Project Name: Vermont Gas Systems

Location: Burlington, VT

Prepared for: 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 RESULTS						
	Calculated Effective Stress (p					
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).

5/25/2016

Rev. 1



Calculation cover sheet

Project Title:	VERMONT GAS SYSTEMS	Project No:	351481KK01		
File No:		No. of Sheets:	18		
Section:		Subject:			
Calc No:					
Project Manager:		Designer:			
Design Phase:	A - Concept or preliminary	C - Design verification			
	B - Analysis and detailed design	D - Other (specify)			

Computer Applications Used:					
Title:	Version Date:				
PIPELINE TOOLBOX	2013				
(a)					

Scopes for Checking Manual and Computer Generated Calculations:

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Sheets	Calculations by			Checked By:			
Checked: *	Name:	Signature:	Date:	Name:	Signature:	Date:	
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· ·	•	uter file has been che ed. (PiMS nickname					
		Source and Refe					
> Design Info. per Mike Reagan's discussions with client > API 1102 for design factors and procedure							
b) Identify documents/technical records where output will be used:							
> calculations summary provided to client							
			1				
Approved by P	roject Manager:	Signature: Print name:	Juseph	WOJNAS	5000000000	Date: 5/2.5/16	

Distribution: Original

Original to project file



Location Burlington, VT		Date 5/24/20	16	~
API 1102 - Gas Pipeline	e Crossing High	way		
PIPE AND OPERATIONAL DATA	:	SITE A	ND INSTALLATION DATA:	
Operating Pressure [psi]	1440	Soil Ty		d silts with hig
Location Class:	3	E' - Mo	plasticities odulus of Soil Reaction [ksi]	0.2
Operating Temperature [°F]	60.0	Er - Re	esilient Modulus [ksi]	5.0
Pipe Outside Diameter [in]	12.75	Avera	ge Unit Weight of Soil [lb/ft³]	120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]	3
Pipe Grade: X65		Bored	Diameter [in]	12.75
Specified Minimum Yield Stress	65,000	Installa	ationTemperature [°F]	60.0
Design Factor	0.50	Desigr	Wheel Load from Single Axle	[kips] 18.4
Longitudinal Joint Factor	1.0	Desigr	Wheel Load from Tandem Ax	es [kips] 18.4
Temperature Derating Factor	1.000	Paverr	nent Type: None	
Pipe Class: API 5L Electric Re	esistance Welded		t Factor Method: ASCE - Highw	/ay
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 Pro	ocedure
RESULTS				
Hoop Stress [psi]		29,423	Maximum Circumferential Str	ess [psi] 34,3
Allowable Hoop Stress [psi]		32,500	Maximum Longitudinal Stress	s [psi] 12,2
Stiffness Factor for Earth Load Ci	rcumferential Stress	2,196	Maximum Radial Stress [psi]	-1,4
Burial Factor for Earth Load Circu	mferential Stress	0.83	Total Effective Stress [psi]	31,2
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effective Stress [ps	si] 32,5
Circumferential Stress from Earth	Load [psi]	1,331		
Impact Factor		1.50	Stress [psi] Calculated Allo	
Highway Stiffness Factor for Cycli	c Circumferential	16.60	Hoop 29,423 32,5 Effective 31,239 32,5	
Highway Geometry Factor for Cyc	lic Circumferential	1.22	Girth Welds 3,229 6,00	
Cyclic Circumferential Stress [psi]		4,271	Long. Welds 4,271 11,5	500 PASS
Highway Stiffness Factor for Cycli	c Longitudinal Stress	13.20		
Highway Geometry Factor for Cyc	lic Longitudinal Stress	1.16		
Cyclic Longitudinal Stress [psi]		3,229		
	culations run using HS-	20 loadir	$na \pm 15\%$	

Prepared By Kelsey Kibbe Approved By

Location Burlington, VT		Date 5/24/20	16	
API 1102 - Gas Pipeline	e Crossing High	way		ж.
PIPE AND OPERATIONAL DATA	:	SITE A	ND INSTALLATION DA	TA:
Operating Pressure [psi]	1440	Soil Ty	•	ays and silts with high
Location Class:	3	E' - Mo	plasticities odulus of Soil Reaction [k	(si] 0.2
Operating Temperature [°F]	60.0		esilient Modulus [ksi]	5.0
Pipe Outside Diameter [in]	12.75		ge Unit Weight of Soil [lb/	
Pipe Wall Thickness [in]	0.312	-	epth [ft]	4
Pipe Grade: X65		•	Diameter [in]	12.75
Specified Minimum Yield Stress	65,000		ationTemperature [°F]	60.0
Design Factor	0.50		Wheel Load from Single	
Longitudinal Joint Factor	1.0	•	Wheel Load from Tand	
Temperature Derating Factor	1.000	-	nent Type: None	
Pipe Class: API 5L Electric Re	esistance Welded		Factor Method: ASCE -	- Highway
Young's Modulus for Steel [ksi]	30,000	•		0
Poisson's Ratio for Steel	0.30			
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied: API 11	102 Procedure
RESULTS				
Hoop Stress [psi]		29,423	Maximum Circumferen	itial Stress [psi] 34,5
Allowable Hoop Stress [psi]		32,500	Maximum Longitudinal	Stress [psi] 12,3
Stiffness Factor for Earth Load Ci	rcumferential Stress	2,196	Maximum Radial Stres	is [psi] -1,4
	unformation Officers	0.07	Total Effective Stress [psi] 31,4
Burial Factor for Earth Load Circu	mierential Stress	0.97		pol] 01,4
			Allowable Effective Str	
Excavation Factor for Earth Load	Circumferential Stress			
Excavation Factor for Earth Load Circumferential Stress from Earth	Circumferential Stress	0.83	Allowable Effective Str	ess [psi] 32,5
Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli	Circumferential Stress Load [psi]	0.83 1,555	Allowable Effective Str Stress [psi] Calculat Hoop 29,423	ed Allowable PASS/F/ 32,500 PASS
Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli	Circumferential Stress Load [psi] ic Circumferential	0.83 1,555 1.50	Allowable Effective Str	ess [psi] 32,5
Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor	Circumferential Stress Load [psi] ic Circumferential clic Circumferential	0.83 1,555 1.50 16.60	Allowable Effective Str Stress [psi] Calculat Hoop 29,423 Effective 31,437	ess [psi] 32,5 ed Allowable PASS/F/ 32,500 PASS 32,500 PASS
Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cyc	Circumferential Stress Load [psi] ic Circumferential clic Circumferential	0.83 1,555 1.50 16.60 1.22	Allowable Effective Str Stress [psi] Calculat Hoop 29,423 Effective 31,437 Girth Welds 3,229	ed Allowable PASS/F/ 32,500 PASS 32,500 PASS 32,500 PASS 6,000 PASS
Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cyc Cyclic Circumferential Stress [psi]	Circumferential Stress Load [psi] ic Circumferential clic Circumferential ic Longitudinal Stress	0.83 1,555 1.50 16.60 1.22 4,271 13.20	Allowable Effective Str Stress [psi] Calculat Hoop 29,423 Effective 31,437 Girth Welds 3,229	ed Allowable PASS/F/ 32,500 PASS 32,500 PASS 32,500 PASS 6,000 PASS
Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cycl Cyclic Circumferential Stress [psi] Highway Stiffness Factor for Cycli	Circumferential Stress Load [psi] ic Circumferential clic Circumferential ic Longitudinal Stress	0.83 1,555 1.50 16.60 1.22 4,271 13.20	Allowable Effective Str Stress [psi] Calculat Hoop 29,423 Effective 31,437 Girth Welds 3,229	ed Allowable PASS/F/ 32,500 PASS 32,500 PASS 32,500 PASS 6,000 PASS

