


# ONERA

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## NOTE DE CALCUL DE FLEXIBILITE D'UN RESEAU DE TUYAUTERIE

0	27/02/25	Etablissement	SSR		
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			Project: -		
			Note de calcul N° <b>ONE-24-322-01</b>		

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## **1. Références**

### **1.1. Logiciel**

[1] Caepipe 13.10. (SST SYSTEMS)

### **1.2. Documents**

[2] Isométrie sans numéro.

### **1.3. Codes**

[3] Code de construction B31.3 2022.

## 2. Sujet

Cette note a pour but d'étudier la flexibilité des tuyauteries et leurs supportage afin que les critères fixés par le code référence [3] soient respectés.

### 3. Hypothèses de calcul

#### 3.1. Description et caractéristiques des tuyauteries

Matière	DN	Epaisseur (mm)	Surépaisseur de corrosion (mm)	Epaisseur Calorifugeage (mm) <sup>(1)</sup>
SA312TP321	40	5.08	0	40

<sup>(1)</sup> La densité du calorifugeage est prise égale à 125 Kg/m<sup>3</sup>.

#### 3.2. Cas de charges et combinaisons

- ⇒ W : Poids propre.
- ⇒ P<sub>1</sub> : Pression de calcul.
- ⇒ T<sub>1</sub> : Température de calcul.

Les combinaisons sont les suivantes :

- W+P<sub>1</sub> : Poids propre + Pression
- W+P<sub>1</sub>+T<sub>1</sub> : Operating 1

#### 3.3. Conditions de calcul

	Condition n°1
Pression de calcul (bar)	30
Température de calcul (°C)	552
Fluide	Gaz
Densité fluide	0

Température de pose: 20°C  
Coefficient de frottement : 0.3

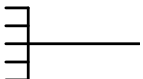


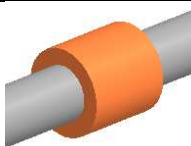


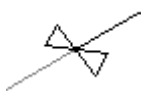
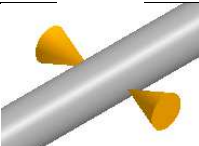
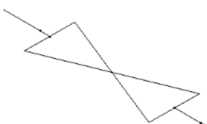

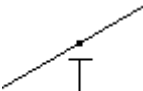
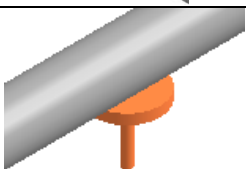
#### 3.4. Caractéristique matériaux

La contrainte admissible se calcule de la façon suivante conformément code référence [3]:

- Contrainte admissible à 20°C : S = 137.90 MPa
- Contrainte admissible à 552°C : S = 88.40 MPa

## 4. Description du modèle

### 4.1. Symboles

Définition	Symbols	Rendering
Point fixe / Connection appareil		
Guide		
Brides		
Blocage (Directionnel)		
Vanne		
Support poids		

### 4.2. Géométrie

Les connexions avec les équipements sont considérés comme des points fixes. Aucun déplacement dus à leur dilatation n'est pris en compte.

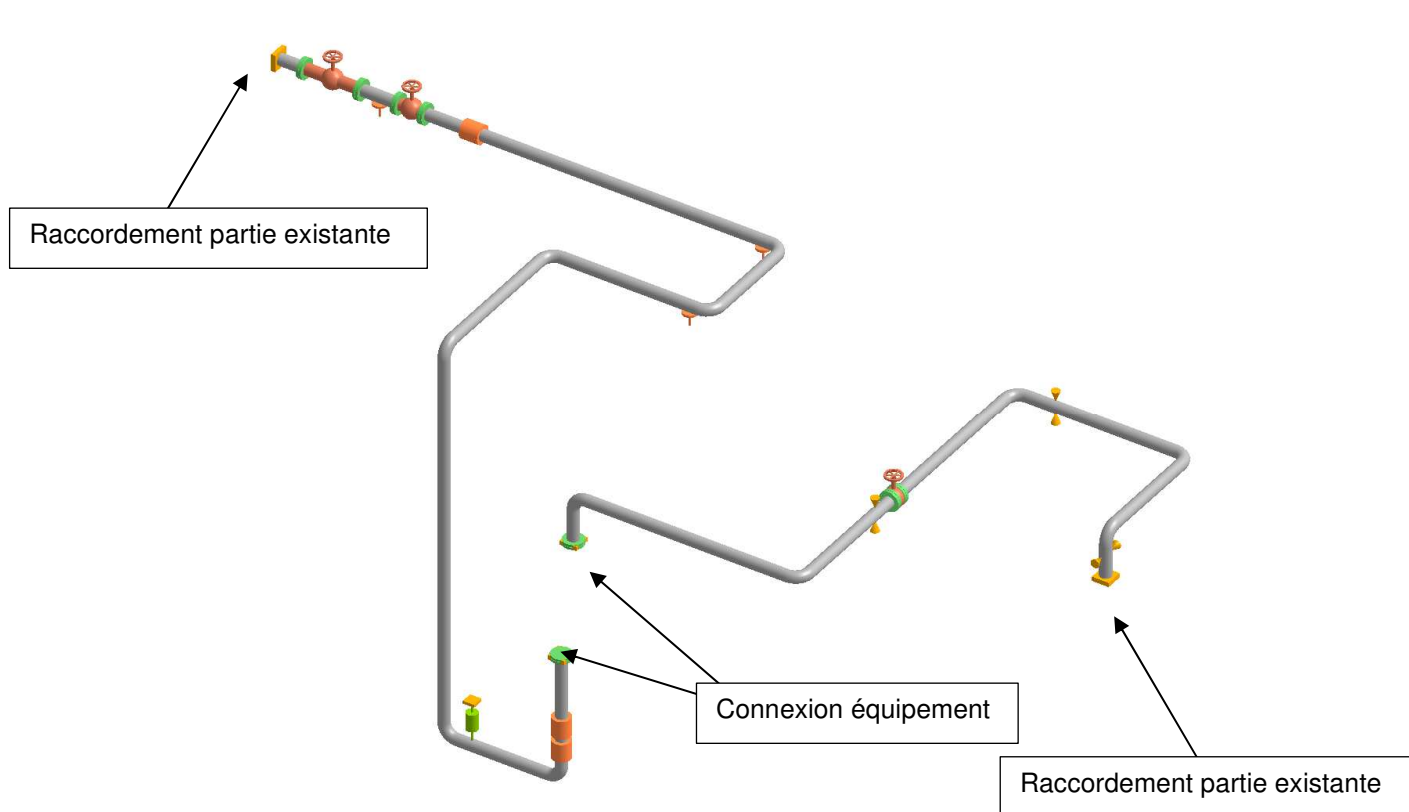
Le raccordement sur les parties existantes sont modélisées en point fixe avec des déplacements imposés :

Specified Displacements (2)										
Node	Type	Load	X/x (mm)	Y/y (mm)	Z/z (mm)	XX/xx (deg)	YY/yy (deg)	ZZ/zz (deg)	Disp. in	
10	Anchor	Desn							GCS	
		T1	30						GCS	
340	Anchor	Desn							GCS	
		T1	-4.3		0.2				GCS	

Les accessoires en ligne (Vanne, clapet, compteur...) sont considérés comme des éléments rigides avec une masse définie dans le tableau suivant:

Valves (3)									
From	To	Weight (kg)	Length (mm)	Thick X	Insul Wgt.X	Add.Wgt (kg)	Offsets of Add.Wgt		
							DX (mm)	DY (mm)	DZ (mm)
20	30	25		3.00	1.75				
50	80	19		3.00	1.75				
270	280	2.2		3.00	1.75				

## 4.3. Vues isométriques du modèle étudié







## 5. Contraintes maximales calculées

Nous nous conformons aux critères énoncés dans le code [3] :

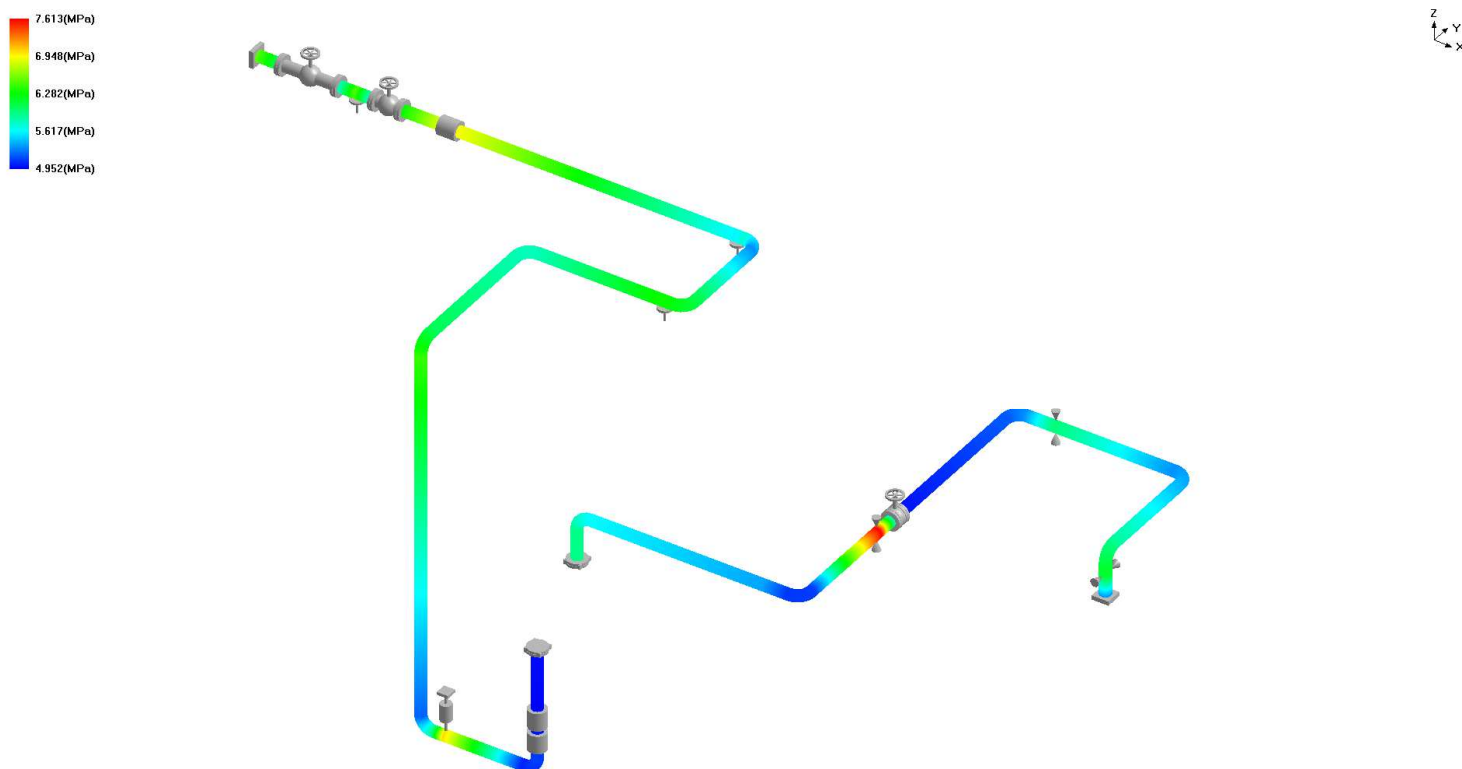
Type de contraintes	Cas de charges associés	Critères d'acceptation
Contraintes dues aux charges permanentes	W+Pmax	S
Etendue de variation de la contrainte engendrée par la dilatation thermique	T1 T1-Tref	$S_a = f(1.25Sc + 0.25Sh)$

