From: Peter W. Lind [mailto:PLIND@velco.com]
Sent: Wednesday, September 21, 2016 5:21 AM
To: John St.Hilaire < jsthilaire@vermontgas.com>

Cc: John Stamatov (US - Advisory) (john.r.stamatov@pwc.com) <john.r.stamatov@pwc.com>; Reagan, Michael J (Michael.Reagan@mottmac.com) <Michael.Reagan@mottmac.com>; Brian Connaughton <BCONNAUGHTON@velco.com>; Mike Fiske <MFISKE@velco.com>; Mark Sciarrotta <MSCIARROTTA@velco.com>; Eric Frazer (efrazer@ececnh.com) <efrazer@ececnh.com>

Subject: Vermont Gas Project - Clay Plains Issue - VELCO K43 Structures 262 - 263

### Good morning John.

Thank you for the follow-up responses and information on the issues you are having in obtaining the 4' foot burial depth of the gas pipeline in the Clay Plains area along VELCO's K43 transmission line between structures 262 and 263. Based upon this information and our discussions yesterday afternoon; VELCO agrees for you to move forward with the installation of the gas pipeline at less than the agreed upon 4' depth in this area with the following conditions as we discussed:

- VGS to document the specific area where the pipe is not going to be installed at the agreed upon 4' depth (Survey, pictures, as-built drawings, etc.).
- VGS will use all reasonable measures to maximize and maintain the loading factor to the HS-20 &15% as possible with concrete coatings and other measures, etc.
- VGS to confirm with PE engineering analysis that the HS-20 & 15% loading factor will be obtained and maintained at this location with the diminished burial depth.
- Additional VGS standard yellow location markers will be installed over the pipeline every 50 feet at this Clay Plains area for the estimated 300 feet section such that it is visibly marked.
- VELCO and VGS will memorialize this specific variance from our established agreement for the standard installation of the gas pipeline at four feet along the VELCO ROW and access roads.

I trust that this correctly represents the issues we addressed and agreed to in our discussion. Please review and confirm. Thanks John.

Best regards,

Peter

Peter W. Lind Senior Project Manager Vermont Electric Power Company 366 Pinnacle Ridge Road Rutland, VT 05701

Tel: (802) 770-6292

Mobile: (802) 353-0418 Fax: (802) 770-6449 plind@velco.com www.velco.com

From: John St.Hilaire [mailto:jsthilaire@vermontgas.com]

Sent: Tuesday, September 20, 2016 12:26 PM

To: Peter W. Lind

Cc: Brian Connaughton; john.r.stamatov@pwc.com; Reagan, Michael J (Michael.Reagan@mottmac.com)

Subject: FW: Draft VELCO compaction reply

#### Hi Peter.

Thanks for the call today. We appreciate your team working expeditiously to review this issue for us. You asked for documentation on compaction for this line. I am attaching a compaction report from Mott McDonald that indicates the compaction of HS20+15% can be met with our 12" pipe specifications with all soils at a depth of 3' or greater. The pipe in the affected area is concrete coated which will only increase the loading capacity of the pipe.

The details of the field conditions were conveyed by Mike Reagan via e-mail on 9/19/16.

We will plan to install line markers every 50'in the affected area if the 3' of cover is approved.

Should you have further questions, please let us know.

John St.Hilaire

<u>Project Name</u>: Vermont Gas Systems 5/25/2016

Location: Burlington, VT Rev. 1

<u>Prepared for</u>: Vermont Gas Systems

Prepared by: Mott MacDonald

#### Purpose:

Mott MacDonald has prepared the stress calculations included herein for Vermont Gas Systems, to ensure the pipeline's integrity under loading without compaction of backfill. The stress calculations were performed per API 1102, using various combinations of soil type and depth of cover to confirm that 90% compaction will not be necessary.

#### Knowns:

- Class 3 Location, Design Factor of 0.5
- 12.75 inch OD
- 0.312 inch WT
- API-5L Electric Resistance Welded
- Grade X-65
- MAOP of 1440 psi
- Design Wheel Load HS-20 + 15%

#### Results:

A summary table has been provided below. The stress calculations show that under all soil types, paired with 3', 4', and 5' of cover, the pipeline passes all stress checks (Hoop, Effective, Girth Weld, and Longitudinal Weld). In conclusion, Mott MacDonald recommends a minimum depth of cover of 4 feet. Although 3 feet of cover is sufficient under the given loading, a one foot buffer would help ensure that even if settlement were to occur, the pipeline would remain safe and operational.

API 1102 STRESS CALCULATION RE	SULTS		
	Calculated	d Effective S	Stress (psi)
Soil type	3' Cover	4' Cover	5' Cover
Soft to medium clays and silts with high plasticities	31,239	31,437	31,234
Soft to medium clays and silts with low/medium plasticities	31,180	31,370	31,159
Loose sands and gravels	30,360	30,550	30,427
Stiff to very stiff clays and silts	30,216	30,366	30,193
Medium dense sands and gravels	30,278	30,453	30,318
Dense to very dense sands and gravels	29,422	29,554	29,437
ALLOWABLE EFFECTIVE STRESS (psi)		32,500	

#### Note:

1. Calculated girth weld and longitudinal weld stress values were less than the allowable (Girth: 6,000 psi & Long. Welds: 11,500 psi).



### **Calculation cover sheet**

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Distribution:

Original to project file



Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	<

API 1102 - Gas Pipeline	Crossing High	way						
PIPE AND OPERATIONAL DATA:		SITE	AND IN	STALLA	TION DATA	A:		
Operating Pressure [psi]	1440	Soil Ty			nedium clay	s and silts	with	h high
Location Class:	3	E' - Mo		plasticition of Soil R	es eaction [ksi	]	0.:	2
Operating Temperature [°F]	60.0	Er - Re	esilient	Modulus	s [ksi]	-	5.	o
Pipe Outside Diameter [in]	12.75	Averag	ge Unit	Weight	of Soil [lb/ft <sup>s</sup>	³]	12	20.00
Pipe Wall Thickness [in]	0.312	Pipe D	epth [f	t]	-		3	
Pipe Grade: X65		Bored	Diame	ter [in]			12	2.75
Specified Minimum Yield Stress	65,000	Installa	ationTe	mperatu	re [°F]		60	0.0
Design Factor	0.50	Design	n Whee	el Load fr	om Single /	Axle [kips]		18.4
Longitudinal Joint Factor	1.0				om Tanden		os]	18.4
Temperature Derating Factor	1.000	_		pe: Non			·	
Pipe Class: API 5L Electric Res	istance Welded				I: ASCE - H	lighway		
Young's Modulus for Steel [ksi]	30,000					0 ,		
Poisson's Ratio for Steel	0.30							
Coefficient of Thermal Expansion [p	oer°F] 0.0000065	Safety	Factor	Applied	: API 1102	2 Procedur	е	
RESULTS								
Hoop Stress [psi]		29,423	Maxi	mum Cir	cumferentia	al Stress [p	si]	34,305
Allowable Hoop Stress [psi]		32,500	Maxii	mum Lor	ngitudinal S	tress [psi]		12,239
Stiffness Factor for Earth Load Circ	umferential Stress	2,196	Maxi	mum Ra	dial Stress	[psi]		-1,440
Burial Factor for Earth Load Circum	ferential Stress	0.83	Total	Effective	e Stress [ps	si]		31,239
Excavation Factor for Earth Load C	ircumferential Stress	0.83	Allow	able Effe	ective Stres	s [psi]		32,500
Circumferential Stress from Earth L	oad [psi]	1,331						
Impact Factor		1.50	Stres	s [psi]	Calculated	Allowable	PA	SS/FAIL
Highway Stiffness Factor for Cyclic	Circumferential	16.60	Hoop		29,423	32,500	PA	
Highway Geometry Factor for Cyclic	c Circumferential	1.22	Effec	Welds	31,239	32,500 6,000		SS SS
Cyclic Circumferential Stress [psi]		4,271		. Welds	4,271	11,500		SS
Highway Stiffness Factor for Cyclic	Longitudinal Stress	13.20			•	•		
Highway Geometry Factor for Cyclic	Longitudinal Stress	1.16						
Cyclic Longitudinal Stress [psi]		3,229						
Notes: Open cut construction, calcu	lations run using HS.	.20 loadin	a + 15	0/2				

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

Prepared By Kelsey Kibbe Approved By Revision: 13.0.1

Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

PIPE AND OPERATIONAL DATA:		SITE A	ND IN	STALLA	TION DATA	<b>A</b> :	
Operating Pressure [psi]	1440	Soil Ty		Soft to m	nedium clay	s and silts	with high
Location Class:	3	E' - Mo			es eaction [ksi	]	0.2
Operating Temperature [°F]	60.0	Er - Re	silient	Modulus	[ksi]		5.0
Pipe Outside Diameter [in]	12.75	Averag	e Unit	Weight o	of Soil [lb/ft <sup>s</sup>	<b>'</b> ]	120.00
Pipe Wall Thickness [in]	0.312	Pipe D	epth [ft	<u>:</u> ]			4
Pipe Grade: X65		Bored	Diame	ter [in]			12.75
Specified Minimum Yield Stress	65,000	Installa	tionTe	mperatu	re [°F]		60.0
Design Factor	0.50	Design	Whee	l Load fr	om Single /	Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design	Whee	l Load fr	om Tanden	n Axles [kip	os] 18.4
Temperature Derating Factor	1.000	Pavem	ent Ty	pe: Non	е		
Pipe Class: API 5L Electric Re	sistance Welded	Impact	Factor	r Method	: ASCE - H	lighway	
Young's Modulus for Steel [ksi]	30,000						
Poisson's Ratio for Steel	0.30				A 50 4 4 6		
Coefficient of Thermal Expansion	per°F] 0.0000065	Safety	Factor	Applied:	API 110	2 Procedur	е
RESULTS							
Hoop Stress [psi]		29,423	Maxii	mum Cir	cumferentia	al Stress [p:	si] 34,52
Allowable Hoop Stress [psi]		32,500	Maxii	mum Lor	ngitudinal S	tress [psi]	12,30
Stiffness Factor for Earth Load Cir	cumferential Stress	2,196	Maxi	mum Ra	dial Stress	[psi]	-1,440
Burial Factor for Earth Load Circur	nferential Stress	0.97	Total	Effective	e Stress [ps	si]	31,43
Excavation Factor for Earth Load (	Circumferential Stress	0.83	Allow	able Effe	ective Stres	s [psi]	32,50
Circumferential Stress from Earth	Load [psi]	1,555					
Impact Factor		1.50		s [psi]		Allowable	
			Hoop		29,423	32,500	PASS
Highway Stiffness Factor for Cyclic	Circumferential	16.60		tivo	31 // 37	32 500	IPASS
Highway Stiffness Factor for Cyclic Highway Geometry Factor for Cyc		16.60 1.22	Effec	tive Welds	31,437 3,229	32,500 6,000	PASS PASS
•			Effect Girth				
Highway Geometry Factor for Cyc	ic Circumferential	1.22	Effect Girth	Welds	3,229	6,000	PASS
Highway Geometry Factor for Cyc Cyclic Circumferential Stress [psi]	ic Circumferential	1.22 4,271	Effect Girth	Welds	3,229	6,000	PASS

Project	
Vermont Gas Systems	
Location	Date
Burlington, VT	5/24/2016

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PIPE AND OPERATIONAL DATA	:	SITE AND I	NSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type:	Soft to medium clays and silts	with high
Location Class:	3	E' - Modulus	plasticities of Soil Reaction [ksi]	0.2
Operating Temperature [°F]	60.0	Er - Resilien	t Modulus [ksi]	5.0
Pipe Outside Diameter [in]	12.75	Average Uni	t Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Depth [	ft]	5
Pipe Grade: X65		Bored Diame		12.75
Specified Minimum Yield Stress	65,000	InstallationT	emperature [°F]	60.0
Design Factor	0.50	Design Whe	el Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0		el Load from Tandem Axles [ki	os] 18.4
Temperature Derating Factor	1.000	Pavement T	ype: None	-
Pipe Class: API 5L Electric Re	esistance Welded	Impact Facto	or Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000			q
Poisson's Ratio for Steel	0.30			
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Facto	or Applied: API 1102 Procedui	e
RESULTS				
Hoop Stress [psi]		29,423 Max	imum Circumferential Stress [p	si] 34,285