Operating Pressure [psi]1440Soil Type:: Soft to medium clays and silts with high plasticitiesLocation Class:3E' - Modulus of Soil Reaction [ksi]0.2Operating Temperature [°F]60.0Er - Resilient Modulus [ksi]5.0Pipe Outside Diameter [in]12.75Average Unit Weight of Soil [lb/ft³]120.00Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel0.30Safety Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]34,28Allowable Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]12,13Stiffness Factor for Earth Load Circumferential Stress2,196Maximum Radial Stress [psi]-1,444Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]31,23	Location Burlington, VT		Date 5/24/20	16			
Operating Pressure [psi]1440Soil Type:Soft to medium clays and silts with high plasticitiesLocation Class:3E' - Modulus of Soil Reaction [ksi]0.2Operating Temperature [°F]60.0Er - Resilient Modulus [ksi]5.0Pipe Outside Diameter [in]12.75Average Unit Weight of Soil [lb/ft³]120.00Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel0.30Coefficient of Thermal Expansion [per"F]0.0000065Coefficient of Thermal Expansion [per"F]0.0000065Safety Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]34,28Allowable Hoop Stress [psi]29,423Maximum Cadial Stress [psi]1,144Burial Factor for Earth Load Circumferential Stress2,196Maximum Radial Stress [psi]31,23Stiffness Factor for Carth Load Circumferential Stress1.08Total Effective Stress [psi]32,500Inspact Factor1.50Stress [psi]2,250PASSEffective Air Load Circumferential Stress1.732Effective 31,23432,500 </th <th>API 1102 - Gas Pipelin</th> <th>e Crossing High</th> <th>way</th> <th></th> <th></th> <th></th> <th></th>	API 1102 - Gas Pipelin	e Crossing High	way				
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API 1102 - Gas Pipeline Crossing Highway PIPE AND OPERATIONAL DATA: Operating Pressure [psi] 1440 Soil Type: Soft to medium clays and silts with Location Class: 3 Certaing Temperature [°F] 60.0 Er - Resilient Modulus [ksi] 5.0 Pipe Outside Diameter [in] 12.75 Average Unit Weight of Soil Tgecino [ksi] 12.75 Average Unit Weight of Soil Tgecino [ksi] 12.75 Specified Minimum Yield Stress 65,000 Installation Temperature [°F] 60.0 Design Factor 0.50 Design Wheel Load from Single Axle [kips] 18.4 Congitudinal Joint Factor 1.0 Design Wheel Load from Single Axle [kips] 18.4 Congitudinal Joint Factor 1.0 Design Wheel Load from Tandem Axles [kips] 18.4 Congitudinal Joint Factor 1.0 Design Wheel Load from Tandem Axles [kips] 18.4 Congitudinal Stress [psi] 30,000 Poisson's Ratio for Steel 0.30 Coefficient of Thermal Expansion [per"F] 32,500 Maximum Circumferential Stress 2,088 Maximum Radial Stress [psi] 32,500 Circumferential Stress 2,088 Maximum Radial Stress [psi] 32,500 Circumferential Stress 2,088 Maximum Radial Stress [psi] 31,18 Excavation Factor for Cyclic Circumferential 16.60 Effective Stress [psi] 32,20 National Stress [psi] 32,20 Nat	Location Burlington, VT		Date 5/24/20	16			
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DescriptionDescriptionDescriptionSpecified Minimum Yield Stress65,000InstallationTemperature ["F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayViong's Modulus for Steel [ksi]30,00030Safety Factor Applied: API 1102 ProcedurePoisson's Ratio for Steel0.30Safety Factor Applied: API 1102 ProcedureRESULTSHoop Stress [psi]29,423Maximum Circumferential Stress [psi]12,21Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]12,21Stiffness Factor for Earth Load Circumferential Stress0.83Total Effective Stress [psi]1,18Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]31,18Excavation Factor for Earth Load Circumferential1.20Stress [psi]2,500Impact Factor1.50Stress [psi]2,500PASSInduct Factor1.50Stress [psi]2,500PASSInduct Factor1.50Stress [psi]2,250PASSInduct Factor1.50Stress [psi]2,500PASSInghavy Stiffness Factor for Cyclic Circumferential1.22Stress [psi]2,500Impact Factor1.50Stress [psi]2,250PASSHighway Geometry Factor for Cyclic Longitudinal Stress <t< td=""><td></td><td>0.312</td><td>Pipe D</td><td>epth [ft]</td><td></td><td></td><td>3</td></t<>		0.312	Pipe D	epth [ft]			3
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Design Wheel Coad from Failed Axes [ki]s] 18.4Temperature Derating Factor1.000Pipe Class:API 5L Electric Resistance WeldedPipe Class:API 5L Electric Resistance WeldedYoung's Modulus for Steel0.30Coefficient of Thermal Expansion [per°F]0.0000065Safety Factor Applied:API 1102 ProcedureRESULTS29,423Hoop Stress [psi]29,423Maximum Circumferential Stress [psi]12,21Stiffness Factor for Earth Load Circumferential Stress0.83Total Effective Stress [psi]31,18Excavation Factor for Earth Load Circumferential Stress0.83Circumferential Stress from Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load Circumferential1,265Impact Factor1.50Mighway Stiffness Factor for Cyclic Circumferential1.22Girth Welds3,229Kighway Stiffness Factor for Cyclic Corcumferential1.22Girth Welds3,229Kighway Stiffness Factor for Cyclic Longitudinal Stress1.320Highway Stiffness Factor for Cyclic Longitudinal Stress1.320Highway Stiffness Factor for Cyclic Longitudinal Stress1.320Highway Stiffness Factor for Cyclic Longitudinal Stress1.16Cyclic Longitudinal Stress [psi]3,229	•		Desigr	Wheel Load fr	om Single A	Axle [kips]	18.4
Pipe Class: API 5L Electric Resistance Welded Impact Factor Method: ASCE - Highway Young's Modulus for Steel [ksi] 30,000 Safety Factor Method: ASCE - Highway 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 Maximum Circumferential Stress [psi] 12,21 Allowable Hoop Stress [psi] 32,500 Maximum Longitudinal Stress [psi] 12,21 Stiffness Factor for Earth Load Circumferential Stress 0.83 Total Effective Stress [psi] 1,44 Burial Factor for Earth Load Circumferential Stress 0.83 Allowable Effective Stress [psi] 31,18 Excavation Factor for Earth Load Circumferential 1,265 Impact Factor 1.50 Stress [psi] 29,423 32,500 PASS Impact Factor 1.50 Stress [psi] 29,423 32,500 PASS Impact Factor 1.50 Stress [psi] 26,000 PASS Impact Factor 1.50 Stress [psi] 22,600 PASS Highway Stiffness Factor for Cyclic Circumferential 1.60 Effective 31,180 32,500 PASS </td <td>0</td> <td></td> <td>Desigr</td> <td>Wheel Load fr</td> <td>om Tandem</td> <td>n Axles [kip</td> <td>os] 18.4</td>	0		Desigr	Wheel Load fr	om Tandem	n Axles [kip	os] 18.4
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Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential16.60Hoop29,42332,500PASSHighway Geometry Factor for Cyclic Circumferential1.22Effective31,18032,500PASSCyclic Circumferential Stress [psi]4,2711.20PASSHighway Stiffness Factor for Cyclic Longitudinal Stress13.2013.20Highway Geometry Factor for Cyclic Longitudinal Stress1.16Cyclic Longitudinal Stress [psi]3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci		32,500 2,088	Maximum Lor Maximum Rae	ngitudinal Sf dial Stress [tress [psi] [psi]	12,21 -1,44
Highway Stiffness Factor for Cyclic Circumferential16.60Highway Geometry Factor for Cyclic Circumferential1.22Cyclic Circumferential Stress [psi]4,271Highway Stiffness Factor for Cyclic Longitudinal Stress13.20Highway Geometry Factor for Cyclic Longitudinal Stress13.20Highway Stiffness Factor for Cyclic Longitudinal Stress1.16Cyclic Longitudinal Stress [psi]3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu	mferential Stress	32,500 2,088 0.83	Maximum Lor Maximum Rad Total Effective	ngitudinal Sf dial Stress [e Stress [ps	tress [psi] [psi] i]	12,21 -1,44 31,18
Highway Stiffness Factor for Cyclic Circumferential18.80Highway Geometry Factor for Cyclic Circumferential1.22Cyclic Circumferential Stress [psi]4,271Highway Stiffness Factor for Cyclic Longitudinal Stress13.20Highway Geometry Factor for Cyclic Longitudinal Stress13.20Cyclic Longitudinal Stress [psi]3,229Stress [psi]3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load	mferential Stress Circumferential Stress	32,500 2,088 0.83 0.83	Maximum Lor Maximum Rad Total Effective	ngitudinal Sf dial Stress [e Stress [ps	tress [psi] [psi] i]	12,21 -1,44 31,18
Highway Geometry Factor for Cyclic Circumferential1.22Girth Welds3,2296,000PASSCyclic Circumferential Stress [psi]4,27111,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress13.20Highway Geometry Factor for Cyclic Longitudinal Stress1.16Cyclic Longitudinal Stress [psi]3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth	mferential Stress Circumferential Stress	32,500 2,088 0.83 0.83 1,265	Maximum Lor Maximum Rad Total Effective Allowable Effe	ngitudinal Si dial Stress [e Stress [ps ective Stress	tress [psi] [psi] i] s [psi] Allowable	12,21 -1,44 31,18 32,50 PASS/FA
Cyclic Circumferential Stress [psi]4,271Long. Welds4,27111,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress13.20Highway Geometry Factor for Cyclic Longitudinal Stress1.16Cyclic Longitudinal Stress [psi]3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor	mferential Stress Circumferential Stress Load [psi]	32,500 2,088 0.83 0.83 1,265 1.50	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423	tress [psi] [psi] i] s [psi] Allowable 32,500	12,21 -1,44 31,18 32,50 PASS/FA PASS
Highway Geometry Factor for Cyclic Longitudinal Stress 1.16 Cyclic Longitudinal Stress [psi] 3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli	mferential Stress Circumferential Stress Load [psi] c Circumferential	32,500 2,088 0.83 0.83 1,265 1.50 16.60	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423 31,180	tress [psi] [psi] i] s [psi] Allowable 32,500 32,500	12,21 -1,44 31,18 32,50 PASS/FA PASS PASS
Cyclic Longitudinal Stress [psi] 3,229	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Cir Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cycli	mferential Stress Circumferential Stress Load [psi] c Circumferential clic Circumferential	32,500 2,088 0.83 0.83 1,265 1.50 16.60 1.22	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423 31,180 3,229	tress [psi] [psi] i] s [psi] Allowable 32,500 32,500 6,000	12,21 -1,440 31,18 32,50 PASS/FA PASS PASS PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cycli Cyclic Circumferential Stress [psi]	mferential Stress Circumferential Stress Load [psi] c Circumferential clic Circumferential	32,500 2,088 0.83 1,265 1.50 16.60 1.22 4,271	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423 31,180 3,229	tress [psi] [psi] i] s [psi] Allowable 32,500 32,500 6,000	12,21 -1,44 31,18 32,50 PASS/FA PASS PASS PASS
Notes: Open cut construction, calculations run using HS-20 loading + 15%	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Cyclic Circumferential Stress [psi] Highway Stiffness Factor for Cycli	mferential Stress Circumferential Stress Load [psi] c Circumferential clic Circumferential	32,500 2,088 0.83 1,265 1.50 16.60 1.22 4,271 13.20	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423 31,180 3,229	tress [psi] [psi] i] s [psi] Allowable 32,500 32,500 6,000	12,21 -1,440 31,18 32,50 PASS/FA PASS PASS PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Cir Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cycli Highway Stiffness Factor for Cycli Highway Stiffness Factor for Cycli	mferential Stress Circumferential Stress Load [psi] c Circumferential clic Circumferential	32,500 2,088 0.83 1,265 1.50 16.60 1.22 4,271 13.20 1.16	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	ngitudinal Si dial Stress [ps ective Stress Calculated 29,423 31,180 3,229	tress [psi] [psi] i] s [psi] Allowable 32,500 32,500 6,000	12,21 -1,44 31,18 32,50 PASS/FA PASS PASS PASS

