NEW TECHNOLOGY APPLICATION

PROPOSED REPLACEMENT/REHABILITATION OF A 6 INCH TRANSMISSION LINE UTLIZING A REINFORCED THERMOPLASTIC PIPE

(RTP)

FOR

NGO TRANSMISSION, INC'S TENNESSEE PIPELINE SEGMENTS 9A and 9B

From

NGO TRANSMISSION, INC TAP TO THE TENNESSEE EASTERN PIPELINE (SPRATT STATION)

IN RICH HILL TOWNSHIP IN MUSKINGUM COUNTY OHIO

To

NGO TRANSMISSION, INC's _new McDonald Rd Station__________________

IN SALT CREEK TOWNSHIP IN MUSKINGUM OHIO

Submitted By:

NGO TRANSMISSION, INC.

August 7, 2017

BACKGROUND INFORMATION AND CALCULATIONS

NGO transmission, Inc. proposes to replace a portion of its six-inch Tennessee Line which was installed in 1955. The current steel line was installed with a design pressure of 225 creating a design SMYS of 11.09%. Currently this pipeline operates at an MAOP of 175PSI and the proposed replacement would include approximately 28,500ft of pipe. This replacement would involve a combination of the insertion of a reinforced thermoplastic pipe (RTP) inside of the existing six-inch steel pipe, boring of reinforced thermoplastic pipe (RTP), or plowing of reinforced thermoplastic pipe (RTP). The method used to install the RTP pipe will be determined by the depth of the current active pipe and the terrain encountered along the existing easement. All bored, plowed or open ditch installation of RTP pipe will provide a minimum of three foot of burial depth.

NGO Transmission's six-inch Tennessee line is supplied from Kinder Morgan's Tennessee Gas Pipeline. Currently, the Tennessee Gas Pipeline company operates the inlet piping of NGOT's Spratt Station at a7 90PSI MAOP. NGO Transmission will design and install all equipment including the RTP pipe rated for a 1,000PSI continuous maximum operating pressure (MAOP). All installed RTP pipe will be a 4-inch OD with a 3.45 inch ID. A map of the pipeline layout is attached as Reference 1.

(i) Description of the Reinforced Thermoplastic Pipe (RTP) – overview:

Specialty RTP, LLC's reinforced thermoplastic pipe (RTP) is comprised of three distinct layers. The inner liner is designed as a corrosion and low permeation barrier layer for the flow of natural gas, a reinforcement layer that provides the static and cyclic load strength to withstand the pressure environment and an outer jacket to provide an abrasion resistant jacket to protect the reinforcement layer. The pipe is terminated with metallic stainless steel couplings swaged onto the RTP to "lock" the reinforcement layer in place. The RTP pipe and couplings must be combined to create a system and one cannot work without the other.

References:

2. Pull Through Case Study
3. Picture of RTP Pipe
4. Picture of a Coupling Swaged onto the Pipe
5. Specialty RTP Brochure

(ii) Description of the Specialty RTP Pipe – Components:

Inner Liner:

The inner liner will be comprised of a Nylon 6 Polymer because of its inherent resistance to hydrocarbons. The primary objective is to withstand the influence of Methane gas. The attached report details the performance of the Nylon used for this application for chemical compatibility and low permeation. The result is no de-rating of the pipe when a Nylon liner is required.

References:
6. Chemical Compatibility
7. Nylon Specification Sheet
8. Nylon Permeation Data

Reinforcement Layer:
Aramid Twaron Aramid fiber provides the reinforcement with a triaxial braid design where by a cross braid pattern provides the hoop strength to maintain the pressure requirements of the pipe and longitudinal fibers running parallel to the pipe length provides resistance against tensile loads.

Aramid fiber is chosen because of its strength, cyclic loading resistance, and its resistance to oilfield environments.

References:
9. Twaron Spec Sheet 2300
10. Twaron Technical Performance Manual

Outer Jacket:
The outer jacket is an abrasion resistant cover designed to protect the braid and resist the gathering line production flow stream. It is Polypropylene with a UV inhibitor additive. In addition to chemical compatibility and permeation resistance, abrasion testing is provided below. The Taber abrasion testing protocol uses an abrasive wheel with one kilogram of weight exerted on to the test sample. The weight of the sample is compared both before and after 1,000 revolutions of the abrasive wheel.

References:
11. Taber Abrasion Data
12. Sand Abrasion Test
13. Specification Sheet

(iii) Maximum source pressure (MSP) for the Line

The input source is from the Tennessee Gas Transmission pipeline. The input pressure varies but has been derated to 790PSI maximum allowable operating pressure (MAOP).

(iv) Maximum allowable operating pressure (MAOP) of the RTP and calculations:

Summary: MAOP for the proposed pipeline is 1,000 psig at 140°F.