Allowable Hoop Stress [psi] 32,500 Maximum Longitudinal Stress [psi] 12,136  Stiffness Factor for Earth Load Circumferential Stress 2,196 Maximum Radial Stress [psi] -1,440  Burial Factor for Earth Load Circumferential Stress 1.08 Total Effective Stress [psi] 31,234  Excavation Factor for Earth Load Circumferential Stress 0.83 Allowable Effective Stress [psi] 32,500  Circumferential Stress from Earth Load [psi] 1,732  Impact Factor 1.50 Stress [psi] Calculated Allowable PASS/FAIL	Hoop Stress [psi]	29,423	3 Maximum Cir	rcumferentia	l Stress [p:	si] 34,285	,
Burial Factor for Earth Load Circumferential Stress 1.08 Total Effective Stress [psi] 31,234  Excavation Factor for Earth Load Circumferential Stress 0.83 Allowable Effective Stress [psi] 32,500  Circumferential Stress from Earth Load [psi] 1,732	Allowable Hoop Stress [psi]	32,500	Maximum Lo	ngitudinal St	ress [psi]	12,136	,
Excavation Factor for Earth Load Circumferential Stress 0.83 Allowable Effective Stress [psi] 32,500  Circumferential Stress from Earth Load [psi] 1,732	Stiffness Factor for Earth Load Circumfe	erential Stress 2,196	Maximum Ra	idial Stress [	psi]	-1,440	
Circumferential Stress from Earth Load [psi] 1,732	Burial Factor for Earth Load Circumfere	ntial Stress 1.08	Total Effectiv	e Stress [ps	i]	31,234	
	Excavation Factor for Earth Load Circur	nferential Stress 0.83	Allowable Eff	ective Stress	s [psi]	32,500	i
Impact Factor 1.50 Stress [psi] Calculated Allowable PASS/FAIL	Circumferential Stress from Earth Load	[psi] 1,732		- 2			
	Impact Factor	1.50	Stress [psi]	Calculated	Allowable	PASS/FAIL	-
Highway Stiffness Factor for Cyclic Circumferential 16.60 Hoop 29,423 32,500 PASS	Highway Stiffness Factor for Cyclic Circ	umferential 16.60		<u> </u>	· · · · · · · · · · · · · · · · · · ·		

		L'adl age	00.00.000		
Highway Stiffness Factor for Cyclic Circumferential	16.60	Ноор	29,423	32,500	PASS
		Effective	31,234	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.10	Girth Welds	3,006	6,000	PASS
Cyclic Circumferential Stress [psi]	3,850	Long. Welds	3,850	11,500	PASS
Highway Stiffness Factor for Cyclic Longitudinal Stress	13.20				

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Highway Geometry Factor for Cyclic Longitudinal Stress 1.08

Cyclic Longitudinal Stress [psi]

Prepared By Kelsey Kibbe	Approved By	Revision: 13.0.1
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Project	
Vermont Gas Systems	
Location	Date
Burlington, VT	5/24/2016

		,					
PIPE AND OPERATIONAL DATA:		SITE A	ND IN	ISTALLA <sup>-</sup>	TION DATA		
Operating Pressure [psi]	1440	Soil Typ	oe:		edium clay		with
Location Class:	3	E' - Mo	dulus		ium plasticit eaction [ksi]		0.5
Operating Temperature [°F]	60.0	Er - Re	silient	Modulus	[ksi]		5.0
Pipe Outside Diameter [in]	12.75	Averag	e Unit	: Weight o	of Soil [lb/ft³]		120.00
Pipe Wall Thickness [in]	0.312	Pipe De	epth [1	t]			3
Pipe Grade: X65		Bored [	Diame	eter [in]			12.75
Specified Minimum Yield Stress	65,000	Installa	tionTe	emperatui	re [°F]		60.0
Design Factor	0.50	Design	Whe	el Load fro	om Single A	xle [kips]	18.4
Longitudinal Joint Factor	1.0	Design	Whe	el Load fro	om Tandem	Axles [kip	s] 18.4
Temperature Derating Factor	1.000	Pavem	ent Ty	pe: None	е		
Pipe Class: API 5L Electric Re	sistance Welded	Impact	Facto	r Method	: ASCE - H	ighway	
Young's Modulus for Steel [ksi]	30,000						
Poisson's Ratio for Steel	0.30						
Coefficient of Thermal Expansion	per°F] 0.0000065	Safety	Facto	r Applied:	API 1102	! Procedur	е
RESULTS							
Hoop Stress [psi]		29,423	Max	mum Circ	cumferentia	Stress [p:	si] 34,239
Allowable Hoop Stress [psi]		32,500	Max	mum Lor	ngitudinal St	ress [psi]	12,219
Stiffness Factor for Earth Load Cir	cumferential Stress	2,088	Max	mum Rad	dial Stress [	psi]	-1,440
Burial Factor for Earth Load Circur	nferential Stress	0.83	Tota	l Effective	Stress [psi	]	31,180
Excavation Factor for Earth Load (	Circumferential Stress	0.83	Allov	vable Effe	ective Stress	s [psi]	32,500
Circumferential Stress from Earth	Load [psi]	1,265					
Impact Factor		1.50		ss [psi]			PASS/FAIL
Highway Stiffness Factor for Cyclic	: Circumferential	16.60	Hoop		29,423 31,180	32,500 32,500	PASS PASS
Highway Geometry Factor for Cycl	ic Circumferential	1.22		Welds	3,229	6,000	PASS
Cyclic Circumferential Stress [psi]		4,271			4,271	11,500	PASS
Highway Stiffness Factor for Cyclic	Longitudinal Stress	13.20	**		-		

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Highway Geometry Factor for Cyclic Longitudinal Stress 1.16

Cyclic Longitudinal Stress [psi]

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

Prepared By Kelsey Kibbe	Approved By	Revision: 13.0.1
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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

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s 0.5
5.0
120.00
4
12.75
60.0
e [kips] 18.4
xxles [kips] 18.4
nway
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Procedure
Stress [psi] 34,453
Stress [psi] 34,453 ss [psi] 12,284
ss [psi] 12,284
ss [psi] 12,284 ii] -1,440
ss [psi] 12,284 ii] -1,440 31,370
ss [psi] 12,284 ii] -1,440 31,370
ss [psi] 12,284 ii] -1,440 31,370 psi] 32,500 lowable PASS/FAIL 2,500 PASS
ss [psi] 12,284 ii] -1,440 31,370 psi] 32,500 lowable PASS/FAIL 2,500 PASS 2,500 PASS
ss [psi] 12,284 ii] -1,440 31,370 psi] 32,500 lowable PASS/FAIL 2,500 PASS
ss [psi] 12,284 ii] -1,440 31,370 psi] 32,500 lowable PASS/FAIL 2,500 PASS 2,500 PASS 000 PASS

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Cyclic Longitudinal Stress [psi]

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

Prepared By Kelsey Kibbe	Approved By	Revision: 13.0.1
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Project	
Vermont Gas Systems	
Location	Date
Burlington, VT	5/24/2016

