Low Cost Manufacturing for Very Large Format, Low Observable Radomes

**Status:** Phase 1 & 2 Complete

**PROBLEM / OBJECTIVE**

Large and very large aperture radomes (20 – 200 sq ft) represent a dramatic upscaling of conventional manufacturing. Defect opportunities for large aperture, multi-function, structural radomes are unprecedented. Without further advances in manufacturing technologies, the production yield, cost, and delivery schedule is at risk.

Radome acquisition cost is reduced by improving manufacturing reliability to near 100% yield. This ManTech project set out to help achieve this fabrication goal by advancing process controls, inspection, and rework technologies for hand lay-up autoclave cured radomes.

**ACCOMPLISHMENTS / PAY-OFF**

**Process Improvement:**

An automated Large Structure Inspection (LSI) system was used after each cure to inspect the laminates for defects and determine the cured laminate thickness.

This “on-the-mold” inspection method decreases handling risks while enabling defect detection earlier in the value stream. It also provides a dense data set that is used to accurately determine the laminate thickness. Thickness control (i.e. Frequency Selective Surface layer spacing) is instrumental in functionality of high frequency, low observable radomes. The LSI method used in conjunction with the radome Ply Calculator demonstrated the ability to achieve incremental and final thickness control of 3/8” thick lay-ups within ±3 mils.

The project also demonstrated multiple rework options for solid laminate and A-Sandwich radomes, including resin injection, scarf repairs, and laminate remove and replace techniques. In doing so, the project overcame the significant challenge of reworking composite panels containing embedded circuit layers while maintaining tight tolerance thickness control and RF performance.

In Phase 2, a reference table of structural knockdowns associated with various defects and repair methods was developed that will facilitate decisions regarding reparability of radomes regardless of defect type or location.

Also in Phase 2, the inspection procedure was scaled up from use on 3’ x 4’ panels demonstrated in Phase 1 to 9’ x 9’ panels. This scale up was demonstrated on a production EHF radome for DDG-1000.

**Implementation and Technology Transfer:**

Improved process flow via optimized debulk routines for frequency and time under vacuum was transferred to the IFF and CEC2 programs. Likewise, in-process thickness control findings, including laminate measurements and micro section results, were transferred to IFF, EHF, and CEC2. Use of the LSI system for thickness control and defect detection was proven on panels up to 9’ x 9’.

Cosmetic and structural repair procedures for a variety of laminate types are now available for production use. In some cases, use on a production part first requires mechanical analysis to determine knockdown. These knockdown tables were developed in Phase II.

**Expected Benefits and Warfighter Impact:**

Improved process control, advanced defect detection, and effective rework procedures have increased yield rates for high value radomes to near 100%. This has resulted in ~$1.6M in savings and is expected to save over $3M on the three DDG-1000 ships expected to be procured, which will in turn reduce radome acquisition costs and prevent costly integration schedule delays. The ManTech improvements will benefit multiple DDG ship sets, as well as multiple future ship platforms that utilize digital arrays.

**TIMELINE / FUNDING**

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**PARTICIPANTS**

US Navy (PMS 500), Office of Naval Research, Composite Manufacturing Technology Center, Raytheon Advanced Products Center, and The Applied Research Laboratory at The Pennsylvania State University

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