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

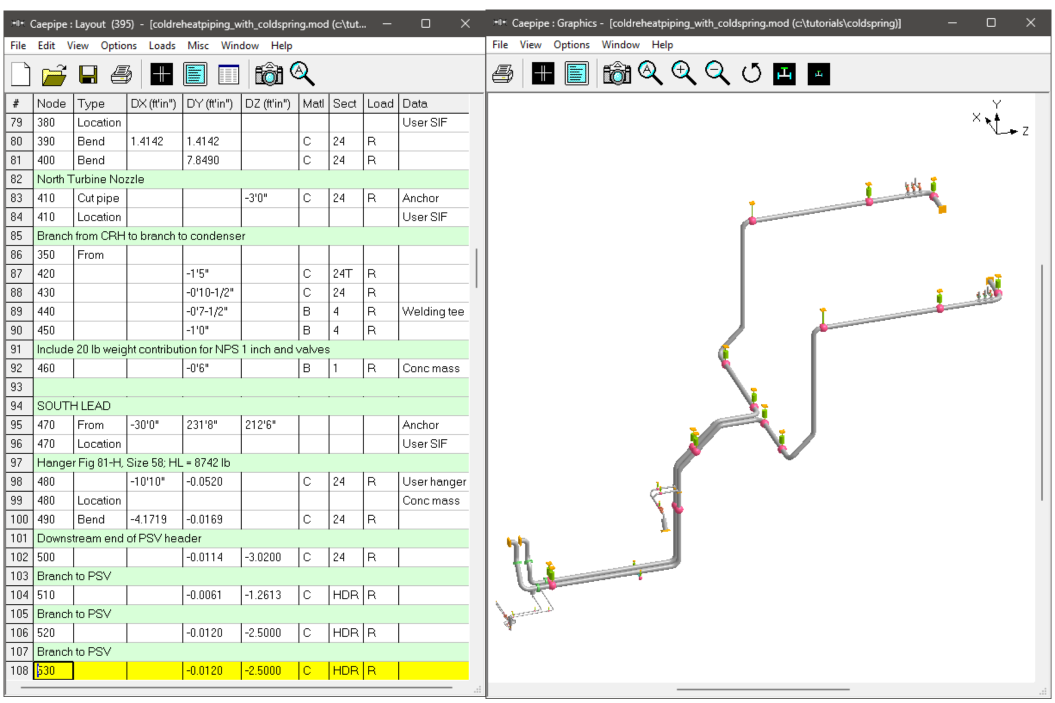
Step 1:

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.

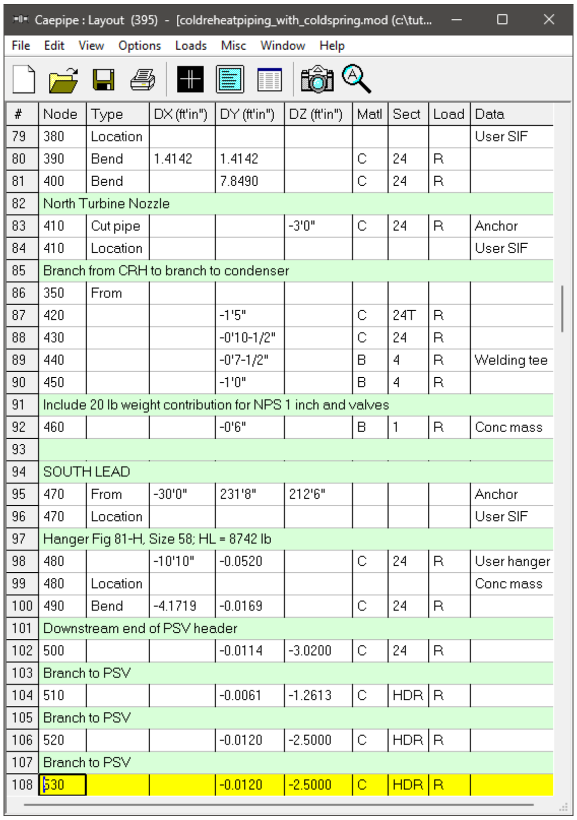
1. Nodes 10 and 470 connect to PSV Headers.
2. Nodes 400 and 870 connect to Turbine Nozzles.
3. No Cold Springs (Cut Pipes) are used in the piping connecting to the Turbine Nozzles.



