S2944: Thermal Insulating Coatings

NSRP All Panel Meeting 2025

Tim Sherrange / Chris Yoko

Huntington Ingalls – Newport News Shipbuilding

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Agenda

1. Project Team
2. Platform/Issue Description
3. Objective
4. Technical Goals
5. Benefits/Pay Off
6. Project Schedule
7. Technical Approach
8. Technical Content and Status
9. Transition/Implementation Plan
10. Next Steps
11. Q & A

Project Organizational Structure

Neil Graf – Program Officer
Office of Naval Research (ONR)

Ryan Frankart – Director
Nick Melillo – Technical Director
De'Andre Cherry– Project Manager

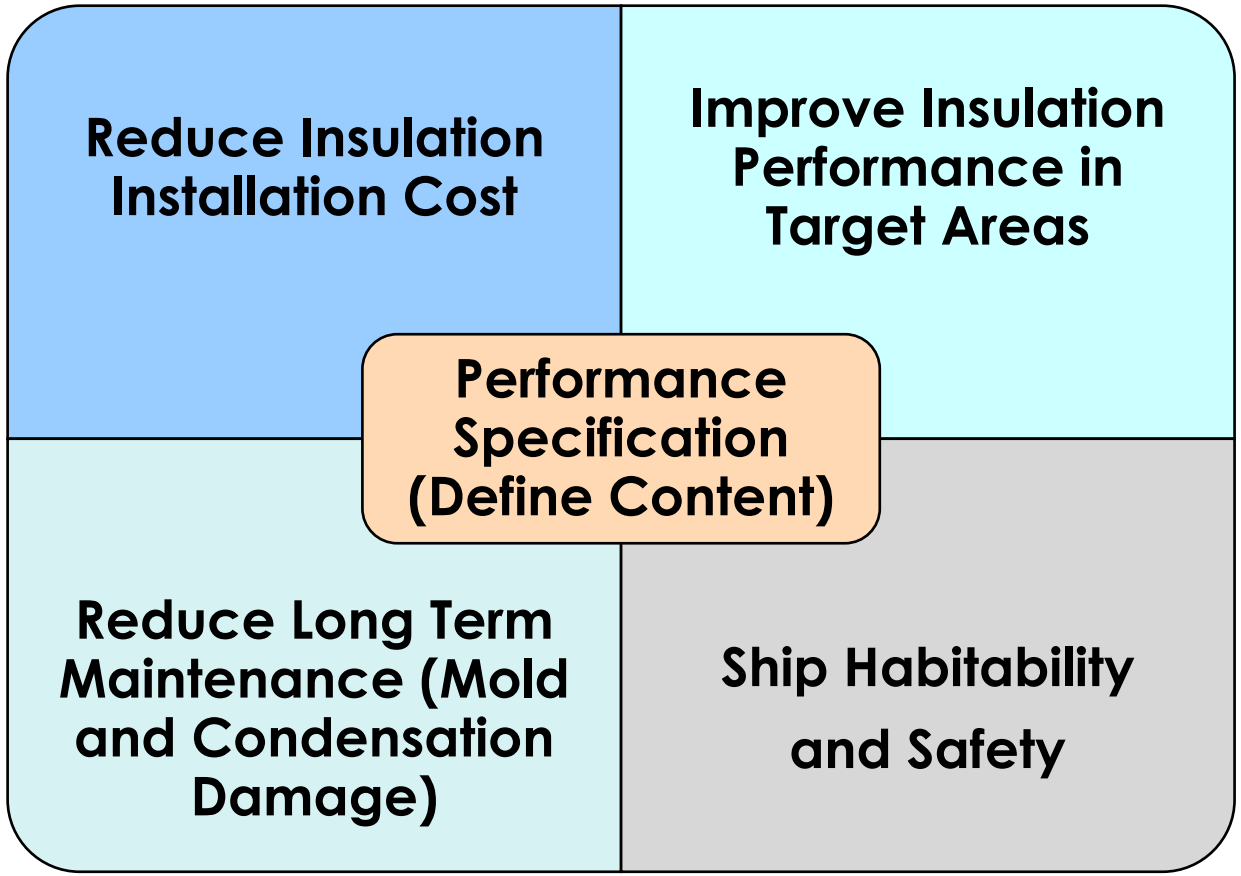
Dave Owen, 05P

Tammy Rossi – ManTech Manager
Tim Sherrange – Technical Lead
Chris Yoko – Technical Advisor
Charles Peacock– ManTech Project Manager

