Tutorial on Reduction of Support Loads with Cold Spring using CAEPIPE

General

Cold spring (cut short or cut long) is used to reduce thermal forces on equipment connected to the piping system. When lengths of pipes are cut short or extended by design, they are pulled together or pushed apart to join them during installation, giving rise to a "cold-sprung" system.

Such an installation process (cold condition) obviously introduces stresses, which are relieved when the system starts up (hot condition). Note however, that the piping codes do not allow credit for any reduction in stresses due to cold spring since the displacement range is unaffected (similar to self-springing). But, codes allow reduction in support loads due to cold spring (which can be helpful at the equipment).

This feature should be used only with a proper understanding of the implications.

The intent of this tutorial is to provide a guideline on reducing the operating load on equipment connections by using the Cold Springs.

Tutorial

Step 1:

Attached are two sample CAEPIPE stress models of a Cold Reheat Piping system connecting the PSV Header to the Turbine Nozzles with and without Cold Spring.

Model 1: ColdReheatPiping_without_ColdSpring.mod

For this model, let us note the following.

- 1. Nodes 10 and 470 connect to PSV Headers.
- 2. Nodes 400 and 870 connect to Turbine Nozzles.
- 3. No Cold Springs (Cut Pipes) are used in the piping connecting to the Turbine Nozzles.

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#	Node	Туре	DX (ft'in")	DY (ft"in")	DZ (ft'in*)	Matl	Sect	Load	Data	Y
79	380	Location							User SIF	× ** - 7
80	390	Bend	1.4142	1.4142		С	24	R		
81	400	Bend		7.8490		С	24	R		
82	North T	urbine No	zzle							z sta i
83	410	Cut pipe			-3'0"	С	24	R	Anchor	
84	410	Location							User SIF	
85	Branch	from CRH	to branch t	o condense	er					
86	350	From								
87	420			-1'5"		С	24T	R		67
88	430			-0'10-1/2"		С	24	R		i 🥵
89	440			-0'7-1/2"		в	4	R	Welding tee	
90	450			-1'0"		В	4	R		
91	Include	20 lb weig	ht contribut	tion for NPS	1 inch and	valve:	в,			
92	460			-0'6"		В	1	R	Conc mass	
93										
94	SOUTH	HLEAD								
95	470	From	-30'0"	231'8"	212'6"				Anchor	
96	470	Location							User SIF	
97	Hange	r Fig 81-H,	Size 58; HL	= 8742 lb						
98	480		-10'10"	-0.0520		С	24	R	User hanger	
99	480	Location							Conc mass	
100	490	Bend	-4.1719	-0.0169		С	24	R		
101	Downs	tream end	of PSV hea	ader						<u>wh</u>
102	500			-0.0114	-3.0200	С	24	R		
103	Branch	to PSV								
104	510			-0.0061	-1.2613	С	HDR	R		
105	Branch	to PSV								Second Second
106	520		1	-0.0120	-2.5000	С	HDR	R		
107	Branch	to PSV								
108	530			-0.0120	-2.5000	С	HDR	R		
										<u>ــــــــــــــــــــــــــــــــــــ</u>

Model 2: ColdReheatPiping_with_ColdSpring.mod

This model is same as Model 1 except that two Cold Springs are added in the piping connecting to the Turbine Nozzles as given below.

- 1. A Cut Pipe between Nodes 400 & 410 which is cut short by 4 inch
- 2. A Cut Pipe between Nodes 860 & 870 which is cut short by 4 inch.

