GRE Pipe Systems in Marine Industry
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- Turn key projects
- System design
- Product range
- GRE Bulk head penetration
- Production

- Applications
- Ballast Water Treatment
- Advantages GRE
- Type approvals
- Fire performance
- Installation
- Retrofits
Quick Facts Future Pipe Industries

- Founded in 1984 and head quartered in Dubai
- Turnover 2009 USD 940 Million
- ISO 9001 & 14001 (ISO 14962)
- Active in ship building industry from 1984
- Ship building department based in The Netherlands
- Production in The Netherlands & Abu Dhabi
Turn Key Projects

- Single point of contact
- Assist with system design
- Stress/surge/flexibility analysis & support location
- Isometrics & spool drawings
- Manufacturing & prefabrication
- Installation & commissioning
- Non GRE, e.g. installation bulk head penetrations, valves etc.
Turn Key Project - Hopper dredger Cristobal Colon
Turn key project - Ice breakers Frej, Atle & Ymer
Design is based on IMO resolution A.753(18). Issued in 1993. “Guidelines for the application of plastic pipes on ships”
### IMO Resolution A.753(18)

In which systems & in which spaces is the use of GRE allowed?

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Machinery space of category A</th>
<th>Other machinery spaces and engine rooms</th>
<th>Cargo pump rooms</th>
<th>Range of engine hold</th>
<th>Other dry engine hold</th>
<th>Cargo holds</th>
<th>Fuel oil tanks</th>
<th>Bilge water tanks</th>
<th>Cooking and service, Armstrong &amp; ducts</th>
<th>Accommodation, service, and miscellaneous</th>
<th>Open decks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo (flammable cargoes f.p. &lt; 90°C)</td>
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<td>Pipe room and branches</td>
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<td>Sanitary/Drains/Suppers</td>
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<td>Deck drains (intervals)</td>
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<td>Suppers and discharges (headroom)</td>
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<td>Sound/Murm</td>
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<td>Water tanks/dry spaces</td>
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<td>Oil entry (f.p. &gt; 90°C)</td>
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<td>Main/Foremost</td>
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<td>Control air</td>
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<td>Service air (non essential)</td>
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<td>Brake</td>
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<tr>
<td>Auxiliary low pressure steam (17 bar)</td>
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Product & System Design

<table>
<thead>
<tr>
<th></th>
<th>Resin</th>
<th>Glass</th>
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<tbody>
<tr>
<td>0.3 mm epoxy coating</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Wall</td>
<td>30%</td>
<td>70% E</td>
</tr>
<tr>
<td>0.5 mm resin rich liner</td>
<td>70%</td>
<td>30% C</td>
</tr>
</tbody>
</table>
Product Range Marine

Fibermar
Product designed for application with vacuum conditions inside the pipe and a head of liquid outside on the pipe

- Diameters 25 – 1600 mm (25 – 900 mm type approved)
- Internal pressure 10 & 16 bar (sf = 4)
- External pressure 20 – 50 mwc (sf = 3)
- Maximum Service Temperature 110°C
- Conductive & non-conductive
Product Range Marine

Wavistrong

Product designed for application without vacuum conditions or head of liquid outside the pipe, only internal pressure.

- Diameters 25 – 1600 mm (25 – 900 mm type approved)
- Internal pressure 6 – 24 bar
- Maximum Service Temperature 110°C
- Conductive & non-conductive
Product Range - Connections

- Rigid type of joining
- All pressure ratings
- Fully restrained
- Adhesive is a two component epoxy resin system
- 25 - 400 mm
- Generally used for diameters over 400 mm
- Rigid connection
- All pressure ratings
- Fully restrained
Laminated Joint

Fig. 3 Reinforcing laminate

ID = Inner diameter
TW = Minimum wall thickness
LU = Run out length
LV = Laminate length
TV = Laminate thickness
A = Fit laminate
B = Reinforcing laminate

Table 6. Tissue reinforcing laminate.

<table>
<thead>
<tr>
<th>Inner diameter (mm)</th>
<th>Pressure class PN (bar)</th>
<th>Surface weight tissue* (gr/m²)</th>
<th>Width tissue (mm)</th>
<th>Laminate thickness TV (mm)</th>
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</thead>
<tbody>
<tr>
<td>25 - 100</td>
<td>≤ 32</td>
<td>270</td>
<td>50</td>
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<tr>
<td>150 - 300</td>
<td>≤ 32</td>
<td>360</td>
<td>100</td>
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<tr>
<td>350 - 500</td>
<td>≤ 12.5</td>
<td>260</td>
<td>100</td>
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<tr>
<td>350 - 600</td>
<td>≥ 16</td>
<td>360</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>350 - 500*</td>
<td>≥ 16</td>
<td>580</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>700 - 1200</td>
<td>≤ 16</td>
<td>360</td>
<td>160</td>
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<td></td>
<td></td>
<td>580</td>
<td>160</td>
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</table>

* For those laminates that are composed of two types of tissue, alternately 4 layers 360 gr/m² and 4 layers 580 gr/m² is used, starting with 360 gr/m². The last two layers are wrapped with 360 gr/m².

