

# Low Cost, Impact Damage Resistant, Deck Edge Safety Net Frames

## **KaZaK Composites, Inc.**

10F Gill Street  
Woburn, MA 01801

### **Contact: Brian Smith**

Phone: (781) 932-5667

Fax: (781) 932-5671

Email: [info@kazakcomposites.com](mailto:info@kazakcomposites.com)

Website: [www.kazakcomposites.com](http://www.kazakcomposites.com)



**Command: ONR - SBIR**

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## **PROBLEM STATEMENT**

Many Navy ships have deck edge safety nets that are positioned to capture crew members who are washed or blown overboard, particularly during flight operations. The support frames and attachment hardware for these nets are currently fabricated from steel tubing. While these steel frames have a relatively low acquisition cost, they require considerable routine maintenance for corrosion prevention and control. In addition, the nets and frames are frequently damaged when docking, or when dragged through the sea by unexpectedly large waves or sudden maneuvers. A recent investigation into safety net/frame damage on DDG-51 Arleigh Burke-class destroyers found over 300 reported instances of major damage. Replacement of the steel frames with new ones made from a highly impact-resistant composite material will eliminate corrosion, reduce weight, and significantly reduce maintenance and repair costs.

## **WHO CAN BENEFIT?**

A number of Navy ships have deck edge safety net systems similar to those carried on the DDG-51 Arleigh Burke class, including CG-47 Ticonderoga-class cruisers and FFG-7 Oliver Hazard Perry-class frigates. It is reasonable to expect that the nets and frames on these ships suffer damage similar to that found on the DDG-51. The US Coast Guard can also directly benefit from an improved safety net system because cutters such as the WMEC Hamilton-class have a flight deck and hanger for helicopter operations. In the commercial sector, the Coast Guard requires helicopter deck safety nets on offshore drilling and production platforms. The potential for reduced maintenance and repair costs would definitely be of interest to the energy industry.

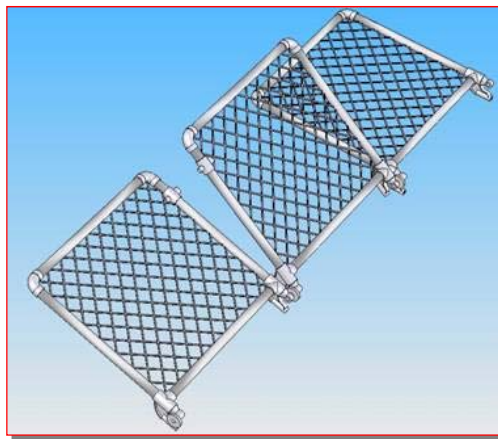
## BASELINE TECHNOLOGY

Deck edge safety nets on US Navy ships are supported by tubular frames that are fabricated from relatively low cost carbon steel tubing. Steel tubing is also used in other safety-critical ship structures, such as the stanchion “fence posts” which support safety lines around elevator openings and the ship’s perimeter. Navy deck edge safety net systems must be in compliance with drawings NAVSEA 803-5000902 and NAVSEA 803-5184097. To control corrosion of the steel, chipping and painting is almost continuously required, resulting in well documented costs for paint, inspection, removal of old paint and rust, application of new paint, and proper disposal of waste materials. For a single DDG-51, the cost of re-painting the safety net frames has been estimated to be at least \$45,000 over a period of 20 years.

Recent studies have determined that the safety nets and steel frames are frequently damaged. A recent investigation of Maintenance History Reports on DDG-51 class stanchion damage found that data for hull numbers 52 to 84 contained a total of 311 net/frame failures, with repair costs as high as \$80,000 for a single incident. Of much greater concern is the fact that many of these incidents required the cessation of flight operations until the damage could be repaired.

## TECHNOLOGY DESCRIPTION

Recent Navy-funded SBIR research has demonstrated that tubular steel stanchions could be replaced with a novel “macro-composite” material that combines an extremely damage-tolerant polyurethane matrix with pre-pultruded unidirectional glass rods. This construction results in a tube that has very high bending stiffness. The tube also has a remarkable ability to bend nearly flat, and then return to its original position when unloaded. This technology is currently being demonstrated for elevator stanchions on a CVN. This program seeks to expand and accelerate the use of the macro-composite construction by applying it deck edge safety net frames.