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#	Node	Туре	DX (ft'in")	DY (ft'in")	DZ (ft'in")	Matl	Sect	Load	Data	Y
79	380	Location							User SIF	× * * - 7
80	390	Bend	1.4142	1.4142		С	24	R		
81	400	Bend		7.8490		С	24	R		
82	North T	Furbine No	zzle							x vita i
83	410	Cut pipe			-3'0"	С	24	R	Anchor	
84	410	Location							User SIF	
85	Branch	from CRH	to branch t	to condense	er					
86	350	From								
87	420			-1'5"		С	24T	R		50 F
88	430			-0'10-1/2"		С	24	R		ii
89	440			-0'7-1/2"		в	4	R	Welding tee	
90	450			-1'0"		В	4	R		
91	Include	20 lb weig	ht contribut	tion for NPS	1 inch and	valve	s			
92	460			-0'6"		В	1	R	Conc mass	
93										
94	SOUTH	H LEAD								
95	470	From	-30'0"	231'8"	212'6"				Anchor	
96	470	Location							User SIF	
97	Hange	r Fig 81-H,	Size 58; HL	_ = 8742 lb						
98	480		-10'10"	-0.0520		С	24	R	User hanger	
99	480	Location							Conc mass	
100	490	Bend	-4.1719	-0.0169		С	24	R		1 1
101	Downs	tream end	of PSV hea	ader						h h
102	500			-0.0114	-3.0200	С	24	R		
103	Branch	to PSV								
104	510			-0.0061	-1.2613	IC	HDR	R		× 27
105	Branch	to PSV								
106	520			-0.0120	-2.5000	C	HDR	R		
107	Branch	to PSV								
108	530			-0.0120	-2.5000	С	HDR	R		
-										

H	Caepip	e : Cut p	oipes (2) -	[coldrehe	eatpipin	g_with	—	\times
File	Edit	View	Options N	Misc W	/indow	Help		
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#	From	То	Cut (inch)	Type				
1	400	410	4	Short				
2	860	870	4	Short				

Step 2:

Material, Section and Load properties of the two models are identical. They are given below for reference.

101	Caepipe : N		_	o >	<										
File	File Edit View Options Misc Window Help														
#															
#	Name	Description	Ty pe	Density (lb/in3)	Nu	Joint factor	Yield (psi)	Tensile (psi)	#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)		
1	В	A106 Grade B	CS	0.283	0.3	1.00			1	70	29.3E+6	6.40E-6	20000		
2	С	A106 Grade C	CS	0.283	0.3	1.00			2	700	25.3E+6	7.60E-6	19070		
3	0	A106 Grade B	CS	0.0	0.3	1.00			3	720	25.0E+6	7.64E-6	18830		
4									4						

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#	Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (Ib/ft3)	Ins.Thk (inch)	Lin.Den: (lb/ft3)	s Lin. Thk (inch)	. Soil			
1	24	Non Std		24	0.585		12.5	11.4	3						
2	HDR	Non Std		26.876	1.758		12.5	11.4	3						
3	24T	Non Std		24	0.735		12.5	11.4	3						
4	8	Non Std		8.625	0.331		12.5	11.4	3						
5	880	8''	80	8.625	0.5		12.5								
6	4	4''	40	4.5	0.237		12.5	11.4	1.5						
7	PSV	Non Std		8.75	1.375			11.4	3						
8	1	1''	40	1.315	0.133		12.5								
9	POT	10"	40	10.75	0.365		12.5	11.4	1.5						
10															
-0-	Caepi	pe : Load	s (3)	- [Cold	Reheat	:Piping	_With_C	ColdSpring).res (C:\`	Futori	_		×		
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+			Ē	<u>i</u>	2	н		← •	⇒						
#	Name	T1 P1 (F) (psi)	Desg (F)	g.T Desi (psi)	g.Pr.S	pecific ravity	Add.Wg (lb/ft)	gt. Wind Load 1	Wind Load 2	Wind Load 3	Wind Load 4				
1	R	675 540	675	540											
2	Р	675 540	675	540			64								
3	L	450 0	450	0											

Step 3:

When the Cold Spring (Cut Pipe) is defined in the stress model, Cold Spring load cases will appear automatically in the Loads menu (under Load cases).

Load cases (4)	×					
☑ Sustained (W+P)	Cold spring (W+P)					
🔲 Empty Weight (W)	Cold spring (W+P1+T1)					
💌 Expansion (T1)	Cold spring (W+PD+TD)					
Operating (W+P1+T1)	🔲 Static seismic 1 (g's)					
🔲 Design (W+PD+TD)	🔲 Modal analysis					
OK Cancel	All None					

For analysis, select the desired Cold Spring load cases from those shown. Please note, the Hanger selection procedure does not consider the cold spring since the selection is based on the first Operating (W+P1+T1) load case. However, if Cold Spring is used, the hanger loads for the Cold Spring load cases [for example, Cold Spring (W+P1+T1)] will include the effect of the Cold Spring.