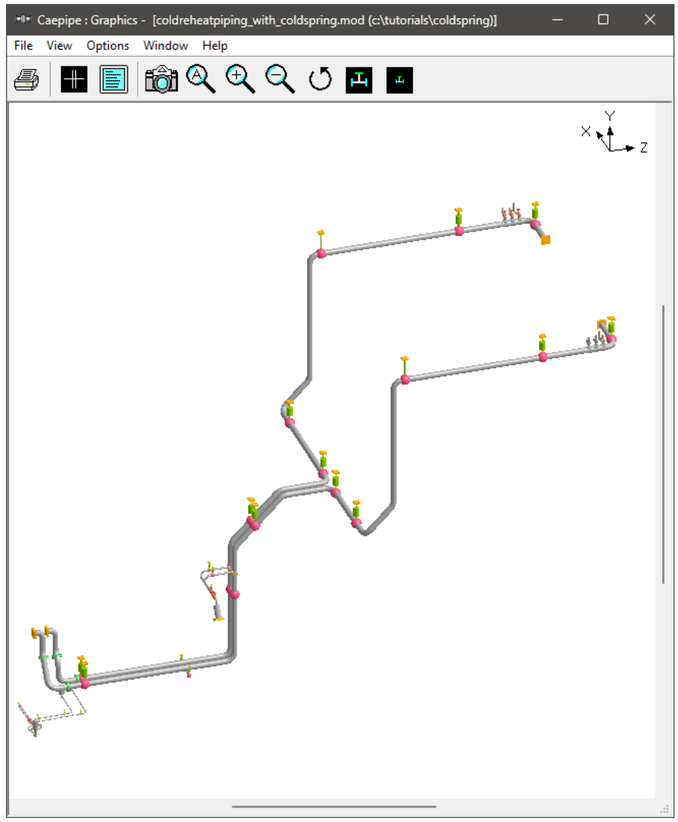
Model 2: ColdReheatPiping_with_ColdSpring.mod

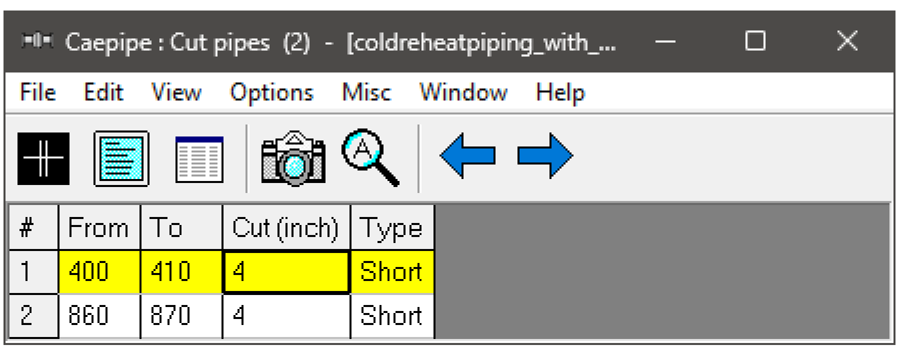
This model is same as Model 1 except that two Cold Springs are added in the piping connecting to the Turbine Nozzles as given below.

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.