•	0 0	,		
PIPE AND OPERATIONAL DATA		SITE AND	INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type:		s with
Location Class:	3	E' - Modul	low/medium plasticities us of Soil Reaction [ksi]	0.5
Operating Temperature [°F]	60.0		ent Modulus [ksi]	5.0
Pipe Outside Diameter [in]	12.75		Jnit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Dept		5
Pipe Grade: X65		Bored Dia		12.75
Specified Minimum Yield Stress	65,000		nTemperature [°F]	60.0
Design Factor	0.50		heel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design W	heel Load from Tandem Axles [k	ips] 18.4
Temperature Derating Factor	1.000	Pavement	t Type: None	
Pipe Class: API 5L Electric Re	sistance Welded	Impact Fa	ctor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000			
Poisson's Ratio for Steel	0.30			
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Fa	ctor Applied: API 1102 Procedu	ire
RESULTS				
Hoop Stress [psi]		29,423 M	aximum Circumferential Stress [	osi] 34,200
Allowable Hoop Stress [psi]		32,500 M	aximum Longitudinal Stress [psi]	12,111

Hoop Stress [psi]	29,423	Maximum Circ	cumferentia	l Stress
Allowable Hoop Stress [psi]	32,500	Maximum Lon	igitudinal St	ress [p
Stiffness Factor for Earth Load Circumferential Stress	2,088	Maximum Rad	dial Stress [	psi]
Burial Factor for Earth Load Circumferential Stress	1.08	Total Effective	Stress [psi	i]
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effe	ctive Stress	s [psi]
Circumferential Stress from Earth Load [psi]	1,647			
Impact Factor	1.50	Stress [psi]	Calculated	Allowa
Highway Stiffness Factor for Cyclic Circumferential	16.60	Ноор	29,423	32,500
• •	4.40	Effective	31,159	32,500
Highway Geometry Factor for Cyclic Circumferential	1.10	Girth Welds	3,006	6,000
Cyclic Circumferential Stress [psi]	3,850	Long. Welds	3,850	11,500
Highway Stiffness Factor for Cyclic Longitudinal Stress	13.20			

Stress [psi]	Calculated	Allowable	PASS/FAIL	
Ноор	29,423	32,500	PASS	
Effective	31,159	32,500	PASS	
Girth Welds	3,006	6,000	PASS	
Long. Welds	3,850	11,500	PASS	

-1,440 31,159

32,500

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Highway Geometry Factor for Cyclic Longitudinal Stress 1.08

Cyclic Longitudinal Stress [psi]

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

-		•	
PIPE AND OPERATIONAL DATA	:	SITE AND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type: Loose sands and gravels	
Location Class:	3	E' - Modulus of Soil Reaction [ksi]	0.5
Operating Temperature [°F]	60.0	Er - Resilient Modulus [ksi]	10.0
Pipe Outside Diameter [in]	12.75	Average Unit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Depth [ft]	3
Pipe Grade: X65		Bored Diameter [in]	12.75
Specified Minimum Yield Stress	65,000	InstallationTemperature [°F]	60.0
Design Factor	0.50	Design Wheel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design Wheel Load from Tandem Axles [kip	s] 18.4
Temperature Derating Factor	1.000	Pavement Type: None	
Pipe Class: API 5L Electric Re	esistance Welded	Impact Factor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000	4	
Poisson's Ratio for Steel	0.30		
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Factor Applied: API 1102 Procedure	е
RESULTS			

Hoop Stress [psi]	29,423	Maximum Circumferential Stress [psi]		si] 33,209	
Allowable Hoop Stress [psi]	32,500	Maximum Longitudinal Stress [psi]		11,265	
Stiffness Factor for Earth Load Circumferential Stress	2,088	Maximum Radial Stress [psi]		-1,440	
Burial Factor for Earth Load Circumferential Stress	0.83	Total Effective Stress [psi]		30,360	
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effective Stress [psi]			32,500
Circumferential Stress from Earth Load [psi]	1,265				
Impact Factor	1.50	Stress [psi]	Calculated	Allowable	PASS/FAIL
Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	32,500	PASS

Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	32,500	PASS
• .		Effective	30,360	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	2,275	6,000	PASS
Cyclic Circumferential Stress [psi]	3,241	Long. Welds	3,241	11,500	PASS
Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30				

Highway Geometry Factor for Cyclic Longitudinal Stress 1.16 Cyclic Longitudinal Stress [psi] 2,275

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

PIPE AND OPERATIONAL DATA	:	SITE AND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type: Loose sands and gravels	
Location Class:	3	E' - Modulus of Soil Reaction [ksi]	0.5
Operating Temperature [°F]	60.0	Er - Resilient Modulus [ksi]	10.0
Pipe Outside Diameter [in]	12.75	Average Unit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Depth [ft]	4
Pipe Grade: X65		Bored Diameter [in]	12.75
Specified Minimum Yield Stress	65,000	InstallationTemperature [°F]	60.0
Design Factor	0.50	Design Wheel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design Wheel Load from Tandem Axles [kip	s] 18.4
Temperature Derating Factor	1.000	Pavement Type: None	
Pipe Class: API 5L Electric Re	esistance Welded	Impact Factor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000		
Poisson's Ratio for Steel	0.30		
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Factor Applied: API 1102 Procedur	e

#### **RESULTS**

Hoop Stress [psi]	29,423	Maximum Circ	Maximum Circumferential Stress [psi]		si] 33,423
Allowable Hoop Stress [psi]	32,500	Maximum Lon	Maximum Longitudinal Stress [psi]		
Stiffness Factor for Earth Load Circumferential Stress	2,088	Maximum Rad	Maximum Radial Stress [psi]		-1,440
Burial Factor for Earth Load Circumferential Stress	0.97	Total Effective	Total Effective Stress [psi]		30,550
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effective Stress [psi]		32,500	
Circumferential Stress from Earth Load [psi]	1,479				
Impact Factor	1.50	Stress [psi]	Calculated	Allowable	PASS/FAIL
Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	32,500	PASS
		Effective	30,550	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	2,275	6,000	PASS
Cyclic Circumferential Stress [psi]	3,241	Long. Welds	3,241	11,500	PASS

Highway Geometry Factor for Cyclic Longitudinal Stress	1.16
Cyclic Longitudinal Stress [psi]	2,275

Highway Stiffness Factor for Cyclic Longitudinal Stress 9.30

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

PIPE AND OPERATIONAL DATA	:	SITE AND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type: Loose sands and gravels	
Location Class:	3	E' - Modulus of Soil Reaction [ksi]	0.5
Operating Temperature [°F]	60.0	Er - Resilient Modulus [ksi]	10.0
Pipe Outside Diameter [in]	12.75	Average Unit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Depth [ft]	5
Pipe Grade: X65		Bored Diameter [in]	12.75
Specified Minimum Yield Stress	65,000	InstallationTemperature [°F]	60.0
Design Factor	0.50	Design Wheel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design Wheel Load from Tandem Axles [kip	s] 18.4
Temperature Derating Factor	1.000	Pavement Type: None	
Pipe Class: API 5L Electric Re		Impact Factor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000		
Poisson's Ratio for Steel	0.30	Safety Factor Applied: API 1102 Procedure	۵.
Coefficient of Thermal Expansion	[per°F] 0.0000065	Carety Factor Applied. AFT 1102 FTocedure	-