La valeur de f est prise égale à 1 car le nombre de cycles thermiques est considéré être inférieur à 7000.

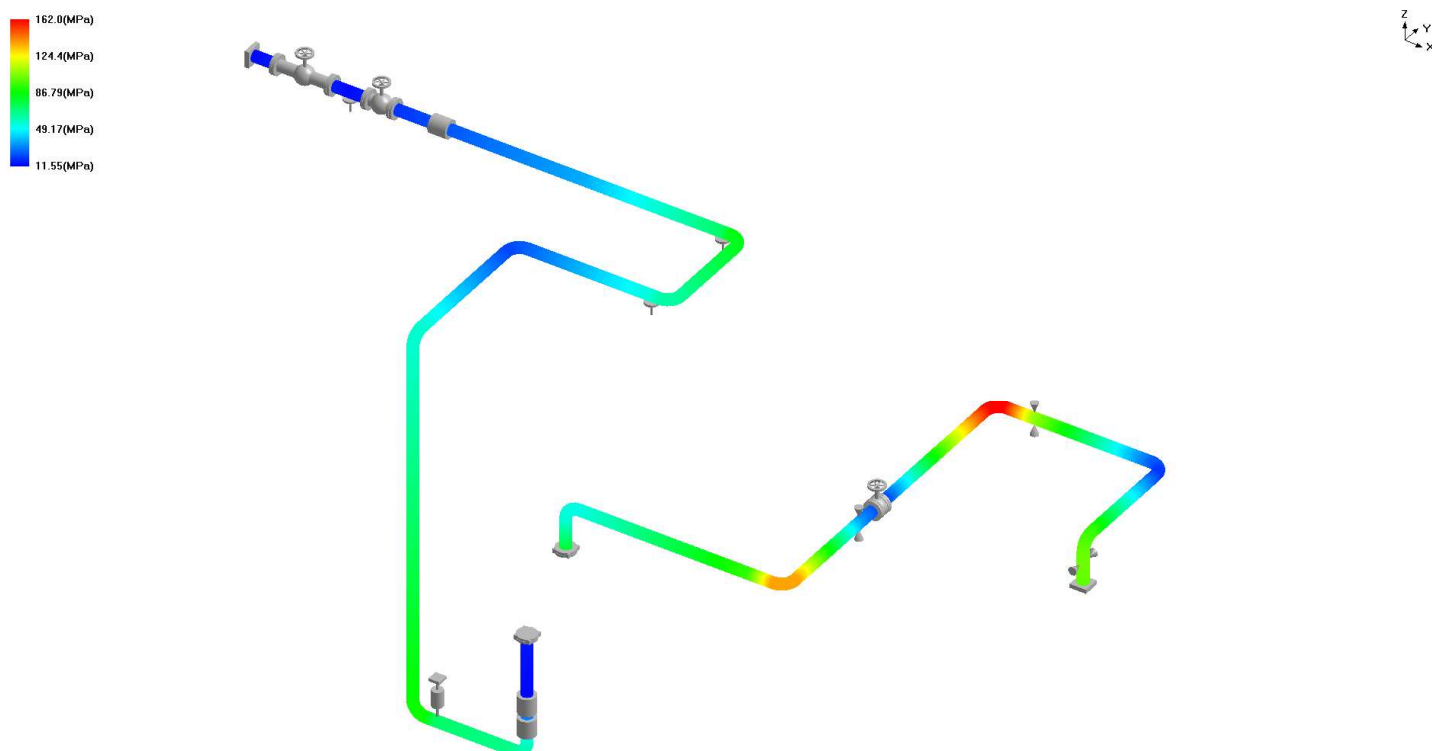
Nœud	Type de contrainte	Cas de charge	Contraintes (Mpa)		
			Calculée	Admissible	Cal/adm
260	Contrainte primaire due exclusivement au poids propre et à la pression maxi	W+Pmax	7.61	88.40	0.09
290B	Contrainte secondaire due exclusivement à l'élévation de température	T1-Tref	162	194.5	0.83

## 6. Représentation graphique des contraintes maxi calculées

### 6.1. Contraintes dues au poids propre et à la pression

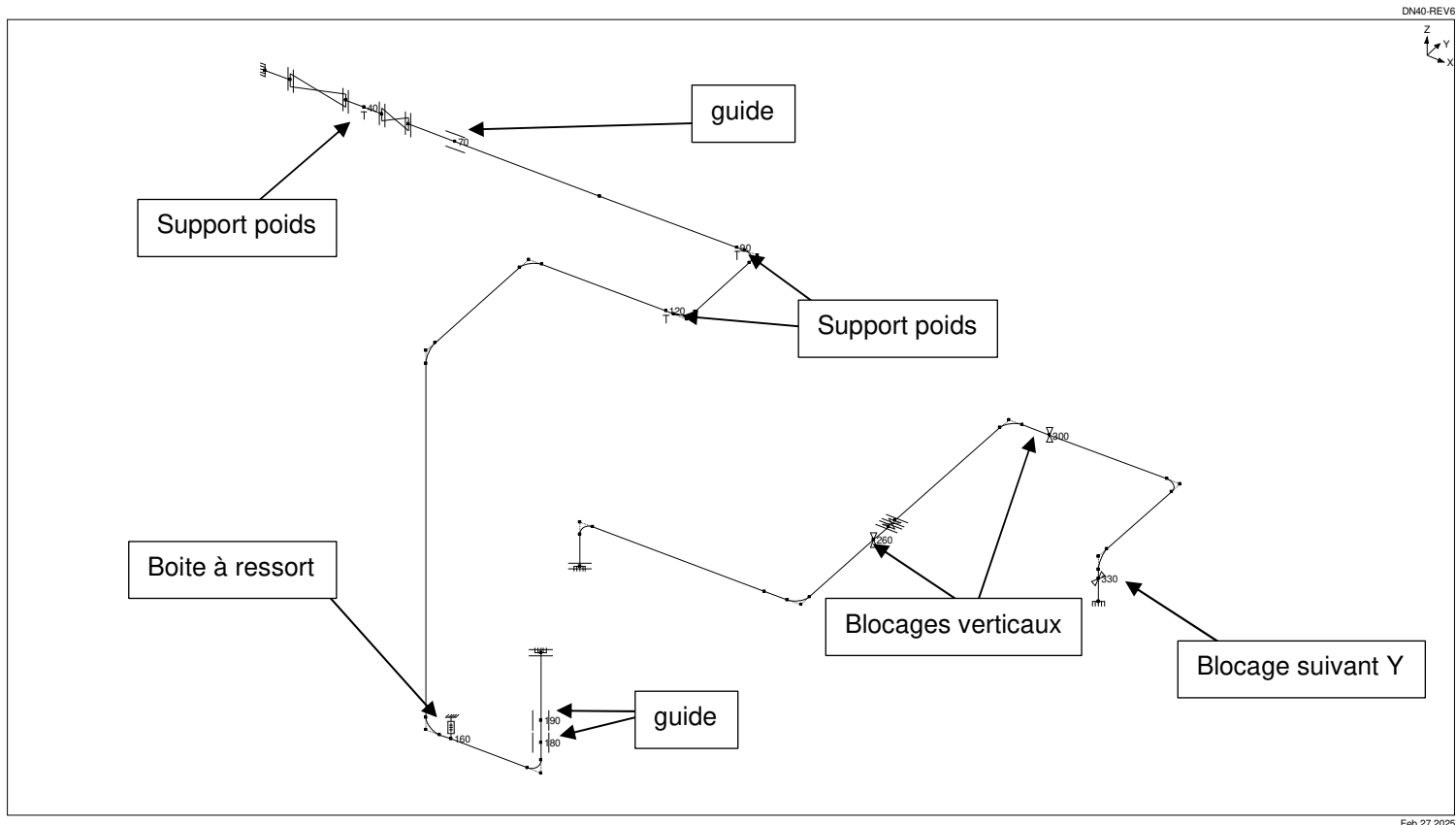


### 6.2. Contraintes dues aux dilatations thermiques



## 7. Supportage

### 7.1. Position des supports



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## 7.2. Effort sur les supports