Calculations:

a. 4” RTP pipe:

The design strength of the RTP pipe is determined by the stress rupture characteristics of the aramid fiber. This can be defined as:

$$P = 2*F*n*\sin(\theta)/D*L$$

Where:

P = Burst pressure of the Pipe
F = Strength of each Cross Fiber
n = Number of Cross Fibers
D = Outside Diameter of the Inner Liner
P = Pitch or length reinforcement travels along pipe after 1 360 degree revolution around the pipe
Θ = Angle of Braid

The long-term strength regression data for Specialty RTP's tubing is:

Log(stress) = 2.1826- 0.05402(log time)
Stress is in bars of pressure and time is in hours

	Hours	Pressure (Bar)	Pressure(PSI)
Short Term Burst Strength	0.1	172.43	2,500.28
Medium Term Strengh	1,000.0	104.84	1,520.23
20 Year Strength	175,200.0	79.31	1,150.04

In addition, the pipe strength is increased by using a 95% confidence interval and divided by a .67 safety factor. The result is a short term burst pressure as follows:

Design Pressure (PSI)	Short Term Burst (PSI)	ST/Design Pressure Multiplier
1,000	3,300	3.3X

Short term testing is in accordance with ASTM D-1599 at Design Temperature (in this case testing was performed at 140F)

<u>Reference:</u>

14. Creep and Stress Rupture of Aramid Fibre

b. <u>Connections</u>:

Specialty RTP connectors will consist of two types:

1. Union couplings to join two sections of RTP pipe together of an approximate length of 2,800 ft. individual spool lengths

2. End terminations will be double raised face ANSI 600 flanges when connecting to flanges and weld style termination couplings designed

for Schedule 40 pipe with a reducer to match up with the existing 6 inch pipe for certain sections of the line

All unions will utilize Duplex 2205 Stainless in accordance with the operating environments spelled out in NACE MR 0175 Specification and will be in accordance to the existing ANSI flange rating currently on the 6" and 4" steel pipe terminations.

The end terminations will be zinc chromate plated carbon steel.

The pipe is designed to withstand a maximum tensile load of 16,000lbs as the pipe coupling system. A two mile pull of RTP pipe requires 8,300lbs of pull force. A tensile test of the actual pipe coupling system will be part of the factory acceptance testing to assure the pipe will not be damaged during pulling. In addition, load sensors are applied to the pulling ropes to assure maximum tensile loads are not exceeded.

The only expansion of the pipe is due to pressure. The ability to withstand pull out from the coupling due to expansion from pressure is determined by the longitudinal reinforcement braids which resist the elongation. The pictures below show the cross braid which provides the hoop strength and the longitudinal reinforcement, which resist elongation. Thermal expansion or contraction is not an issue with flexible reinforced thermoplastic pipe.

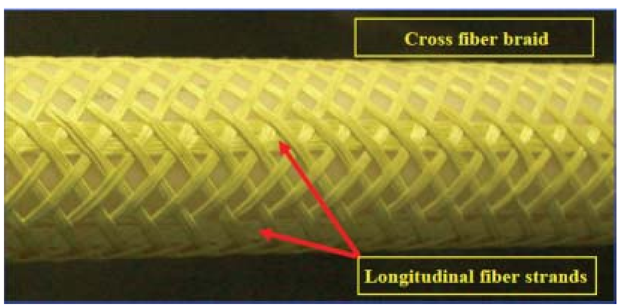

Figure 1:

By adjusting the number of longitudinal braids, Specialty RTP can adjust the tensile load required for the application. For the application applied for, Specialty RTP has taken the MAOP of the line which is 750PSI and multiplied it by 1.5 for the hydrotest pressure and then determined the tensile load on the pipe. (Cross sectional area times pressure). The chart below summarizes the calculations.

Tensile Load Calculations		
ID of RTP (in)	3.45	
Cross Sectional Area of 4" (in^2)	9.35	
Tensile Load at 750PSI (lbs)	701	
Tensile Load at 1,125PSI (lbs)	10,517	

The pipe should not see more than 10,517 lbs. of tensile load and it has been designed to withstand 16,000lbs of tensile load.

Existing Steel Pipeline Requirements:

The existing 6 inch steel line currently operates at 500PSI and has a pressure regulator a the connection to the Tennessee Gas Transmission line which has a maximum pressure rating of 790PSI. The regulator will be set to 790PSI for the the RTP line inserted into the existing 6 inch steel line

(v) <u>Hydrostatic test pressure (HTP), test medium, and period of time:</u>

Hydrostatic test pressure for the Specialty RTP pipeline and risers: 1,500 psig

Test medium: Water
Test period: 8 hours
Calculation:
HTP = 1.50 x MAOP
= 1.50 x 1,000
= 1,500 psig

<u>References:</u>
15. Specialty RTP Hydrostatic Test Procedure

(vi) <u>MAOP of tie-in piping:</u>

Any steel tie in piping requirements will be Schedule 40 Steel

(vii) <u>Summary of the installation procedure:</u>

The installation procedure is as follows:
1. Pig the line to clean out any debris
2. Pig a pulling synthetic rope with 5X the maximum pulling force tensile rating through the existing pipeline.
3. Pull the Thermoflex pipe through the existing pipeline
4. Flange off against the existing termination flanges for the existing pipe
5. Hydro-test
6. Commission

<u>Reference:</u>
16. Case Studies (2)
17. Texas RR Commission approval of a very similar system
18. DOT approval of an RTP gas line in Mobile Bay

(viii) <u>Proposed date for commencing installation and estimated time for construction:</u>

Construction will be performed in two phases. The first is approximately 1-2 miles adjacent to the Tennessee Gas Transmission connection. It will be comprised of some trenching, Bores and Pull Throughs in accordance with the 49 CFR Part 192 Regulations for construction. Commence construction date: October 2017

The balance of the line will be a pull through and finished in the spring of 2018.

Estimated construction time:

Phase 1: 10 Days
Phase 2: 15 Days

(ix) Type of protection to the offended crossing pipelines:

The Specialty RTP pipe shall be incased inside of the existing 6" pipeline except for sections in phase one where bores are required because the existing steel is exposed on the surface.

The 6" pipeline serves as a conduit/casing for the RTP pipe

The Bores will be below 3 ft. minimal burial depth

(x) Additional design precautions

There will be a pressure sensor on the line to assure integrity of the pipeline

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