784	27000
A18	Max P							HOOP	4104	21600
	GR + Max P	159641	22207	0	1.00	1.00		SUST	11786	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	159868	45855	0	1.00	1.00		OCC	13166	24000
	OPER	159868	45855	0	1.00	1.00		COMB	14589	27000
	Max Equiv.	159641	22207	0	1.00	1.00	Trsc	EQTN	12771	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
A10	Max P							HOOP	4104	21600
	GR + Max P	159378	22461	0	1.00	1.00		SUST	11773	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	159605	46218	0	1.00	1.00		OCC	13159	24000
	OPER	159605	46218	0	1.00	1.00		COMB	14583	27000
	Max Equiv.	159378	22461	0	1.00	1.00	Trsc	EQTN	12758	27000
A19	Max P							HOOP	4104	21600
	GR + Max P	159153	22099	0	1.00	1.00		SUST	11757	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	159380	45654	0	1.00	1.00		OCC	13131	24000
	OPER	159380	45654	0	1.00	1.00		COMB	14555	27000
	Max Equiv.	159153	22099	0	1.00	1.00	Trsc	EQTN	12742	27000
A09	Max P							HOOP	4104	21600
	GR + Max P	158824	22416	0	1.00	1.00		SUST	11741	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	159051	46107	0	1.00	1.00		OCC	13123	24000
	OPER	159051	46107	0	1.00	1.00		COMB	14546	27000
	Max Equiv.	158824	22416	0	1.00	1.00	Trsc	EQTN	12726	27000
A20	Max P							HOOP	4104	21600
	GR + Max P	158550	21973	0	1.00	1.00		SUST	11721	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	158776	45418	0	1.00	1.00		OCC	13089	24000
	OPER	158776	45418	0	1.00	1.00		COMB	14513	27000
	Max Equiv.	158550	21973	0	1.00	1.00	Trsc	EQTN	12706	27000
A08	Max P							HOOP	4104	21600
	GR + Max P	158155	22354	0	1.00	1.00		SUST	11701	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	158381	45962	0	1.00	1.00		OCC	13079	24000
	OPER	158381	45962	0	1.00	1.00		COMB	14502	27000
	Max Equiv.	158155	22354	0	1.00	1.00	Trsc	EQTN	12687	27000
A21	Max P							HOOP	4104	21600
	GR + Max P	157830	21831	0	1.00	1.00		SUST	11678	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	158056	45148	0	1.00	1.00		OCC	13039	24000
	OPER	158056	45148	0	1.00	1.00		COMB	14462	27000
	Max Equiv.	157830	21831	0	1.00	1.00	Trsc	EQTN	12664	27000
A07	Max P							HOOP	4104	21600
	GR + Max P	157370	22275	0	1.00	1.00		SUST	11655	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	157595	45783	0	1.00	1.00		OCC	13027	24000
	OPER	157595	45783	0	1.00	1.00		COMB	14451	27000
	Max Equiv.	157370	22275	0	1.00	1.00	Trsc	EQTN	12641	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (ft-lb)	Out-Pl. Moment (ft-lb)	Torsion Moment (ft-lb)	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (psi)	Code Allow. (psi)
A22	Max P							HOOP	4104	21600
	GR + Max P	156996	21672	0	1.00	1.00		SUST	11629	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	157220	44844	0	1.00	1.00		OCC	12981	24000
	OPER	157220	44844	0	1.00	1.00		COMB	14404	27000
	Max Equiv.	156996	21672	0	1.00	1.00	Trsc	EQTN	12614	27000
A06	Max P							HOOP	4104	21600
	GR + Max P	156470	22180	0	1.00	1.00		SUST	11603	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	156693	45569	0	1.00	1.00		OCC	12967	24000
	OPER	156693	45569	0	1.00	1.00		COMB	14391	27000
	Max Equiv.	156470	22180	0	1.00	1.00	Trsc	EQTN	12588	27000
A23	Max P							HOOP	4104	21600
	GR + Max P	156045	21496	0	1.00	1.00		SUST	11573	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	156268	44504	0	1.00	1.00		OCC	12915	24000
	OPER	156268	44504	0	1.00	1.00		COMB	14339	27000
	Max Equiv.	156045	21496	0	1.00	1.00	Trsc	EQTN	12558	27000
A05	Max P							HOOP	4104	21600
	GR + Max P	155454	22067	0	1.00	1.00		SUST	11543	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	155675	45320	0	1.00	1.00		OCC	12900	24000
	OPER	155675	45320	0	1.00	1.00		COMB	14323	27000
	Max Equiv.	155454	22067	0	1.00	1.00	Trsc	EQTN	12528	27000
A24	Max P							HOOP	4104	21600
	GR + Max P	154979	21303	0	1.00	1.00		SUST	11509	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	155200	44130	0	1.00	1.00		OCC	12841	24000
	OPER	155200	44130	0	1.00	1.00		COMB	14265	27000
	Max Equiv.	154979	21303	0	1.00	1.00	Trsc	EQTN	12495	27000
A04	Max P							HOOP	4104	21600
	GR + Max P	154322	21937	0	1.00	1.00		SUST	11477	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	154542	45037	0	1.00	1.00		OCC	12824	24000
	OPER	154542	45037	0	1.00	1.00		COMB	14248	27000
	Max Equiv.	154322	21937	0	1.00	1.00	Trsc	EQTN	12462	27000
A25	Max P							HOOP	4104	21600
	GR + Max P	153797	21092	0	1.00	1.00		SUST	11439	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	154016	43722	0	1.00	1.00		OCC	12760	24000
	OPER	154016	43722	0	1.00	1.00		COMB	14183	27000
	Max Equiv.	153797	21092	0	1.00	1.00	Trsc	EQTN	12425	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (ft-lb)	Out-Pl. Moment (ft-lb)	Torsion Moment (ft-lb)	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (psi)	Code Allow. (psi)
A03	Max P							HOOP	4104	21600
	GR + Max P	153074	21790	0	1.00	1.00		SUST	11403	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	153293	44719	0	1.00	1.00		OCC	12741	24000
	OPER	153293	44719	0	1.00	1.00		COMB	14165	27000
	Max Equiv.	153074	21790	0	1.00	1.00	Trsc	EQTN	12389	27000
A26	Max P							HOOP	4104	21600
	GR + Max P	152499	20865	0	1.00	1.00		SUST	11363	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	152717	43279	0	1.00	1.00		OCC	12670	24000