Once the required load cases are selected, perform Analyses of both the models using CAEPIPE.

Step 4:

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		Susta	uned			Expan	sion									
#	Node	SL (psi)	SH (psi)	SL SH	Node	SE (psi)	SA (psi)	SE SA								
1	930	7842	16746	0.47	930	33882	35249	0.96								
2	780	8117	19107	0.42	1070	19901	36378	0.55								
3	470	8038	19107	0.42	1020	15753	38567	0.41								
4	10	8007	19107	0.42	1030A	11251	39728	0.28								
5	1070	6736	16746	0.40	1000	9106	37936	0.24								
6	110	7313	19107	0.38	1040	9333	39642	0.24								
7	570	7137	19107	0.37	580A	10058	43581	0.23								
8	330	7078	19107	0.37	1030B	8955	39791	0.23								
9	790	7023	19107	0.37	970	8762	39546	0.22								
10	320	7015	19107	0.37	490B	9926	45603	0.22								
11	20	6860	19107	0.36	580B	9731	45480	0.21								
12	480	6850	19107	0.36	30B	9044	45458	0.20								
13	120A	6836	19107	0.36	10	8226	41745	0.20								
14	770	6786	19107	0.36	470	7935	41713	0.19								
14	770	6786	19107	0.36	470	7935	41713	0.19								~
14 Filt (770 Caepipe :	6786 B31.1 (19107 (2022) Co	0.36 ode co	470 mpliance	7935 (Sorted	41713 stresses)	0.19 - [coldre	eheatpip	oing_wit	hout_col	ldsprin	g.res (-	0	×
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14 File	770 Caepipe : Results Node 930 780	6786 B31.1 (View Suste SL (psi) 7842 8117	19107 (2022) Cc Option ined SH (psi) 16746 19107	0.36 ode co ns W SL SH 0.47 0.42	470 mpliance indow	7935 (Sorted Help Expan SE (psi) 33882 19901	41713 stresses) ston SA (psi) 35249 36378	0.19 - [coldred SE SA 0.96 0.55 0.41	eheatpip	ping_wit	hout_co	ldsprin	g.res (-		×
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#	Node	Press. Allow. (psi)	SL (psi)	ustaineo SH (psi)	d SL SH	Ex SE (psi)	pansior SA (psi)	n SE SA	
1	10 20	540 829	8007 6859	19107 19107	0.42 0.36	8226 6304	41745 42917	0.20 0.15	
2	20 30A	540 829	6860 6412	19107 19107	0.36 0.34	6304 6240	42916 43375	0.15 0.14	
3	30A 30B	540 1046	5516 4372	19107 19107	0.29 0.23	6219 9044	44289 45458	0.14 0.20	
4	30B 40	540 829	5396 5399	19107 19107	0.28 0.28	5570 5566	44411 44409	0.13	
5	40 50	540 2292	1747 1838	19107 19107	0.09 0.10	1673 1599	48138 48046	0.03	
6	50 60	540 2292	1843 2003	19107 19107	0.10 0.10	1599 1451	48040 47877	0.03	
7	60 70	540 2292	2004 2084	19107 19107	0.10 0.11	1451 1303	47876 47794	0.03	
8	70 80	540 2292	2085 2085	19107 19107	0.11 0.11	1303 1227	47794 47793	0.03	
			0500			4000	40000		~
HDR (Caepipe : Results	B31.1 (2 View	022) Co	ode Com	pliance	e - [cold	reheatpi	iping_without_coldspring.res (c:\tutorials\colds — 🛛	×
File	Caepipe : Results	B31.1 (2 View	022) Co Option	ode Com	pliance dow	e - [cold Help	reheatpi	piping_without_coldspring.res (c:\tutorials\colds — 🗆	×
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File	Caepipe : Results	B31.1 (2 View Press. Allow. (psi)	022) Co Option	ode Com ns Win ustaine SH (psi)	plianco dow (A) (SL) SL	E - [cold Help Ex SE (psi)	reheatpij	piping_without_coldspring.res (c:\tutorials\colds – piping_without_coldspring.res (c:\tutorials\colds – piping_without_colds – piping_without_colds	×
File # 1	Caepipe : Results	B31.1 (2 View Press. Allow. (psi) 540 829	022) Co Option SL (psi) 8007 6859	ode Com ns Win ustaine SH (psi) 19107 19107	pliance dow d SL SH 0.42 0.36	E - [cold Help Ex SE (psi) 8226 6304	reheatpi pansion SA (psi) 41745 42917	piping_without_coldspring.res (c:\tutorials\colds — □	×