#	Node	Type	DX (ft'in")	DY (ft'in")	DZ (ft'in")	Matl	Sect	Load	Data
79	380	Location							User SIF
80	390	Bend	1.4142	1.4142		C	24	R	
81	400	Bend		7.8490		C	24	R	
82	North Turbine Nozzle								
83	410	Cut pipe			-3'0"	C	24	R	Anchor
84	410	Location							User SIF
85	Branch from CRH to branch to condenser								
86	350	From							
87	420			-1'5"		C	24T	R	
88	430			-0'10-1/2"		C	24	R	
89	440			-0'7-1/2"		B	4	R	Welding tee
90	450			-1'0"		B	4	R	
91	Include 20 lb weight contribution for NPS 1 inch and valves								
92	460			-0'6"		B	1	R	Conc mass
93									
94	SOUTH LEAD								
95	470	From	-30'0"	231'8"	212'6"				Anchor
96	470	Location							User SIF
97	Hanger Fig 81-H, Size 58; HL = 8742 lb								
98	480		-10'10"	-0.0520		C	24	R	User hanger
99	480	Location							Conc mass
100	490	Bend	-4.1719	-0.0169		C	24	R	
101	Downstream end of PSV header								
102	500			-0.0114	-3.0200	C	24	R	
103	Branch to PSV								
104	510			-0.0061	-1.2613	C	HDR	R	
105	Branch to PSV								
106	520			-0.0120	-2.5000	C	HDR	R	
107	Branch to PSV								
108	530			-0.0120	-2.5000	C	HDR	R	

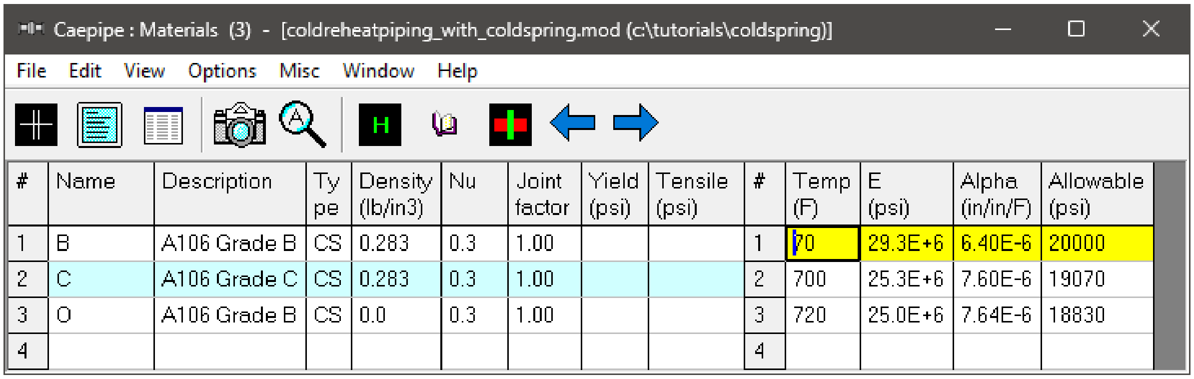




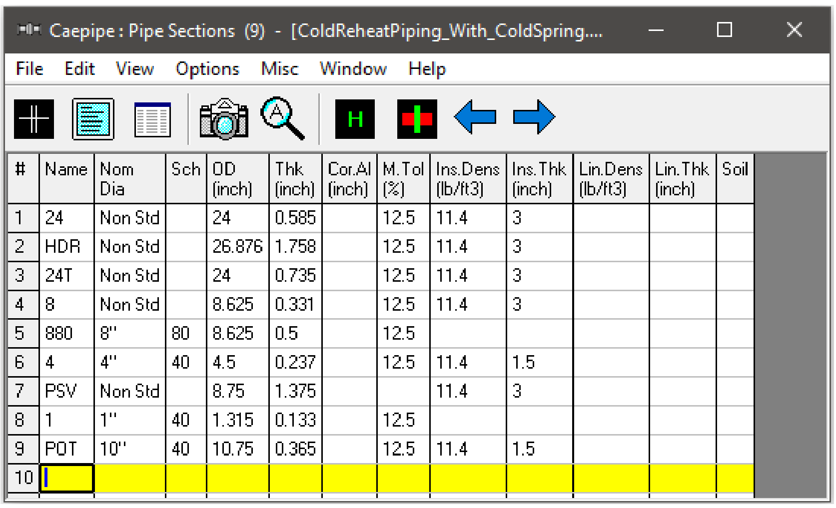
#	From	To	Cut (inch)	Type
1	400	410	4	Short
2	860	870	4	Short

Step 2:

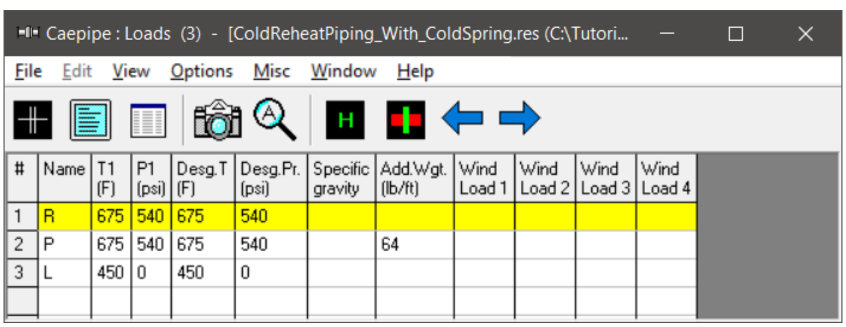
Material, Section and Load properties of the two models are identical. They are given below for reference.



#	Name	Description	Type	Density (lb/in3)	Nu	Joint factor	Yield (psi)	Tensile (psi)	#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	B	A106 Grade B	CS	0.283	0.3	1.00			1	70	29.3E+6	6.40E-6	20000
2	C	A106 Grade C	CS	0.283	0.3	1.00			2	700	25.3E+6	7.60E-6	19070
3	O	A106 Grade B	CS	0.0	0.3	1.00			3	720	25.0E+6	7.64E-6	18830
4									4				



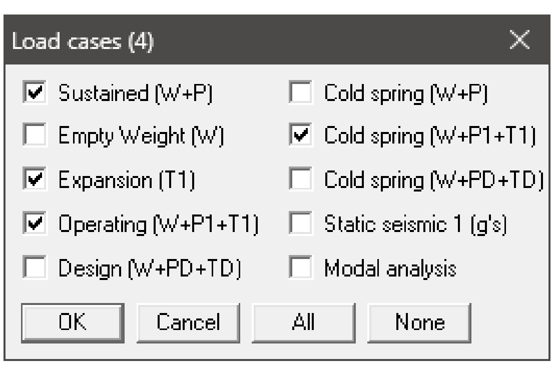
#	Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (lb/ft3)	Ins.Thk (inch)	Lin.Dens (lb/ft3)	Lin.Thk (inch)	Soil
1	24	Non Std		24	0.585		12.5	11.4	3			
2	HDR	Non Std		26.876	1.758		12.5	11.4	3			
3	24T	Non Std		24	0.735		12.5	11.4	3			
4	8	Non Std		8.625	0.331		12.5	11.4	3			
5	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												



#	Name	T1 (F)	P1 (psi)	Desg.T (F)	Desg.Pr. (psi)	Specific gravity	Add.Wgt. (lb/ft)	Wind Load 1	Wind Load 2	Wind Load 3	Wind Load 4
1	R	675	540	675	540						
2	P	675	540	675	540		64				
3	L	450	0	450	0						

Step 3:

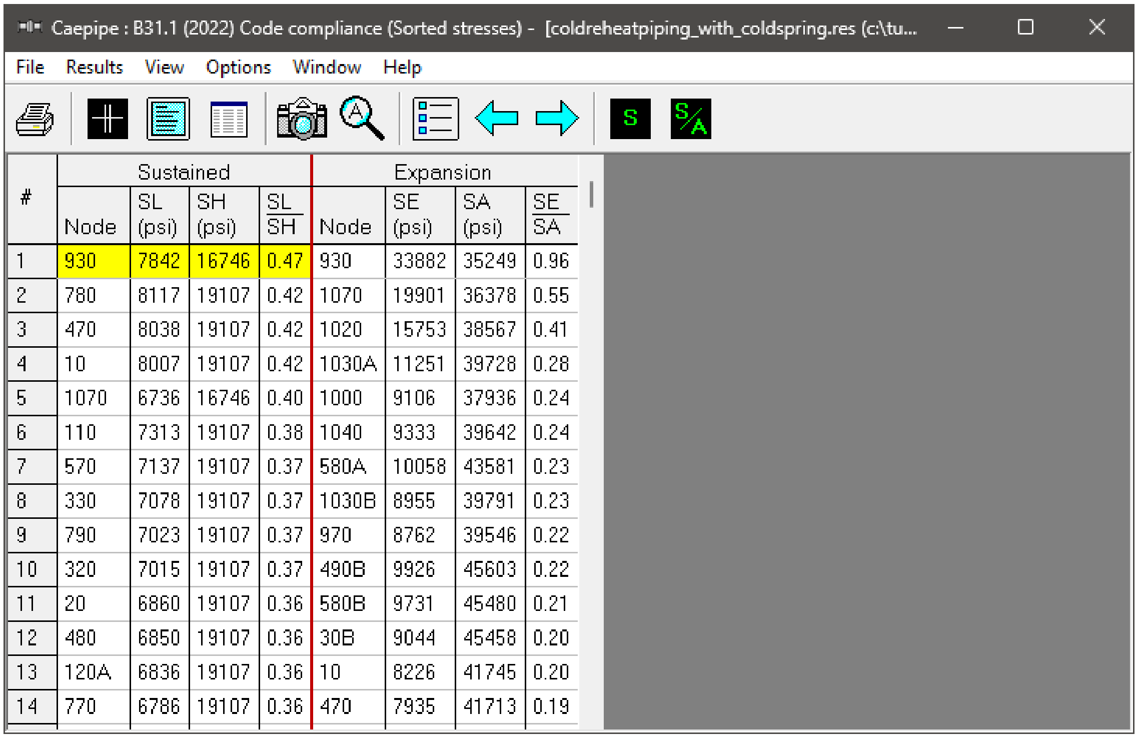
When the Cold Spring (Cut Pipe) is defined in the stress model, Cold Spring load cases will appear automatically in the Loads menu (under Load cases).



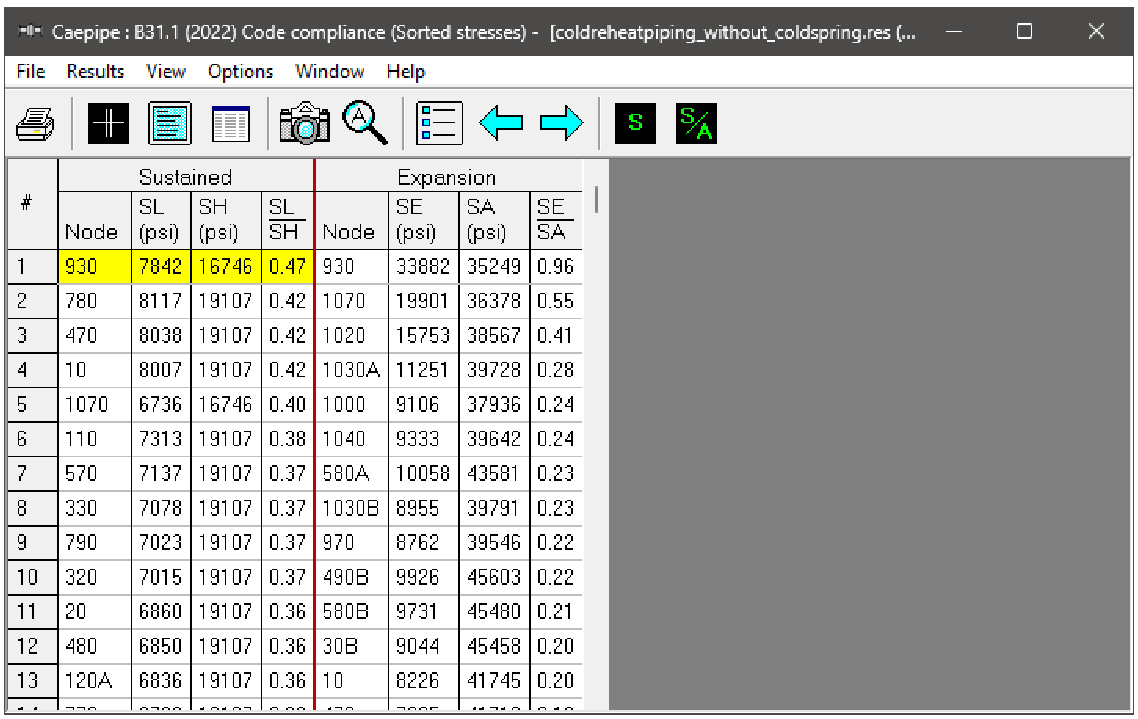
For analysis, select the desired Cold Spring load cases from those shown. Please note, the Hanger selection procedure does not consider the cold spring since the selection is based on the first Operating (W+P1+T1) load case. However, if Cold Spring is used, the hanger loads for the Cold Spring load cases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



