

# Airborne

## Oil & Gas

### TCP Downline

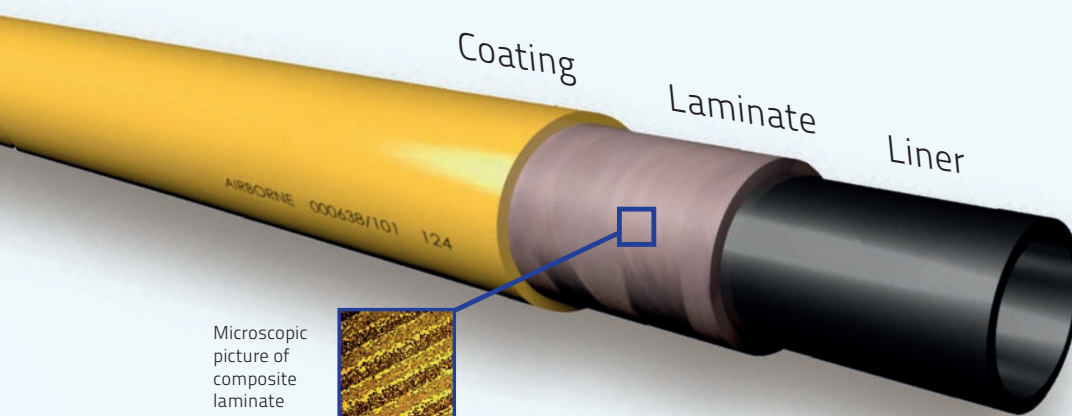
Airborne Oil & Gas is the world's first and leading manufacturer of fully bonded, Thermoplastic Composite Pipe. The lightweight, high strength and corrosion resistant composite pipes provide cost and operational benefits in subsea production & oil field service applications.

[airborneoilandgas.com](http://airborneoilandgas.com)



## Thermoplastic Composite Pipe

The Thermoplastic Composite Pipe (TCP) developed by Airborne Oil & Gas features a solid pipe wall, constructed from glass or carbon reinforcement fibres and thermoplastic polymeric materials. The unique, certified and proprietary manufacturing process results in a fully bonded composite pipe structure, with the fibres fully embedded within the polymer matrix and ensuring the strongest interface possible between the different pipe layers.



### The TCP Downline offers the following advantages:

- Field proven, fast deployment without the need to attached ballast or buoyancy modules
- Large smooth & clean bore for the highest flowrates
- One continuous pipe from surface to seabed without midline connectors
- Flexible to run to any depth up to the maximum length of the downline, while pumping through the downline at rated pressure
- High internal and external pressure ratings, collapse resistant with vacuum capability
- Simple and reliable end-fittings, can be re-terminated offshore
- Rugged coating for offshore handling
- Field repair

The TCP Downline can be combined with the TCP Jumper providing the flexible connection from downline to wellhead, injection skid or pig launcher (pipeline pre-commissioning).