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Support load summary for anchor at node 10												
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)			
									X (mm)	Y (mm)	Z (mm)	
Empty W	0	0	-168	0	11	0	168	11	0.000	0.000	0.000	
Sustained	0	0	-168	0	11	0	168	11	0.000	0.000	0.000	
Operating1	-817	106	-78	-75	3	29	827	80	30.000	0.000	0.000	
Maximum	0	106	-78	0	11	29	827	80	30.000	0.000	0.000	
Minimum	-817	0	-168	-75	3	0	168	11	0.000	0.000	0.000	
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000	
Support load summary for anchor at node 200												
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)			
									X (mm)	Y (mm)	Z (mm)	
Empty W	0	0	-48	0	0	1	48	1	0.000	0.000	0.000	
Sustained	0	0	-48	0	0	1	48	1	0.000	0.000	0.000	
Operating1	-45	16	1357	2	4	-73	1358	74	0.000	0.000	0.000	
Maximum	0	16	1357	2	4	1	1358	74	0.000	0.000	0.000	
Minimum	-45	0	-48	0	0	-73	48	1	0.000	0.000	0.000	
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000	
Support load summary for anchor at node 210												
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)			
									X (mm)	Y (mm)	Z (mm)	
Empty W	0	0	-97	2	6	0	97	7	0.000	0.000	0.000	
Sustained	0	0	-97	2	6	0	97	7	0.000	0.000	0.000	
Operating1	-1255	-1218	-308	199	-102	-363	1776	426	0.000	0.000	0.000	
Maximum	0	0	-97	199	6	0	1776	426	0.000	0.000	0.000	
Minimum	-1255	-1218	-308	2	-102	-363	97	7	0.000	0.000	0.000	
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000	
Support load summary for anchor at node 340												
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)			
									X (mm)	Y (mm)	Z (mm)	
Empty W	0	-90	-51	1	2	0	103	2	0.000	0.000	0.000	
Sustained	0	-90	-51	1	2	0	103	2	0.000	0.000	0.000	
Operating1	1255	-2530	-314	23	147	-658	2841	674	-4.300	0.000	0.200	
Maximum	1255	-90	-51	23	147	0	2841	674	0.000	0.000	0.200	
Minimum	0	-2530	-314	1	2	-658	103	2	-4.300	0.000	0.000	
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000	
Support load summary for guide at node 70												
Load combination	fx (N)	fy (N)	fz (N)	Displacements (global)								
				X (mm)	Y (mm)	Z (mm)						
Empty W	0	2	-172	0.000	0.000	0.000						
Sustained	0	2	-172	0.000	0.000	0.000						
Operating1	172	136	556	38.231	0.000	0.000						
Maximum	172	136	556	38.231	0.000	0.000						
Minimum	0	2	-172	0.000	0.000	0.000						
Support load summary for guide at node 180												
Load combination	fx (N)	fy (N)	fz (N)	Displacements (global)								
				X (mm)	Y (mm)	Z (mm)						
Empty W	0	-6	6	0.000	0.000	0.000						
Sustained	0	-6	6	0.000	0.000	0.000						
Operating1	-778	782	2472	0.000	0.000	-3.996						
Maximum	0	782	2472	0.000	0.000	0.000						
Minimum	-778	-6	6	0.000	0.000	-3.996						
Support load summary for guide at node 190												
Load combination	fx (N)	fy (N)	fz (N)	Displacements (global)								
				X (mm)	Y (mm)	Z (mm)						
Empty W	0	0	-11	0.000	0.000	0.000						
Sustained	0	0	-11	0.000	0.000	0.000						
Operating1	-914	-1037	-2866	0.000	0.000	-3.004						
Maximum	0	0	-11	0.000	0.000	0.000						
Minimum	-914	-1037	-2866	0.000	0.000	-3.004						
Support load summary for hanger at node 160												
Load combination	Load (N)	Displacements (global)										
		X (mm)	Y (mm)	Z (mm)								
Empty W	-224	0.000	-0.007	-0.003								
Sustained	-224	0.000	-0.007	-0.003								
Operating1	-252	-3.936	1.004	-3.482								
Maximum	-224	0.000	1.004	-0.003								
Minimum	-252	-3.936	-0.007	-3.482								

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Support load summary for limit stop at node 40 (0.000,0.000,1.000)						
Load combination	Load (N)	Friction (N)	Displacements (global)			
			X (mm)	Y (mm)	Z (mm)	
Empty W	-375	0	0.000	0.000	0.000	
Sustained	-375	0	0.000	0.000	0.000	
Operating1	-844	253	34.273	0.032	0.000	
Maximum	-375	253	34.273	0.032	0.000	
Minimum	-844	0	0.000	0.000	0.000	
Support load summary for limit stop at node 90 (0.000,0.000,1.000)						
Load combination	Load (N)	Friction (N)	Displacements (global)			
			X (mm)	Y (mm)	Z (mm)	
Empty W	-59	0	0.000	0.000	0.000	
Sustained	-59	0	0.000	0.000	0.000	
Operating1	-146	44	50.455	-4.198	0.000	
Maximum	-59	44	50.455	0.000	0.000	
Minimum	-146	0	0.000	-4.198	0.000	
Support load summary for limit stop at node 120 (0.000,0.000,1.000)						
Load combination	Load (N)	Friction (N)	Displacements (global)			
			X (mm)	Y (mm)	Z (mm)	
Empty W	-51	15	-0.014	0.006	0.000	
Sustained	-51	15	-0.014	0.006	0.000	
Operating1	0	0	44.064	-8.341	3.400	
Maximum	0	15	44.064	0.006	3.400	
Minimum	-51	0	-0.014	-8.341	0.000	
Support load summary for restraint at node 260						
Load combination	FX (N)	FY (N)	FZ (N)	Displacements (global)		
				X (mm)	Y (mm)	Z (mm)
Empty W			-203	0.003	0.000	0.000
Sustained			-203	0.003	0.000	0.000
Operating1			121	4.177	2.047	0.000
Maximum			121	4.177	2.047	0.000
Minimum			-203	0.003	0.000	0.000
Allowables			0	0.000	0.000	0.000
Support load summary for restraint at node 300						
Load combination	FX (N)	FY (N)	FZ (N)	Displacements (global)		
				X (mm)	Y (mm)	Z (mm)
Empty W			-75	0.000	0.000	0.000
Sustained			-75	0.000	0.000	0.000
Operating1			74	-4.516	10.734	0.000
Maximum			74	0.000	10.734	0.000
Minimum			-75	-4.516	0.000	0.000
Allowables			0	0.000	0.000	0.000
Support load summary for restraint at node 330						
Load combination	FX (N)	FY (N)	FZ (N)	Displacements (global)		
				X (mm)	Y (mm)	Z (mm)
Empty W		89		0.000	0.000	0.000
Sustained		89		0.000	0.000	0.000
Operating1		3748		-4.279	0.000	1.192
Maximum		3748		0.000	0.000	1.192
Minimum		89		-4.279	0.000	0.000
Allowables		0		0.000	0.000	0.000

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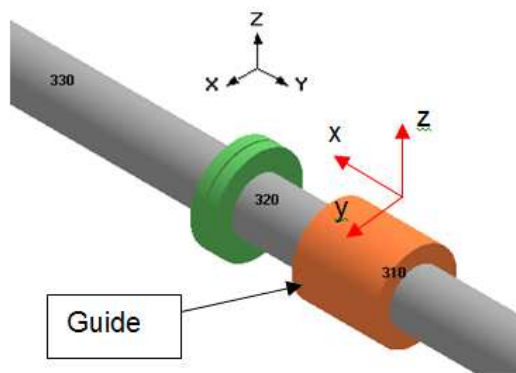
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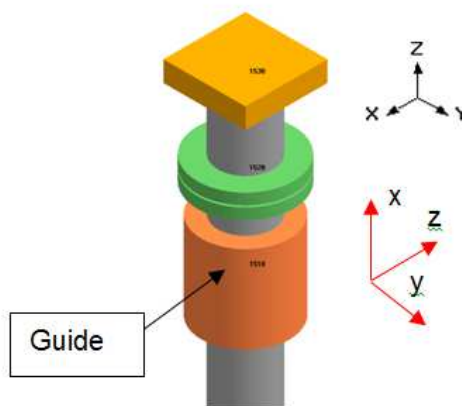
Note: FX, FY, FZ : Repère global (En noir).

fx, fy, fz : Repère local (En rouge):

- x : axe de la tuyauterie défini dans le sens de description du modèle.
- y,z : axe formant le trièdre direct.



Repère local guide horizontal



Repère local guide vertical

## 7.3. Récapitulatif

N° nœud	Type	Déplacements			Rotations		
		X	Y	Z	X	Y	Z
70	Guide	L	B	B	L	L	L
180-190	Guide	B	B	L	L	L	L
160	Boite à ressort	L	L	L	L	L	L
40-90-120	Support poids	L	L	B(-)	L	L	L
260-300	Blocage	L	L	B	L	L	L
330	Blocage	L	B	L	L	L	L

Note: B = Bloqué, L = Libre, B(-)/(+) = Bloqué dans le sens positif ou négatif.

## 8. Vérification critère d'étanchéité bride

Flange report - NC.3658.1 of ASME Section III Class 2 (2017)							
Node	Pipe NS/OD (mm)	Pressure (bar)	Bending Torsion (Nm)	Gasket diameter (mm)	Flange Pressure (bar)	Allowable Pressure (bar)	Flange Pressure Allowable
210		30.0	224	61.25	79.5	49.7	1.602
270	1-1/2"	30.0	85	61.25	48.8	49.7	0.983
60	1-1/2"	30.0	75	61.25	46.6	49.7	0.939
50	1-1/2"	30.0	75	61.25	46.6	49.7	0.939
30	1-1/2"	30.0	75	61.25	46.6	49.7	0.939
20	1-1/2"	30.0	75	61.25	46.6	49.7	0.939
200		30.0	73	61.25	46.3	49.7	0.932
280	1-1/2"	30.0	62	61.25	43.8	49.7	0.883

La pression admissible est issue de la norme ASME B16.5. Matière SA182GrF321 600#.

Compte tenu de la sévérité de ce critère, les bride ayant un ratio inférieur ou égal à 1.6 sont validées par expérience. Pour les autres, une autre méthode de calcul ou un changement de serie peut etre envisagée.

La nomenclature des bride ne communique pas de pression admissible pour ce niveau de température. ONERA, a tous de même validé l'utilisation de cette matière et à validé l'extrapolation linéaire pour obtenir une valeur de pression.

