ADTECH FRP Pty Ltd.

ACN 073 320 546
1 / 345 Victoria Rd, Malaga WA 6090, Australia
Fax +61 08 9249 3966
Phone +61 08 9262 7000
Email: sales@adtechfrp.com

ADTECH PROJECT COMPLETION REPORT July 2010

Incitec Pivot Pty Ltd – Dyno Nobel Ammonia Nitrate Gas Supply
Location: Moranbah QLD
Service: Coal Seam Methane
Product: Ameron Bondstrand 16” ISO 14692 / AS2885 / ANSI #150

The largest diameter GRE gas pipeline designed and installed in Australia to date (2010)

16” Ameron GRE Gas line Poly water line by others

ADTECH PROJECT COMPLETION REPORT July 2010

Project Background

1. GENERAL

1.1 Introduction

The Dyno Nobel Gas Pipeline will transport coal seam gas (CSG) from Arrow Energy's Gas Metering Station to the Dyno Nobel Ammonia Nitrate facility, a total distance of approximately 900m. Arrow Energy constructed a 2,700m long pipeline, also designed by ADTECH FRP, to transport CSG from the existing Moranbah Gas Processing Facility (MGPF) to the Gas Metering Station.

1.2 Project Rationale

Dyno Nobel Moranbah Pty Ltd entered into a Gas Sales Agreement with Arrow Energy. Dyno Nobel intended to construct, operate and own an ammonia, nitric acid and ammonium nitrate manufacturing plant and associated facilities near the town of Moranbah.

Dyno Nobel will use the gas supplied by Arrow Energy as feedstock for ammonia manufacture and as fuel for a power station to generate electricity for use at the manufacturing plant. The total demand for gas at the Dyno Nobel facilities is approximately 20 TJ/d and gas was required at full capacity by the Dyno Nobel facilities commissioning date. Commissioning was scheduled to take place in April 2010 to enable commissioning of plant and utility systems (power generation, flare pilots etc).

2. MAINLINE PIPEWORK – MECHANICAL DESIGN

2.1.1 Design Pressures

Maximum Allowable Operating Pressure (MAOP) of Dyno Nobel Pipeline	1,875 kPag
Hydrostatic Test Pressure of GRE Pipeline	2,800 kPag (Please see Appendix II)
Expected Operating Pressure of GRE Pipeline	1,200 kPag

2.1.2 Design Temperatures

Design Temperature Range	-5 to 65ºC
Above Ground Ambient Temperature Range	-5 to 45ºC
Underground Temperature Range	10 to 30ºC

2.1.3 Design Flows

Pipeline Design Flow	20 TJ/day	
Expected Gas Composition	Methane	96.30 %mol
	Ethane	0.010 %mol
	Propane	0.005 %mol
	i-Butane	0.005 %mol
	n-Butane	0.005 %mol
	n-Pentane	0.005 %mol
	Hexane	0.003 %mol
	CO_2	1.30 %mol
	N_2	2.37 %mol
	H_2S	3.0 mg/m^3
	Total Sulphur	20.0 mg/m^3
	Water Content	Saturated
	Total Inerts	3.67 %mol
	Wobbe Index	47.8 MJ/m^3
	Water Droplet Size	600 µm
	Free Water in Gas	5%vol

Pipeline Selection

The Dyno Nobel Gas Pipeline was constructed from 400NB Ameron GRE pipe with tapered male/female adhesive joints. The robust Ameron Series 2400 fibreglass pipe is well suited to pipelines and was selected for this CSG application.

Design Code	ISO 14692-3:2002 as referred to by AS 2885-1:2007
Manufacturing Code	ISO 14692-2:2002 and API 15LR as referred to by AS 2885-1:2007
Location Class (to AS2885-1:2007)	R1 (Rural) – Buried
Design Application	Saturated Coal Seam Gas
Design Life	20 years
Design Pressure (MAOP)	1,875 kPag
Hydrostatic Test Pressure	2,800 kPag
Design Temperature	-5 to 65°C
Pipeline Length	1.0 km

Line Pipe Diameter	DN400 (16”)	
Line Pipe Material	Aromatic Amine Resin	
Line Pipe Selection	S2400 Series (S2418)	
End Connections	Permanent bonded type connections using heat-cured RP48 epoxy. Taper Angle: 2.5 degrees	
Manufactured Lengths	11.89m Taper Male x Taper Female	
Nominal Inside Diameter	393.7mm	
Wall Thickness: Liner Thickness T_L Min Total Thickness Min Structural Wall Thickness * Nominal WT	 0.50 mm (0.020”) 7.70 mm (0.303”) 7.20 mm (0.283”) * Used for Design 8.23 mm (0.324”)	
Nominal Outside Diameter	409.1 mm (16.11”)	
Mean Reinforced Diameter	401.9 mm	
Outside Diameter of Box Joints	Approximately 442 mm	
For Comparison Only, the Minimum Req’d Wall Thickness: to API 15LR to AS 2885-1:2007	3.9 mm (Refer Appendix V) 3.3 mm (Refer Appendix V)	
Hazen Williams Flow Coefficient	150	
Flanges	To ASME B16.5 Class 150	
Coefficient of Thermal Expansion	18×10^{-6} mm/mm/°C	
Poisson’s Ratio (Axial-Hoop)	0.75	Refer to Appendix III
Poisson’s Ratio (Hoop-Axia)	0.42	
Hoop Modulus of Elasticity	23,305 MPa @ 65°C	
Axial Modulus of Elasticity	10,790 MPa @ 65°C	