#### **RESULTS**

Hoop Stress [psi]	29,423	Maximum Circumferential Stress [psi]			si] 33,	273
Allowable Hoop Stress [psi]	32,500	Maximum Lor	Maximum Longitudinal Stress [psi]			223
Stiffness Factor for Earth Load Circumferential Stress	2,088	Maximum Rad	Maximum Radial Stress [psi]		-1,4	440
Burial Factor for Earth Load Circumferential Stress	1.08	Total Effective Stress [psi]		30,	427	
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effective Stress [psi]		32,	500	
Circumferential Stress from Earth Load [psi]	1,647					
Impact Factor	1.50	Stress [psi]	Calculated	Allowable	PASS/F	AIL
Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	·	PASS	
Highway Geometry Factor for Cyclic Circumferential	1.10	Effective	30,427		PASS	
riighway Geometry Factor for Cyclic Circumferential	1.10	Girth Welds	2,118	6,000	PASS	
Cyclic Circumferential Stress [psi]	2,923	Long. Welds	2,923	11,500	PASS	
Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30					

Highway Geometry Factor for Cyclic Longitudinal Stress 1.08 Cyclic Longitudinal Stress [psi] 2,118

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

PIPE AND OPERATIONAL DATA	:	SITE AND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type: Stiff to very stiff clays and silts	
Location Class:	3	E' - Modulus of Soil Reaction [ksi]	1.0
Operating Temperature [°F]	60.0	• •	10.0
Pipe Outside Diameter [in]	12.75		120.00
Pipe Wall Thickness [in]	0.312		3
Pipe Grade: X65			12.75
Specified Minimum Yield Stress	65,000		60.0
Design Factor	0.50	Design Wheel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design Wheel Load from Tandem Axles [kips	3] 18.4
Temperature Derating Factor	1.000	Pavement Type: None	
Pipe Class: API 5L Electric Re	esistance Welded	Impact Factor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000		
Poisson's Ratio for Steel	0.30		
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Factor Applied: API 1102 Procedure	
RESULTS			

#### RESULTS

Hoop Stress [psi]	29,423	Maximum Circumferential Stress [psi]	33,046
Allowable Hoop Stress [psi]	32,500	Maximum Longitudinal Stress [psi]	11,216
Stiffness Factor for Earth Load Circumferential Stress	1,934	Maximum Radial Stress [psi]	-1,440
Burial Factor for Earth Load Circumferential Stress	0.78	Total Effective Stress [psi]	30,216
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effective Stress [psi]	32,500
Circumferential Stress from Earth Load [psi]	1,102		
Impact Factor	1.50	Stress [psi]   Calculated Allowable PAS	SS/FAIL

Impact Factor	1.50	Stress [psi]	Calculated	Allowable	PASS/FAIL
Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	32,500	PASS
•		Effective	30,216	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	2,275	6,000	PASS
Cyclic Circumferential Stress [psi]	3,241	Long. Welds	3,241	11,500	PASS
LEST COMMERCE FOR CONTRACT OF THE LOCAL CONTRACT OF THE CONTRA	0.00				

Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30
Highway Geometry Factor for Cyclic Longitudinal Stress	1.16
Cyclic Longitudinal Stress [psi]	2.275

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

	API 1102 - Gas Pipeline Crossing Highway									
PIPE AND OPERATIONAL DATA:			SITE AND INSTALLATION DATA:							
	Operating Pressure [psi]	1440	Soil Ty	pe:	Stiff to v	ery stiff clay	s and silts			
	Location Class:	3	E' - Mo	dulus	of Soil R	eaction (ksi	1	1.0		
	Operating Temperature [°F]	60.0			t Modulus	-	•	10.0		
	Pipe Outside Diameter [in]	12.75				of Soil [lb/ft³	<b>'</b> ]	120.0	00	
	Pipe Wall Thickness [in]	0.312	Pipe De		_		•	4		
	Pipe Grade: X65		Bored I	Diame	eter [in]			12.75	5	
	Specified Minimum Yield Stress	65,000	Installa	tionTe	emperatu	re [°F]		60.0		
	Design Factor	0.50	Design	Whe	el Load fr	om Single /	Axle [kips]	18.	4	
	Longitudinal Joint Factor	1.0	Design	Whe	el Load fr	om Tanden	n Axles [kip	s [kips] 18.4		
	Temperature Derating Factor	1.000	Pavem	ent T	ype: Non	е				
	Pipe Class: API 5L Electric Res	sistance Welded	Impact Factor Method: ASCE - F		lighway					
	Young's Modulus for Steel [ksi]	30,000								
	Poisson's Ratio for Steel	0.30	Cofoty	F4-	- AI:I	ADI 440	O Dunnandii	_		
	Coefficient of Thermal Expansion [p	per°F] 0.0000065	Safety	racio	r Applied.	API 1102	2 Procedur	е		
	RESULTS									
	Hoop Stress [psi]		29,423	Max	imum Cire	cumferentia	al Stress [p	si] 33	,215	
	Allowable Hoop Stress [psi]	24	32,500	Max	imum Lor	ngitudinal S	tress [psi]	11	,267	
	Stiffness Factor for Earth Load Circ	umferential Stress	1,934	Max	imum Rad	dial Stress	[psi]	-1	,440	
	Burial Factor for Earth Load Circum	ferential Stress	0.90	Tota	I Effective	Stress [ps	i]	30	,366	
	Excavation Factor for Earth Load C	ircumferential Stress	0.83	Allov	wable Effe	ective Stres	s [psi]	32	,500	
	Circumferential Stress from Earth L	oad [psi]	1,271							
	Impact Factor		1.50		ss [psi]	Calculated			FAIL	
	Highway Stiffness Factor for Cyclic	Circumferential	12.60	Hoop	ctive	29,423 30,366	32,500 32,500	PASS PASS		
	Highway Geometry Factor for Cyclic	c Circumferential	1.22		n Welds	2,275	6,000	PASS		
	Cyclic Circumferential Stress [psi]		3,241	Long	g. Welds	3,241	11,500	PASS		
	Highway Stiffness Factor for Cyclic	Longitudinal Stress	9.30							
	Highway Geometry Factor for Cyclic	c Longitudinal Stress	1.16							
	Cyclic Longitudinal Stress [psi]		2,275							