	OPER	152717	43279	0	1.00	1.00		COMB	14094	27000
	Max Equiv.	152499	20865	0	1.00	1.00	Trsc	EQTN	12348	27000
A02	Max P							HOOP	4104	21600
	GR + Max P	151711	21627	0	1.00	1.00		SUST	11323	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	151927	44366	0	1.00	1.00		OCC	12650	24000
	OPER	151927	44366	0	1.00	1.00		COMB	14074	27000
	Max Equiv.	151711	21627	0	1.00	1.00	Trsc	EQTN	12308	27000
A27	Max P							HOOP	4104	21600
	GR + Max P	151086	20621	0	1.00	1.00		SUST	11279	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	151302	42801	0	1.00	1.00		OCC	12573	24000
	OPER	151302	42801	0	1.00	1.00		COMB	13997	27000
	Max Equiv.	151086	20621	0	1.00	1.00	Trsc	EQTN	12264	27000
A28	Max P							HOOP	4104	21600
	GR + Max P	149557	20360	0	1.00	1.00		SUST	11189	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	149771	42289	0	1.00	1.00		OCC	12468	24000
	OPER	149771	42289	0	1.00	1.00		COMB	13892	27000
	Max Equiv.	149557	20360	0	1.00	1.00	Trsc	EQTN	12174	27000
A29	Max P							HOOP	4104	21600
	GR + Max P	147913	20081	0	1.00	1.00		SUST	11091	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	148124	41742	0	1.00	1.00		OCC	12355	24000
	OPER	148124	41742	0	1.00	1.00		COMB	13779	27000
	Max Equiv.	147913	20081	0	1.00	1.00	Trsc	EQTN	12077	27000
A30	Max P							HOOP	4104	21600
	GR + Max P	146152	19786	0	1.00	1.00		SUST	10987	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	146361	41160	0	1.00	1.00		OCC	12234	24000
	OPER	146361	41160	0	1.00	1.00		COMB	13658	27000
	Max Equiv.	146152	19786	0	1.00	1.00	Trsc	EQTN	11972	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A31	Max P							HOOP	4104	21600
	GR + Max P	144276	19474	0	1.00	1.00		SUST	10876	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	144482	40544	0	1.00	1.00		OCC	12106	24000
	OPER	144482	40544	0	1.00	1.00		COMB	13529	27000
	Max Equiv.	144276	19474	0	1.00	1.00	Trsc	EQTN	11862	27000
A32	Max P							HOOP	4104	21600
	GR + Max P	142285	19145	0	1.00	1.00		SUST	10759	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	142488	39894	0	1.00	1.00		OCC	11969	24000
	OPER	142488	39894	0	1.00	1.00		COMB	13393	27000
	Max Equiv.	142285	19145	0	1.00	1.00	Trsc	EQTN	11744	27000
A33	Max P							HOOP	4104	21600
	GR + Max P	140177	18798	0	1.00	1.00		SUST	10634	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	140377	39209	0	1.00	1.00		OCC	11825	24000
	OPER	140377	39209	0	1.00	1.00		COMB	13248	27000
	Max Equiv.	140177	18798	0	1.00	1.00	Trsc	EQTN	11619	27000
A34	Max P							HOOP	4104	21600
	GR + Max P	137954	18435	0	1.00	1.00		SUST	10503	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	138151	38489	0	1.00	1.00		OCC	11673	24000
	OPER	138151	38489	0	1.00	1.00		COMB	13096	27000
	Max Equiv.	137954	18435	0	1.00	1.00	Trsc	EQTN	11488	27000
A35	Max P							HOOP	4104	21600
	GR + Max P	135615	18055	0	1.00	1.00		SUST	10364	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	135809	37734	0	1.00	1.00		OCC	11513	24000
	OPER	135809	37734	0	1.00	1.00		COMB	12936	27000
	Max Equiv.	135615	18055	0	1.00	1.00	Trsc	EQTN	11350	27000
A36	Max P							HOOP	4104	21600
	GR + Max P	133161	17658	0	1.00	1.00		SUST	10219	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	133351	36945	0	1.00	1.00		OCC	11345	24000
	OPER	133351	36945	0	1.00	1.00		COMB	12768	27000
	Max Equiv.	133161	17658	0	1.00	1.00	Trsc	EQTN	11205	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
A01	Max P							HOOP	4104	21600
	GR + Max P	131715	19054	0	1.00	1.00		SUST	10147	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	131903	38939	0	1.00	1.00		OCC	11307	24000
	OPER	131903	38939	0	1.00	1.00		COMB	12731	27000
	Max Equiv.	131715	19054	0	1.00	1.00	Trsc	EQTN	11132	27000
A37	Max P							HOOP	4104	21600
	GR + Max P	130591	17244	0	1.00	1.00		SUST	10068	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	130777	36122	0	1.00	1.00		OCC	11169	24000
	OPER	130777	36122	0	1.00	1.00		COMB	12593	27000
	Max Equiv.	130591	17244	0	1.00	1.00	Trsc	EQTN	11053	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A38	Max P							HOOP	4104	21600
	GR + Max P	116005	14917	0	1.00	1.00		SUST	9206	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	116170	31485	0	1.00	1.00		OCC	10173	24000
	OPER	116170	31485	0	1.00	1.00		COMB	11596	27000
	Max Equiv.	116005	14917	0	1.00	1.00	Trsc	EQTN	10191	27000
A39	Max P							HOOP	4104	21600
	GR + Max P	179995	30370	0	1.00	1.00		SUST	13032	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	180252	59715	0	1.00	1.00		OCC	14745	24000
	OPER	180252	59715	0	1.00	1.00		COMB	16168	27000
	Max Equiv.	179995	30370	0	1.00	1.00	Trsc	EQTN	14018	27000
A40	Max P							HOOP	4104	21600
	GR + Max P	88174	4181	0	1.00	1.00		SUST	7529	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	88299	11451	0	1.00	1.00		OCC	7954	24000
	OPER	88299	11451	0	1.00	1.00		COMB	9377	27000
	Max Equiv.	88174	4181	0	1.00	1.00	Trsc	EQTN	8521	27000
A40	Max P							HOOP	4104	21600
	GR + Max P	88174	4181	0	1.00	1.00		SUST	7529	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	88299	11451	0	1.00	1.00		OCC	7954	24000
	OPER	88299	11451	0	1.00	1.00		COMB	9377	27000
	Max Equiv.	88174	4181	0	1.00	1.00	Trsc	EQTN	8521	27000