Location Burlington, VT		Date 5/24/20	16		
API 1102 - Gas Pipelin	e Crossing High	way			
PIPE AND OPERATIONAL DATA	A:	SITE A	ND INSTALLATION DAT	A:	
Operating Pressure [psi]	1440	Soil Ty			with
Location Class:	3	F' - Mc	low/medium plastic odulus of Soil Reaction [ks		0.5
Operating Temperature [°F]	60.0		esilient Modulus [ksi]	.1	5.0
Pipe Outside Diameter [in]	12.75		ge Unit Weight of Soil [lb/ft	3]	120.00
Pipe Wall Thickness [in]	0.312		epth [ft]		4
Pipe Grade: X65		-	Diameter [in]		12.75
Specified Minimum Yield Stress	65,000		ationTemperature [°F]		60.0
Design Factor	0.50		Wheel Load from Single	Axle [kips]	18.4
Longitudinal Joint Factor	1.0	•	Wheel Load from Tander		osl 18.4
Temperature Derating Factor	1.000	•	nent Type: None		
Pipe Class: API 5L Electric R	esistance Welded		t Factor Method: ASCE - I	Highway	
Young's Modulus for Steel [ksi]	30,000			0)	
Poisson's Ratio for Steel	0.30				
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied: API 110	2 Procedur	e
RESULTS					
Hoop Stress [psi]		29,423	Maximum Circumferenti	al Stress [p	si] 34,48
Allowable Hoop Stress [psi]		32,500	Maximum Longitudinal S	Stress [psi]	12,28
Stiffness Factor for Earth Load C	ircumferential Stress	2,088	Maximum Radial Stress	[psi]	-1,44
Burial Factor for Earth Load Circu	umferential Stress	0.97	Total Effective Stress [p	si]	31,37
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effective Stres	ss [psi]	32,50
Circumferential Stress from Earth	n Load [psi]	1,479			
Impact Factor		1.50		Allowable	
Highway Stiffness Factor for Cyc	lic Circumferential	16.60	Hoop 29,423 Effective 31,370	32,500 32,500	PASS PASS
Highway Geometry Factor for Cy	clic Circumferential	1.22	Girth Welds 3,229	6,000	PASS
Cyclic Circumferential Stress [psi]	4,271	Long. Welds 4,271	11,500	PASS
Highway Stiffness Factor for Cyc	lic Longitudinal Stress	13.20			
Highway Geometry Factor for Cy	clic Longitudinal Stress	1.16			
Cyclic Longitudinal Stress [psi]		3,229			
Notes: Open cut construction, ca	lculations run using HS	-20 loadir	ng + 15%		
Reference: API RP 1102 "Steel F	-		-		
			proved By	Revi	

Location Rurlington VT		Date 5/24/20	16			
Burlington, VT	- Crossing High					
API 1102 - Gas Pipeline	e crossing riigh	vvay				
PIPE AND OPERATIONAL DATA	.:	SITE A	ND INSTALLA	TION DATA	.:	
Operating Pressure [psi]	1440	Soil Ty		edium clay		with
Location Class:	3	E' - Mo	odulus of Soil Re	um plasticit eaction [ksi]		0.5
Operating Temperature [°F]	60.0	Er - Re	esilient Modulus	[ksi]		5.0
Pipe Outside Diameter [in]	12.75	Avera	e Unit Weight o	of Soil [lb/ft³	1	120.00
Pipe Wall Thickness [in]	0.312	Pipe D	epth [ft]	-	-	5
Pipe Grade: X65		·	Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatu	re [°F]		60.0
Design Factor	0.50		Wheel Load fr		xle [kips]	18.4
Longitudinal Joint Factor	1.0		Wheel Load fr	-		osl 18.4
Temperature Derating Factor	1.000	•	nent Type: Non			-
Pipe Class: API 5L Electric Re	esistance Welded		t Factor Method		iahwav	
Young's Modulus for Steel [ksi]	30,000				<u> </u>	
Poisson's Ratio for Steel	0.30					
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied:	API 1102	2 Procedur	e
RESULTS						
Hoop Stress [psi]		29,423	Maximum Cire	cumferentia	l Stress [p	si] 34,20
Allowable Hoop Stress [psi]		32,500	Maximum Lor	ngitudinal St	tress [psi]	12,1
Stiffness Factor for Earth Load Ci	rcumferential Stress	2,088	Maximum Ra	dial Stress [psi]	-1,44
Burial Factor for Earth Load Circu	Imferential Stress	1.08	Total Effective	e Stress [ps	i]	31,1
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effe	ective Stres	s [psi]	32,50
Circumferential Stress from Earth	Load [psi]	1,647				
Impact Factor		1.50	Stress [psi]	Calculated		PASS/FA
Highway Stiffness Factor for Cycl	ic Circumferential	16.60	Hoop	29,423	32,500	PASS
Highway Geometry Factor for Cyc	clic Circumferential	1.10	Effective Girth Welds	31,159 3,006	32,500 6,000	PASS PASS
Cyclic Circumferential Stress [psi]	3,850	Long. Welds	3,850	11,500	PASS
	ic Longitudinal Stress	13.20				
Highway Stiffness Factor for Cycl		1 00				
	clic Longitudinal Stress	1.08				
Highway Stiffness Factor for Cycl	clic Longitudinal Stress	3,006				

Prepared By Kelsey Kibbe	Approved By
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Location Burlington, VT		Date 5/24/20	16				
API 1102 - Gas Pipeline	e Crossing High	way					
PIPE AND OPERATIONAL DATA	:	SITE A		ALLA		A:	
Operating Pressure [psi]	1440	Soil Ty	pe: Lo	ose sa	ands and g	ravels	
Location Class:	3	E' - Mc	dulus of S	Soil Re	eaction [ks	il	0.5
Operating Temperature [°F]	60.0		silient Mo		-		10.0
Pipe Outside Diameter [in]	12.75				of Soil [lb/ft	3]	120.00
Pipe Wall Thickness [in]	0.312	_	epth [ft]	- 3			3
Pipe Grade: X65		•	Diameter	[in]			12.75
Specified Minimum Yield Stress	65,000		ationTemp	• •	re [°F]		60.0
Design Factor	0.50				om Single	Axle [kips]	18.4
Longitudinal Joint Factor	1.0	Ū			om Tandei		
Temperature Derating Factor	1.000		ent Type:			•	
Pipe Class: API 5L Electric Re	esistance Welded				: ASCE - H	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 Ap	oplied:	API 110)2 Procedu	re
RESULTS							
Hoop Stress [psi]		29,423	Maximu	im Cir	cumferenti	al Stress [psi] 33,2
Allowable Hoop Stress [psi]		32,500	Maximu	ım Lor	ngitudinal S	Stress [psi]	11,2
Stiffness Factor for Earth Load Ci	rcumferential Stress	2,088	Maximu	ım Ra	dial Stress	[psi]	-1,4
Burial Factor for Earth Load Circu	mferential Stress	0.83	Total Ef	fective	e Stress [p	si]	30,3
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowab	le Effe	ective Stres	ss [psi]	32,
Circumferential Stress from Earth	Load [psi]	1,265					
Impact Factor		1.50	Stress [psi]	-	Allowable	3
Highway Stiffness Factor for Cycli	c Circumferential	12.60	Hoop Effective	ρ	29,423 30,360	32,500 32,500	PASS PASS
Highway Geometry Factor for Cyc	clic Circumferential	1.22	Girth W		2,275	6,000	PASS
Cyclic Circumferential Stress [psi]		3,241	Long. V	Velds	3,241	11,500	PASS
Highway Stiffness Factor for Cycl	c Longitudinal Stress	9.30					
Highway Geometry Factor for Cyc	clic Longitudinal Stress	1.16					
Cyclic Longitudinal Stress [psi]		2,275					
	culations run using HS-		450/				

