SUBSTANTIATIONS OF AN AIRBORNE COMPOSITE RADOME MOUNTED ON AN AIRCRAFT DOME

Presented by Ido Kressel
Israel Aerospace Industries
Substantiations of an Airborne Composite Radome Mounted on an Aircraft Dome

OUTLINE

- Radome Design
- Radome Production
- Substantiation Method
  - Analysis
  - Elements Tests
  - Full Scale Static Test
- Summary

Radome trimming and inspection hangar
Design Concept

Each Radome was designed as a single, integral piece, thus ensuring:

- Minimal weight – no splicing, no rivets, etc...
- Optimal Electrical performance
- Reduction in No. of parts
- Elimination of assembly problems due to parts manufacturing tolerances
- Reduction in labor & assembly costs
AEW Radome Design & Substantiation

Structural Design Criteria

- Electrical requirements
- Minimal weight
- Environmental conditions: -55°C to 70°C/wet
- Damage tolerance
- Lightning strike protection
- Interchangeability
Radome Manufacturing

- Radome manufactured on a steel lay-up tool
- Challenge in ensuring: final geometry, uniform temperature distribution during curing process
- Automation in ply cutting, lay up using laser projector
- Honeycomb core formed & NC machined

Radome lay-up tool in the clean room
AEW Radome Production

Automated Inspection by Special “C” Scan Ultrasonic Machine

- Software developed at IAI for analysis of C-Scan data
Substantiation Method

- Finite Element (FE) & detail stress analysis
- Building block approach:
  - Coupon tests for mechanical properties
  - Element tests for critical design details
  - Full-scale static test for final proof of structure
Element Tests

- Leading edge typical structure
- Edge specimen (for tension and bending tests)
Edge specimens - Tension Test

- Two static tests
  - Environmental knock-Up factor on loads
  - Embedded defects

- Loaded up to 220% ULT. **No failure**, test stopped
Edge Specimens - Bending Test

- Two static tests:
  - Environmental knock-Up factor on load
  - Loaded up to 260% ULT.
- Two fatigue tests
  - Environmental aging
  - Embedded defects
  - 20 lifetimes
  - Residual strength test up to 170% ULT at RTD, **No failure**, test stopped
Leading Edge Specimen

- Two static tests:
  - Environmental knock-Up factor on load
  - Loaded up to 440% ULT. **No failure**

- Two fatigue tests
  - Environmental aging
  - Embedded defects
  - 20 lifetimes
  - Residual strength test up to 170% ULT at RTD
    **No failure**, test stopped
**Full Scale Static Test**

- Radome test article identical to serial design
- Radome mounted on a rigid rig representing Dome interface
- Test environmental condition: RTD
- Test performed up to Ultimate load
- Load enhancement factor to account for variability & environmental effects

![Diagram showing test flow and details](image)
Full Scale Static Test Concept

- The Radome surface was divided into 52 cells
- Average aerodynamic pressure for each cell was calculated
- Internal pressure, on each cell, was applied by air-bags in order to simulate the actual air load distribution
Comparison Between Air-Bags Pressure and Aerodynamic Loading

Note: A.B. → Air Bag

P Aerodynamic
P AirBag Limit
Air-Bags Supporting Rig

- Each air-bag pressure is controlled separately
- Left Hand Side & Right Hand Side rig reactions measured separately, to allow pressure adjustment on each surface.
- 241 strain & 14 displacement channels.
Test Setup
AEW Radome Design & Substantiation

Full Scale Static Test Set UP
Radial Strain Distribution at Radome Leading Edge Ult. Test

- Inner ply, analysis
- Inner ply, test results
- Outer ply, test results
- Outer ply, analysis
AEW Radome Design & Substantiation

Tangential Strain Distribution at Radome C/L Ult. Test

![Graph showing tangential strain distribution at Radome C/L Ult. Test]

- Inner ply, analysis
- Inner ply, test
- Outer ply, analysis
- Outer ply, test
A dome mounted composite Radome was designed and substantiated for an early warning surveillance system.

Innovative design and manufacturing concepts allowed construction of this Radome as a single integral part, thus reducing cost and assembly problems.

The substantiation method relied on analysis, supported by testing at component and full-scale level.

The two primary damage tolerance requirements were addressed: damage growth characterization and residual strength-capability.