#	Sustained				Expansion			
	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



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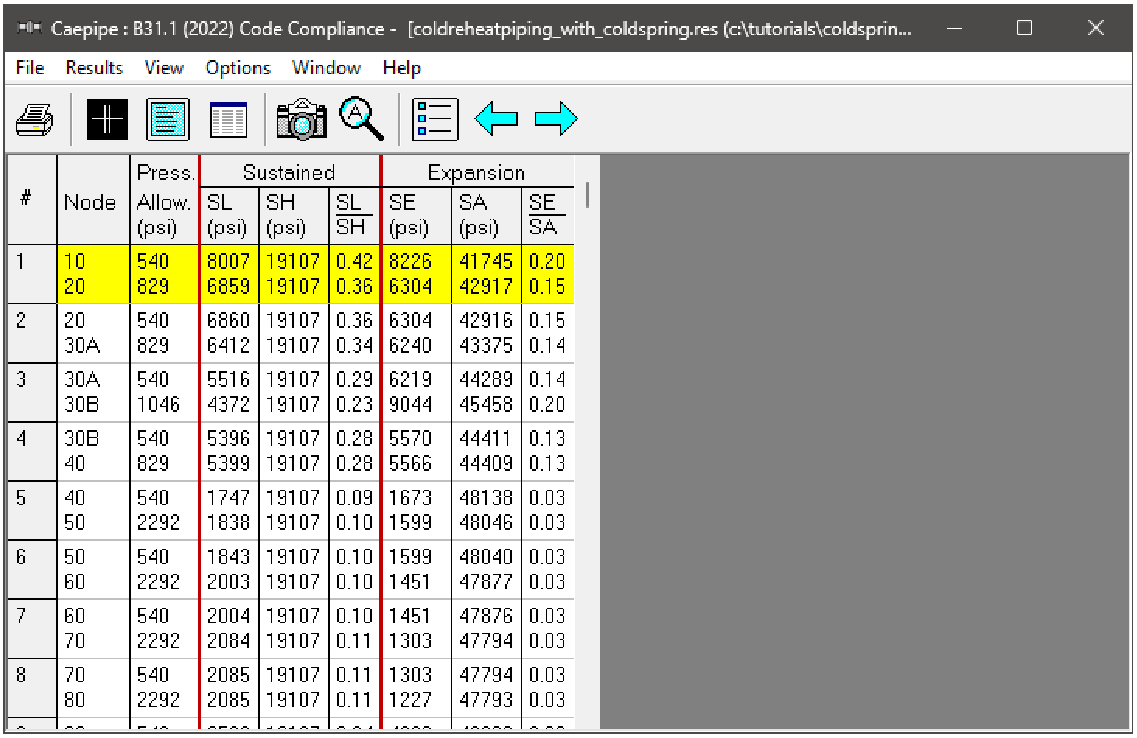
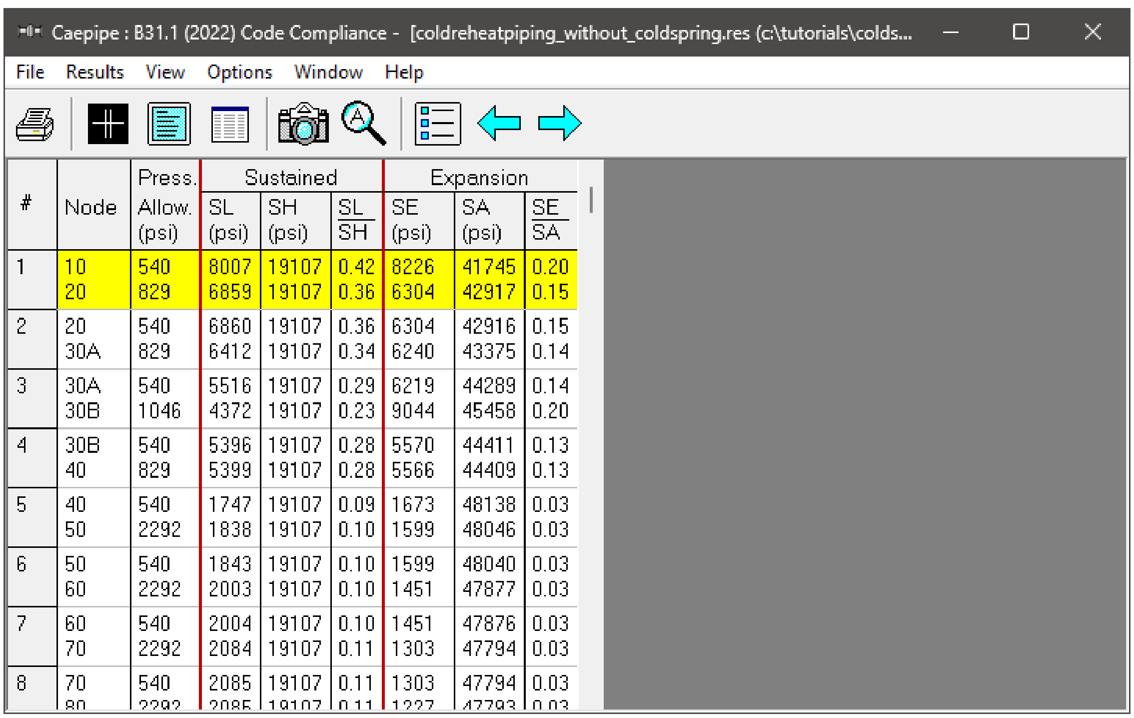