Fig. 4 Finishing layer

ID = Inner diameter
TW = Minimum wall thickness
A = Fit laminate
B = Reinforcing laminate
C = Surface fleece
Product Range - Connections

- Quick & simple installation without gluing
- Integral filament wound socket and spigot end
- O-ring positioned on the spigot end
- Allows axial movement
- Allows limited angular deflection
- All diameters
Product Range - Connections

- Quick & simple installation without gluing
- Integral filament wound socket and spigot end
- O-ring positioned on the spigot end
- Locking device inserted through socket in groove
- Allows some axial movement and angular deflection
- All diameters
Rubber Seal Lock Joint
Product Range - Connections

Rubber Seal Lock Joint
## Flexible Couplings

<table>
<thead>
<tr>
<th>ID mm</th>
<th>End Float</th>
<th>Angularity</th>
<th>ID mm</th>
<th>End Float</th>
<th>Angularity</th>
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<tbody>
<tr>
<td>200</td>
<td>38</td>
<td>3°</td>
<td>200</td>
<td>8</td>
<td>1°30”</td>
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<tr>
<td>400</td>
<td>63</td>
<td>3°</td>
<td>400</td>
<td>13</td>
<td>1°30”</td>
</tr>
<tr>
<td>800</td>
<td>69</td>
<td>3°</td>
<td>800</td>
<td>19</td>
<td>1°</td>
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</tbody>
</table>
Product Range - Connections

- Connect spigot end pipes, no glue/laminates
- Diameter 200 - 900 mm
- Easy & simple installation
- To connect piping in adjacent blocks
- Allows axial movement
Product Range – Mechanical couplings

- Non axial restraint & axial restraint couplings
- Available in fire proof versions
- Suitable for joining GRE pipes
Product range – Supports & Fixation

- Fully restrained system
- Reduced need for expansion loops
- Reduced need for expansion bellows

Standard Anchor

With Laminated Shoulders

Expansion Force 10 times less than steel
GRE bulk head penetration
Ballast Water Treatment Systems – GRE vs steel/CUNI

- GRE reduces installation time/cost due to the light weight
- Chemically treated ballast water will increase corrosion
- GRE lasts a ship’s life time
Production Process - Pipes

Glass station

Impregnation with epoxy resin

Mandrel

Pre-curing oven
Production Process - Pipes

- Extraction
- Sawing machine
- Machining
- To curing oven
Production Process - Pipes
Production Process - Pipes
Production Process - Pipes
Production Process - Pipes
Production Process - Fittings
Production Process - Prefabrication
Production Process - Prefabrication
Tools - Shavers
Marine Applications GRE

- Ballast water
- Sea water cooling
- Potable water
- Fire fight
- Gland & flushing (dredgers)
- Navy ships
- Black & grey water
- In-tank cargo lines
- Ballast water treatment
- Scrubber units
Navy Ships – shock tests

- Simulation of shock waves going through ships.
- Pipes to keep integrity to assure good operation of systems.
- FPI successfully conducted tests in 2008 at Qinetiq, UK
Advantages GRE for Ship Owner

- GRE reduces through life cost
- GRE is non corrosive
- GRE weighs 25% of steel only (more cargo/passengers)
- GRE is easy and cheaper to install than steel systems
- GRE is non hazardous for environment and personnel
- GRE is easy to repair
- GRE has low maintenance costs
- GRE reduces amount of hot work
Advantages GRE for Ship Yard

• Due to light weight (25% of steel), prefabricated spools, easy & quick installation significant time savings can be achieved. Cheaper installation than steel pipe systems

• Apposed to Vinylester & Polyester, working with GRE is not a risk for health as it does not contain styrene
Type Approvals

FPI obtained type approvals of major classification societies:

- ABS
- Lloyd’s Register
- Bureau Veritas
- Germanische Lloyd
- Det Norske Veritas
- RINA

Production in factory in The Netherlands & Abu Dhabi
Fire Performance

FPI complies with FTP code for fire test procedures

• Fire endurance L3 acc. to IMO resolution A.753(18)
• Flame spread acc. to IMO resolution A.653(16)
• Flame spread acc. to ASTM D635
Fire Performance GRE – Mechanical coupling
Fire Performance GRE – Mechanical coupling

- Test witnessed & approved by Lloyds in October 2008
- After test of 35 minutes @ 850 °C, installation was pressure tested
- Coupling showed slight leakage at 63 bar, pipe & coupling kept integrity
Why accept corroding steel any longer?

- Applying maintenance free & costs effective GRE system will contribute to reduced through life costs
- Ship’s crew will spend less time on corroded steel problems
- Replacing steel pipes will be a thing of the past
Retrofit Steel with GRE

- Onboard survey by FPI to assess pipe systems
- Produce isometrics, MTO and quotation
- Turn key removal steel pipes & mounting GRE pipes