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ASME B31.4 (1998) CODE COMPLIANCE

Point name	Load combination	In-Pl. Moment (Moments in ft-lb)	Out-Pl. Moment	Torsion Moment	S.I.F In	S.I.F Out	Eq. no.	Load type	Code Stress (Stress in psi)	Code Allow.
A40	Max P							HOOP	4104	21600
	GR + Max P	88174	4181	0	1.00	1.00		SUST	7529	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	88299	11451	0	1.00	1.00		OCC	7954	24000
	OPER	88299	11451	0	1.00	1.00		COMB	9377	27000
	Max Equiv.	88174	4181	0	1.00	1.00	Trsc	EQTN	8521	27000
A42	Max P							HOOP	4104	21600
	GR + Max P	10661	31	0	1.00	1.00		SUST	2997	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	10676	489	0	1.00	1.00		OCC	3024	24000
	OPER	10676	489	0	1.00	1.00		COMB	4448	27000
	Max Equiv.	10661	31	0	1.00	1.00	Trsc	EQTN	4104	27000
A41	Max P							HOOP	4104	21600
	GR + Max P	10662	76	0	1.00	1.00		SUST	2998	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	10678	150	0	1.00	1.00		OCC	3002	24000
	OPER	10678	150	0	1.00	1.00		COMB	4426	27000
	Max Equiv.	10662	76	0	1.00	1.00	Trsc	EQTN	4104	27000
A40	Max P							HOOP	4104	21600
	GR + Max P	88174	4181	0	1.00	1.00		SUST	7529	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	88299	11451	0	1.00	1.00		OCC	7954	24000
	OPER	88299	11451	0	1.00	1.00		COMB	9377	27000
	Max Equiv.	88174	4181	0	1.00	1.00	Trsc	EQTN	8521	27000
A40	Max P							HOOP	4104	21600
	GR + Max P	88174	4181	0	1.00	1.00		SUST	7529	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	88299	11451	0	1.00	1.00		OCC	7954	24000
	OPER	88299	11451	0	1.00	1.00		COMB	9377	27000
	Max Equiv.	88174	4181	0	1.00	1.00	Trsc	EQTN	8521	27000
A41	Max P							HOOP	4104	21600
	GR + Max P	10662	76	0	1.00	1.00		SUST	2998	24000
	Cold to T1	0	0	0	1.00	1.00		DISP	1424	21600
	SUS. + U1	10678	150	0	1.00	1.00		OCC	3002	24000
	OPER	10678	150	0	1.00	1.00		COMB	4426	27000
	Max Equiv.	10662	76	0	1.00	1.00	Trsc	EQTN	4104	27000