## 9. Efforts sur équipement

### 9.1. Efforts sur le pot (Nœud 200 et 210)

Support load summary for anchor at node 200											
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)		
									X (mm)	Y (mm)	Z (mm)
Empty W	0	0	-48	0	0	1	48	1	0.000	0.000	0.000
Sustained	0	0	-48	0	0	1	48	1	0.000	0.000	0.000
Operating1	-45	16	1357	2	4	-73	1358	74	0.000	0.000	0.000
Maximum	0	16	1357	2	4	1	1358	74	0.000	0.000	0.000
Minimum	-45	0	-48	0	0	-73	48	1	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000

Support load summary for anchor at node 210											
Load combination	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)	FR (N)	MR (Nm)	Displacements (global)		
									X (mm)	Y (mm)	Z (mm)
Empty W	0	0	-97	2	6	0	97	7	0.000	0.000	0.000
Sustained	0	0	-97	2	6	0	97	7	0.000	0.000	0.000
Operating1	-1255	-1218	-308	199	-102	-363	1776	426	0.000	0.000	0.000
Maximum	0	0	-97	199	6	0	1776	426	0.000	0.000	0.000
Minimum	-1255	-1218	-308	2	-102	-363	97	7	0.000	0.000	0.000
Allowables	0	0	0	0	0	0	0	0	0.000	0.000	0.000



## 10. Caractéristiques boîtes à ressort

Hanger Report										
Node	No of	Type	Figure No.	Size	Spring rate (N/mm)	Vert travel (mm)	Horz travel (mm)	Hot load (N)	Cold load (N)	Var (%)
160	1	Leega	--	21D.191	8.3009	-3.393	4.187	245	217	11

Le modèle est indiqué dans la colonne Size. Le point est à remplacer par le dernier chiffre. Par exemple, pour le nœud 160, il faut lire 21D119.

## 11. Déformations

La flèche maximum au poids propre est la suivante :

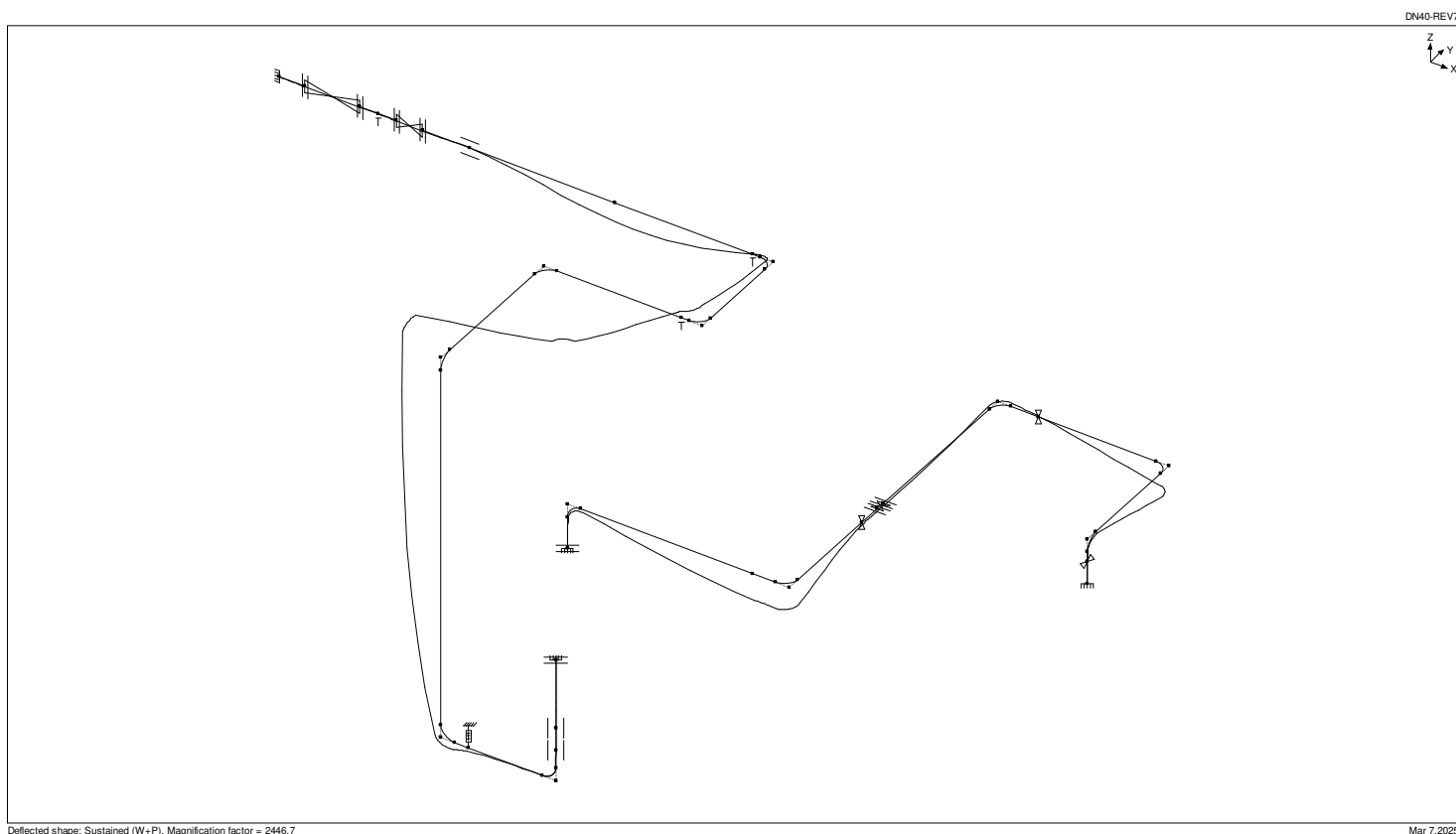
- Déplacement verticale dans la direction Z : -0.18 mm au nœud 130B

Les déplacements maximum en services sont les suivants :

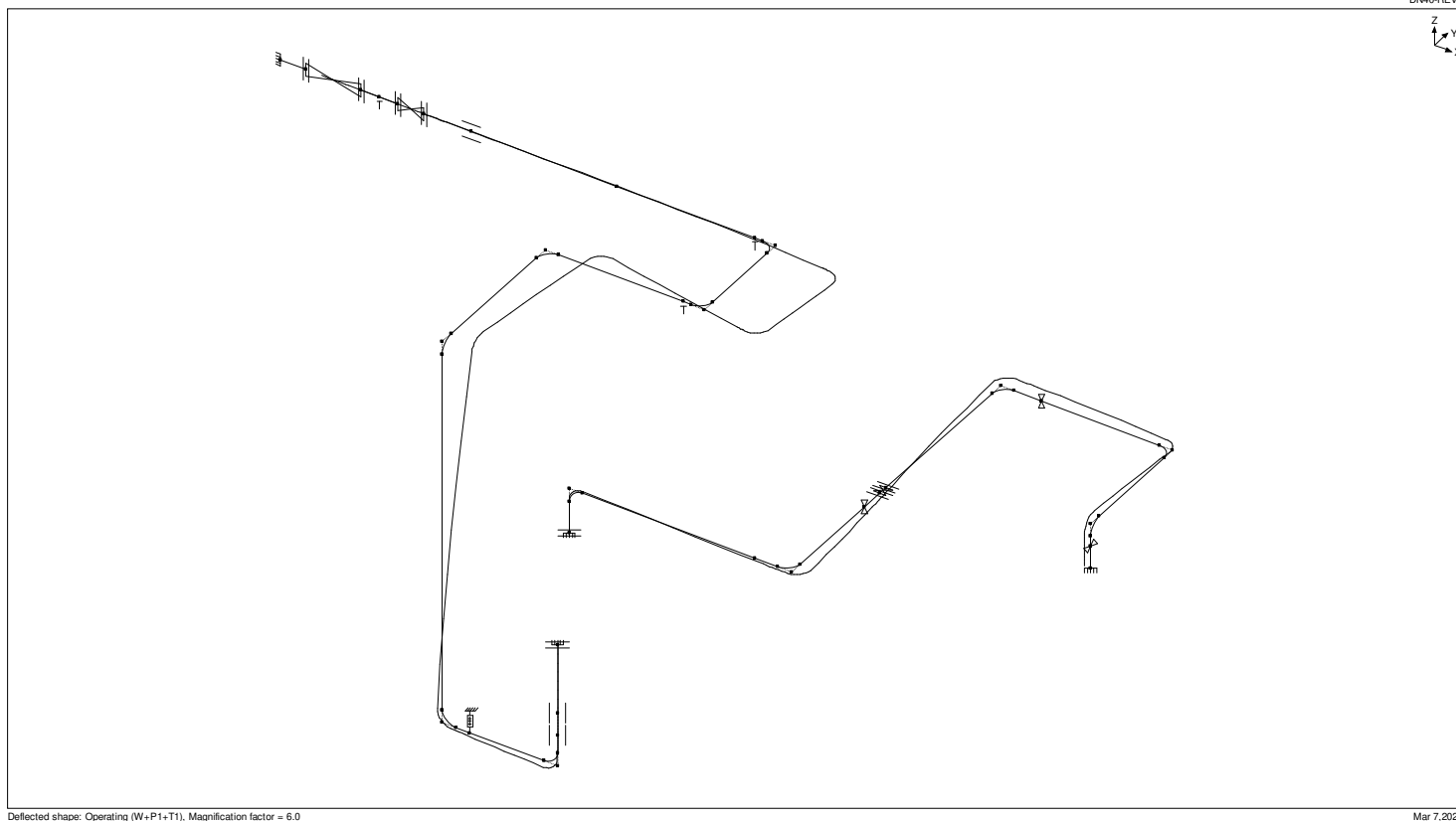
Direction			Nœud
X	Minimum (mm)	-6.12	290A
	Maximum (mm)	50.78	100A
Y	Minimum (mm)	-9.23	110A
	Maximum (mm)	11.11	290B
Z	Minimum (mm)	-5.18	170A
	Maximum (mm)	14.33	140A

Ces déplacements sont considérés comme acceptables sous réserve d'être permis par l'environnement.

### 11.1. Déformation au poids propre



**11.2. Déformation dans la situation de fonctionnement**



## 12. Conclusion

L'ensemble du réseau respecte les exigences du code de construction pour ce qui concerne les contraintes, il est donc acceptable. Il est nécessaire également de s'assurer que les efforts calculés sur les connexions des équipements sont admissibles, car aucune valeur n'a été communiquée.