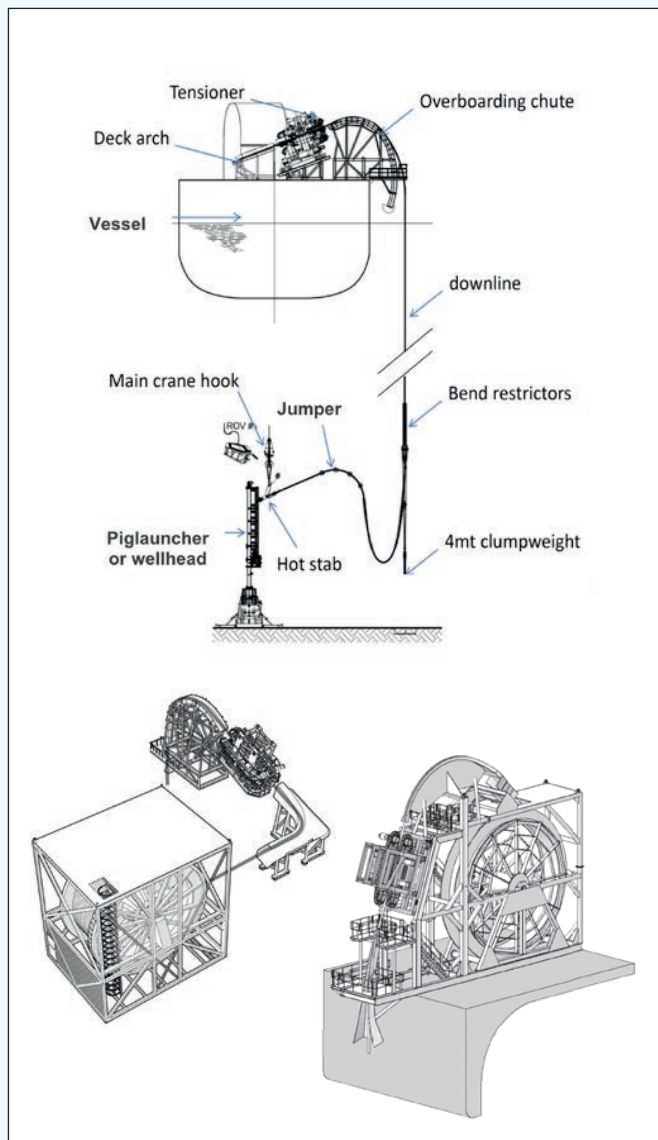
## TCP Downline

The TCP Downline is a superior conduit for pumping fluids from vessel to seabed. The TCP Downline and TCP Jumper in combination with our field proven, efficient deployment methods reduce cost per intervention and deliver higher flowrates compared to alternatives available in the market place today.

### Fast, Flexible and Safe Deployment

The TCP Downline and Jumper are deployed quickly and safely:

- Prior to deployment, the TCP Downline is fitted with a clump weight ensuring dynamic stability subsea
- The TCP Downline and Jumper are prepared and pressure tested at surface on the vessel
- The system is deployed to 2500+ meter water depth in only 2 hours; no ballast or buoyancy modules need to be fitted during paying out of the downline
- Pumping can start immediately with the swivel and piping arrangement inside the reeler
- The TCP Downline has no spring effect like steel coiled tubing
- The TCP Downline does not require paying out the pipe during the operation; the fatigue life supports multiple campaigns for many years of service at any water depth



### Running Equipment & Ancillaries

Depending on the client preferences, several options exist for the equipment running the downline. These include:

- Semi or fully enclosed reelers that feature an integrated power unit, constant tension (when running with tensioner), swivel and levelwind. The reelers are manufactured to the highest standards including DNV 2.7-1 and DNV 2.7-3
- With 2 or 4 tracks and adapted pads, communicating with the reeler, our tensioners run the pipes to the largest depths fast and safely
- Overboarding chute. Retractable with provisions to allow for passage of injection skids, our overboarding chutes are designed for efficient operations whilst maximising the life of the pipe

The deployment system can be supplied as individual items or as fully integrated system.

### TCP Downline Specifications

Our downlines are designed and produced in sizes ranging from 2 to 6 inch ID and pressure ratings up to 10,000 psi. Where required, different sizes can be produced as well. The TCP Downline is available in two designs: high-flex and high tension. High tension results in higher maximum water depth but also larger MBR. For all sizes, the corresponding flexible TCP Jumper is available too.

### TCP Downline product overview

Internal Diameter	Design Temperature	Maximum Pressure Rating	Maximum Water Depth	Storage MBR
2.0 inch	0°C to +60°C	690 bar / 10,000 psi*	800 m / 2600 ft	1.9 m / 6 ft 2 inch
			2500 m / 8200 ft	3.2 m / 10 ft 5 inch
2.5 inch	0°C to +60°C	690 bar / 10,000 psi*	800 m / 2600 ft	2.3 m / 7 ft
			2000 m / 6565 ft	3.5 m / 11 ft 5 inch
3.0 inch	0°C to +60°C	345 bar / 5,000 psi	800 m / 2600 ft	2.7 m / 8 ft 8 inch
			2000 m / 6565 ft	4.6 m / 15 ft 1 inch
4.0 inch	0°C to +60°C	345 bar / 5,000 psi	800 m / 2600 ft	3.5 m / 11 ft 5 inch

Notes: Downlines are available in two designs, high-flex and high tension. High tension results in larger maximum water depth but also larger MBR.  
\* In development.