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R E S U L T S U M M A R Y

Maximum displacements (in)

Maximum X :	-0.013	Point : A39	Load Comb.: GR
Maximum Y :	-2.653	Point : A13	Load Comb.: OPER
Maximum Z :	-9.549	Point : A14	Load Comb.: OPER
Max. total:	9.910	Point : A14	Load Comb.: OPER

Maximum rotations (deg)

Maximum Y :	-0.544	Point : A38	Load Comb.: OPER
Maximum Z :	0.164	Point : A38	Load Comb.: OPER
Max. total:	0.568	Point : A38	Load Comb.: OPER

Maximum restraint forces (lb)

Maximum X :	79165	Point : A42	Load Comb.: OPER
Maximum Y :	-3102	Point : A00	Load Comb.: OPER
Maximum Z :	-10576	Point : A00	Load Comb.: OPER
Max. total:	79616	Point : A00	Load Comb.: OPER

Maximum restraint moments (ft-lb)

Maximum Y :	322024	Point : A00	Load Comb.: OPER
Maximum Z :	-92778	Point : A00	Load Comb.: OPER
Max. total:	335123	Point : A00	Load Comb.: OPER

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R E S U L T S U M M A R Y

Maximum pipe forces (lb)

Maximum X :	79160	Point : A41	Load Comb.: OPER
Maximum Y :	3990	Point : A39	Load Comb.: OPER
Maximum Z :	10576	Point : A00	Load Comb.: OPER
Max. total:	79616	Point : A00	Load Comb.: OPER

Maximum pipe moments (ft-lb)

Maximum Y :	-322024	Point : A00	Load Comb.: OPER
Maximum Z :	92778	Point : A00	Load Comb.: OPER
Max. total:	335123	Point : A00	Load Comb.: OPER

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                          R E S U L T    S U M M A R Y
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     Maximum sustained stress

                              Point            : A00
                              Stress    psi    : 21327
                              Allowable psi    : 24000
                              Ratio            : 0.89
                              Load combination : GR + Max P

     Maximum displacement stress

                              Point            : A00
                              Stress    psi    : 1424
                              Allowable psi    : 21600
                              Ratio            : 0.07
                              Load combination : Cold to T1

     Maximum occasional stress

                              Point            : A00
                              Stress    psi    : 24113
                              Allowable psi    : 24000
                              Ratio            : 1.00
                              Load combination : SUS. + U1