### 13. Résultats annexe listing (Détailés)

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Version 13.10

Client :  
Project :  
File Number :  
Report Number :  
Model Name : DN40-REV7  
Title :  
Analyzed : Fri Mar 07 17:46:15 2025

Prepared by : \_\_\_\_\_ Date:

Checked by : \_\_\_\_\_ Date:

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## Options

Piping code = B31.3 (2022)  
Do not use liberal allowable stresses  
Include axial force in stress calculations  
Use B31J for SIFs and Flexibility Factors  
Reference temperature = 20 (C)  
Number of thermal cycles = 7000  
Number of thermal loads = 1  
Thermal = Operating - Sustained  
Use modulus at reference temperature  
Include hanger stiffness  
Include Bourdon effect to Expansion Loads  
Do not use pressure correction for bends  
Pressure stress =  $Pd^2 / (D^2 - d^2)$   
Peak pressure factor = 1.00  
Cut off frequency = 33 Hz  
Number of modes = 20  
Include missing mass correction  
Do not use friction in dynamic analysis  
Vertical direction = Z

#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Mat	Sec	Load	Data
1	Title =								
2	10	From							Anchor
3	20		110			321	40	L1	Flange
4	30	Valve	241			321	40	L1	Flange
5	40		80			321	40	L1	Rest. Supp
6	50		79			321	40	L1	Flange
7	60	Valve	114			321	40	L1	Flange
8	70		206			321	40	L1	Guide
9	80		632			321	40	L1	
10	90		600			321	40	L1	Rest. Supp
11	100	Bend	90			321	40	L1	
12	110	Bend		-480		321	40	L1	
13	120		-90			321	40	L1	Rest. Supp
14	130	Bend	-600			321	40	L1	
15	140	Bend		-688		321	40	L1	
16	150	Bend			-1700	321	40	L1	
17	160		120			321	40	L1	Hanger
18	170	Bend	380			321	40	L1	
19	180				135	321	40	L1	Guide
20	190				100	321	40	L1	Guide
21	200				303	321	40	L1	Anchor
22	200	Location							Flange
23	210	From	1962	-1090	-708				Anchor
24	210	Location							Flange
25	220	Bend			198	321	40	L1	
26	240		807			321	40	L1	
27	250	Bend	158			321	40	L1	
28	260			490		321	40	L1	Z restraint
29	270			100		321	40	L1	Flange
30	280	Valve		45		321	40	L1	Flange
31	290	Bend		765		321	40	L1	
32	300		178			321	40	L1	Z restraint

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#	Node	Type	DX (mm)	DY (mm)	DZ (mm)	Mat	Sec	Load	Data
33	310	Bend	570			321	40	L1	
34	320	Bend		-550		321	40	L1	
35	330				-100	321	40	L1	Y restraint
36	340				-100	321	40	L1	Anchor

## Anchors

Node	KX/kx	(N/mm) KY/ky	KZ/kz	KXX/kxx	(Nm/deg) KYY/kyy	KZZ/kzz	Releases X Y Z XXYYZZ	CS Level Tag
10	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid		GCS
200	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid		GCS
210	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid		GCS
340	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid		GCS

## Bends

Bend Node	Radius (mm)	Thickness (mm)	Bend Matl	Flex. Factor	Int. Node	Angle (deg)	Int. Node	Angle (deg)
100	57.15	L						
110	57.15	L						
130	57.15	L						
140	57.15	L						
150	57.15	L						
170	57.15	L						
220	57.15	L						
250	57.15	L						
290	57.15	L						
310	57.15	L						
320	57.15	L						

## Flanges

Node	Type	Weight (kg)	Gasket Dia (mm)	Bolt Circle (mm)	Allowable pressure (bar)
20	Single welded slip on	4.74	61.25		49.7
30	Single welded slip on	4.74	61.25		49.7
50	Single welded slip on	4.74	61.25		49.7
60	Single welded slip on	4.74	61.25		49.7
200	Single welded slip on	4.74	61.25		49.7
210	Single welded slip on	4.74	61.25		49.7
270	Single welded slip on	4.74	61.25		49.7
280	Single welded slip on	4.74	61.25		49.7

## Guides

Node	Friction coefficient	Stiffness (N/mm)	CNode	Gap (mm)	Level Tag
70	0.300	Rigid		0	
180	0.300	Rigid		0	
190	0.300	Rigid		0	

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## Hangers

Node	Type	No. of	Load var (%)	Short Range	SpringRate (N/mm)	HangerLoad (N)	Load type	Level Tag
160	Lisega	1	25					

## Limit stops

Node	Cnect Node	Lower Lmt (mm)	Upper Lmt (mm)	Direction X comp	Y comp	Z comp	Friction Coeff.	Stiffness (N/mm)	Level Tag	Type
40		0.000	None			1.000	0.300	Rigid		Rest. Supp
90		0.000	None			1.000	0.300	Rigid		Rest. Supp
120		0.000	None			1.000	0.300	Rigid		Rest. Supp

## Restraints

Node	X	Y	Z	Level Tag
260			Yes	
300			Yes	
330	Yes			

## Specified Displacements

Node	Type	Load	X/(mm)	Y/(mm)	Z/(mm)	XX(deg)	YY(deg)	ZZ(deg)	Disp. in
10	Anchor	Desn T1	30.000						GCS GCS
340	Anchor	Desn T1	-4.300		0.200				GCS GCS

## Valves

From	To	Weight (kg)	Length (mm)	Thick X	Insul Wgt X	Add Wght (kg)	DX (mm)	DY (mm)	DZ (mm)
20	30	25		3.00	1.75				
50	60	19		3.00	1.75				
270	280	2.2		3.00	1.75				

## Coordinates

Node	X (mm)	Y (mm)	Z (mm)
10	0	0	0
20	110	0	0
30	351	0	0
40	431	0	0
50	510	0	0
60	624	0	0
70	830	0	0
80	1462	0	0



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Coordinates			
Node	X (mm)	Y (mm)	Z (mm)
90	2062	0	0
100A	2094.85	0	0
100	2152	0	0
100B	2152	-57.15	0
110A	2152	-422.85	0
110	2152	-480	0
110B	2094.85	-480	0
120	2062	-480	0
130A	1519.15	-480	0
130	1462	-480	0
130B	1462	-537.15	0
140A	1462	-1110.85	0
140	1462	-1168	0
140B	1462	-1168	-57.15
150A	1462	-1168	-1642.85
150	1462	-1168	-1700
150B	1519.15	-1168	-1700
160	1582	-1168	-1700
170A	1904.85	-1168	-1700
170	1962	-1168	-1700
170B	1962	-1168	-1642.85
180	1962	-1168	-1565
190	1962	-1168	-1465
200	1962	-1168	-1162
210	1962	-1090	-708
220A	1962	-1090	-567.15
220	1962	-1090	-510
220B	2019.15	-1090	-510
240	2769	-1090	-510
250A	2869.85	-1090	-510
250	2927	-1090	-510
250B	2927	-1032.85	-510
260	2927	-600	-510
270	2927	-500	-510
280	2927	-455	-510
290A	2927	252.85	-510
290	2927	310	-510
290B	2984.15	310	-510
300	3105	310	-510
310A	3617.85	310	-510
310	3675	310	-510
310B	3675	252.85	-510
320A	3675	-182.85	-510
320	3675	-240	-510
320B	3675	-240	-567.15
330	3675	-240	-610
340	3675	-240	-710

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Pipe material 321: A312 TP321 SMLS<=3/8" & WLD

Density = 8027 (kg/m3), Nu = 0.300, Joint factor = 0.85, Type = AS  
Yield strength = 206.8 (MPa)  
Tensile strength = 517.1 (MPa)

Temp (C)	E (MPa)	Alpha (mm/mm/C)	Allowable (MPa)
-198.3	208911	13.50E-6	137.9
-195.6	208911	13.52E-6	137.9
-170.6	207532	13.75E-6	137.9
-128.9	204774	14.15E-6	137.9
-101.1	203395	14.40E-6	137.9
-73.33	201327	14.58E-6	137.9
-59.44	200638	14.67E-6	137.9
-48.33	199948	14.74E-6	137.9
-45.56	199259	14.76E-6	137.9
-28.89	198569	14.90E-6	137.9
-7.778	197190	15.07E-6	137.9
21.11	195122	15.30E-6	137.9
37.78	193743	15.46E-6	137.9
93.33	189606	16.02E-6	137.9
148.9	186159	16.56E-6	137.9
204.4	182022	17.10E-6	137.9
260	178574	17.46E-6	133.1
315.6	174437	17.82E-6	126.2
343.3	173058	17.91E-6	122.7
371.1	170990	18.00E-6	120.7
398.9	168922	18.18E-6	118.6
426.7	166164	18.18E-6	116.5
454.4	164095	18.36E-6	115.1
482.2	162027	18.36E-6	113.8
510	159958	18.54E-6	113.1
537.8	157201	18.54E-6	111.7
565.6	154443	18.72E-6	66.19
593.3	151685	18.72E-6	47.57
621.1	148927	18.90E-6	34.47
648.9	146169	19.08E-6	24.82
676.7	143411	19.26E-6	17.93
704.4	139964	19.26E-6	11.72
732.2	136516	19.44E-6	7.584
760	132379	19.44E-6	5.516

## Pipe Sections

Name	Nominal Dia.	Sch	O.D. (mm)	Thk (mm)	Cor.Al (mm)	M.Tol (%)	Ins.Dens (kg/m3)	Ins.Th (mm)	Lin.Dens (kg/m3)	Lin.Th (mm)	Soil
40	1-1/2"	XS	48.26	5.08	0	12.5	125	40			

