



September 6, 2019

Alco Industrial Inc
Edmonton Alberta,

Subject: NPS 26, NPS 28, NPS 30 Lateral SIF Calculations

Pi Engineering Inc. was contracted to calculate the stress intensification factors (SIF) on HCWI lined 45° lateral spools sizes: NPS26, NPS28, NPS30. 3D models of each lateral were developed in Solidworks 2019 using drawings A1-19037-100, 200 and 300. The SIFs are calculated with the following equation:

$$SIF = \frac{\text{Peak Stress in Wye from FEA}}{2 \times \text{Bending Stress in Straight Pipe}}$$

In Solidworks Simulation one end of the spool run was fixed and a moment was applied to the opposite run end or the branch. The amplitude of the moment applied would produce bending stress of 10 MPa in a straight pipe of the same size. The applied moments are tabulated below:

NPS 26	Outer Diameter	OD	33.25	in	0.84455	m
	Thickness	t	1.5	in	0.0381	m
	Calculated Moment For FEA	M	1648431	in-lb	186248	N-m
NPS 28	Outer Diameter	OD	35.25	in	0.89535	m
	Thickness	t	1.5	in	0.0381	m
	Calculated Moment For FEA	M	1867163	in-lb	210961	N-m
NPS 30	Outer Diameter	OD	37.25	in	0.94615	m
	Thickness	t	1.5	in	0.0381	m
	Calculated Moment For FEA	M	2099562	in-lb	237219	N-m

Four independent FEA simulations for each spool size were completed to produce the peak stresses from the in-plane and out-plane moments applied to the branch and run. The models were meshed with tetrahedral 3D solid elements with 4 Jacobian points. The meshes were refined around the predicted high stress areas. The peak stresses are located at the junction of the run piping and the branch piping.

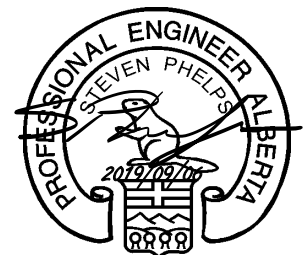
The Branch and Run SIFs were calculated and are Tabulated below:

	NPS 26	NPS 28	NPS 30
Branch In-plane SIF	1.83	2.01	2.34
Branch Out-plane SIF	2.76	2.71	2.86
Run In-plane SIF	2.34	2.81	2.37
Run Out-plane SIF	1.00	1.62	1.10

Regards,

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Pi Engineering Inc.
APEGA Permit to
Practice #: P-8918