



# **Evaluation Of Cavitation Damage Resistant Coatings For Use On Naval Structures**

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# Evaluation Of Cavitation Damage Resistant Coatings For Use On Naval Structures



- **Problem**
- **Objectives and Benefits**
- **Approach**
- **Accomplishments**
- **Summary and Conclusions**
- **Future Considerations**



## Typical Cavitation Damage on Naval Structures



Large Areas of Erosion on a Naval Structure



Close-up View Of Damage Showing Exposure Of Base Steel



### Objectives:

- Primary - Develop replacement coating for use on naval structures subject to high cavitation (damage) intensity
  - High cavitation damage resistance
  - Environmentally durable
  - Shipyard compatible
  - Low/no VOCs
- Secondary - Investigate material property/cavitation damage resistance relationship

### Benefits:

- Extended service time between scheduled dry-docking
- Minimize repair of cavitation-damaged structures
- Reduced cost associated with low/no VOC materials



### Candidate coating identification

- Coating vendors
- Navy recommendation
- Previous experience

### Fabrication of candidate coatings samples

- Coating vendors
- Navy (NSWCCD)
- In-house

### Evaluation

- Screening test - Modified ASTM method G-32-85
- Water tunnel test – ARL Penn State's 1.5-inch Ultra High Speed Cavitation Tunnel