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Pipe Loads												
Load	T1	P1	T2	P2	T3	P3	DT	DP	Specific	Add.Wgt	Wind 1 2 3 4	
Ice	(C)	(bar)	(C)	(bar)	(C)	(bar)	(C)	(bar)	gravity	(kg/m)	Load	
Name												
L1	552	30.0					552	30.0				
B31.3 (2022) Code Compliance (Sorted Stresses)												
Sustained			Expansion			Occasional						
Node	SL (MPa)	SL/SH	Node	SE (MPa)	SE/SA	Node	SL+SO (MPa)	SL+SO/ SHO				
260	7.613	0.09	290B	162.0	0.83							
160	7.291	0.08	290A	161.6	0.83							
70	6.988	0.08	250A	138.2	0.71							
10	6.556	0.07	250B	137.8	0.71							
40	6.487	0.07	300	109.9	0.57							
140B	6.418	0.07	330	103.1	0.53							
120	6.326	0.07	320B	102.6	0.53							
110B	6.273	0.07	340	99.97	0.51							
60	6.251	0.07	240	94.12	0.48							
80	6.200	0.07	320A	93.80	0.48							
320B	6.159	0.07	150B	88.46	0.45							
330	6.152	0.07	150A	88.17	0.45							
110A	6.090	0.07	100A	83.74	0.43							
140A	6.061	0.07	100B	82.79	0.43							
20	6.049	0.07	210	82.41	0.42							
300	5.976	0.07	90	71.45	0.37							
220A	5.933	0.07	160	70.73	0.36							
210	5.919	0.07	170A	65.95	0.34							
320A	5.869	0.07	110A	64.95	0.33							
150B	5.812	0.07	110B	60.92	0.31							
130A	5.809	0.07	170B	58.84	0.30							
130B	5.805	0.07	140B	56.68	0.29							
100A	5.750	0.07	140A	55.60	0.29							
30	5.644	0.06	220A	55.43	0.29							
220B	5.622	0.06	120	54.45	0.28							
90	5.602	0.06	220B	52.70	0.27							
50	5.584	0.06	180	44.91	0.23							
270	5.522	0.06	80	37.06	0.19							
310B	5.408	0.06	260	33.72	0.17							
240	5.383	0.06	310A	25.92	0.13							
100B	5.335	0.06	130A	25.46	0.13							
310A	5.332	0.06	70	23.53	0.12							
290B	5.331	0.06	270	22.56	0.12							
150A	5.242	0.06	130B	21.53	0.11							
340	5.238	0.06	310B	18.83	0.10							
290A	5.192	0.06	60	18.77	0.10							
170B	5.151	0.06	280	16.40	0.08							
250B	5.112	0.06	30	15.79	0.08							
250A	5.094	0.06	50	15.63	0.08							
180	5.088	0.06	20	15.23	0.08							
170A	5.033	0.06	200	14.73	0.08							
280	4.990	0.06	40	12.83	0.07							
200	4.970	0.06	10	12.44	0.06							
190	4.943	0.06	190	11.55	0.06							

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Node	Press Allow (bar)	B31.3 (2022) Code Compliance						Occasional		
		--- Sustained ---	SL	SH	SL/ SH	SE	SA	SE/ SA	SL+SO (MPa)	SHO (MPa)
10	30.0	6.556	88.40	0.07	12.44	194.5	0.06			
20	139	6.049	88.40	0.07	15.23	194.5	0.08			
30	30.0	5.644	88.40	0.06	15.79	194.5	0.08			
40	139	6.487	88.40	0.07	12.83	194.5	0.07			
40	30.0	6.487	88.40	0.07	12.65	194.5	0.07			
50	139	5.584	88.40	0.06	15.63	194.5	0.08			
60	30.0	6.251	88.40	0.07	18.77	194.5	0.10			
70	139	6.988	88.40	0.08	23.53	194.5	0.12			
70	30.0	6.988	88.40	0.08	23.31	194.5	0.12			
80	139	6.200	88.40	0.07	37.06	194.5	0.19			
80	30.0	6.200	88.40	0.07	37.06	194.5	0.19			
90	139	5.589	88.40	0.06	71.45	194.5	0.37			
90	30.0	5.602	88.40	0.06	71.40	194.5	0.37			
100A	139	5.750	88.40	0.07	73.09	194.5	0.38			
100A	30.0	5.750	88.40	0.07	83.74	194.5	0.43			
100B	139	5.335	88.40	0.06	82.79	194.5	0.43			
100B	30.0	5.335	88.40	0.06	73.25	194.5	0.38			
110A	139	6.090	88.40	0.07	60.13	194.5	0.31			
110A	30.0	6.090	88.40	0.07	64.95	194.5	0.33			
110B	139	6.273	88.40	0.07	60.92	194.5	0.31			
110B	30.0	6.273	88.40	0.07	56.12	194.5	0.29			
120	139	6.306	88.40	0.07	54.45	194.5	0.28			
120	30.0	6.326	88.40	0.07	54.43	194.5	0.28			
130A	139	5.809	88.40	0.07	24.12	194.5	0.12			
130A	30.0	5.809	88.40	0.07	25.46	194.5	0.13			
130B	139	5.805	88.40	0.07	21.53	194.5	0.11			
130B	30.0	5.805	88.40	0.07	21.20	194.5	0.11			
140A	139	6.061	88.40	0.07	48.42	194.5	0.25			
140A	30.0	6.061	88.40	0.07	55.60	194.5	0.29			
140B	139	6.418	88.40	0.07	56.68	194.5	0.29			
140B	30.0	6.418	88.40	0.07	49.61	194.5	0.26			
150A	139	5.242	88.40	0.06	74.04	194.5	0.38			
150A	30.0	5.242	88.40	0.06	88.17	194.5	0.45			
150B	139	5.812	88.40	0.07	88.46	194.5	0.45			

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B31.3 (2022) Code Compliance										
	Press Allow	--- Sustained	--- Expansion					--- Occasional		
Node	(bar)	SL (MPa)	SH (MPa)	SL/SH	SE (MPa)	SA (MPa)	SE/SA	SL+SO (MPa)	SHO (MPa)	SL+SO/SHO
150B	30.0	5.812	88.40	0.07	74.10	194.5	0.38			
160	139	7.291	88.40	0.08	70.73	194.5	0.36			
160	30.0	7.291	88.40	0.08	70.73	194.5	0.36			
170A	139	5.033	88.40	0.06	55.18	194.5	0.28			
170A	30.0	5.033	88.40	0.06	65.95	194.5	0.34			
170B	139	5.151	88.40	0.06	58.84	194.5	0.30			
170B	30.0	5.151	88.40	0.06	49.14	194.5	0.25			
180	139	5.088	88.40	0.06	44.61	194.5	0.23			
180	30.0	5.088	88.40	0.06	44.91	194.5	0.23			
190	139	4.943	88.40	0.06	11.22	194.5	0.06			
190	30.0	4.943	88.40	0.06	11.55	194.5	0.06			
200	139	4.970	88.40	0.06	14.73	194.5	0.08			
210	30.0	5.919	88.40	0.07	82.41	194.5	0.42			
220A	139	5.933	88.40	0.07	54.91	194.5	0.28			
220A	30.0	5.933	88.40	0.07	55.43	194.5	0.29			
220B	139	5.622	88.40	0.06	52.70	194.5	0.27			
220B	30.0	5.622	88.40	0.06	49.69	194.5	0.26			
240	139	5.383	88.40	0.06	94.12	194.5	0.48			
240	30.0	5.383	88.40	0.06	94.12	194.5	0.48			
250A	139	5.094	88.40	0.06	112.4	194.5	0.58			
250A	30.0	5.094	88.40	0.06	138.2	194.5	0.71			
250B	139	5.112	88.40	0.06	137.8	194.5	0.71			
250B	30.0	5.112	88.40	0.06	112.1	194.5	0.58			
260	139	7.613	88.40	0.09	33.72	194.5	0.17			
260	30.0	7.613	88.40	0.09	33.72	194.5	0.17			
270	139	5.522	88.40	0.06	22.56	194.5	0.12			
280	30.0	4.990	88.40	0.06	16.40	194.5	0.08			
290A	139	5.192	88.40	0.06	131.4	194.5	0.68			
290A	30.0	5.192	88.40	0.06	161.6	194.5	0.83			
290B	139	5.331	88.40	0.06	162.0	194.5	0.83			
290B	30.0	5.331	88.40	0.06	131.8	194.5	0.68			
300	139	5.976	88.40	0.07	109.9	194.5	0.57			
300	30.0	5.976	88.40	0.07	109.9	194.5	0.57			
310A	139	5.332	88.40	0.06	23.06	194.5	0.12			

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Node	Press Allow (bar)	B31.3 (2022) Code Compliance						Occasional		
		SL	SH	SL/SH	SE	SA	SE/SA	SL+SO	SHO	SL+SO/SHO
310A	30.0	5.332	88.40	0.06	25.92	194.5	0.13			
310B	139	5.408	88.40	0.06	18.83	194.5	0.10			
310B	30.0	5.408	88.40	0.06	18.20	194.5	0.09			
320A	139	5.869	88.40	0.07	90.95	194.5	0.47			
320A	30.0	5.869	88.40	0.07	93.80	194.5	0.48			
320B	139	6.159	88.40	0.07	102.6	194.5	0.53			
320B	30.0	6.159	88.40	0.07	100.9	194.5	0.52			
330	139	6.152	88.40	0.07	103.1	194.5	0.53			
330	30.0	6.152	88.40	0.07	103.1	194.5	0.53			
340	139	5.238	88.40	0.06	99.97	194.5	0.51			

## Loads on Anchors in Global Coordinates: Empty Weight (W)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
10	0	0	-168	0	11	0
200	0	0	-48	0	0	1
210	0	0	-97	2	6	0
340	0	-90	-51	1	2	0

## Loads on Anchors in Local Coordinates: Empty Weight (W)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
10	0	0	-168	0	11	0
200	-48	0	0	1	0	0
210	-97	0	0	0	6	-2
340	51	90	0	0	-2	-1

## Loads on Restraints: Empty Weight (W)

Node	FX (N)	FY (N)	FZ (N)
260			-203
300			-75
330		89	

## Loads on Hangers: Empty Weight (W)

Node	Type	Load (N)	No. of	Total (N)
160	Lisega	-224	1	-224

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-----  
Loads on Guides in Local Coordinates: Empty Weight (W)  
-----

Node	fx (N)	fy (N)	fz (N)	x Xcomp	x Ycomp	x Zcomp
70	0	2	-172	1.000		
180	0	-6	6			1.000
190	0	0	-11			1.000

-----  
Loads on Guides in Global Coordinates: Empty Weight (W)  
-----

Node	FX (N)	FY (N)	FZ (N)
70	0	2	-172
180	-6	-6	0
190	11	0	0

-----  
Loads on Limit Stops in Local Coordinates: Empty Weight (W)  
-----

Node	Lower Limit	Upper Limit	Load (N)	Friction Force(N)	X comp	Y comp	Z comp	Type
40	Reached	None	-375	0			1.000	Rest. Supp
90	Reached	None	-59	0			1.000	Rest. Supp
120	Reached	None	-51	15			1.000	Rest. Supp