2.2 GRE Design Methodology

ISO 14692 uses a comprehensive assessment of the pipelines ability to withstand stress safely. This is done by:

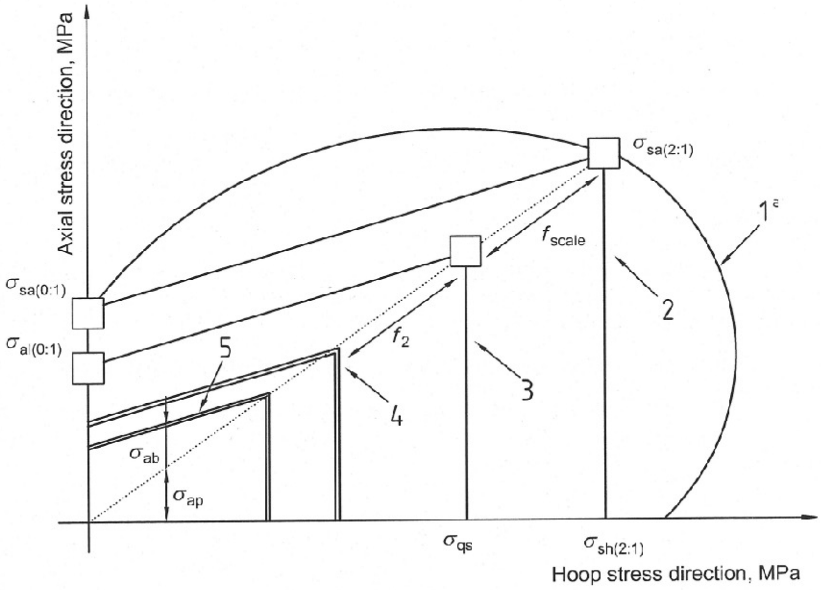
- Generating a short-term stress envelope on a plot of hoop and axial stress. This is achieved by using proven destructive testing techniques whereby a *Regression Curve* is generated in accordance with ASTM D2992. The Regression Curve contains important information to use in various calculations as shown in the Appendices of this Basis of Design. The calculations in turn generate the short-term stress envelope.
- Further destructive testing (long term) is then used to develop a scaled version of the failure envelope suitable for a sustained 20 year salt water, steady pressure load at 65°C;
- This envelope is further scaled using correction factors, which adjust the test results to suit the actual Project conditions;
    - Design life other than 20 years;
    - Operating temperature other than 65°C – Factor A1;
    - A fluid other than salt water – Factor A2;
    - Cycling loading conditions and fatigue – Factor A3;
- A suitable design factor (Factor f2) is then applied to further scale the failure envelope depending on the load duration being either sustained or occasional.

Loading Type	Load Duration	f_2	Example of Loading Type
Occasional	Short-term	0.89	Hydrostatic Test
Sustained including thermal loads	Long-term	0.83	Self-mass plus thermal expansion
Sustained excluding thermal loads	Long-term	0.67	Self-mass

As a result of this methodology, design envelopes are generated to verify whether the design loads are **Acceptable** or **Not Acceptable**.

The design loads are determined using all relevant combinations of loads which may generate stress in the GRE pipe wall, including hoop and axial stresses resulting from internal pressure, pipe deflection, installation curvature, thermal loads, buckling stresses, vehicle wheel loads, and others.

The following **Figure 2** is an excerpt from ISO14692-3:2002 and illustrates how the factored long-term design envelope is generated (scaled) from the short-term envelope.



Key

1 schematic representation of the short-term failure envelope
2 idealized short-term envelope
3 idealized long-term envelope
4 non-factored long-term design envelope
5 factored long-term design envelope

a For design purposes, the shape should be based on actual measured data points.

Figure 2 — Short and long-term idealized failure and design envelopes for a single wound angle ply GRP pipe with winding angles in the range of approximately 45° to 75°

Adtech Scope of Work

Engineering Basis of Design of Dyno Nobel Pipeline (3rd Party Validated)

Logistics coordination: Manufacturing of product
International Shipping - Australian customs clearance, De-stuffing of 40' Containers ready for transport to site, Domestic Transport Brisbane Port to Moranbah site.

Pipe handling: string out along ROW

Make up of pipe to Manufacturers specifications

Hydro-testing

Handover for service

Shaving male spigot for Bell and Spigot pipe joint

Plant road and drainage channel crossing

SAFETY ACHIEVEMENT

No reportable Accident – No LTI's reported for the total project duration and operations.