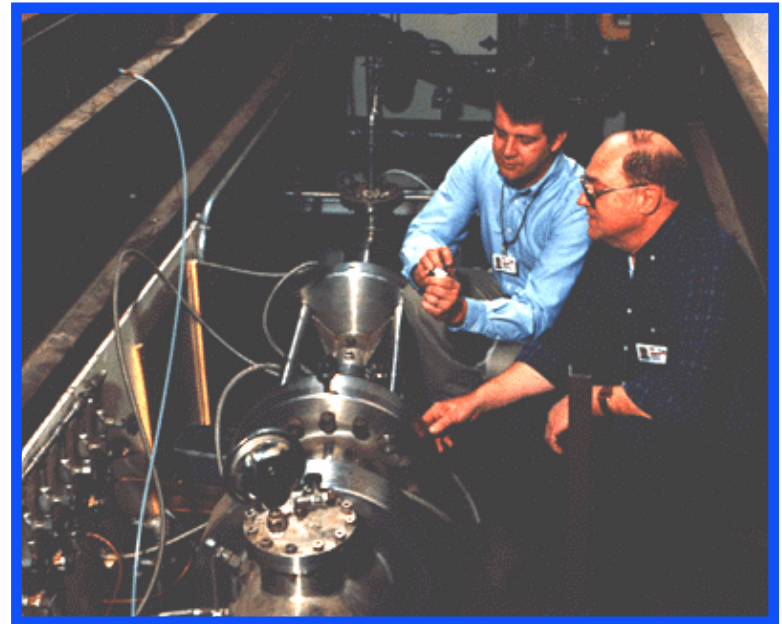
### Optimization

- Coating properties
- Shipyard application

## Cavitation Test Equipment



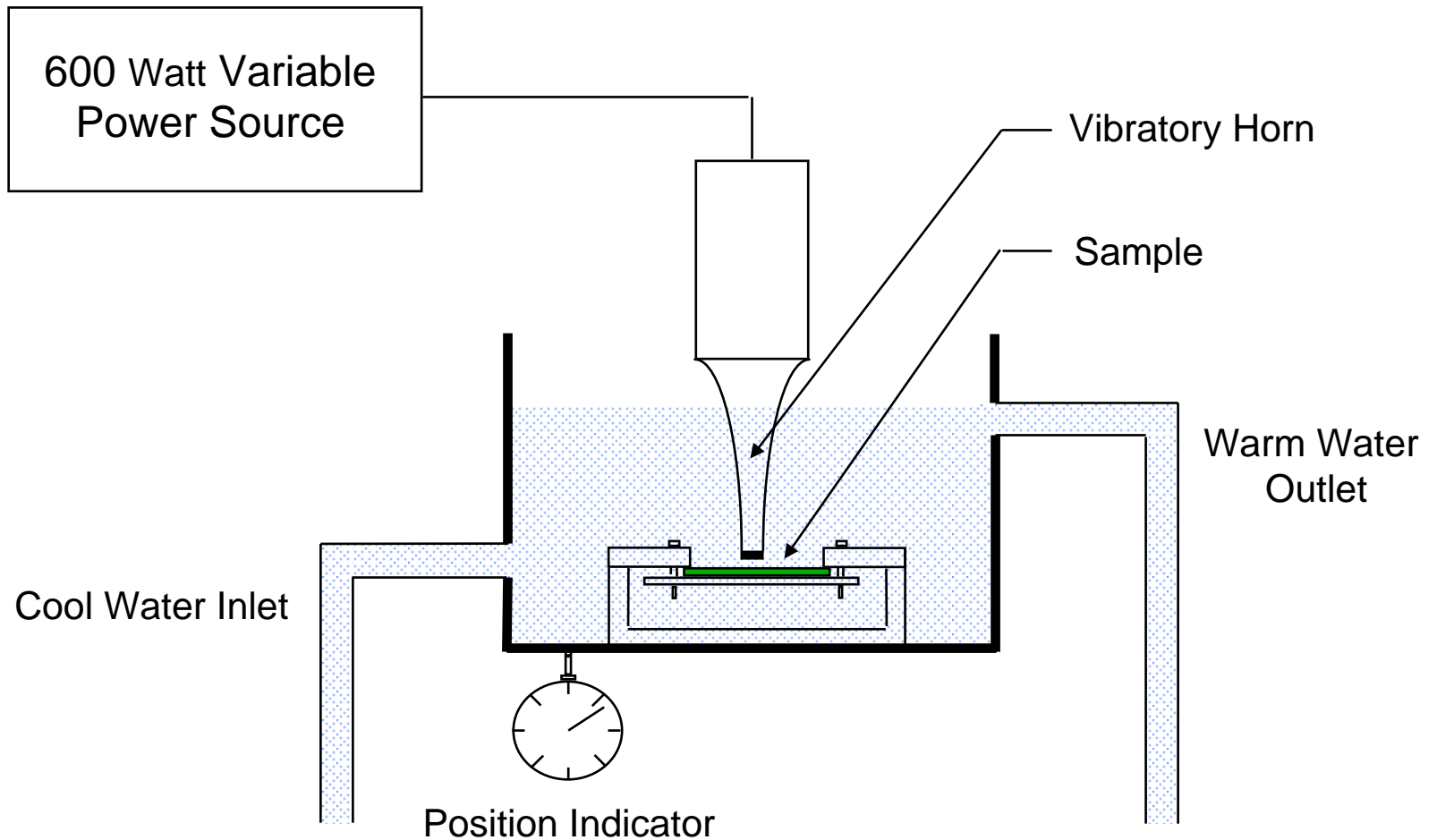
**Ultrasonic Screening Fixtures  
Modified ASTM G32-85**



**1.5-inch Ultra High Speed  
Water Tunnel**

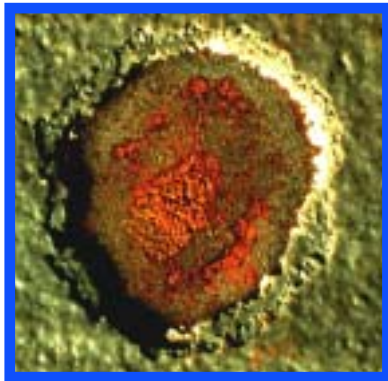


## Cavitation Damage Screening Test





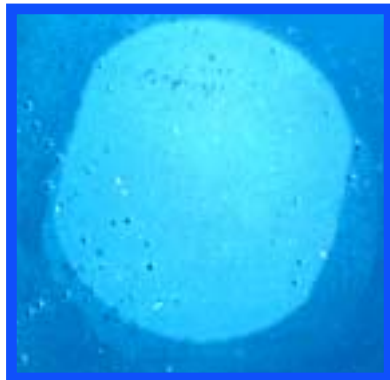
## Cavitation Damage Screening Test Results