## Qualification

Airborne Oil & Gas is the world's first company to have certified and qualified the design methods and production process in compliance to the new DNV standard for TCP, DNVGL RP F119. Our products are designed in accordance with this Recommended Practice and supplied with a Manufacturer's Certificate of Conformity.

**DNV-GL**  
Statement No: 2015-3256

**STATEMENT OF CONFORMITY**

Owner: Airborne Oil & Gas

Name of system/installation: Production principles for manufacturing Thermoplastic Composite Pipes (TCP) based on tape-winding on a liner and extruding an outer cover

Location: Airborne Oil & Gas, IJmuiden, The Netherlands

Description: Generic methodology describing the production process and the production parameters for making a range of TCPs, including methods to obtain permissible production tolerances

Main Operational Limitations: The production principles will be used for obtaining production procedures for specific thermoplastic composite pipes. The principles describe what parameters to control and how accurately the process needs to be controlled

Designated use: This statement is only valid together with the Report on the Verification of Production Principles (ref. /1/) that specifies the product, the general production process and limitations and conditions that apply. The main limitations are the choice of fibre reinforced thermoplastic tape, production speed, dimensional range and flow angles

Verification: A specific production process shall be verified against the procedures and limitations described in /1.3/. Deviations of the general approach shall be verified according to /3.4/.

**This is to verify:**  
That the above mentioned principles for manufacturing have been verified, by appropriate methods, to comply with the requirements of DNV-OS-C501 and DNV-RP-F119, for the main operational limits stated above and further described in the Reference documents listed below.

**Verification involvement:**  
The verification involvement has included:  
• production procedures  
• checking the procedures against the actual process  
• evaluation of the completeness of the described production parameters

The detailed scope of work is described in the appended DNV GL Verification report /1/.

Validity:  
This statement is valid on the date of issue.

Reference documents:  
/1/ DNVGL Report No. 2015-3022 Rev 0 "Verification of Production Principles for TCP", 29 January 2016  
/2/ Production Principles, Airborne Oil & Gas Report ADG330504R001, Rev. 04, 24 Dec. 2015  
/3/ DNV-OS-C501, Composite Components, November 2013  
/4/ DNVGL-RP-F119, Thermoplastic Composite Pipes, December 2015

Issued at Havik on 2016-02-08

for DNV GL  
Gustav Heiberg  
Project Sponsor

**DNV-GL**

**TECHNOLOGY CERTIFICATE**

Certificate no.: 2015-3256 Initial date: 26 January 2016 Valid until: 26 January 2020

This is to certify that the

**General Design Methodology for Thermoplastic Composite Pipes** as detailed in /1/ is qualified in accordance with DNV-RP-A203 Technology Qualification /2/ and specifically for design of products according to DNVGL RP-F119 Thermoplastic Composite Pipes /3/ (TCP) provided that the conditions below and specified in /4/ are met.

This is a certificate for the design methods and tools. This is not a product certificate. Products can be subjected to design verification according to DNVGL RP-F119/3/ and manufacturing survey

Technology owner: Airborne Oil & Gas

Name of technology: Generic Design Methodology and Tools for Thermoplastic Composite Pipes based on finite element analysis and micromechanics.

Description: Analysis of the TCP pipe body and end fitting by finite element calculations based on material tests on the coupon level and confirmation tests on pipe samples.

Designated use: The design methodology will be used for design calculations of TCPs. It describes how the calculations are based on material test data and validated against pipe sample tests.