	Caepipe : Results Node 10 20 30A	B31.1 (2 View Press. Allow. (psi) 540 829 540 829	022) Co Option S SL (psi) 8007 6859 6860 6412	ode Com ns Win ustaine SH (psi) 19107 19107 19107 19107	pliance dow d <u>SL</u> <u>SH</u> 0.36 0.36 0.34	E - [cold Help Ex SE (psi) 8226 6304 6304 6304	reheatpi pansion SA (psi) 41745 42917 42916 43375	piping_without_coldspring.res (c:\tutorials\colds —	×
	Caepipe : Results Node 10 20 20 30A 30A 30B	B31.1 (2 View Press. Allow. (psi) 540 829 540 829 540 1046	022) Co Option SL (psi) 8007 6859 6860 6412 5516 4372	ade Com ns Win ECT SH (psi) 19107 19107 19107 19107 19107 19107	pliance dow d SL SH 0.42 0.36 0.36 0.34 0.29 0.23	E - [cold Help SE (psi) 8226 6304 6304 6304 6219 9044	reheatpin pansion SA (psi) 41745 42917 42916 43375 44289 45458	siping_without_coldspring.res (c:\tutorials\colds — □ m SE SA 0.20 0.15 0.15 0.14 0.20	×
•II File # 1 2 3 4 1	Caepipe : Results Node 10 20 20 30A 30A 30B 40	B31.1 (2 View Press. Allow. (psi) 540 829 540 829 540 1046 540 829	022) Cc Option SL (psi) 8007 6859 6860 6412 5516 4372 5396 5399	ustaine SH (psi) 19107 19107 19107 19107 19107 19107 19107 19107 19107	pliance dow d SL SH 0.36 0.36 0.34 0.29 0.23 0.28 0.28	E - [cold Help SE (psi) 8226 6304 6304 6304 6240 6219 9044 5570 5566	reheatpi pansio SA (psi) 41745 42916 43375 44289 45458 44411 44409	siping_without_coldspring.res (c:\tutorials\colds — □ an	×
•II File # 1 2 3 4 5	Caepipe : Results Node 10 20 30A 30A 30B 40 40 50	B31.1 (2 View Press. Allow. (psi) 540 829 540 829 540 1046 540 829 540 2292	022) Cc Option S SL (psi) 8007 6859 6860 6412 5516 4372 5396 5399 1747 1838	ade Com ns Win ECT SH (psi) 19107 19107 19107 19107 19107 19107 19107 19107 19107 19107	pliance dow d SL SH 0.42 0.36 0.36 0.34 0.29 0.23 0.28 0.28 0.28 0.28 0.28 0.28	 Cold Help Ex SE (psi) 8226 6304 6304 6304 6240 6219 9044 5570 5566 1673 1599 	reheatpi pansion SA (psi) 41745 42916 43375 4289 45458 44411 44409 48138 48046	siping_without_coldspring.res (c:\tutorials\colds — □ an	×
•II File # 1 2 3 4 5 6 6	Caepipe : Results Node 10 20 30A 30A 30B 30B 40 40 50 50 60	B31.1 (2 View Press. Allow. (psi) 540 829 540 1046 540 1046 540 829 540 1046 540 2292 540 2292	022) Co Option S SL (psi) 8007 6859 6860 6412 5516 4372 5396 5399 1747 1838 1843 2003	bde Com ns Win ustaine SH (psi) 19107	pliance dow d SL SH 0.42 0.36 0.34 0.29 0.23 0.28 0.28 0.28 0.28 0.28 0.29 0.10 0.10 0.10	E - [cold Help SE (psi) 8226 6304 6304 6304 6219 9044 5570 5566 1673 1599 1599 1451	reheatpin pansion SA (psi) 41745 42917 42916 43375 44289 45458 44411 44409 48138 48046 48040 48040 47877	siping_without_coldspring.res (c:\tutorials\colds — □ pn	×
# File # 1 2 3 4 5 6 7	Caepipe : Results Node 10 20 30A 30B 30B 30B 40 40 50 50 60 70	B31.1 (2 View Press. Allow. (psi) 540 829 540 829 540 1046 540 829 540 2292 540 2292 540 2292 540 2292	022) Co Option S SL (psi) 8007 6859 6860 6412 5516 4372 5396 5399 1747 1838 1843 2003 2004 2084	Dede Com ns Win Uustaine SH (psi) 19107	pliance dow d SL SH 0.42 0.36 0.36 0.34 0.29 0.23 0.28 0.28 0.28 0.28 0.29 0.10 0.10 0.10 0.10 0.11	E - [cold Help SE (psi) 8226 6304 6304 6304 6240 6219 9044 5570 5566 1673 1599 1599 1451 1303	reheatpin pansion SA (psi) 41745 42916 43375 44289 45458 44411 44409 48138 48046 48040 47877 47876 47794	siping_without_coldspring.res (c:\tutorials\colds —	×

