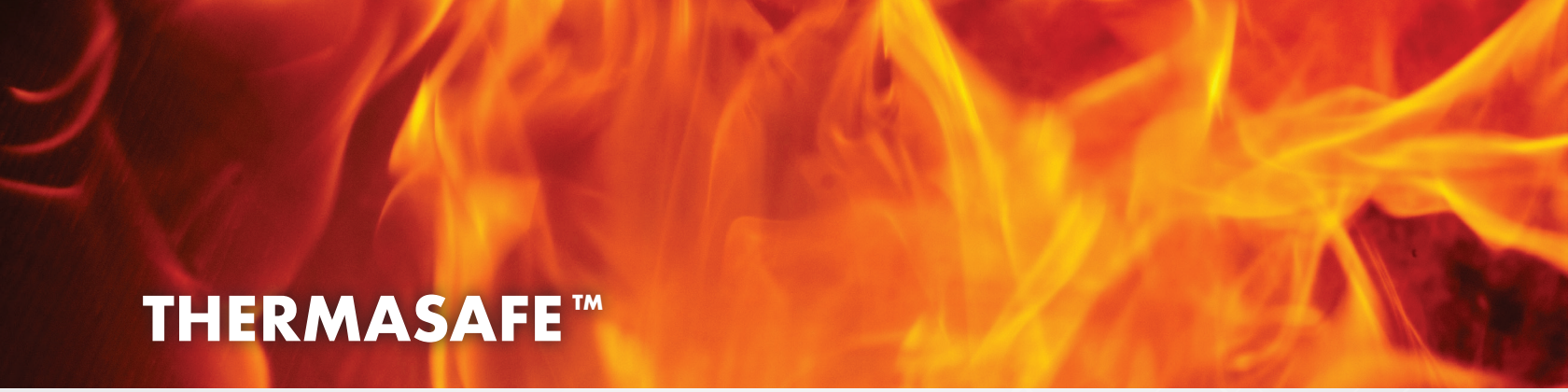

THERMASAFE™

Due to their intrinsic corrosion resistance, lighter weight, and reduced maintenance requirements, polymer matrix composites have been used aboard U.S. Navy ships for some exterior applications such as topside structures, fairings, and control surfaces. There has been increasing interest in the use of composites for applications inside ships, such as machinery foundations, piping, gratings, cable hangers, ventilation ducts, cabinets, storage lockers and berthing bunks. A serious issue that has limited composite use inside ships is the flammability, smoke and toxic gas emissions from polymer composites.

TRI's Thermasafe™ composite materials meet the fire, smoke, and toxic gas emission (FST) requirements and possess the physical properties required for use in ships and enable the Navy to introduce a wide range of composites for internal applications. The replacement of metallic components with composites will reduce procurement and life cycle costs, eliminate corrosion damage and greatly reduce maintenance, and reduce weight. A large number of components have been identified as candidates for fabrication of this new approved composite.

DEVELOPMENT OF THERMASAFE™ COMPOSITES

Under the sponsorship of NAVSEA, Texas Research Institute Austin, Inc. (TRI Austin) successfully completed an SBIR (Small Business Innovation Research) Phase II project to develop a cost effective, low smoke, fire resistant, structural composite for use inside the pressure hull of submarines. State-of-the-art fire resistant resin systems were developed for fabrication of glass fiber reinforced structural composites. These composites possess the physical and environmental properties for internal shipboard applications while meeting the stringent fire, smoke and toxicity (FST) requirements of MIL-STD-2031, "Fire and Toxicity Test Methods and Qualification Procedures for Composite Materials Used In Hull, Machinery, and Structural Applications Inside Naval Submarines."

TRI Austin's Thermasafe™ composites are a low cost modified phenolic resin system reinforced with glass fibers which has passed MIL-STD-2031 FST test requirements such as time-to-ignition, heat release rates, flame spread, smoke generation and toxic gas emissions. Figured 2 provides a summary of the MIL-STD-2031 FST requirements and the test results for these ThermaSafe™ composite materials.

In addition to FST requirements, the composite must be able to endure the harsh marine environment encountered on ships. Tests were conducted to determine the behavior of ThermaSafe composite when under shock and exposed to shipboard contaminants.