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

PIPE AND OPERATIONAL DATA	:	SITE AND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Type: Stiff to very stiff clays and silts	
Location Class:	3	E' - Modulus of Soil Reaction [ksi]	1.0
Operating Temperature [°F]	60.0	Er - Resilient Modulus [ksi]	10.0
Pipe Outside Diameter [in]	12.75	Average Unit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	Pipe Depth [ft]	5
Pipe Grade: X65		Bored Diameter [in]	12.75
Specified Minimum Yield Stress	65,000	InstallationTemperature [°F]	60.0
Design Factor	0.50	Design Wheel Load from Single Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Design Wheel Load from Tandem Axles [kip	os] 18.4
Temperature Derating Factor	1.000	Pavement Type: None	
Pipe Class: API 5L Electric Re	esistance Welded	Impact Factor Method: ASCE - Highway	
Young's Modulus for Steel [ksi]	30,000		
Poisson's Ratio for Steel	0.30	14	
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety Factor Applied: API 1102 Procedur	е
RESULTS			

#### RESULTS

Hoop Stress [psi]	29,423	Maximum Circumferential Stress [psi] 33,010	
Allowable Hoop Stress [psi]	32,500	Maximum Longitudinal Stress [psi] 11,144	
Stiffness Factor for Earth Load Circumferential Stress	1,934	Maximum Radial Stress [psi] -1,440	
Burial Factor for Earth Load Circumferential Stress	0.98	Total Effective Stress [psi] 30,193	
Excavation Factor for Earth Load Circumferential Stress	0.83	Allowable Effective Stress [psi] 32,500	
Circumferential Stress from Earth Load [psi]	1,384		
Impact Factor	1.50	Stress [psi]   Calculated Allowable PASS/FAIL	
	40.00	Hoop 29 423 32 500 PASS	1

impact ractor	1.50	Otress [bail	Calculated	MICWADIC	I AOON AIL
Highway Stiffness Factor for Cyclic Circumferential	12.60	Ноор	29,423	32,500	PASS
•		Effective	30,193	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.10	Girth Welds	2,118	6,000	PASS
Cyclic Circumferential Stress [psi]	2,923	Long. Welds	2,923	11,500	PASS
Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30				

Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30
Highway Geometry Factor for Cyclic Longitudinal Stress	1.08
Cyclic Longitudinal Stress [psi]	2,118

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

11 1102 - Cas i ipeline Crossing riighway								
PIPE AND OPERATIONAL DATA:		SITE A	ND IN	ISTALLAT	TION DATA	<b>\</b> :		
Operating Pressure [psi]	1440	Soil Typ	e:	Medium	dense sand	ls and grav	/els	
Location Class:	3	E' - Mod	dulus	of Soil Re	eaction [ksi]		1.0	
Operating Temperature [°F]	60.0	Er - Res	silient	Modulus	[ksi]		10.0	
Pipe Outside Diameter [in]	12.75	Average	e Unit	: Weight c	of Soil [lb/ft³]	l	120.00	
Pipe Wall Thickness [in]	0.312	Pipe De	epth [1	ft]		-	3	
Pipe Grade: X65		Bored [	Diame	eter [in]			12.75	
Specified Minimum Yield Stress	65,000	Installat	ionTe	emperatur	e [°F]		60.0	
Design Factor	0.50	Design	Whe	el Load fro	om Single A	xle [kips]	18.4	
Longitudinal Joint Factor	1.0	Design	Whe	el Load fro	om Tandem	n Axles [kip	os] 18.4	
Temperature Derating Factor	1.000	Paveme	ent Ty	/pe: None	e			
Pipe Class: API 5L Electric Res	sistance Welded	Impact	Facto	r Method:	ASCE - H	ighway		
Young's Modulus for Steel [ksi]	30,000							
Poisson's Ratio for Steel	0.30	0.64		A 1: 1	A DI 4400	<b>.</b> D I		
Coefficient of Thermal Expansion [	per°F] 0.0000065	Safety	-acto	r Applied:	API 1102	2 Procedur	е	
RESULTS								
Hoop Stress [psi]		29,423	Max	imum Circ	cumferentia	l Stress [p	si] 33,1	16
Allowable Hoop Stress [psi]		32,500	Max	imum Lon	gitudinal St	ress [psi]	11,23	38
Stiffness Factor for Earth Load Circ	cumferential Stress	1,934	Max	imum Rad	dial Stress [	psi]	-1,44	10
Burial Factor for Earth Load Circum	nferential Stress	0.83	Tota	I Effective	Stress [psi	i]	30,27	78
Excavation Factor for Earth Load C	Circumferential Stress	0.83	Allov	vable Effe	ctive Stress	s [psi]	32,50	<b>0</b> 0
Circumferential Stress from Earth L	₋oad [psi]	1,172						
Impact Factor		1.50		ss [psi]	Calculated			\IL
Highway Stiffness Factor for Cyclic	Circumferential	12.60	Hoop		29,423	32,500	PASS	

		Effective	30,278	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	2,275	6,000	PASS
Cyclic Circumferential Stress [psi]	3,241	Long. Welds	3,241	11,500	PASS
Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30				

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Highway Geometry Factor for Cyclic Longitudinal Stress 1.16

Cyclic Longitudinal Stress [psi]

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

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Project	
Vermont Gas Systems	
Location	Date
Burlington, VT	5/24/2016

PIPE AND OPERATIONAL DATA:		SITE A	ND IN	ISTALLATI	ON DATA:		
Operating Pressure [psi]	1440	Soil Typ	e:	Medium de	ense sands and grave	els	
Location Class:	3	E' - Mod	dulus	of Soil Rea	ction [ksi]	1.0	
Operating Temperature [°F]	60.0	Er - Res	silient	Modulus [k	(Si]	10.0	
Pipe Outside Diameter [in]	12.75	Average	e Unit	: Weight of	Soil [lb/ft³]	120.00	
Pipe Wall Thickness [in]	0.312	Pipe De	pth [f	t]		4	
Pipe Grade: X65		Bored D	)iame	eter [in]		12.75	
Specified Minimum Yield Stress	65,000	Installat	ionTe	emperature	[°F]	60.0	
Design Factor	0.50	Design	n Single Axle [kips]	18.4			
Longitudinal Joint Factor	1.0	Design	Whee	el Load fron	m Tandem Axles [kip	s] 18.4	
Temperature Derating Factor	1.000	Paveme	ent Ty	/pe: None			
Pipe Class: API 5L Electric Res	sistance Welded	Impact	Facto	or Method:	ASCE - Highway		
Young's Modulus for Steel [ksi]	30,000						
Poisson's Ratio for Steel	0.30						
Coefficient of Thermal Expansion [	per°F] 0.0000065	Safety I	-acto	r Applied:	API 1102 Procedure	<del>)</del>	
RESULTS							
Hoop Stress [psi]		29,423	Maxi	imum Circu	ımferential Stress [ps	si] 33,314	ļ
Allowable Hoop Stress [psi]		32,500	Maxi	imum Long	itudinal Stress [psi]	11,297	7
Stiffness Factor for Earth Load Circ	cumferential Stress	1,934	Maxi	imum Radia	al Stress [psi]	-1,440	
Burial Factor for Earth Load Circum	nferential Stress	0.97	Tota	l Effective S	Stress [psi]	30,453	3
Excavation Factor for Earth Load C	Circumferential Stress	0.83	Allov	vable Effec	tive Stress [psi]	32,500	)