**Deck Edge Safety Net Macro-Composite Frame Concept**

The use of the macro-composite for the safety net frames would result in several significant cost and performance-enhancing benefits:

<b>FEATURES</b>	<b>ADVANTAGES</b>	<b>BENEFITS</b>
<b>Designed to collapse at a pre-determined load level, and then recover without any damage</b>	<b>Frame structure can safely handle all loading conditions</b>	<b>Efficient use of material; reduced repair costs; increased operational readiness</b>
<b>Polymer matrix</b>	<b>No rust or corrosion</b>	<b>Cost of maintenance is significantly reduced</b>
<b>Weighs significantly less than steel</b>	<b>Easier for crewmembers to deploy and retract.</b>	<b>Reduced risk of injury</b>
<b>Cost is 60% of carbon steel and 25% of type 316 stainless</b>	<b>Reduced acquisition cost</b>	<b>Lowest life-cycle cost</b>
<b>Fully compatible with existing deck hardware</b>	<b>Replaces steel frame with no shipboard modifications</b>	<b>Reduced cost of retrofits</b>

### **CURRENT STATE OF DEVELOPMENT**

The plan for this SBIR program was significantly revised by KaZaK and approved by the Navy in September 2006. The revised basic Phase II program will be completed by the end of October 2007. Option Phases A and B will be completed by April 2008 and September 2008, respectively.

KaZaK’s overall Phase II approach to the development of macro-composite safety net frames is to integrate the mechanical and strength properties of the material, structural design and analysis, and low-cost manufacturing into a performance optimized, damage-resistant solution. The macro-composite material characterization is in-progress, and is scheduled to be complete by June 2007. Design concepts for the new safety net frame and attachment hardware are complete, and work is underway to size all of the structural components and hardware. Weight and cost estimates can then be made for comparison with the steel baseline. This work is scheduled to be completed by July 2007.

The technology development milestones for this program are shown in the following table:

<b>MILESTONE</b>	<b>TRL</b>	<b>DEVELOPMENT RISK</b>	<b>MEASURE OF SUCCESS</b>	<b>TRL DATE</b>
Phase II - Materials	3	Moderate	Model predictions of properties agree with experimental data	06/07
Phase II - Structure	3	Low	Design concept has lower cost & weight than baseline	07/07
Phase II-Option Phase A	4	Low	Detailed structural analysis shows that design meets all specifications	04/08
Phase II – Option Phase B	6	Moderate	Tests verify the predicted design performance	09/08

## TECHNOLOGY AVAILABILITY

This Phase II program will culminate with the design verification testing of a safety net frame. A successful demonstration will allow KaZaK to move forward with a Navy partner interested in the benefits that will accrue from the rapid deployment of this system.

The following table shows the transition plan that is currently envisioned by KaZaK:

<b>TRL</b>	<b>REQUIRED TESTS AND DEMOS</b>	<b>TARGET DATE</b>	<b>\$ NEEDED</b>
<b>7</b>	<b>Gather data on composite CVN and Army causeway stanchions that are currently in use</b>	<b>12/08</b>	<b>300K</b>
<b>8</b>	<b>Fabricate prototype safety net systems; Sea trials</b>	<b>09/09</b>	<b>750K</b>
<b>9</b>	<b>Final design and manufacturing modifications; Deployment to the fleet</b>	<b>12/09</b>	<b>TBD</b>

## REFERENCES

### **Phase II Technical Point of Contact:**

Dr. Paul E. Hess III  
Ship Systems and Engineering Division  
The Office of Naval Research  
875 N. Randolph Street, Code 331  
Arlington, VA 22203  
(703) 696-9776  
hessp@onr.navy.mil

### **Phase III Transition Participant:**

Dr. Roger Crane, Section Head  
Marine Composites Branch, Code 6553  
NSWC Carderock Division  
9500 MacArthur Blvd.  
West Bethesda, MD 2081  
(301) 227-5126  
cranerm@nswccd.navy.mil

Dr. Crane is very familiar with use of composite materials on Navy ships, and originally brought the deck edge safety net application to the attention of KaZaK.

## ABOUT THE COMPANY

KaZaK Composites Inc. is a Massachusetts based company that designs, develops, manufactures, and markets high performance composite structures. By integrating innovative engineering design and proprietary low cost manufacturing processes, with specialization in large and unusual pultrusion processing, the Company provides superior value products for the aerospace, military, and commercial markets.

A privately held company, KaZaK Composites, Incorporated was established in 1992 and has grown to nearly 35 employees, most of whom are degreed engineers and scientists. KaZaK's expertise is in composite materials, mechanical design, and structural analysis. The Company is headquartered in Woburn, Massachusetts and maintains a manufacturing facility in Hudson, New Hampshire. The Hudson facility houses the world's largest pultrusion equipment, capable of producing sandwich panels up to 10 feet in width, and 6 inches in thickness.