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

Prepared By Kelsey Kibbe	Approved By	Revision: 13.0.1

Location Burlington, VT		Date 5/24/20	16				
API 1102 - Gas Pipeline	e Crossing High	way					
PIPE AND OPERATIONAL DATA	:	SITE A		ISTALLA	TION DATA	ν:	
Operating Pressure [psi]	1440	Soil Ty	vpe:	Loose sa	ands and gr	avels	
Location Class:	3	E' - Mo	odulus	of Soil Re	eaction [ksi]		0.5
Operating Temperature [°F]	60.0			Modulus			10.0
Pipe Outside Diameter [in]	12.75				of Soil [lb/ft ³	1	120.00
Pipe Wall Thickness [in]	0.312	Pipe D		_			4
Pipe Grade: X65		Bored		-			12.75
Specified Minimum Yield Stress	65,000			emperatu	re [°F]		60.0
Design Factor	0.50			-	om Single A	xle [kips]	18.4
Longitudinal Joint Factor	1.0	_			om Tanden		
Temperature Derating Factor	1.000	•		pe: Non		i i indo fini	.01 .0
Pipe Class: API 5L Electric Re	esistance Welded				: ASCE - H	iahway	
Young's Modulus for Steel [ksi]	30,000	mpao		, mourou		ignitaj	
Poisson's Ratio for Steel	0.30						
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Facto	r Applied:	API 1102	2 Procedur	e
RESULTS						7	
Hoop Stress [psi]		29,423	Maxi	mum Ciro	cumferentia	I Stress [p	si] 33,42
Allowable Hoop Stress [psi]		32,500	Maxi	mum Lor	ngitudinal St	ress [psi]	11,33
Stiffness Factor for Earth Load Ci	rcumferential Stress	2,088	Maxi	mum Rad	dial Stress [psi]	-1,44
Burial Factor for Earth Load Circu	mferential Stress	0.97	Tota	I Effective	e Stress [ps	i]	30,58
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allov	vable Effe	ective Stress	s [psi]	32,50
Circumferential Stress from Earth	Load [psi]	1,479					
Impact Factor		1.50	Stres	ss [psi]	Calculated		
Highway Stiffness Factor for Cycli	c Circumferential	12.60	Hoop		29,423	32,500	PASS
Highway Geometry Factor for Cyc	lic Circumferential	1.22	Effec	Welds	30,550 2,275	32,500 6,000	PASS PASS
Cyclic Circumferential Stress [psi]		3,241			3,241	11,500	PASS
Highway Stiffness Factor for Cycli	c Longitudinal Stress	9.30	5V				
Highway Geometry Factor for Cyc	lic Longitudinal Stress	1.16					
Cyclic Longitudinal Stress [psi]		2,275					
				i%			