-----  
Loads on Limit Stops in Global Coordinates: Empty Weight (W)  
-----

Node	FX (N)	FY (N)	FZ (N)	Type
40	0	0	-375	Rest. Supp
90	0	0	-59	Rest. Supp
120	-11	11	-51	Rest. Supp

-----  
Pipe element forces in local coordinates: Empty Weight (W)  
-----

Node	...In plane...				.Out of plane..			
	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF
10	0	0	-168	0	0		11	
20	0	0	-161	0	0	1.30	-7	1.30
30	0	0	183	0	0	1.30	-5	1.30
40	0	0	189	0	0		10	
40	0	-1	-186	0	0		10	
50	0	-1	-180	0	0	1.30	-4	1.30
60	0	-1	102	0	0	1.30	-9	1.30
70	0	-1	115	0	0		14	
70	0	1	-56	0	0		14	
80	0	1	-13	0	0		-8	

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Pipe element forces in local coordinates: Empty Weight (W)								
-----...In plane... .Out of plane..-----								
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF
80	0	1	-13	0	0		-8	
90	0	1	27	0	-1		-4	
90	9	0	-32	0	-1		-4	
100A	9	0	-30	0	-1		-5	
100A	9	0	30	0	1	1.23	5	1.03
100B	0	-9	24	7	1	1.23	1	1.03
100B	0	9	-24	7	-1		-1	
110A	0	9	1	7	-4		-5	
110A	0	-9	-1	7	4	1.23	5	1.03
110B	-9	0	-7	5	5	1.23	-7	1.03
110B	-9	0	7	5	-5		7	
120	-9	0	10	5	-5		7	
120	5	-6	-41	5	-5		7	
130A	5	-6	-4	5	-2		-5	
130A	5	-6	-4	5	-2	1.23	-5	1.03
130B	-6	-5	2	-5	-1	1.23	-5	1.03
130B	-6	-5	2	-5	-1		-5	
140A	-6	-5	41	-5	2		7	
140A	-6	-41	-5	-5	7	1.23	-2	1.03
140B	-47	6	-5	-2	9	1.23	5	1.03
140B	-47	-6	5	-2	-9		-5	
150A	-154	-6	5	-2	0		3	
150A	-154	-5	-6	-2	3	1.23	0	1.03
150B	-5	160	-6	-1	-5	1.23	2	1.03
150B	-5	6	160	-1	2		5	
160	-5	6	165	-1	1		16	
160	-5	6	-59	-1	1		16	
170A	-5	6	-37	-1	0		0	
170A	-5	-37	-6	-1	0	1.23	0	1.03
170B	-31	5	-6	-1	1	1.23	0	1.03
170B	-31	6	5	-1	0		-1	
180	-26	6	5	-1	0		-1	
180	-26	0	11	-1	0		-1	
190	-19	0	11	-1	0		0	



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Pipe element forces in local coordinates: Empty Weight (W)								
-----...In plane... .Out of plane..-----								
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF
190	-19	0	0	-1	0		0	
200	2	0	0	-1	0	1.30	0	1.30
210	-51	0	0	0	-2	1.30	6	1.30
220A	-41	0	0	0	-2		6	
220A	-41	0	0	0	6	1.23	2	1.03
220B	0	35	0	3	4	1.23	0	1.03
220B	0	0	-35	3	0		4	
240	0	0	16	3	0		-3	
240	0	0	16	3	0		-3	
250A	0	0	23	3	0		-1	
250A	0	0	23	3	0	1.23	-1	1.03
250B	0	0	29	1	0	1.23	-1	1.03
250B	0	0	29	1	0		-1	
260	0	0	58	1	0		18	
260	0	0	-144	1	0		18	
270	0	0	-138	1	0	1.30	4	1.30
280	0	0	-22	1	0	1.30	0	1.30
290A	0	0	26	1	0		2	
290A	0	0	-26	1	0	1.23	-2	1.03
290B	0	0	-32	-3	0	1.23	-2	1.03
290B	0	0	32	-3	0		2	
300	0	0	40	-3	0		7	
300	0	0	-35	-3	0		7	
310A	0	0	0	-3	0		-2	
310A	0	0	0	-3	0	1.23	2	1.03
310B	0	0	-6	2	0	1.23	3	1.03
310B	0	0	6	2	0		-3	
320A	0	0	35	2	0		6	
320A	0	-35	0	2	6	1.23	0	1.03
320B	-41	0	0	0	8	1.23	-2	1.03
320B	-41	0	0	0	-8		2	
330	-44	0	0	0	-8		2	
330	-44	-90	0	0	-8		2	
340	-51	-90	0	0	1		2	

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Other forces in local coordinates: Empty Weight (W)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
20	Valve	0	0	-114	0	-7	0
30		0	0	137	0	-5	0
50	Valve	0	-1	-134	0	-4	0
60		0	-1	55	0	-9	0
270	Valve	0	0	-91	1	4	0
280		0	0	-69	1	0	0

Loads on Anchors in Global Coordinates: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
10	0	0	-168	0	11	0
200	0	0	-48	0	0	1
210	0	0	-97	2	6	0
340	0	-90	-51	1	2	0

Loads on Anchors in Local Coordinates: Sustained (W+P)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
10	0	0	-168	0	11	0
200	-48	0	0	1	0	0
210	-97	0	0	0	6	-2
340	51	90	0	0	-2	-1

Loads on Restraints: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)
260			-203
300			-75
330		89	

Loads on Hangers: Sustained (W+P)

Node	Type	Load(N)	No.of	Total (N)
160	Lisega	-224	1	-224

Loads on Guides in Local Coordinates: Sustained (W+P)

Node	fx (N)	fy (N)	fz (N)	x Xcomp	x Ycomp	x Zcomp
70	0	2	-172	1.000		
180	0	-6	6			1.000
190	0	0	-11			1.000

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Loads on Guides in Global Coordinates: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)
70	0	2	-172
180	-6	-6	0
190	11	0	0

Loads on Limit Stops in Local Coordinates: Sustained (W+P)

Node	Lower Limit	Upper Limit	Load (N)	Friction Force(N)	X comp	Y comp	Z comp	Type
40	Reached	None	-375	0			1.000	Rest. Supp
90	Reached	None	-59	0			1.000	Rest. Supp
120	Reached	None	-51	15			1.000	Rest. Supp

Loads on Limit Stops in Global Coordinates: Sustained (W+P)

Node	FX (N)	FY (N)	FZ (N)	Type
40	0	0	-375	Rest. Supp
90	0	0	-59	Rest. Supp
120	-11	11	-51	Rest. Supp

Pipe element forces in local coordinates: Sustained (W+P)

Node	...In plane...				.Out of plane..				SL (MPa)
	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	
10	0	0	-168	0	0		11		6.556
20	0	0	-161	0	0	1.30	-7	1.30	6.049
30	0	0	183	0	0	1.30	-5	1.30	5.644
40	0	0	189	0	0		10		6.487
40	0	-1	-186	0	0		10		6.487
50	0	-1	-180	0	0	1.30	-4	1.30	5.584
60	0	-1	102	0	0	1.30	-9	1.30	6.251
70	0	-1	115	0	0		14		6.988
70	0	1	-56	0	0		14		6.988
80	0	1	-13	0	0		-8		6.200
80	0	1	-13	0	0		-8		6.200
90	0	1	27	0	-1		-4		5.589
90	9	0	-32	0	-1		-4		5.602
100A	9	0	-30	0	-1		-5		5.750
100A	9	0	30	0	1	1.23	5	1.03	5.750
100B	0	-9	24	7	1	1.23	1	1.03	5.335

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Pipe element forces in local coordinates: Sustained (W+P)									
-----In plane... Out of plane.-----									
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	SL (MPa)
100B	0	9	-24	7	-1		-1		5.335
110A	0	9	1	7	-4		-5		6.090
110A	0	-9	-1	7	4	1.23	5	1.03	6.090
110B	-9	0	-7	5	5	1.23	-7	1.03	6.273
110B	-9	0	7	5	-5		7		6.273
120	-9	0	10	5	-5		7		6.306
120	5	-6	-41	5	-5		7		6.326
130A	5	-6	-4	5	-2		-5		5.809
130A	5	-6	-4	5	-2	1.23	-5	1.03	5.809
130B	-6	-5	2	-5	-1	1.23	-5	1.03	5.805
130B	-6	-5	2	-5	-1		-5		5.805
140A	-6	-5	41	-5	2		7		6.061
140A	-6	-41	-5	-5	7	1.23	-2	1.03	6.061
140B	-47	6	-5	-2	9	1.23	5	1.03	6.418
140B	-47	-6	5	-2	-9		-5		6.418
150A	-154	-6	5	-2	0		3		5.242
150A	-154	-5	-6	-2	3	1.23	0	1.03	5.242
150B	-5	160	-6	-1	-5	1.23	2	1.03	5.812
150B	-5	6	160	-1	2		5		5.812
160	-5	6	165	-1	1		16		7.291
160	-5	6	-59	-1	1		16		7.291
170A	-5	6	-37	-1	0		0		5.033
170A	-5	-37	-6	-1	0	1.23	0	1.03	5.033
170B	-31	5	-6	-1	1	1.23	0	1.03	5.151
170B	-31	6	5	-1	0		-1		5.151
180	-26	6	5	-1	0		-1		5.088
180	-26	0	11	-1	0		-1		5.088
190	-19	0	11	-1	0		0		4.943
190	-19	0	0	-1	0		0		4.943
200	2	0	0	-1	0	1.30	0	1.30	4.970
210	-51	0	0	0	-2	1.30	6	1.30	5.919
220A	-41	0	0	0	-2		6		5.933
220A	-41	0	0	0	6	1.23	2	1.03	5.933
220B	0	35	0	3	4	1.23	0	1.03	5.622