#	Node	Press. Allow. (psi)	Sustained SL (psi)	Sustained SH (psi)	Sustained SL/SH	Expansion SE (psi)	Expansion SA (psi)	Expansion SE/SA
1	10	540	8007	19107	0.42	8226	41745	0.20
	20	829	6859	19107	0.36	6304	42917	0.15
2	20	540	6860	19107	0.36	6304	42916	0.15
	30A	829	6412	19107	0.34	6240	43375	0.14
3	30A	540	5516	19107	0.29	6219	44289	0.14
	30B	1046	4372	19107	0.23	9044	45458	0.20
4	30B	540	5396	19107	0.28	5570	44411	0.13
	40	829	5399	19107	0.28	5566	44409	0.13
5	40	540	1747	19107	0.09	1673	48138	0.03
	50	2292	1838	19107	0.10	1599	48046	0.03
6	50	540	1843	19107	0.10	1599	48040	0.03
	60	2292	2003	19107	0.10	1451	47877	0.03
7	60	540	2004	19107	0.10	1451	47876	0.03
	70	2292	2084	19107	0.11	1303	47794	0.03
8	70	540	2085	19107	0.11	1303	47794	0.03
	80	2292	2085	19107	0.11	1227	47793	0.03



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	60	2292	2003	19107	0.10	1451	47877	0.03
7	60	540	2004	19107	0.10	1451	47876	0.03
	70	2292	2084	19107	0.11	1303	47794	0.03
8	70	540	2085	19107	0.11	1303	47794	0.03

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.

Step 5:

Caepipe : Support load summary for anchor at node 410 - [coldreheatpiping_with_coldspring.res (c:\tut...

File Results View Options Window Help

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

Caepipe : Support load summary for anchor at node 410 - [coldreheatpiping_without_coldspring.res (...

File Results View Options Window Help

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

Caepipe : Support load summary for anchor at node 870 - [coldreheatpiping_with_coldspring.res (c:\tut...

File Results View Options Window Help

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

Caepipe : Support load summary for anchor at node 870 - [coldreheatpiping_without_coldspring.res (...

File Results View Options Window Help

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 Moment MX for Cold Spring 1 [= Operating 1 (W+P1+T1) + Cold Spring] for the model with Cold Springs are considerably low compared to the Forces and Moment MX for Operating 1 (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.