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Approved By

API 1102 - Gas Pipeline Crossing Highway PIPE AND OPERATIONAL DATA: SITE AND INSTALLATION DATA: Operating Pressure [psi] 1440 Soil Type: Loces 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 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 1.00 Pavement Type: None Impact Factor Method: ASCE - Highway Young's Modulus for Steel 0.30 Coefficient of Thermal Expansion [per"F] 0.0000065 Safety Factor Applied: API 1102 Procedure RESULTS 29,423 Maximum Circumferential Stress [psi] 33,27 Allowable Hoop Stress [psi] 29,423 Maximum Longitudinal Stress [psi] 11,22 Stiffness Factor for Earth Load Circumferential Stress 2,08 Maximum Radial Stress [psi] 1,44 Buri	Location Burlington, VT		Date 5/24/20	16			
Operating Pressure [psi] 1440 Soil Type: Locas 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 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 [kips] 18.4 Temperature Derating Factor 1.000 Pavement Type: None Impact Factor Method: ASCE - Highway Young's Modulus for Steel 0.30 Coefficient of Thermal Expansion [per°F] 0.0000065 RESULTS 32,500 Maximum Circumferential Stress [psi] 33,27 Allowable Hoop Stress [psi] 29,423 Maximum Circumferential Stress [psi] 31,22 Stiffness Factor for Earth Load Circumferential Stress 2,088 Maximum Calualitated Allowable PASS/FA Burial Factor for Earth Load Circumferential Stress 0.83		e Crossing High	way				
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/ft ^a] 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 [kips] 18.4 Temperature Derating Factor 1.000 Pavement Type: None Impact Factor Method: ASCE - Highway Young's Modulus for Steel 0.30 Coefficient of Thermal Expansion [per*F] 0.000065 Safety Factor Applied: API 1102 Procedure RESULTS Hoop Stress [psi] 32,500 Maximum Longitudinal Stress [psi] 33,27 Allowable Hoop Stress [psi] 29,423 Maximum Longitudinal Stress [psi] 34,42 Burial Factor for Earth Load Circumferential Stress 0.83 Allowable Effective Stress [psi] 30,42	PIPE AND OPERATIONAL DATA		SITE A	ND INSTALLA	TION DATA:		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Operating Pressure [psi]	1440	Soil Ty	pe: Loose sa	ands and gra	ivels	
Operating Temperature [°F]60.0Er - Resilient Modulus [ksi]10.0Pipe Outside Diameter [in]12.75Average Unit Weight of Soil [lb/ft ^a]120.00Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel0.30Safety Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]31,27Allowable Hoop Stress [psi]29,423Maximum Radial Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]34,42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]30,42Excavation Factor for Earth Load Circumferential1.647Impact Factor1.50Effective 30,42732,500Ingate Factor1.50Stress [psi]2,942332,500PASSEffective 30,42732,500PASSGircumferential Stress [psi]1.647Impact Factor1.50Effective 30,42732,500PASSHighway Geometry Factor for Cyclic Circumferential1.60Stress [psi]2,9423 <td>Location Class:</td> <td>3</td> <td>E' - Mo</td> <td>dulus of Soil Re</td> <td>eaction [ksi]</td> <td></td> <td>0.5</td>	Location Class:	3	E' - Mo	dulus of Soil Re	eaction [ksi]		0.5
Pipe Outside Diameter [in]12.75Average Unit Weight of Soil [lb/ft ^{an}]120.00Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000Installation Temperature ["F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel [ksi]30,00030Safety Factor Applied:API 1102 ProcedurePipe Stress [psi]0.30Safety Factor Applied:API 1102 Procedure33.27Allowable Hoop Stress [psi]29,423Maximum Circumferential Stress [psi]11.22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]11.22Stiffness Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]30.42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32.500Circumferential Stress form Earth Load Circumferential1.647Impact Factor1.50Stress [psi]22.500Impact Factor1.50Stress [psi]2.602PASSEffective 30.42732.500PASSCyclic Circumferential1.10Girth Welds 2.1186.000PASSStress [psi]2.92311.500PASSStr	Operating Temperature [°F]	60.0					
Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade::X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel [ksi]30,00030Coefficient of Thermal Expansion [per°F]0.0000065Poisson's Ratio for Steel0.30Safety Factor Applied: API 1102 ProcedureAPI 1102 ProcedureRESULTSHoop Stress [psi]29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Excavation Factor or Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Impact Factor1.50Stress [psi]32,500PASSHighway Stiffness Factor for Cyclic Circumferential1.647Hoop29,42332,500Impact Factor1.50Stress [psi]32,500PASSHighway Geometry Factor for Cyclic Circumferential1.04Girth Welds 2,1186,000PASSKiffness Factor for Cyclic Circumferential1.00Girth Welds 2,92311,500PASSHighway Stiffness F	Pipe Outside Diameter [in]	12.75					
Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel [ksi]30,00030.000Safety Factor Applied:API 1102 ProcedureRESULTS0.30Safety Factor Applied:API 1102 Procedure11.22RESULTS29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]32,500Maximum Longitudinal Stress [psi]11.42Stiffness Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Linautor Factor1.50Stress [psi]32,500PASSHighway Stiffness Factor for Cyclic Circumferential1.50Stress [psi]32,500Highway Stiffness Factor for Cyclic Circumferential1.50Stress [psi]29,42332,500Highway Stiffness Factor for Cyclic Circumferential1.50Stress [psi]30,427Highway Geometry Factor for Cyclic Circumferential1.10Girth Weids 2,1186,000Cyclic Circumferential Stress [psi]2,92311,500PASSHighway Geometry Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Lo	Pipe Wall Thickness [in]	0.312	-	-			
Specified Minimum Yield Stress65,000InstallationTemperature ["F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel [ksi]30,00030,000Safety Factor Applied: API 1102 ProcedurePoisson's Ratio for Steel0.30Coefficient of Thermal Expansion [per"F]0.0000065RESULTS100029,423Maximum Circumferential Stress [psi]11,22Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]1,44Burial Factor1.6471.6471.647Impact Factor1.50Stress [psi]29,42332,500Highway Stiffness Factor for Cyclic Circumferential1.6471.6029,42332,500Highway Stiffness Factor for Cyclic Circumferential1.6471.6029,42332,500PASSHighway Stiffness Factor for Cyclic Circumferential1.10Stress [psi]Calculated Allowable PASS/FAHighway Geometry Factor for Cyclic Longitudinal Stress9.3011,500PASSLinghway Stiffness Factor for Cyclic Longitudinal Stress9.3011,500PASSLinghway Geometry Factor for Cyclic Longitudinal Stress9.3011,500PASSLinghway Geometry Factor for Cyclic Lon	Pipe Grade: X65						-
Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayPipe Class:API 5L Electric Resistance WeldedImpact Factor Method: ASCE - HighwayImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel0.30Safety Factor Applied: API 1102 ProcedureCoefficient of Thermal Expansion [per*F]0.0000065Safety Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress0.88Maximum Radial Stress [psi]-1,44Burial Factor1.50Stress [psi]32,5009A23Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load Circumferential1.647Impact Factor1.50Impact Factor1.50Stress [psi]29,42332,500Highway Geometry Factor for Cyclic Circumferential1.00Effective 30,42732,500Cyclic Circumferential Stress9.30Impact Factor1.00Impact FactorHighway Geometry Factor for Cyclic Longitudinal Stress9.30Impact Factor1.08Highway Geometry Factor for Cyclic Longitudinal Stress9.30Impact FactorImpact FactorHighway Geometry Factor	Specified Minimum Yield Stress	65,000			re [°F]		
Longitudinal Joint Factor1.0Design Wheel Load from Tandem Axles [kips]18.4Temperature Derating Factor1.000Pavement Type: NoneImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel0.30Safety Factor Applied: API 1102 ProcedurePoisson's Ratio for Steel0.30Safety Factor Applied: API 1102 ProcedureRESULTS4000 Stress [psi]29,423Maximum Circumferential Stress [psi]11,22Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load Circumferential1.647Impact Factor1.50Stress [psi]22,42332,500Highway Stiffness Factor for Cyclic Circumferential1.260Hoop29,42332,500PASSHighway Geometry Factor for Cyclic Circumferential1.00Girth Weids 2,1186,000PASSCyclic Circumferential Stress [psi]2,92311,500PASSHighway Geometry Factor for Cyclic Longitudinal Stress9.301.08Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,1181.08Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,1181.08Cyclic Longitudinal Stress	Design Factor	0.50				xle [kins]	
Temperature Derating Factor1.000Pavement Type: NonePipe Class:API 5L Electric Resistance WeldedImpact Factor Method: ASCE - HighwayYoung's Modulus for Steel [ksi]30,000Safety Factor Method: ASCE - HighwayPoisson's Ratio for Steel0.30Safety Factor Applied: API 1102 ProcedureCoefficient of Thermal Expansion [per°F]0.0000065Safety Factor Applied: API 1102 ProcedureRESULTS4000 Stress [psi]29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]32,500Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]1,44Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,422Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load [psi]1,6471.6471.647Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Geometry Factor for Cyclic Circumferential1.10Girth Welds 2,1186,000Cyclic Circumferential Stress [psi]2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.082,92311,500Highway Geometry Factor for Cyclic Longitudinal Stress9.301.082,1182,118Cyclic Longitudinal Stress [psi]2,1182,1182,1182,118	Longitudinal Joint Factor	1.0	-		-		
Pipe Class:API 5L Electric Resistance Welded Joung's Modulus for Steel [ksi]30,000Poisson's Ratio for Steel0.30Safety Factor Method: ASCE - HighwayCoefficient of Thermal Expansion [per*F]0.0000065Safety Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]-1,44Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Circumferential Stress from Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load [psi]1,647Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential1.08Circumferential Stress [psi]29,42332,500PASSCyclic Circumferential Stress [psi]2,92311,500PASSStiffness Factor for Cyclic Circumferential1.08Cyclic Circumferential Stress [psi]2,9231.08Cong. Welds 2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.08Cong. Welds 2,92311,500PASSHighway Geometry Factor for Cyclic Longitudinal Stress9.301.08Cong. Welds 2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.08Cong. Welds 2,92311,	Temperature Derating Factor	1.000	•			i olioo [ilii]	
Young's Modulus for Steel [ksi] 30,000 Poisson's Ratio for Steel 0.30 Coefficient of Thermal Expansion [per*F] 0.0000065 RESULTS 29,423 Hoop Stress [psi] 29,423 Allowable Hoop Stress [psi] 32,500 Maximum Longitudinal Stress [psi] 11,22 Stiffness Factor for Earth Load Circumferential Stress 2,088 Maximum Radial Stress [psi] -1,444 Burial Factor for Earth Load Circumferential Stress 1.08 Circumferential Stress from 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/FA Highway Stiffness Factor for Cyclic Circumferential 12.60 Hoop 29,423 32,500 PASS Highway Stiffness Factor for Cyclic Circumferential 1.10 Girth Weids 2,118 6,000 PASS Cyclic Circumferential Stress [psi] 2,923 11,500 PASS Highway Stiffness Factor for Cyclic Longitudinal Stress 9.30 Into Neids 2,923 11,500 PASS Hi	Pipe Class: API 5L Electric Re	esistance Welded		• •		nhway	
Coefficient of Thermal Expansion [per°F] 0.0000065Safety Factor Applied: API 1102 ProcedureRESULTSHoop Stress [psi]29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]32,500Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]-1,44Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load [psi]1,6471.6471.647Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential12.60Effective 30,42732,500Highway Geometry Factor for Cyclic Corcumferential1.10Girth Welds 2,1186,000PASSCyclic Circumferential Stress [psi]2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.08Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress1.082,118Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,1182,1181.00PASS	Young's Modulus for Steel [ksi]	30,000	mpao			gintay	
RESULTSHoop Stress [psi]29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]32,500Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]-1,44Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load [psi]1,6471.6471.647Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential12.60Hoop29,42332,500Highway Geometry Factor for Cyclic Circumferential1.10Girth Welds 2,1186,000PASSCyclic Circumferential Stress [psi]2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.08Cyclic Longitudinal Stress [psi]2,1182,118	Poisson's Ratio for Steel	0.30					
Hoop Stress [psi]29,423Maximum Circumferential Stress [psi]33,27Allowable Hoop Stress [psi]32,500Maximum Longitudinal Stress [psi]11,22Stiffness Factor for Earth Load Circumferential Stress2,088Maximum Radial Stress [psi]-1,44Burial Factor for Earth Load Circumferential Stress1.08Total Effective Stress [psi]30,42Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,500Circumferential Stress from Earth Load [psi]1,647111Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential12.60Iffective30,42732,500Highway Geometry Factor for Cyclic Circumferential1.10Girth Welds2,1186,000PASSCyclic Circumferential Stress [psi]2,92311,500PASSSHighway Stiffness Factor for Cyclic Longitudinal Stress9.30Allowable Stress [psi]1.08Highway Geometry Factor for Cyclic Longitudinal Stress1.08Curcumferential Stress [psi]1.08Cyclic Longitudinal Stress [psi]2,1181.08Curcumferential Stress [psi]1.08Cyclic Longitudinal Stress [psi]2,1181.08Curcumferential Stress [psi]1.08	Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied:	API 1102	Procedur	re
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	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Cyclic Circumferential Stress [psi] Highway Stiffness Factor for Cycl Highway Stiffness Factor for Cycl	mferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential ic Longitudinal Stress	32,500 2,088 1.08 0.83 1,647 1.50 12.60 1.10 2,923 9.30 1.08	Maximum Lor Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	ngitudinal Str dial Stress [psi] e Stress [psi] ective Stress Calculated / 29,423 30,427 2,118	Allowable 32,500 6,000	11,22 -1,44 30,42 32,50 PASS/FA PASS PASS PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl Highway Stiffness Factor for Cycl Highway Stiffness Factor for Cycl Highway Stiffness Factor for Cycl Cyclic Circumferential Stress [psi]	mferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential ic Longitudinal Stress clic Longitudinal Stress	32,500 2,088 1.08 0.83 1,647 1.50 12.60 1.10 2,923 9.30 1.08 2,118 -20 loadin	Maximum Lor Maximum Rad Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds Long. Welds	ngitudinal Str dial Stress [psi] e Stress [psi] ective Stress Calculated / 29,423 30,427 2,118	Allowable 32,500 6,000	11,22 -1,440 30,42 32,50 PASS/FA PASS PASS PASS

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

API 1102 - Gas Pipeline Crossing Highway

- 1				
	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]	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 [kips	s] 18.4
	Temperature Derating Factor	1.000	Pavement Type: None	
	Pipe Class: API 5L Electric Re	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
Allowable Hoop Stress [psi]	32,500
Stiffness Factor for Earth Load Circumferential Stress	1,934
Burial Factor for Earth Load Circumferential Stress	0.78
Excavation Factor for Earth Load Circumferential Stress	0.83
Circumferential Stress from Earth Load [psi]	1,102
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]	2,275

