



Landing Helicopter Dock Ship – HJ1 Composite Armor System

High-Strength Solutions for Your Toughest Reinforcement Challenges



Helicopter Deck



S-2 Glass Conventional Roving Package



The USS Wasp Class LHD Amphibious Assault Ship

S-2 Glass® fiber reinforced phenolic HJ1 composite has replaced aramid fiber-reinforced vinyl ester for shipboard armor of a major class of naval assault ships. The primary reason for the switch was to reduce costs without sacrificing ballistics performance.

The amphibious assault ship class is the Landing Helicopter Dock (LHD). This ship can launch an assault using a combination of helicopters, vertical/short takeoff and landing aircraft and amphibious vehicles. The 256m (844 ft) long vessel is the largest amphibious assault ship in the world.

The ship's protective armor must resist the sophisticated threats posed by today's enhanced weaponry. In the past, getting more protection, as a matter of using more metal, meant incurring a serious weight penalty. Consequently, naval engineers turned to spall liners made of AGY's lightweight HJ1 Composite Armor System. The combination of ballistic protection and structural load-bearing capability inherent in S-2 Glass armor systems make them ideal for blast mitigation and other structurally demanding ballistic applications.

The deckhouse on the original LHD class ship (USS Wasp/LHD-1) included a spall liner molded of a flame retardant grade of vinyl ester, reinforced with aramid fibers. The change to the S-2 Glass fiber/phenolic HJ1 composite was based upon a Department of Defense cost/performance program. A "Value Engineering Change Proposal" (VECP) was submitted by Ingalls Shipbuilding, now owned by Northrop Grumman, for the use of HJ1 as an alternative for deckhouse armor on the USS Essex (LHD-2), and approved by the Navy. The benefits were equal ballistic performance at the same weight, improved fire/smoke performance, easier fabrication and lower cost.

As a result, LHD deckhouse armor is now manufactured using AGY's HJ1 Composite Armor System, a patented material solution based on AGY's S-2 Glass reinforcement and a phenolic resin. The S-2 Glass input reinforcement is a woven roving fabric that meets MIL-R-60346C, Type IV. The resin is a phenolic that meets MIL-R-9299C, Grade B.

In recent years, the effects of smoke and toxic gases have been singled out as being one of the leading causes of injury and death in fire. Phenolic resins are fire-resistant materials with low smoke emissions and toxicity levels. The phenolic polymer structure facilitates the formation of a high carbon form structure, or char, that radiates heat and functions as an insulator. The use of a phenolic resin in conjunction with an inorganic glass reinforcement results in superior performance.

PRODUCT INFORMATION

The following table is a summary comparison of fire/smoke properties of HJ1 laminate and aramid-reinforced halogenated vinyl ester laminates.

Fire, Smoke and Toxicity Data for HJ1 Phenolic System					
	Limiting Oxygen Index		Smoke Obscuration	Flaming Soldering	Flame Spread Index
	23°C	150°F			
NAVSEA Guidelines	>27	>27	<250	<250	<250
S-2 Glass Fiber/Phenolic	56	75	30	2	1
Aramid/Vinyl Ester	39	39	405	152	13

When properly processed, the HJ1 system represents a new generation composite armor system with impressive ballistic and fire/smoke performance. S-2 Glass composite armor offers the additional benefit of negligible water absorption (<1%), which is important in a marine environment. Overall economics are attractive as the system provides a 25 percent to 40 percent cost savings over comparable performing aramid armor systems. Rights to AGY's technology have been licensed to 20 manufacturing companies, 12 of which are in the US, to provide consistent, competitive and assured availability of this product which meets MIL-DTL-64154, Class A, Code 1. A list of these companies are available from AGY upon request.

This fiber/resin combination creates a semi-compatible bond that results in superior resistance to penetration by incoming threats. The energy of a projectile is first absorbed by compressive failure as the laminate is impacted. Fibers are cut and a cavity is formed. Then, as the projectile continues, it strikes individual strands, which stretch, break and delaminate. This reaction disseminates the projectile's energy in a radial direction. AGY's HJ1 Composite Armor System offers protection that is equivalent to that of the aramid fiber/vinyl ester system – at a lower cost.

HJ1 Composite Armor System	
Features	Benefits
Fire and flame resistance	Safety
Low smoke and toxicity	Safety
Ease of repair at sea or in harbor	Low cost of ownership
Same ballistic performance as aramid at lower thickness and cost	Low cost of purchase. More space. Defeats threats.
Low moisture absorption	Consistent performance in marine environments

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