Allowable Hoop Stress [psi]	32,500
Stiffness Factor for Earth Load Circumferential Stress	1,934
Burial Factor for Earth Load Circumferential Stress	0.97
Excavation Factor for Earth Load Circumferential Stress	0.83
Circumferential Stress from Earth Load [psi]	1,370
Impact Factor	1.50
Highway Stiffness Factor for Cyclic Circumferential	12.60
Highway Geometry Factor for Cyclic Circumferential	1.22
Cyclic Circumferential Stress [psi]	3,241
Highway Stiffness Factor for Cyclic Longitudinal Stress	9.30

Highway Geometry Factor for Cyclic Longitudinal Stress 1.16

Cyclic Longitudinal Stress [psi]

Stress [psi]	Calculated	Allowable	PASS/FAIL
Ноор	29,423	32,500	PASS
Effective	30,453	32,500	PASS
Girth Welds	2,275	6,000	PASS
Long. Welds	3,241	11,500	PASS

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

Prepared By Kelsey Kibbe Approved By Revision: 13.0.1

Project		
Vermont Gas Systems		
Location	Date	-
Burlington, VT	5/24/2016	

	PIPE AND OPERATIONAL DATA:		SITE AND INSTALLATION DATA:					
	Operating Pressure [psi]	1440	Soil Typ	e:	Medium	dense sand	s and grav	els
	Location Class:	3	E' - Mod	lulus	of Soil Re	eaction [ksi]		1.0
	Operating Temperature [°F]	60.0	Er - Res	silient	Modulus	[ksi]		10.0
	Pipe Outside Diameter [in]	12.75	Average	e Unit	: Weight c	of Soil [lb/ft³]		120.00
	Pipe Wall Thickness [in]	0.312	Pipe De	pth [1	ft]			5
	Pipe Grade: X65		Bored D	)iame	eter [in]			12.75
	Specified Minimum Yield Stress	65,000	Installat	ionTe	emperatur	e [°F]		60.0
	Design Factor	0.50	Design	Whe	el Load fro	om Single A	xle [kips]	18.4
	Longitudinal Joint Factor	1.0	Design	Whe	el Load fro	om Tandem	Axles [kip	s] 18.4
	Temperature Derating Factor	1.000	Paveme	ent Ty	pe: None	€		
	Pipe Class: API 5L Electric Res	sistance Welded	Impact	Facto	r Method	: ASCE - H	ighway	
	Young's Modulus for Steel [ksi]	30,000						
00	Poisson's Ratio for Steel	0.30						
	Coefficient of Thermal Expansion [	per°F] 0.0000065	Safety F	-acto	r Applied:	API 1102	! Procedure	€
	RESULTS				TWE			
	Hoop Stress [psi]		29,423	Max	imum Circ	cumferentia	Stress [ps	si] 33,151
	Allowable Hoop Stress [psi]		32,500	Max	imum Lor	igitudinal St	ress [psi]	11,186
	Stiffness Factor for Earth Load Circ	cumferential Stress	1,934	Max	imum Rad	dial Stress [	psi]	-1,440
	Burial Factor for Earth Load Circum	nferential Stress	1.08	Tota	I Effective	Stress [ps	i]	30,318
	Excavation Factor for Earth Load C	ircumferential Stress	0.83	Allov	vable Effe	ective Stress	s [psi]	32,500
	Circumferential Stress from Earth L	oad [psi]	1,525					
	Impact Factor		1.50		ss [psi]	Calculated	- A	
	Highway Stiffness Factor for Cyclic	Circumferential	12.60	Hoop	ctive	29,423 30,318		PASS PASS
	Highway Geometry Factor for Cycli	c Circumferential	1.10		) Welds	2,118		PASS
	Cyclic Circumferential Stress [psi]		2,923			2,923		PASS
	Highway Stiffness Factor for Cyclic	Longitudinal Stress	9.30					
	Highway Geometry Factor for Cycli	c Longitudinal Stress	1.08					
	Cyclic Longitudinal Stress [psi]		2,118					

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project		
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Location	Date	
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	7.1.1.102 Gdo / 1.pom.10	orocoming ringing	way						
	PIPE AND OPERATIONAL DATA:		SITE A	ND IN	NSTALLA <sup>-</sup>	TION DATA	Λ:		
	Operating Pressure [psi]	1440	Soil Ty	oe:	Dense to	very dense	e sands an	d gr	avels
	Location Class:	3	E' - Mo	dulus	of Soil Re	eaction [ksi]		2.0	)
	Operating Temperature [°F]	60.0	Er - Re	silient	t Modulus	[ksi]		20.	.0
	Pipe Outside Diameter [in]	12.75	Average	e Uni	t Weight c	of Soil [lb/ft³]	]	120	0.00
	Pipe Wall Thickness [in]	0.312	Pipe De	epth [	ft]			3	
	Pipe Grade: X65		Bored [	Diame	eter [in]			12.	.75
	Specified Minimum Yield Stress	65,000	Installa	tionTe	emperatui	re [°F]		60.	.0
	Design Factor	0.50	Design	Whe	el Load fro	om Single A	xle [kips]	1	18.4
	Longitudinal Joint Factor	1.0	Design	Whe	el Load fro	om Tandem	n Axles [kip	os] 1	18.4
	Temperature Derating Factor	1.000	Paveme	ent T	ype: None	e			
	Pipe Class: API 5L Electric Res	sistance Welded	Impact Factor Method: ASCE - Highway						
	Young's Modulus for Steel [ksi]	30,000							
	Poisson's Ratio for Steel	0.30	0.1.1			A DI 4400			
	Coefficient of Thermal Expansion [	per°F] 0.0000065	Safety	racto	r Applied:	API 1102	2 Procedur	е	
	RESULTS								
	Hoop Stress [psi]		29,423	Max	imum Circ	cumferentia	Stress [p	si]	32,060
	Allowable Hoop Stress [psi]		32,500	Max	imum Lon	igitudinal St	ress [psi]		10,417
Stiffness Factor for Earth Load Circumferential Stress		1,693	Maximum Radial Stress [psi]		-1,440				
Burial Factor for Earth Load Circumferential Stress		0.78	Total Effective Stress [psi] 29			29,422			
	Excavation Factor for Earth Load C	ircumferential Stress	0.83	Allov	vable Effe	ctive Stress	s [psi]		32,500
	Circumferential Stress from Earth L	oad [psi]	964						
	Impact Factor		1.50	Stre		Calculated			
				HOOK	`	ככא מכיו	22 600	DAC	,,,