9,423	Maximum Circumferential Stress [psi]	33,046
2,500	Maximum Longitudinal Stress [psi]	11,216
934	Maximum Radial Stress [psi]	-1,440
78	Total Effective Stress [psi]	30,216
.83	Allowable Effective Stress [psi]	32,500

Stress [psi]	Calculated	Allowable	PASS/FAIL
Ноор	29,423	32,500	PASS
Effective	30,216	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	
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Location Burlington, VT		Date 5/24/20	16			
API 1102 - Gas Pipeline	e Crossing High	way				
PIPE AND OPERATIONAL DATA	:	SITE A	ND INSTALLA	TION DATA		
Operating Pressure [psi]	1440	Soil Ty	pe: Stiff to ve	ery stiff clay	s and silts	
Location Class:	3	E' - Mo	dulus of Soil Re	eaction [ksi]		1.0
Operating Temperature [°F]	60.0		silient Modulus			10.0
Pipe Outside Diameter [in]	12.75		e Unit Weight o		1	120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]	•	<u>.</u>	4
Pipe Grade: X65		-	Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatu	re [°F]		60.0
Design Factor	0.50		Wheel Load fr		xle [kips]	18.4
Longitudinal Joint Factor	1.0	•	Wheel Load fr	-		
Temperature Derating Factor	1.000	•	ent Type: Non		.	
Pipe Class: API 5L Electric Re	esistance Welded		Factor Method		iahwav	
Young's Modulus for Steel [ksi]	30,000				.g,	
Poisson's Ratio for Steel	0.30					
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied	API 1102	Procedur	е
RESULTS						
Hoop Stress [psi]		29,423	Maximum Cir	cumferentia	l Stress [p	si] 33,21
Allowable Hoop Stress [psi]	24	32,500	Maximum Lor	ngitudinal St	ress [psi]	11,26
Stiffness Factor for Earth Load Ci	rcumferential Stress	1,934	Maximum Ra	dial Stress [psi]	-1,44
Burial Factor for Earth Load Circu	mferential Stress	0.90	Total Effective	e Stress [ps	i]	30,36
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effe	ective Stress	s [psi]	32,50
Circumferential Stress from Earth	Load [psi]	1,271				
Impact Factor		1.50	Stress [psi]	Calculated		
Highway Stiffness Factor for Cycli	c Circumferential	12.60	Hoop Effective	29,423 30,366	32,500 32,500	PASS PASS
Highway Geometry Factor for Cyc	lic Circumferential	1.22	Girth Welds	2,275	6,000	PASS
Cyclic Circumferential Stress [psi]		3,241		3,241	11,500	PASS
Highway Stiffness Factor for Cycli	c Longitudinal Stress	9.30				
Highway Geometry Factor for Cyc	lic Longitudinal Stress	1.16				
Cyclic Longitudinal Stress [psi]		2,275				
	culations run using HS-					

Prepared By	Kelsey Kibb	be
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Approved By

Location Burlington, VT		Date 5/24/20	16			
API 1102 - Gas Pipeline	e Crossing High	way				
PIPE AND OPERATIONAL DATA		SITE A	ND INSTALLA	TION DAT	۹:	
Operating Pressure [psi]	1440	Soil Ty	pe: Stiff to ve	ery stiff clay	ys and silts	5
Location Class:	3	E' - Mo	dulus of Soil Re	eaction [ksi	1]	1.0
Operating Temperature [°F]	60.0		silient Modulus	-		10.0
Pipe Outside Diameter [in]	12.75		e Unit Weight o		3]	120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]			5
Pipe Grade: X65		•	Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatu	re [°F]		60.0
Design Factor	0.50		Wheel Load fr		Axle [kips]	18.4
Longitudinal Joint Factor	1.0	-	Wheel Load fr	•		
Temperature Derating Factor	1.000	•	ent Type: None		Ľ	
Pipe Class: API 5L Electric Re	esistance Welded		Factor Method		liqhway	
Young's Modulus for Steel [ksi]	30,000					
Poisson's Ratio for Steel	0.30				5	
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied:	API 110	2 Procedu	re
RESULTS						
Hoop Stress [psi]		29,423	Maximum Cire	cumferentia	al Stress [p	osi] 33,01
Allowable Hoop Stress [psi]		32,500	Maximum Lor	igitudinal S	tress [psi]	11,14
Stiffness Factor for Earth Load Ci	rcumferential Stress	1,934	Maximum Rad	dial Stress	[psi]	-1,44
Burial Factor for Earth Load Circu	mferential Stress	0.98	Total Effective	e Stress [ps	si]	30,19
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effe	ective Stres	ss [psi]	32,50
Circumferential Stress from Earth	Load [psi]	1,384				
Impact Factor		1.50	Stress [psi]		Allowable	- 12
Highway Stiffness Factor for Cycli	c Circumferential	12.60	Hoop Effective	29,423 30,193	32,500 32,500	PASS PASS
Highway Geometry Factor for Cyc	lic 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 Cycli	c Longitudinal Stress	9.30				
Highway Geometry Factor for Cyc	lic Longitudinal Stress	1.08				
Cyclic Longitudinal Stress [psi]		2,118				