From the Sorted Stresses and Code Compliance results (shown above) obtained from the two models, it is noted that the stresses for Sustained and Expansion Load cases are identical between the two models.

This confirms the statement that the piping codes do not allow credit for any reduction in stresses due to cold spring since the displacement range is unaffected.

•II• Caepipe : Suppor	rt load sumr	mary for and	hor at node	410 - [cold	reheatpipin	g_with_colds	pring.res (c:\tut —		×
File Results View	Options	Window	Help						
# 🔳 🖹		<u>i a</u>							
Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)			
Sustained	4	-2379	407	-471	-1784	-4616			
Cold spring1	161	-638	-654	4455	6479	-18092			
Maximum	161	-638	407	4455	6479	-4616			
Minimum	4	-2379	-654	-471	-1784	-18092			
Allowables	0	0	0	0	0	0			
		,		440 5 1		·		_	~
File Besults View	ontions	Mindow	hor at node	2410 - [cold	ireheatpipir	ig_without_c	coldspring.res (—	U	~
File Results View		window							
							>		
Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)			
Sustained	4	-2379	407	-471	-1784	-4616			
Operating1	112	-1106	-2411	27512	-4726	-19266			
Maximum	112	-1106	407	27512	-1784	-4616			
Minimum	4	-2379	-2411	-471	-4726	-19266			
Allowables	0	0	0	0	0	0			
•II• Caepipe : Suppo	rt load sumr	nary for and	hor at node	870 - [cold	reheatpipin	a with colds	spring.res (c:\tut —	Ο	×
File Results View	Options	Window	Help						
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					' ≣↓ ^				
Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)			
Sustained	-12	-2835	19	1127	1476	-9390			
Cold spring1	691	-1310	-768	4316	28624	-5562			
Maximum	691	-1310	19	4316	28624	-5562			
Minimum	-12	-2835	-768	1127	1476	-9390			
Allowables	0	0	0	0	0	0			
	-+	6		070 []-	J			-	~
File Decide View		mary for and	nor at node	870 - Icolo	areneatpipir	ig_without_c	oldspring.res (—		^
File Results View	Options	window	нер						
		<u>i</u> (2)					>		
Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)			
Sustained	-12	-2835	19	1127	1476	-9390			
Operating1	835	-1428	-3448	35565	12802	462			
Maximum	835	-1428	19	35565	12802	462			
Minimum	-12	-2835	-3448	1127	1476	-9390			
Allowables	0	0	0	0	0	0			

Now from the Support Load Summary results obtained from the two models (shown above), it is to be noted that the Forces and <u>Moment MX for Cold Spring 1 [= Operating 1 (W+P1+T1) + Cold Spring] for the model with Cold Springs are considerably low</u> compared to the Forces and <u>Moment MX for Operating 1</u> (W+P1+T1) for the model without Cold Springs.

This effectively confirms that the operating load on equipment connections can be reduced using the Cold Springs.