Highway Stiffness Factor for Cyclic Circumferential	9.30	Ноор	29,423	32,500	PASS	1
,		Effective	29,422	32,500	PASS	
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	1,517	6,000	PASS	٦
Cyclic Circumferential Stress [psi]	2,393	Long. Welds	2,393	11,500	PASS	
Highway Stiffness Factor for Cyclic Longitudinal Stress	6.20					_

Highway Stiffness Factor for Cyclic Longitudinal Stress 6.20
Highway Geometry Factor for Cyclic Longitudinal Stress 1.16
Cyclic Longitudinal Stress [psi] 1,517

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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Project			
Vermont Gas Systems			
Location	Date	2	
Burlington, VT	5/24/2016		

PIPE AND OPERATIONAL DATA:	SITE A	ND INSTALLA	TION DAT	A:	
Operating Pressure [psi] 1440	Soil Ty	pe: Dense to	nd gravels		
Location Class: 3	E' - Mo	dulus of Soil R	eaction [ks	i]	2.0
Operating Temperature [°F] 60.0	Er - Re	esilient Modulus	[ksi]	•	20.0
Pipe Outside Diameter [in] 12.75		je Unit Weight o		31	120.00
Pipe Wall Thickness [in] 0.312	-	epth [ft]		•	4
Pipe Grade: X65	Bored	Diameter [in]			12.75
Specified Minimum Yield Stress 65,000		ntionTemperatu	re [°F]		60.0
Design Factor 0.50		Wheel Load fr		Axle [kips]	7.50
Longitudinal Joint Factor 1.0	_	Wheel Load fr	_		
Temperature Derating Factor 1.000		ent Type: Non		_	
Pipe Class: API 5L Electric Resistance Welded		Factor Method		Highway	
Young's Modulus for Steel [ksi] 30,000					
Poisson's Ratio for Steel 0.30					-
Coefficient of Thermal Expansion [per°F] 0.0000065	Safety	Factor Applied:	: API 110	)2 Procedu	re
RESULTS					
Hoop Stress [psi]	29,423	Maximum Cir			
Allowable Hoop Stress [psi]	32,500	Maximum Lor			
Stiffness Factor for Earth Load Circumferential Stress	1,693	Maximum Ra			-1,440
Burial Factor for Earth Load Circumferential Stress	0.90	Total Effective		-	29,554
Excavation Factor for Earth Load Circumferential Stress		Allowable Effe	ective Stres	ss [psi]	32,500
Circumferential Stress from Earth Load [psi]	1,113		Y		
Impact Factor	1.50	Stress [psi] Hoop	Calculated 29,423	Allowable 32,500	PASS/FAIL PASS
Highway Stiffness Factor for Cyclic Circumferential	9.30	Effective	29,554	32,500	PASS
Highway Geometry Factor for Cyclic Circumferential	1.22	Girth Welds	1,517	6,000	PASS
• , , ,		Lana Malda	2,393	11,500	PASS
Cyclic Circumferential Stress [psi]	2,393	Long. Welds	2,393	11,500	1700
	2,393 6.20	Long. vveids	2,393	11,500	I AOO
Cyclic Circumferential Stress [psi]	6.20	Long. vveids	2,393	11,500	1700

Notes: Open cut construction, calculations run using HS-20 loading + 15%

Reference: API RP 1102 "Steel Pipelines Crossing Railroads and Highways"

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Project		
Vermont Gas Systems		
Location	Date	
Burlington, VT	5/24/2016	

API 1102 - Gas Pipeline Crossing Highway							
PIPE AND OPERATIONAL DATA:		SITE A	ND IN	NSTALLAT	TION DATA	λ:	
Operating Pressure [psi]	1440	Soil Typ	oe:	Dense to	very dense	sands an	d gravels
Location Class:	3	E' - Mod	dulus	of Soil Re	eaction [ksi]		2.0
Operating Temperature [°F]	60.0			Modulus			20.0
Pipe Outside Diameter [in]	12.75				of Soil [lb/ft³]	1	120.00
Pipe Wall Thickness [in]	0.312	Pipe De		•		•	5
Pipe Grade: X65		Bored D	Diame	eter [in]			12.75
Specified Minimum Yield Stress	65,000			emperatur	e [°F]		60.0
Design Factor	0.50	Design	Whe	el Load fro	om Single A	xle [kips]	18.4
Longitudinal Joint Factor	1.0	Design	Whe	el Load fro	om Tandem	Axles [kip	os] 18.4
Temperature Derating Factor	1.000	Paveme	ent T	ype: None	Э		
Pipe Class: API 5L Electric Res	sistance Welded	Impact Factor Method: ASCE - Highway					
Young's Modulus for Steel [ksi]	30,000						
Poisson's Ratio for Steel	0.30						
Coefficient of Thermal Expansion [per°F] 0.0000065			Safety Factor Applied: API 1102 Procedure				
RESULTS							
Hoop Stress [psi]		29,423	Max	imum Circ	cumferentia	Stress [p	si] 32,071
Allowable Hoop Stress [psi]		32,500	Max	imum Lon	gitudinal St	ress [psi]	10,386
Stiffness Factor for Earth Load Circ	cumferential Stress	1,693	Max	imum Rad	dial Stress [	psi]	-1,440
Burial Factor for Earth Load Circum	nferential Stress	0.98	Tota	I Effective	Stress [psi	]	29,437
Excavation Factor for Earth Load C	ircumferential Stress	0.83	Allov	wable Effe	ctive Stress	s [psi]	32,500
Circumferential Stress from Earth L	oad [psi]	1,211					
Impact Factor		1.50	440		Company of the contract of the		PASS/FAIL
Highway Stiffness Factor for Cyclic	Circumferential	9.30	Hoop	ctive	29,423 29,437	32,500 32,500	PASS PASS
Highway Geometry Factor for Cyclin	c Circumferential	1.10		) Welds	1,412	6,000	PASS
Cyclic Circumferential Stress [psi]		2,157	Long	g. Welds	2,157	11,500	PASS
Highway Stiffness Factor for Cyclic	Longitudinal Stress	6.20					
Highway Geometry Factor for Cycli	c Longitudinal Stress	1.08					
Cyclic Longitudinal Stress [psi]		1,412					

Notes: Open cut construction, calculations run using HS-20 loading + 15%

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