



Pipe Spring™ Class Upgrade

Natural Gas pipelines in the USA operate under PHMSA regulations which require class location designation based on population density and other risk factors. Several basic engineering parameters are considerations for the class location allowable stress limits.

- The pressure calculation is based on the traditional Barlow's equation with the allowable stress being reduced.
- This effectively also provides more wall thickness for future corrosion, metal loss or third-party damage tolerance.
- More wall thickness mitigates crack growth or related fatigue issues. Toughness must be considered.

The Pipe Spring™ Class Upgrade system provides extra wall thickness. The thin layer form of the steel serves to maximize effective toughness and the selected adhesive has excellent fatigue, impact, toughness, and shock load resistance properties. The design and material selection result in multiple arrest paths in the event that a subsequent third-party damage event should impact the augmentation sleeve. The effective toughness of the system is far greater than a traditional welded steel sleeve.

Pipe Spring™ Class Upgrade provides the ability to conform to out of round pipe conditions. The thin layer laminated steel design in conjunction with the high modulus filler material promotes an almost instantaneous sharing of the load and a quick stress/strain response. The steel coil modulus matches the base pipe modulus. 360° of the pipe outer surface is placed in intimate contact with the Pipe Spring™ augmentation system. Loads are quickly shared and the stress concentration is limited. Low strain failures are avoided. Any increase in internal pipe pressure results in an almost immediate load sharing and equilibration between pipe and augmentation sleeve. Existing anomalies or discontinuities are rendered sub-critical and made stable. The fatigue life of any potential existing crack is greatly increased.

Specifications:

General Characteristics	<ul style="list-style-type: none">• Laminated Steel coil reinforcement system• MMA adhesive system• Two component epoxy filler material
System	<ul style="list-style-type: none">• Design failure stress ≥ 60 Ksi• Design Elastic modulus $\geq 25 \times 10^6$ psi
Steel	<ul style="list-style-type: none">• AISI 1010. ¼ hard tempered prime quality steel strip• .025 -+ .001 inches thick• 12 inches wide -+ .005 inches
Adhesive	<ul style="list-style-type: none">• Tensile strength 2500- 3000 psi (ASTM D638)• Lap Shear 1800-2300 psi (ASTM D1002)• Max operating temperature 180° F
Filler Material	<ul style="list-style-type: none">• Compressive strength ≥ 12000 psi (ASTM D695)