Approved By

Prepared By Kelsey Kibbe

Location Burlington, VT		Date 5/24/20	16			
API 1102 - Gas Pipelir	ne Crossing High					
PIPE AND OPERATIONAL DAT	A:	SITE A	AND INSTALLA	TION DATA	A:	
Operating Pressure [psi]	1440	Soil Ty	vpe: Medium	dense sand	is and grav	/els
Location Class:	3	F' - Mc	odulus of Soil Re	eaction [ksi]	1	1.0
Operating Temperature [°F]	60.0		esilient Modulus		1	10.0
Pipe Outside Diameter [in]	12.75		ge Unit Weight o		' 1	120.00
Pipe Wall Thickness [in]	0.312		epth [ft]		1	3
Pipe Grade: X65			Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatu	re [°F]		60.0
Design Factor	0.50		n Wheel Load fr		Axle [kips]	18.4
Longitudinal Joint Factor	1.0	-	n Wheel Load fr	-		
Temperature Derating Factor	1.000	-	nent Type: Non			
Pipe Class: API 5L Electric F	Resistance Welded		t Factor Method		liahway	
Young's Modulus for Steel [ksi]	30,000	mpue				
Poisson's Ratio for Steel	0.30					
Coefficient of Thermal Expansio	n [per°F] 0.0000065	Safety	Factor Applied:	: API 1102	2 Procedure	е
	n [per°F] 0.0000065	Safety	Factor Applied:	: API 1102	2 Procedure	e
RESULTS	n [per°F] 0.0000065	Safety 29,423				
RESULTS Hoop Stress [psi]	n [per°F] 0.0000065		Factor Applied: Maximum Circ Maximum Lor	cumferentia	al Stress [ps	si] 33,1
RESULTS		29,423	Maximum Cire	cumferentia ngitudinal St	al Stress [ps tress [psi]	si] 33,1 11,2
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi]	Circumferential Stress	29,423 32,500	Maximum Ciro Maximum Lor	cumferentia ngitudinal Sf dial Stress [al Stress [ps tress [psi] [psi]	si] 33,1 11,2 -1,44
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load 0	Circumferential Stress	29,423 32,500 1,934 0.83	Maximum Ciro Maximum Lor Maximum Rao	cumferentia ngitudinal Sf dial Stress [e Stress [ps	al Stress [pa tress [psi] [psi] ii]	si] 33,1 11,2 -1,44 30,2
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circ Excavation Factor for Earth Load	Circumferential Stress sumferential Stress d Circumferential Stress	29,423 32,500 1,934 0.83	Maximum Ciro Maximum Lor Maximum Rao Total Effective	cumferentia ngitudinal Sf dial Stress [e Stress [ps	al Stress [pa tress [psi] [psi] ii]	si] 33,1 11,2 -1,44 30,2
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circ Excavation Factor for Earth Load Circumferential Stress from Earth	Circumferential Stress sumferential Stress d Circumferential Stress	29,423 32,500 1,934 0.83 0.83	Maximum Ciro Maximum Lor Maximum Rao Total Effective	cumferentia ngitudinal St dial Stress [e Stress [ps ective Stress	al Stress [pa tress [psi] [psi] ii]	si] 33,1 11,2 -1,44 30,2 32,5
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circ	Circumferential Stress sumferential Stress d Circumferential Stress h Load [psi]	29,423 32,500 1,934 0.83 0.83 1,172	Maximum Ciro Maximum Lor Maximum Rao Total Effective Allowable Effe Stress [psi] Hoop	cumferentia ngitudinal St dial Stress [e Stress [ps ective Stress Calculated 29,423	al Stress [psi tress [psi] [psi] s [psi] s [psi] Allowable 32,500	si] 33,1 11,2 -1,44 30,2 32,5 PASS/FA PASS
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Notes: Open cut construction, calculations run using HS-20 loading + 15%	Impact Factor Highway Stiffness Factor for Cycli Highway Geometry Factor for Cyc Cyclic Circumferential Stress [psi] Highway Stiffness Factor for Cycli Highway Geometry Factor for Cyc	clic Circumferential ic Longitudinal Stress	12.60 1.22 3,241 9.30 1.16	Effective Girth Welds	30,453 2,275	6,000	
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Operating Pressure [psi]1440Soil Type:Medium dense sands and gravesLocation Class:3E' - Modulus of Soil Reaction [ksi]1.0Operating Temperature [°F]60.0Er - Resilient Modulus [ksi]10.0Pipe Outside Diameter [in]12.75Average Unit Weight of Soil [lb/ft³]120.00Pipe Wall Thickness [in]0.312Pipe Depth [ft]5Pipe Grade:X65Bored Diameter [in]12.75Specified Minimum Yield Stress65,000InstallationTemperature [°F]60.0Design Factor0.50Design Wheel Load from Single Axle [kips]18.4Longitudinal Joint Factor1.00Pavement Type: None18.4Temperature Derating Factor1.000Pavement Type: None19.2Pipe Class:API 5L Electric Restance WeldedImpact Factor Method: ASCE - Highway18.4Young's Modulus for Steel [ksi]30,0003036etty Factor Applied: API 1102 ProcedureRESULTS29,423Maximum Circumferential Stress [psi]33,14Allowable Hoop Stress [psi]29,423Maximum Longitudinal Stress [psi]33,14Allowable Hoop Stress [psi]1.934Maximum Radial Stress [psi]11,14Stiffness Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]30,37Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]30,37Excavation Factor for Earth Load Circumferential Stress0.83Allowable Effective Stress [psi]32,50 <th>Location Burlington, VT</th> <th></th> <th>Date 5/24/20</th> <th>16</th> <th></th> <th></th>	Location Burlington, VT		Date 5/24/20	16		
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Circumferential Stress from Earth Load [psi]1,525Impact Factor1.50Highway Stiffness Factor for Cyclic Circumferential12.60Highway Geometry Factor for Cyclic Circumferential1.10Cyclic Circumferential Stress [psi]2,923Highway Stiffness Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi]	ircumferential Stress	32,500	Maximum Lon	gitudinal Stress	s [psi] 11,18
Impact Factor1.50Stress [psi]Calculated Allowable PASS/FAHighway Stiffness Factor for Cyclic Circumferential12.60Hoop29,42332,500PASSHighway Geometry Factor for Cyclic Circumferential1.10Effective30,31832,500PASSCyclic Circumferential Stress [psi]2,9231.186,000PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.301.08Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C		32,500 1,934	Maximum Lon Maximum Rac	gitudinal Stress dial Stress [psi]	s [psi] 11,18 -1,44
Highway Stiffness Factor for Cyclic Circumferential12.60Highway Geometry Factor for Cyclic Circumferential1.10Cyclic Circumferential Stress [psi]2,923Highway Stiffness Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress9.30Cyclic Longitudinal Stress [psi]2,118Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu	umferential Stress	32,500 1,934 1.08	Maximum Lon Maximum Rac Total Effective	gitudinal Stress dial Stress [psi] e Stress [psi]	s [psi] 11,18 -1,44 30,31
Highway Stiffness Factor for Cyclic Circumferential12.80Highway Geometry Factor for Cyclic Circumferential1.10Cyclic Circumferential Stress [psi]2,923Highway Stiffness Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress9.30Cyclic Longitudinal Stress [psi]2,118Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load	umferential Stress Circumferential Stress	32,500 1,934 1.08 0.83	Maximum Lon Maximum Rac Total Effective	gitudinal Stress dial Stress [psi] e Stress [psi]	s [psi] 11,18 -1,44 30,31
Highway Geometry Factor for Cyclic Circumferential1.10Girth Welds2,1186,000PASSCyclic Circumferential Stress [psi]2,923Long. Welds2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth	umferential Stress Circumferential Stress	32,500 1,934 1.08 0.83 1,525	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi]	gitudinal Stress dial Stress [psi] Stress [psi] ective Stress [ps Calculated Allo	s [psi] 11,18 -1,44 30,31 si] 32,50
Cyclic Circumferential Stress [psi]2,923Long. Welds2,92311,500PASSHighway Stiffness Factor for Cyclic Longitudinal Stress9.30Highway Geometry Factor for Cyclic Longitudinal Stress1.08Cyclic Longitudinal Stress [psi]2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor	umferential Stress Circumferential Stress n Load [psi]	32,500 1,934 1.08 0.83 1,525 1.50	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop	gitudinal Stress dial Stress [psi] Stress [psi] ctive Stress [ps Calculated Allo 29,423 32,	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS
Highway Geometry Factor for Cyclic Longitudinal Stress 1.08 Cyclic Longitudinal Stress [psi] 2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential	32,500 1,934 1.08 0.83 1,525 1.50 12.60	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [ps Calculated Allo 29,423 32, 30,318 32,	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS 500 PASS
Cyclic Longitudinal Stress [psi] 2,118	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc Highway Geometry Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential clic Circumferential	32,500 1,934 1.08 0.83 1,525 1.50 12.60 1.10	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [psi Calculated Allo 29,423 32, 30,318 32, 2,118 6,0	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS 500 PASS 00 PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc Highway Geometry Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential clic Circumferential]	32,500 1,934 1.08 0.83 1,525 1.50 12.60 1.10 2,923	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [psi Calculated Allo 29,423 32, 30,318 32, 2,118 6,0	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS 500 PASS 00 PASS
Notes: Open cut construction, calculations run using HS-20 loading + 15%	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc Cyclic Circumferential Stress [psi Highway Stiffness Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential clic Circumferential] lic Longitudinal Stress	32,500 1,934 1.08 0.83 1,525 1.50 12.60 1.10 2,923 9.30	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [psi Calculated Allo 29,423 32, 30,318 32, 2,118 6,0	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS 500 PASS 00 PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc Cyclic Circumferential Stress [psi Highway Stiffness Factor for Cyc Highway Stiffness Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential clic Circumferential] lic Longitudinal Stress	32,500 1,934 1.08 0.83 1,525 1.50 12.60 1.10 2,923 9.30 1.08	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [psi Calculated Allo 29,423 32, 30,318 32, 2,118 6,0	s [psi] 11,18 -1,44 30,37 si] 32,50 wable PASS/FA 500 PASS 500 PASS 00 PASS
	Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load C Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cyc Highway Geometry Factor for Cyc Highway Stiffness Factor for Cyc Highway Stiffness Factor for Cyc Highway Stiffness Factor for Cyc	umferential Stress Circumferential Stress h Load [psi] lic Circumferential clic Circumferential] lic Longitudinal Stress clic Longitudinal Stress liculations run using HS	32,500 1,934 1.08 0.83 1,525 1.50 12.60 1.10 2,923 9.30 1.08 2,118 -20 loadir	Maximum Lon Maximum Rac Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds Long. Welds	gitudinal Stress dial Stress [psi] e Stress [psi] ective Stress [psi Calculated Allo 29,423 32, 30,318 32, 2,118 6,0	s [psi] 11,18 -1,44 30,31 si] 32,50 wable PASS/FA 500 PASS 500 PASS 00 PASS

