**Friction Stir Processing Repair of Nickel Aluminum Bronze Propellers**

**Status:** Technical Success

**PROBLEM / OBJECTIVE**

The objective of this project is to develop and implement joining processes that improve performance, reduce costs and reduce the time to repair nickel aluminum bronze propellers. The need for this project is driven by the high cost of in-service repairs of ship and submarine propellers. Current practice is to repair defects and rebuild surfaces by arc welding and then straighten where necessary to restore the correct geometry. Presently welding is limited to gas metal arc welding for the flat position and gas tungsten arc welding for out-of-position repairs. When the propeller can be removed from the vessel, special fixtures are used to position the large parts for flat position welding. Some of the most recent designs make propeller removal extremely difficult and costly.

**ACCOMPLISHMENTS / PAYOFF**

**Process Improvement:**
Friction stir processing is a solid-state welding process that can be used to repair surface and near surface defects and increase material strength. This process can be combined with a robot to provide a portable process that can be applied to both new and in-service propellers. Friction plug welding is a portable solid-state joining method being investigated for localized repairs. In addition, pulsed gas metal arc welding procedures are being developed to permit high-productivity, out-of-position arc welding of those propellers that cannot easily be removed from the vessel.

**Implementation and Technology Transfer:**
This project supports implementation of friction stir processing and improved welding processes for repair of propellers for Virginia and Trident Class submarines. The project supports final qualification and demonstration of the processes developed and their transition to user facilities. The technology will be implemented at the Naval Foundry and Propeller Center (NFPC), Wartsila Defense, Inc., and other facilities where in-service repairs are performed. The project supports the certification of the friction stir process as well as the design, construction, and installation of a friction stir processing robot.

**Expected Benefits and Warfighter Impact:**
Fiction stir processing can reduce the time to repair surface and subsurface defects in propellers. The process also can strengthen critical areas as well as reduce residual stresses and distortion. In addition, pulsed gas metal arc welding and portable friction plug welding can permit repairs without having to remove the propeller from the vessel. These improved welding and processing methods will reduce labor costs; decrease repair cycles times, and improve propeller performance. It is estimated that friction stir processing alone can save $400K per year in propeller repair costs.

**TIME LINE / MILESTONE**

Start Date: September 2007  
End Date: December 2010

**FUNDING**

Total ManTech Investment: $0.605M

**PARTICIPANTS**

Edison Welding Institute  
Naval Surface Warfare Center, Carderock Division  
Naval Foundry and Propeller Center  
Friction Stir Link  
Wartsila Defense, Inc.