     Maximum hoop stress

                              Point            : A00
                              Stress    psi    : 4104
                              Allowable psi    : 21600
                              Ratio            : 0.19
                              Load combination : Max P

     Maximum combined stress

                              Point            : A00
                              Stress    psi    : 25536
                              Allowable psi    : 27000
                              Ratio            : 0.95
                              Load combination : OPER

     Maximum tensile stress

                              Point            : A00
                              Stress    psi    : 22312
                              Allowable psi    : 27000
                              Ratio            : 0.83
                              Load combination : Max Equiv.
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                          R E S U L T    S U M M A R Y
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     Maximum sustained stress ratio

                              Point            : A00
                              Stress    psi    : 21327
                              Allowable psi    : 24000
                              Ratio            : 0.89
                              Load combination : GR + Max P

     Maximum displacement stress ratio

                              Point            : A00
                              Stress    psi    : 1424
                              Allowable psi    : 21600
                              Ratio            : 0.07
                              Load combination : Cold to T1

     Maximum occasional stress ratio

                              Point            : A00
                              Stress    psi    : 24113
                              Allowable psi    : 24000
                              Ratio            : 1.00
                              Load combination : SUS. + U1

     Maximum hoop stress ratio

                              Point            : A00
                              Stress    psi    : 4104
                              Allowable psi    : 21600
                              Ratio            : 0.19
                              Load combination : Max P

     Maximum combined stress ratio

                              Point            : A00
                              Stress    psi    : 25536
                              Allowable psi    : 27000
                              Ratio            : 0.95
                              Load combination : OPER

     Maximum tensile stress ratio

                              Point            : A00
                              Stress    psi    : 22312
                              Allowable psi    : 27000
                              Ratio            : 0.83
                              Load combination : Max Equiv.
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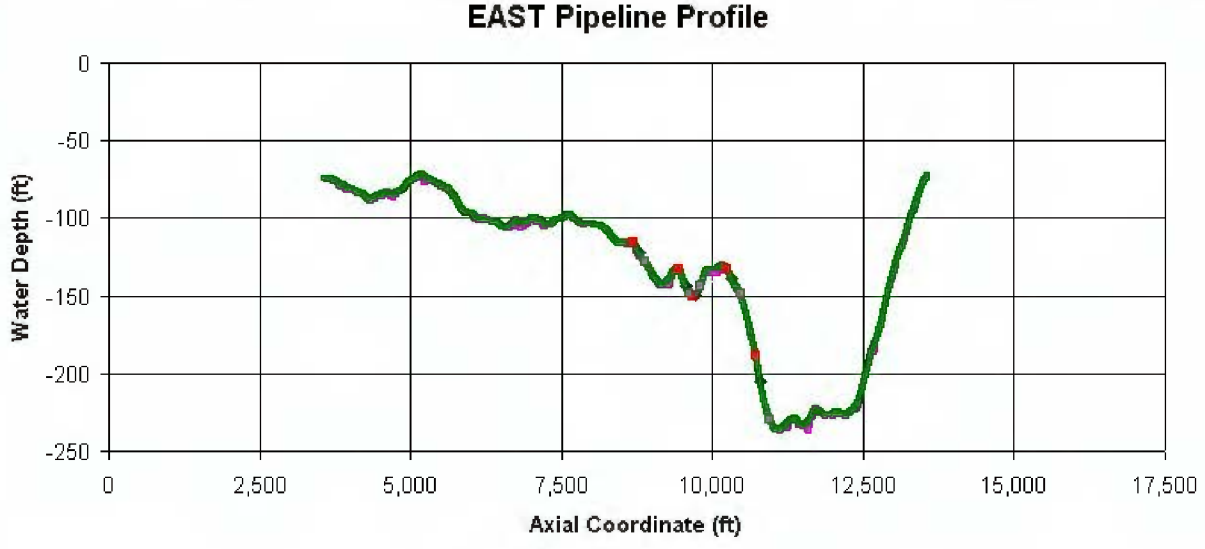
R E S U L T S U M M A R Y

* * * The system does not satisfy ASME B31.4 code requirements * * *
* * * for the selected options * * *

NOTE - AT LIMIT (UNITY CHECK OF 1.00). LESSOR SPANS ARE ACCEPTABLE.

APPENDIX B: PHOTO / PROFILE


ENBRIDGE


EAST Pipeline Profile
Water Depth (ft)
0
-50
-100
-150
-200
-250
0
2,500
5,000
7,500
10,000
12,500
15,000
17,500
Axial Coordinate (ft)