Conditions: This certificate is only valid together with the Qualification Report /4/ that specifies the intended use and limitations and conditions that apply. For application to a specific product, material inputs must be confirmed for the actual production and the modelling results verified by comparing them to full-scale test results as described in /3/.

Involvement: DNV GL has been involved in the qualification process in accordance with /5/, has evaluated the design procedures and commented on reports as detailed in /4/.

Verification and certification: Specific design calculations shall be verified against the procedures and limitations described in /1.3.4/. Additional calculations beyond the general approach shall be verified according to /3/.

Reference documents:  
/1/ Generic design qualification - design analysis methodology, Airborne Oil and Gas Report ADG330502R004, Rev. 03, 11 Dec. 2015  
/2/ DNV-RP-A203, Qualification of New Technology, July 2013  
/3/ DNVGL-RP-F119, Thermoplastic Composite Pipes, December 2015  
/4/ DNVGL Technical Report No. 2015-3036 Rev 0 "Evaluation of the General Design Methodology for TCP", 26 January 2016  
/5/ DNVGL-SE-C160, Technology Qualification Management and Verification, December 2015

DNV GL shall not be held liable for undiscovered failure modes or causes or for missing qualification activities.

26 January 2016 for DNV GL AS  
Gustav Heiberg  
Business Development Leader, Materials

Odd Sund  
Project Manager

**DNV-GL**  
Statement No: 2015-3256

**STATEMENT OF CONFORMITY**

Owner: Airborne Oil & Gas

Name of system/installation: Airborne HDPE TCP material properties

Location: Airborne Oil & Gas, IJmuiden, The Netherlands

Description: This statement provides a summary of verified material properties for Airborne-HDPE TCP family materials.

Main Operational Limitations: Materials covered

Material ID	Description	Designation
1181	Class Bm reinforced HDPE tape	Tape
1181	HDPE liner material, black	Liner
1181	HDPE welding material, orange	Cover

Conditions: This statement is only valid together with the Report on the Evaluation of the Generic Design Methodology for TCP /1/ for the use in Airborne-HDPE TCP.

**This is to verify:**  
That the summary material properties of the above given materials were verified, by appropriate methods, to comply with the requirements of DNV-OS-C501 and DNV-RP-F119, for the main operational limits stated above, and further outlined in the Reference documents /2-3/ listed below.

**Thermal and physical properties**

	Tape	Liner	Cover	Unit
Density	980	962	961	kg/m³
Permeability CH4 (23 / 60°C)	0.5 / 0.8	1.1 / 1.8	1.4 / 1.4	ml/m²/24h/MPa
Permeability CO2 (23 / 60°C)	0.5 / 0.8	1.1 / 1.8	1.4 / 1.4	ml/m²/24h/MPa
Thermal conductivity (23 / 60°C)	0.19 / 0.20	0.19 / 0.20	0.19 / 0.20	W/m.K
CTE L flow / fiber direction	7	288	171	µm/m.°C
CTE L flow / fiber direction	80	10	270	µm/m.°C
Specific heat capacity (20°C)	1.4	1.4	1.4	J/kg.K

**Static mechanical properties**

Typical stiffness properties¹	-20 °C	23 °C	60 °C	Unit
Tape E-modulus (E fiber)	15.1	14.7	14.3	GPa
Tape shear modulus	1.1	1.0	0.9	GPa
Liner	2.3	2.0	1.8	GPa
Cover	2.7	2.0	1.8	GPa

1: Typical properties for TCP design a non-linear material model 170 is used.



## Manufacturing

Airborne Oil & Gas' manufacturing facility is based in IJmuiden (Port of Amsterdam), The Netherlands. With a floorspace of 9000 m2 and three production lines, our production capability extends to continuous pipe systems from 1 inch ID up to 7.75 inch ID. The facility has direct sea access and the products can be loaded directly on our client's vessels. The quay has a length of 330 m with a water depth of 9.5m.

## Contact us!

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