**Extensive Damage**



**Moderate Damage**

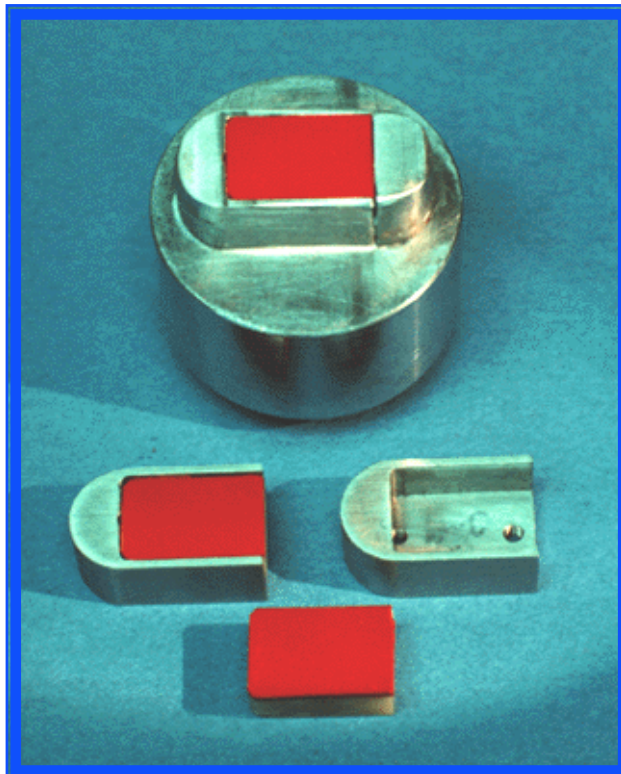


**Low Damage**



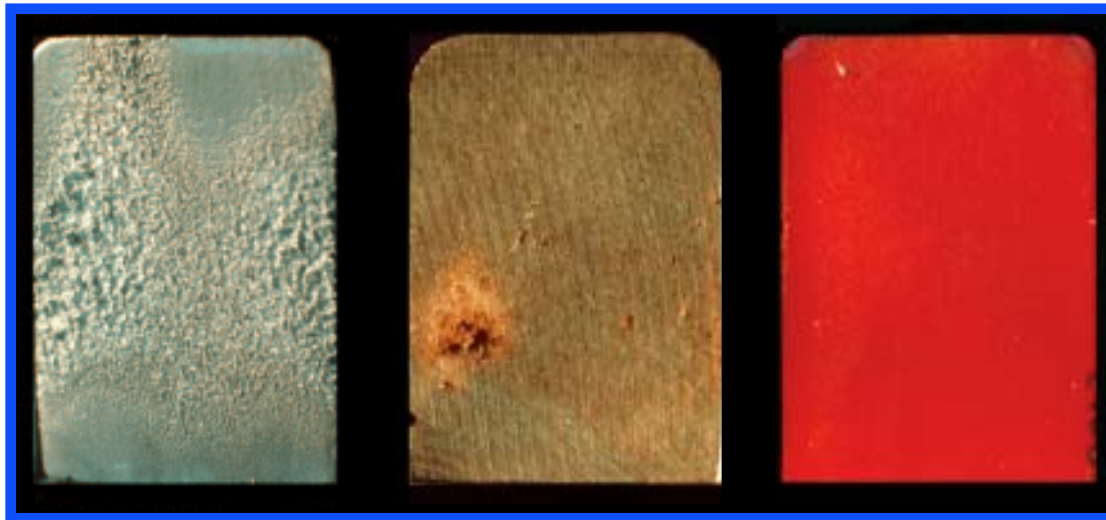
**No Damage**

## 1.5-inch Ultra High Speed Water Tunnel Test Specimen Configuration





## 1.5-inch Ultra High Speed Water Tunnel Damage Comparison



**Aluminum  
(2.5 Hrs)  
Extensive  
Erosion**

**NiAl Bronze  
(20 Hrs)  
Moderate  
Erosion**

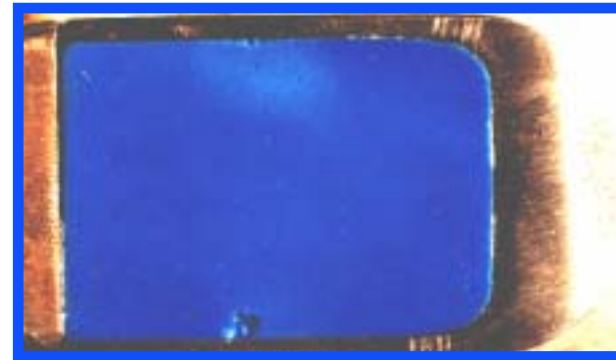
**Polyurethane  
(20 hrs)  
No  
Erosion**



## 1.5-inch Ultra High Speed Water Tunnel Typical Failure Modes



**Erosive Failure**



**Pitting Failure**



**Dynamic Failure**



**Adhesive Failure**

## Coating Properties

- Cavitation damage resistance
- Coating-to-substrate adhesion
- Galvanic protection/immersion durability

## Shipyards Application

- Application techniques/procedures
- Environmental compliance



## Impact of Shipyard Application Procedures



**Cast Sample**



**Sprayed Sample**

### Performance:

- Air entrapment
- Defects
- Thickness
- Uniformity
- Adhesion

### Cost:

- Equipment
- Tooling
- VOC containment



Projects Sponsored by iMAST REPTech (LINC) Program and NSWCCD

- Testing protocol and evaluation criterion established using baseline coating
- Over 50 candidate replacement coating systems evaluated
- Critical parameters affecting coating performance determined
- Promising new candidates identified/investigated
- Success spraying 100% solids 'castable' systems



- Cavitation damage to Naval structures is a continuing problem
- ARL Penn State has investigated a large number of potential protective coatings
- Several good candidate coatings have been identified
- Coating application is an issue
- Solutions are available, but need to be further optimized



- Continue to develop/optimize efficient application methods for materials demonstrating superior cavitation damage resistance
- Investigate small scale repair issues
- Continue to investigate environmentally friendly coating options
- Continue to investigate relationship between material properties and performance