Location Burlington, VT		Date 5/24/20	16			
API 1102 - Gas Pipelin	e Crossing High					
PIPE AND OPERATIONAL DATA	• •			TION DATA	۹:	
Operating Pressure [psi]	1440	Soil Ty	pe: Dense to	o very dens	e sands ar	nd gravels
Location Class:	3	E' Mo	dulus of Soil R	- eaction [kei	1	2.0
Operating Temperature [°F]	60.0		silient Modulus	-	1	20.0
Pipe Outside Diameter [in]	12.75		je Unit Weight		31	120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]		1	3
Pipe Grade: X65			Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatu	re [°E]		60.0
Design Factor	0.50		Wheel Load fr		Avle [kins]	
Longitudinal Joint Factor	1.0	•		•		
Temperature Derating Factor	1.000	Design Wheel Load from Tandem Axle Pavement Type: None Impact Factor Method: ASCE - Highwa			10.4 10.4	
Pipe Class: API 5L Electric R	esistance Welded				liahway	
Young's Modulus for Steel [ksi]	30,000	mpuo			inginitay	
Poisson's Ratio for Steel	0.30					
Coefficient of Thermal Expansion		Safety	Factor Applied	: API 110	2 Procedu	re
Coefficient of Thermal Expansion RESULTS		Safety	Factor Applied	: API 110	2 Procedu	re
		Safety 29,423	Factor Applied Maximum Cir			
RESULTS				cumferentia	al Stress [p	osi] 32,0
RESULTS Hoop Stress [psi]	[per°F] 0.0000065	29,423	Maximum Cir	cumferentia ngitudinal S	al Stress [p Stress [psi]	osi] 32,0 10,4
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi]	[per°F] 0.0000065	29,423 32,500	Maximum Cir Maximum Loi	cumferentia ngitudinal S dial Stress	al Stress [p stress [psi] [psi]	osi] 32,00 10,4 -1,44
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Ci	[per°F] 0.0000065 ircumferential Stress imferential Stress	29,423 32,500 1,693 0.78	Maximum Cir Maximum Loi Maximum Ra	cumferentia ngitudinal S dial Stress e Stress [ps	al Stress [p stress [psi] [psi] si]	osi] 32,00 10,4 -1,44 29,43
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress	29,423 32,500 1,693 0.78	Maximum Cir Maximum Lor Maximum Ra Total Effective	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres	al Stress [p stress [psi] [psi] si] ss [psi]	osi] 32,00 10,4 -1,44 29,44 32,5
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress	29,423 32,500 1,693 0.78 0.83	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres [Calculated	al Stress [p stress [psi] [psi] si] ss [psi]	osi] 32,00 10,4 -1,44 29,4 32,50
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth	[per°F] 0.0000065 frcumferential Stress imferential Stress Circumferential Stress Load [psi]	29,423 32,500 1,693 0.78 0.83 964	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe Stress [psi] Hoop	cumferentia ngitudinal S dial Stress e Stress [ps ective Stress Calculated 29,423	al Stress [psi] Stress [psi] [psi] si] ss [psi] Allowable [32,500	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA PASS
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress Load [psi] ic Circumferential	29,423 32,500 1,693 0.78 0.83 964 1.50	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres [Calculated	al Stress [p stress [psi] [psi] si] ss [psi]	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential	29,423 32,500 1,693 0.78 0.83 964 1.50 9.30	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe Stress [psi] Hoop Effective	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres Calculated 29,423 29,422 1,517	al Stress [p stress [psi] [psi] si] ss [psi] Allowable 32,500 32,500	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA PASS PASS
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential	29,423 32,500 1,693 0.78 0.83 964 1.50 9.30 1.22	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres Calculated 29,423 29,422 1,517	al Stress [psi] [psi] si] ss [psi] d Allowable 32,500 32,500 6,000	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA PASS PASS PASS
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl Cyclic Circumferential Stress [psi	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential clic Circumferential	29,423 32,500 1,693 0.78 0.83 964 1.50 9.30 1.22 2,393 6.20	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres Calculated 29,423 29,422 1,517	al Stress [psi] [psi] si] ss [psi] d Allowable 32,500 32,500 6,000	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA PASS PASS PASS
RESULTS Hoop Stress [psi] Allowable Hoop Stress [psi] Stiffness Factor for Earth Load Circu Burial Factor for Earth Load Circu Excavation Factor for Earth Load Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl Highway Stiffness Factor for Cycl	[per°F] 0.0000065 ircumferential Stress imferential Stress Circumferential Stress Load [psi] ic Circumferential clic Circumferential clic Circumferential	29,423 32,500 1,693 0.78 0.83 964 1.50 9.30 1.22 2,393 6.20	Maximum Cir Maximum Lor Maximum Ra Total Effective Allowable Effe Stress [psi] Hoop Effective Girth Welds	cumferentia ngitudinal S dial Stress e Stress [ps ective Stres Calculated 29,423 29,422 1,517	al Stress [psi] [psi] si] ss [psi] d Allowable 32,500 32,500 6,000	osi] 32,00 10,4 -1,44 29,4 32,5 PASS/FA PASS PASS PASS

Location Burlington, VT		Date 5/24/20	16		2		
API 1102 - Gas Pipeline	e Crossing High	way					
PIPE AND OPERATIONAL DATA	:	SITE A		ALLA	TION DAT	A:	
Operating Pressure [psi]	1440	Soil Ty	rpe: De	nse to	very dens	se sands ar	d gravels
Location Class:	3	E' - Mo	dulus of S	Soil Re	eaction [ks	i]	2.0
Operating Temperature [°F]	60.0	Er - Re	esilient Mo	odulus	[ksi]	-	20.0
Pipe Outside Diameter [in]	12.75				of Soil [lb/ft	3]	120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]	U		-	4
Pipe Grade: X65		Bored	Diameter	[in]			12.75
Specified Minimum Yield Stress	65,000		ationTemp	-	re [°F]		60.0
Design Factor	0.50				•	Axle [kips]	18.4
Longitudinal Joint Factor	1.0	-			-	m Axles [ki	ps] 18.4
Temperature Derating Factor	1.000	Paver	nent Type:	None	е		_
Pipe Class: API 5L Electric Re	esistance Welded	Impac	t Factor M	lethod	: ASCE - I	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 Ap	oplied:	API 110)2 Procedu	re
RESULTS							
Hoop Stress [psi]		29,423	Maximu	m Ciro	cumferenti	al Stress [p	si] 32,209
Allowable Hoop Stress [psi]		32,500	Maximu	m Lor	ngitudinal S	Stress [psi]	10,462
Stiffness Factor for Earth Load Ci	rcumferential Stress	1,693	Maximu	ım Rad	dial Stress	[psi]	-1,440
Burial Factor for Earth Load Circu	mferential Stress	0.90	Total Ef	fective	e Stress [p	si]	29,554
	Circumferential Stress	0.83	Allowab	le Effe	ective Stre	ss [psi]	32,500
Excavation Factor for Earth Load		1,113					
Excavation Factor for Earth Load Circumferential Stress from Earth	Load [psi]	- ,		nail	Calculate	- 1 I I I I I I I I I I I I I I I I I I	PASS/FAIL
	Load [psi]	1.50	Stress [psij		22 500	PASS
Circumferential Stress from Earth			Ноор		29,423	32,500	DACC
Circumferential Stress from Earth Impact Factor	c Circumferential	1.50		e	29,423 29,554 1,517	32,500 32,500 6,000	PASS PASS
Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl	c Circumferential	1.50 9.30	Hoop Effective	e 'elds	29,554	32,500	
Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cyc	c Circumferential	1.50 9.30 1.22	Hoop Effective Girth W	e 'elds	29,554 1,517	32,500 6,000	PASS
Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl Cyclic Circumferential Stress [psi]	ic Circumferential clic Circumferential ic Longitudinal Stress	1.50 9.30 1.22 2,393 6.20	Hoop Effective Girth W	e 'elds	29,554 1,517	32,500 6,000	PASS
Circumferential Stress from Earth Impact Factor Highway Stiffness Factor for Cycl Highway Geometry Factor for Cycl Cyclic Circumferential Stress [psi] Highway Stiffness Factor for Cycl	ic Circumferential clic Circumferential ic Longitudinal Stress	1.50 9.30 1.22 2,393 6.20	Hoop Effective Girth W	e 'elds	29,554 1,517	32,500 6,000	PASS

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Prepared By Kelsey Kibbe Approved By Revision: 13.0.1

Location Burlington, VT		Date 5/24/20	16			
API 1102 - Gas Pipeline	e Crossing High	way				
PIPE AND OPERATIONAL DATA	:	SITE A	ND INSTALLAT		:	
Operating Pressure [psi]	1440	Soil Ty	pe: Dense to	very dense	sands an	d gravels
Location Class:	3	E' - Mo	dulus of Soil Re	action [ksi]		2.0
Operating Temperature [°F]	60.0	Er - Re	silient Modulus	[ksi]		20.0
Pipe Outside Diameter [in]	12.75	Averag	je Unit Weight c	f Soil [lb/ft³]		120.00
Pipe Wall Thickness [in]	0.312	-	epth [ft]			5
Pipe Grade: X65			Diameter [in]			12.75
Specified Minimum Yield Stress	65,000		ationTemperatur	e [°F]		60.0
Design Factor	0.50		Wheel Load fro		xle [kips]	18.4
Longitudinal Joint Factor	1.0	-	Wheel Load fro	-		os] 18.4
Temperature Derating Factor	1.000	•	ent Type: None			•
Pipe Class: API 5L Electric Re	esistance Welded		Factor Method		ighway	
Young's Modulus for Steel [ksi]	30,000				0 2	
Poisson's Ratio for Steel	0.30					
Coefficient of Thermal Expansion	[per°F] 0.0000065	Safety	Factor Applied:	API 1102	Procedur	е
RESULTS						
Hoop Stress [psi]		29,423	Maximum Circ	cumferentia	l Stress [p	si] 32,0
Allowable Hoop Stress [psi]		32,500	Maximum Lor	gitudinal St	ress [psi]	10,3
Stiffness Factor for Earth Load Ci	rcumferential Stress	1,693	Maximum Rad	dial Stress [psi]	-1,44
Burial Factor for Earth Load Circu	mferential Stress	0.98	Total Effective	Stress [psi]	29,4
Excavation Factor for Earth Load	Circumferential Stress	0.83	Allowable Effe	ective Stress	s [psi]	32,5
Circumferential Stress from Earth	Load [psi]	1,211				
Impact Factor		1.50	Stress [psi]	Calculated	the second s	
Highway Stiffness Factor for Cycl	c Circumferential	9.30	Hoop Effective	29,423 29,437	32,500 32,500	PASS PASS
Highway Geometry Factor for Cyc	lic Circumferential	1.10	Girth Welds	1,412	6,000	PASS
Cyclic Circumferential Stress [psi]		2,157	Long. Welds	2,157	11,500	PASS
Highway Stiffness Factor for Cycl	c Longitudinal Stress	6.20				
Highway Geometry Factor for Cyc	clic Longitudinal Stress	1.08				
Cyclic Longitudinal Stress [psi]		1,412				
Notes: Open cut construction, cal		20 loodir	a + 150/			

Prepared By Kelsey Kibbe	Approved By	Revision: 13.0.1