Bondstrand™ FP Series

Piping in Fire Conditions

OIL & GAS | CHEMICAL & INDUSTRIAL | MARINE | OFFSHORE | MINING

Bondstrand Pipe Systems in Fire Conditions

Bondstrand glass fiber composite piping products are widely used for underground and above ground fire water systems. For above ground systems, the fire response of the material itself, how the composite pipe behaves when exposed to fire, is an important issue in the decision to specify Bondstrand GRE piping.

The most common applications where the fire resistance of Bondstrand piping is important are for fire mains (ring mains on FLNGs, FPSOs, FPUs, MODUs, platforms and above ground), sprinkler systems, dry deluge systems and foam lines, since these are used to fight the fire itself. Also important, however, are other applications like cooling water lines, vents, drainage and flowlines where the fluid being transferred may be critical and especially where the piping systems are routed in confined spaces which are also working spaces with human traffic.

In all these applications, Bondstrand epoxy based glass fiber composite pipe is primarily chosen because of the corrosion resistance. For fire water systems, corrosion does not only limit the life time of steel or other metallic fire water piping, but with corrosion scale and salt encrustation causing plugging of nozzles and sprinkler heads, the risk for safety becomes unacceptable. With Bondstrand epoxy based glass fiber composite pipe systems, designed for 40 or more years of continuous service at pressures up to 50 bar, none of these corrosion related life cycle or operational problems occur.

The fire resistance of Bondstrand epoxy based glass fiber composite pipe systems are tested and approved for many applications on marine commercial vessels, offshore structures (FLNGs, platforms, FPSOs, FPUs, MODUs, and platforms) industrial installations such as refineries, petrochemical plants, storage facilities and tank farms and also in specialty applications like in tunnels, ports and jetties and at airports.

The behaviour of an epoxy based glass fiber composite pipe in fire is different than a steel or metallic pipe, and in this bulletin we try to explain the differences and advantages of using Bondstrand epoxy based glass fiber composite pipe, in areas where fire exposure presents a serious hazard.

Bondstrand Pipe Systems in Fire Conditions Cont'd

Behavior and endurance of Bondstrand pipe systems in fire conditions

Bondstrand epoxy based glass fiber composite pipe systems have a surprisingly high resistance to fire.
This endurance comes from the composite structure of the material. The combination of low thermal conductivity, low thermal capacitance, and the endothermic decomposition of the resin matrix material enables the material to be very resistant to fire. As the resin component of the matrix burns, a carbonaceous ceramic-type layer (char) forms, still reinforced with fiberglass, which effectively isolates the rest of the pipe, and slowing down the burning process.

The final endurance of a Bondstrand pipe depends also on the type of fire: the intensity (heat flux) and the type of fuel (which defines the temperature of the fire).

The operational situation of the piping has an important influence on the fire endurance of the pipe system: i.e. if the pipe is internally dry, or filled with stagnant water, of has continuously flowing water.

Fire testing of pipe in dry conditions

Only piping that is intumescent coated (2000MFP – WD, 2000MFP-L2, 2000MFP-L1 or 2000MFP-JF) should be used in the dry condition (or the electrically conductive equivalents of 7000MFP-WD, etc.)

If the pipe is exposed to a fire, first the resin in the pipe wall needs to be protected from extreme temperature (over 205°C or 400°F). Then the outer protective layers are exposed, and a carbonaceous ceramic-type layer (char) will form which effectively isolates the rest of the pipe, slowing down the excessive heating of the remaining pipe wall. The thicknesses of the intumescent coating will vary depending on the type and duration of the fire. IMO A(18) 753 provides guidance for these fire tests on pipe in dry conditions.

Fire testing of pipe in initially dry conditions followed by flowing water

If after a certain time the pipe is filled with water under pressure, the situation stabilizes and further degradation stops. Depending on the intensity of the fire, the time exposed while dry (typically 5 minutes in qualification testing) and the wall thickness, the pipe may start to weep, but even then the functionality of the pipe system is intact. Due to a combination of the insulation properties, low thermal capacitance and the elasticity of the composite pipe, the piping is resistant to the temperature and stress shocks related to abrupt water flow (such as when a deluge valve opens quickly). Several tests have shown that carbon steel pipes may burst in a similar situation due to the thermal and pressure shocks occurring from the resultant explosive steam formation when water hits the red hot steel. The industry standard commonly adopted for fire test in this condition is the OTI 95-634.

Effect of fire on pipes filled with water

A water filled pipe in fire will last a lot longer due to the cooling effect or "heat sink" of the water in the pipe, again in combination with the low heat conductivity of the composite pipe material. Tests have been passed which required endurance times up to 120 minutes. IMO 753 A(18) provides guidance for fire test on piping filled with stagnant water. All Bondstrand Pipes without intumescent coating meet this test criterion.