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Pipe element forces in local coordinates: Sustained (W+P)									
-----In plane... .Out of plane.-----									
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	SL (MPa)
220B	0	0	-35	3	0		4		5.622
240	0	0	16	3	0		-3		5.383
240	0	0	16	3	0		-3		5.383
250A	0	0	23	3	0		-1		5.094
250A	0	0	23	3	0	1.23	-1	1.03	5.094
250B	0	0	29	1	0	1.23	-1	1.03	5.112
250B	0	0	29	1	0		-1		5.112
260	0	0	58	1	0		18		7.613
260	0	0	-144	1	0		18		7.613
270	0	0	-138	1	0	1.30	4	1.30	5.522
280	0	0	-22	1	0	1.30	0	1.30	4.990
290A	0	0	26	1	0		2		5.192
290A	0	0	-26	1	0	1.23	-2	1.03	5.192
290B	0	0	-32	-3	0	1.23	-2	1.03	5.331
290B	0	0	32	-3	0		2		5.331
300	0	0	40	-3	0		7		5.976
300	0	0	-35	-3	0		7		5.976
310A	0	0	0	-3	0		-2		5.332
310A	0	0	0	-3	0	1.23	2	1.03	5.332
310B	0	0	-6	2	0	1.23	3	1.03	5.408
310B	0	0	6	2	0		-3		5.408
320A	0	0	35	2	0		6		5.869
320A	0	-35	0	2	6	1.23	0	1.03	5.869
320B	-41	0	0	0	8	1.23	-2	1.03	6.159
320B	-41	0	0	0	-8		2		6.159
330	-44	0	0	0	-8		2		6.152
330	-44	-90	0	0	-8		2		6.152
340	-51	-90	0	0	1		2		5.238

Other forces in local coordinates: Sustained (W+P)							
-----							
Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
20	Valve	0	0	-114	0	-7	0
30		0	0	137	0	-5	0

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Other forces in local coordinates: Sustained (W+P)

Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
50	Valve	0	-1	-134	0	-4	0
60		0	-1	55	0	-9	0
270	Valve	0	0	-91	1	4	0
280		0	0	-69	1	0	0

Loads on Anchors in Global Coordinates: Operating (W+P1+T1)

Node	FX (N)	FY (N)	FZ (N)	MX (Nm)	MY (Nm)	MZ (Nm)
10	-817	106	-78	-75	3	29
200	-45	16	1357	2	4	-73
210	-1255	-1218	-308	199	-102	-363
340	1255	-2530	-314	23	147	-658

Loads on Anchors in Local Coordinates: Operating (W+P1+T1)

Node	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
10	-817	106	-78	-75	3	29
200	1357	16	45	-73	4	-2
210	-308	-1218	1255	-363	-102	-199
340	314	2530	-1255	658	-147	-23

Loads on Restraints: Operating (W+P1+T1)

Node	FX (N)	FY (N)	FZ (N)
260			121
300			74
330		3748	

Loads on Hangers: Operating (W+P1+T1)

Node	Type	Load (N)	No. of	Total (N)
160	Lisega	-252	1	-252

Loads on Guides in Local Coordinates: Operating (W+P1+T1)

Node	fx (N)	fy (N)	fz (N)	x Xcomp	x Ycomp	x Zcomp
70	172	136	556	1.000		
180	-778	782	2472			1.000
190	-914	-1037	-2866			1.000

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Loads on Guides in Global Coordinates: Operating (W+P1+T1)									
Node	FX (N)	FY (N)	FZ (N)						
70	172	136	556						
180	-2472	782	-778						
190	2866	-1037	-914						
Loads on Limit Stops in Local Coordinates: Operating (W+P1+T1)									
Node	Lower Limit	Upper Limit	Load (N)	Friction Force(N)	X comp	Y comp	Z comp	Type	
40	Reached	None	-844	253			1.000	Rest. Supp	
90	Reached	None	-146	44			1.000	Rest. Supp	
120	Not Reachd	None					1.000	Rest. Supp	
Loads on Limit Stops in Global Coordinates: Operating (W+P1+T1)									
Node	FX (N)	FY (N)	FZ (N)	Type					
40	-179	179	-844	Rest. Supp					
90	-31	31	-146	Rest. Supp					
120	0	0	0	Rest. Supp					
Pipe element forces in local coordinates: Operating (W+P1+T1)									
	...In plane...				.Out of plane..				
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	Sopr (MPa)
10	-817	106	-78	-75	29		3		13.71
20	-817	106	-70	-75	17	1.30	-5	1.30	12.83
30	-817	106	274	-75	-9	1.30	19	1.30	13.06
40	-817	106	279	-75	-17		41		15.20
40	-563	106	-565	-75	-17		41		15.45
50	-563	106	-560	-75	-25	1.30	-3	1.30	13.66
60	-563	106	-278	-75	-38	1.30	-51	1.30	17.51
70	-563	106	-264	-75	-60		-107		24.87
70	-392	242	292	-75	-60		-107		25.09
80	-392	242	335	-75	-213		91		40.27
80	-392	242	335	-75	-213		91		40.27
90	-392	242	376	-75	-358		305		74.91
90	-349	239	230	-75	-358		305		74.97
100A	-349	239	232	-75	-366		312		76.57
100A	-349	-239	-232	-75	366	1.23	-312	1.03	76.57
100B	-239	349	-238	-326	360	1.23	61	1.03	75.99

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Pipe element forces in local coordinates: Operating (W+P1+T1)									
-----...In plane... .Out of plane..-----									
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	Sopr (MPa)
100B	-239	-349	238	-326	-360		-61		75.99
110A	-239	-349	263	-326	-232		30		62.24
110A	-239	349	-263	-326	232	1.23	-30	1.03	62.24
110B	349	239	-269	-45	198	1.23	310	1.03	60.45
110B	349	-239	269	-45	-198		-310		60.45
120	349	-239	271	-45	-191		-302		58.72
120	349	-239	271	-45	-191		-302		58.72
130A	349	-239	308	-45	-61		-144		29.46
130A	349	-239	308	-45	-61	1.23	-144	1.03	29.46
130B	-239	-349	314	-127	-27	1.23	63	1.03	23.90
130B	-239	-349	314	-127	-27		63		23.90
140A	-239	-349	353	-127	173		255		53.62
140A	-239	-353	-349	-127	255	1.23	-173	1.03	53.62
140B	-359	239	-349	-193	261	1.23	107	1.03	54.38
140B	-359	-239	349	-193	-261		-107		54.38
150A	-467	-239	349	-193	117		447		78.17
150A	-467	-349	-239	-193	447	1.23	-117	1.03	78.17
150B	-349	473	-239	-131	440	1.23	179	1.03	77.33
150B	-349	239	473	-131	179		-440		77.33
160	-349	239	477	-131	164		-410		72.57
160	-349	239	225	-131	164		-410		72.57
170A	-349	239	247	-131	87		-334		58.90
170A	-349	247	-239	-131	334	1.23	87	1.03	58.90
170B	253	349	-239	73	300	1.23	117	1.03	54.15
170B	253	239	349	73	117		-300		54.15
180	258	239	349	73	99		-273		49.52
180	-518	1021	2821	73	99		-273		48.43
190	-511	1021	2821	73	-3		9		12.29
190	-1424	-16	-45	73	-3		9		11.73
200	-1403	-16	-45	73	2	1.30	-4	1.30	11.46
210	-261	-1218	1255	-363	-199	1.30	-102	1.30	65.65
220A	-252	-1218	1255	-363	-27		75		56.19
220A	-252	-1255	-1218	-363	75	1.23	27	1.03	56.19
220B	-1255	246	-1218	-42	133	1.23	293	1.03	51.18



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Pipe element forces in local coordinates: Operating (W+P1+T1)									
-----...In plane... .Out of plane..-----									
Node	Axial (N)	y shear (N)	z shear (N)	Torque (Nm)	Bend.Moment (Nm)	SIF	Bend.Moment (Nm)	SIF	Sopr (MPa)
220B	-1255	-1218	-246	-42	-293		133		51.18
240	-1255	-1218	-195	-42	621		-33		95.43
240	-1255	-1218	-195	-42	621		-33		95.43
250A	-1255	-1218	-188	-42	743		-52		113.8
250A	-1255	-1218	-188	-42	743	1.23	-52	1.03	113.8
250B	-1218	1255	-182	-62	741	1.23	32	1.03	113.5
250B	-1218	1255	-182	-62	741		32		113.5
260	-1218	1255	-152	-62	198		-41		34.45
260	-1218	1255	-32	-62	198		-41		34.45
270	-1218	1255	-25	-62	73	1.30	-43	1.30	18.27
280	-1218	1255	91	-62	16	1.30	-42	1.30	13.53
290A	-1218	1255	139	-62	-872		39		132.9
290A	-1218	-1255	-139	-62	872	1.23	-39	1.03	132.9
290B	-1255	1218	-145	-47	874	1.23	54	1.03	133.1
290B	-1255	-1218	145	-47	-874		-54		133.1
300	-1255	-1218	153	-47	-727		-36		111.2
300	-1255	-1218	227	-47	-727		-36		111.2
310A	-1255	-1218	262	-47	-102		89		24.25
310A	-1255	1218	-262	-47	102	1.23	-89	1.03	24.25
310B	1218	1255	-268	-104	-39	1.23	32	1.03	21.03
310B	1218	-1255	268	-104	39		-32		21.03
320A	1218	-1255	298	-104	586		91		95.89
320A	1218	-298	-1255	-104	91	1.23	-586	1.03	95.89
320B	-304	-1218	-1255	-658	178	1.23	33	1.03	102.4
320B	-304	1218	1255	-658	-178		-33		102.4
330	-307	1218	1255	-658	-230		21		104.9
330	-307	-2530	1255	-658	-230		21		104.9
340	-314	-2530	1255	-658	23		147		101.0
340	-314	-2530	1255	-658	23		147		101.0
-----									
Other forces in local coordinates: Operating (W+P1+T1)									
-----									
Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)		
20	Valve	-817	106	-24	-75	-5	17		
30		-817	106	227	-75	19	-9		

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Other forces in local coordinates: Operating (W+P1+T1)							
Node	Type	fx (N)	fy (N)	fz (N)	mx (Nm)	my (Nm)	mz (Nm)
50	Valve	-563	106	-513	-75	-3	-25
60		-563	106	-324	-75	-51	-38
270	Valve	-1218	1255	22	-62	-43	73
280		-1218	1255	44	-62	-42	16

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