MIL-STD-2031 Fire and Toxicity Test Methods and Qualification Procedure for Composite Material Systems Used in Hull, Machinery, and Structural Applications Inside Naval Submarines

Fire Test/Characteristic	Requirement	Test Method	ThermaSafe™ Composite
Oxygen-temperature index	Minimum	ASTM D-2863-2013 Modified	
% oxygen at 25°C	35		>99.99
% oxygen at 75°C	30		>99.99
% oxygen at 300°C	21		50
Flame-spread index	20 (maximum)	ASTM E-162	0
Ignitibility(s)	Minimum	ASTM E-1354-16a	
100 kW/m^2 irradiance	60		94
75 kW/m^2 irradiance	90		125
50 kW/m^2 irradiance	150		417
25 kW/m^2 irradiance	300		No Ignition
Heat release (kW/m^2)	Maximum	ASTM E-1354-16a	
100 kW/m^2 irradiance, peak	150		80.13
Average for 300 s	120		54.84
75 kW/m^2 irradiance, peak	100		65.97
Average for 300 s	100		48.48
50 kW/m^2 irradiance, peak	65		45.53
Average for 300 s	50		34.38
25 kW/m^2 irradiance, peak	50		11.87
Average for 300 s	50		0
Smoke obscuration	Maximum	ASTM E-662	
D_s during 300 s	100		1
D_{max}	200		8.7
Combustion gas generation	CO=200 ppm	ASTM E-1354	Not Detected
(25 kW/m^2)	CO_2 = 40000 ppm		751 ppm
	HCN = 30 ppm		Not Detected
	HCl = 100 ppm		Not Detected

DDS-078-1 Composite Materials, Surface Ships, Topside Structural and Other Topside Applications - Fire Performance Requirements

Fire Test/Characteristic	Requirement	Test Method	ThermaSafe™ Composite
Surface Flammability	Maximum	ASTM E 84-01	
Maximum Flame Spread Index	25		0
Maximum Smoke Developed Index	75		5
Fire Gas Toxicity	Maximum	ASTM E-800-14	
CO: 600 ppm (max)	660 ppm		171
HCl: 30 ppm (max)	30 ppm		Not Detected
HCN: 30 ppm (max)	30 ppm		Not Detected
Fire Gas IDLH Index, I IDLH < (Less than) 1	Less than 1		0.13

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THERMASAFE™

SUBMARINE TORPEDO RECONFIGURABLE BERTH SYSTEM AND GEAR STOWAGE

The Navy requires the ability to transport Special Forces covertly on submarines. During a PEO Subs-funded SBIR Phase II effort, TRI Austin engineers analyzed, designed, fabricated and tested a pultruded fiberglass reinforced phenolic composite reconfigurable berth system for use in Virginia-class submarine torpedo rooms. TRI Austin delivered a prototype to NAVSEA in November of 2005 for testing and evaluation. TRI Austin's design allows for torpedoes to be removed and extra personnel berths and gear stowage to be installed. The ThermaSafe™ composite reconfigurable berth is 30% lighter than a metallic version. NSWCCD tested the prototype, which passed a full-room fire test. The berth pans were manufactured using a hand lay-up process. The truss was manufactured by the pultrusion process with bonded steel inserts and aluminum face sheets, which demonstrated that ThermaSafe™ composites bond well to metallic materials. The reconfigurable berth is designed and proof tested to withstand 250 pounds in each of the 42 sleeping surfaces with a safety factor of four.

TRI Austin's ThermaSafe composite reconfigurable berth for the Virginia-class submarine torpedo room. This unit has been delivered to NAVSEA and passed a full-room fire test at NSWCCD.

MANUFACTURING OPTIONS

ThermaSafe™ composite structures are economical to produce, in part, because of the low base resin cost. The resin system can also be used for a variety of fabrication methods, including:

- Pultrusion
- Hand lay-up
- Filament winding
- Compression molding

Lightweight prototypes can be manufactured with excellent mechanical properties, and TRI Austin's ThermaSafe™ composite has a good strength to weight ratio. Pultruded prototypes reinforced with E-glass have been manufactured with an average density of 0.06 pounds per cubic inch, as compared to aluminum with a density of 0.098 pounds per cubic inch. Composite prototypes reinforced with lightweight carbon fibers have been constructed offering additional weight savings due to the enhanced strength of carbon fibers.

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TO LEARN IF TRI THERMASAFE™ CAN HELP YOU WITH YOUR APPLICATION, CONTACT:

ROBERT BRUSHABER
DIRECTOR OF ENGINEERING
Office: 512.615.4457
Cell: 512.897.0327
rbrushaber@tri-austin.com