Other factors in fire conditions:

- **Flame spread:** A measure of the extent, under prescribed conditions, to which a pipe becomes a self-sustaining source of fire, meaning that the flames will continue to spread from an ignition source. In this regard, epoxy based glass fiber composite pipe is considered self-extinguishing (requires external heat source to continue burning) and performs very well compared to polyester, vinyl ester and thermoplastic pipe materials. Special additives may be added to the pipe resin matrix which can improve this performance, but these additives may increase costs dramatically and often increase the toxicity of the smoke emitted.
- **Smoke emissions and smoke toxicity:** The optical density and toxicity of smoke emissions of the composite pipe under fire exposure are measured. This will typically be done with high and low radiant energy levels to see the effects of burning as well as smouldering conditions.
- **In July 2012, IMO adopted the IMO FTP 2010 Code:** This is an International Code for the application of fire test procedures. In time, this code will replace nominally accepted ASTM A635 and IMO 653 standards. Bondstrand FP-FTP 2010 meets the requirements of the code. The piping is developed for use in Accommodation and confined spaces, such as in Machinery Spaces.

Bondstrand solutions for piping in applications and zones with fire hazards

On board of seagoing vessels and floating offshore structures the specifications and solutions for fire water systems with Bondstrand materials are most clearly defined:

- Sprinkler systems according to IMO A.753 (18) Level 3 in wet condition: standard Bondstrand 2000M, 7000M, 2400, 2400C.
- For sprinkler systems in living quarters, piping should perform in accordance with IMO FTP 2010 Code for smoke emissions and smoke toxicity: Bondstrand 2000MFP-FTP 2010.
- Dry deluge systems in accordance with ABS / USCG: Bondstrand 2000MFP-WD, 7000MFP-WD, 2400FP-WD, 2400CFP-WD.
- Dry deluge systems in jet fire zones: Bondstrand 2000MFP-JF, 7000MFP-JF, 2400MFP-JF or 2400CFP-JF.
- Fire Mains on Floating Offshore Installations – typically filled with water and pressurised – Bondstrand 7000M, 2400C. (Conditions stated by Classification Societies need to be complied with.)

In other industries and applications, the clear specifications and rules as set by IMO can be used as guideline on how to apply the different Bondstrand solutions.

The above described certified specifications are not the technical limits of the Bondstrand piping systems for example:

- In the standard wet IMO Level 3 fire tests the endurance of Bondstrand pipe systems can be much longer than the 30 minutes test requirement.
- Depending on the wall thickness of the pipe, and the thickness of the protective coating, the endurance in dry condition can be longer than the 5 minutes as defined in the USCG PFM 1-98 or Jet Fire tests, and will be longer in the wet condition than the 25 minutes the test requires.
- Foam extinguishing lines could be considered as dry deluge systems.

We can engage with the necessary professional staff to discuss both Safety and Piping Issues to provide a comprehensive and competitive solution for the Fire Water Piping Application on any facility. Call us for a discussion.

Classification code for fire endurance properties

A: Service (Fluid or fluid state)		B: Fire type		C: Integrity/Duration*	
DE	Dry or empty.	JF	Jet Fire	EA	Capable of maintaing the test pressure without leakage during or after test
DF	Initially dry/empty for minimum of 5 min followed by flowing water (linear velocity ≤ 1 m/s)	HF	Hydrocarbon Pool Fire	EB	No leakage during fire test except a slight weeping may be accepted. Capable of maintaining the test pressure after cooling without significant leakage, i.e. not exceeding 0,2 l/min for a minimum of 15 min
ST	Stagnant water	IF	Impinging flame	EC	Minimum or no leakage (≤ 0,5 l/m) during fire test. Capable of maintaining the test pressure after cooling with known leakage (leakage rate per metre length of pipe to be quantified in each case)
SF	Initially stagnant for minimum of 5 min followed by flowing water (linear velocity ≤ 1 m/s)	CF	Cellulosic fire	ED	Leakage permitted (≤ 0,5 l/m) during fire test. Pressure that can be maintained after cooling with known leakage to be quantified.
WF	Flowing water (linear velocity ≤ 1 m/s)			EE	No endurance required
FG	Flammable gas			EF	
HL	Hydrocarbon liquid				
OC	Other chemical				

* The indicator for duration shows the test period in minutes, e.g. / 120: greater than 2 h.

* The test pressure shall be the design pressure P_d. Where P_d is not known, the est pressure shall be P_d max which is 0,67 x P_{q1} where P_q is the qualified pressure.

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