Project Overview/Objectives

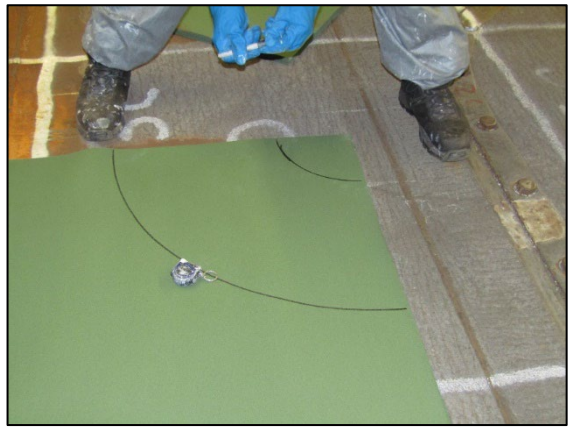
- Platform: Surface ships
- Issue Description:
  - This project investigates thermal insulating coating (TIC) materials as a potential replacement to legacy fiber/foam insulation
  - Performance specification governing TIC materials for thermal insulation and system anti-sweat use does not exist.
  - Federal Specification, Coatings, Anti-sweat, issued for surface treatments (not applicable for pipe, ventilation, bulkhead, or thermal boundaries).
    - Previous NNS IRAD project.
    - Currently marketed products that meet specs available for use.
    - Generally, 125 mils and under.

Project Overview/Objectives



Project Overview/Objectives

- Reduced Insulation Installation Cost
  - Independent research identified potential cost savings
    - ~70% on piping systems
    - ~70% on ventilation systems
    - ~ 50% on bulkheads
  - 95% of the cost to install insulation consumed by hand work & custom fitting



Laying out shapes

Gluing pipe seams

Pipe manifold

Cutting to shape

Vent duct fitting, gluing, and taping

Project Overview/Objectives

- Improve Insulation Performance in Target Areas
  - Exposure to high humidity conditions beyond the design conditions, even for short cyclic periods, introduces surface and substrate condensation as the insulation surface temperature falls below the dew point.
  - Moisture erodes the thermal conductivity performance of the insulation exacerbating the situation.
  - Increased A/C demand is broadening the issue.

Condensation

Condensation

Condensation with mold growth

Project Overview/Objectives

- Reduce Long Term Maintenance (Mold and Condensation Damage)
  - Cold vent and pipes and uninsulated A/C boundaries are exposed to consistently high humidity environments, moisture condenses and promotes mold growth.
  - TICs eliminate need to replace saturated and mold laden insulation.
  - NAVSEA study revealed that mold is a widespread issue throughout the fleet.
  - Any condensation that does form on TIC surface does not infiltrate the material allowing evaporation from the surface.
  - Wetted TIC retains its original properties.
  - TICs offer an economical insulating option for areas outside specification driven insulation requirements – eliminates cleaning / repainting of moldy bulkheads.

Mold growth

Mold growth

Mold growth

Project Overview/Objectives

- Ship Habitability, Performance, and Safety
  - Dripping condensation provides slip hazards, damage to equipment, and erosion of flooring materials.
  - Extreme condensation can impact cooling systems performance and impede ship operations.
  - Condensation can impact ship habitability exposing the crew to an uncomfortable environment.

Condensation

Mold Growth

Project Overview/Objectives

Use case examples:

ManTech Metrics

- Goal 1:
  - Thermal Performance verified via condensation testing
  - Acoustic properties tested – no significant advantage – some positive damping attribute
  - Shock and vibration – in process
- Goal 2:
  - Weight impact
    - Positive interior use cases – near equal trade off
    - Negative exterior – performance vs weight increase decision
    - Cost analysis - average 79% savings (all interior use cases)
    - Capital investment minimal – built into NNS expansion initiatives

Goal 1: Thermal Performance ↑	**Goal 1: Acoustic Performance** ↓	**Goal 1:** Shock and Vibe ↕
Goal 2: Weight Impact ↑↓	**Goal 2: Cost** ↓	**Goal 2: Capital Investment** ↓

Benefits / Payoff / Business Case Update

- Major Benefit:
  - Have Identified Requirements for Specification Development
  - Acquisition Affordability: Projecting Significant Cost Savings
  - Life-cycle Affordability: Reduces Maintenance Burden

- Provides a more durable, insulation coating
- Installs in 1/10th the time, no cutting/mitering/fitting/gluing, etc.
- ROI for this project is >10, however, work still needs done to authorize materials for shipboard use.

Business Case Update

All Insulation Material Cost	Total Estimate (Supplier A)	Total Estimate (Supplier B)
$4.44M	$22.2M	$16.6M
All Insulation Labor	Install Labor (Supplier A)	Install Labor (Supplier B)
$66.2M	$2.95M	$940K
Total Cost Traditional Insulation	Total Cost Supplier A	Total Cost Supplier B
$70.6M	$25.2M	$17.6M
Cost Savings	@100% Possible Replaced	@50% Possible Replaced
	$46.2M	$23.1M
	$53.1M	$26.5M
ManTech Project Cost	$1.2M	

ROI per One Ship:

All “Acceptable”(Similar expectations other surface ship platforms)

Implementation Cost	$1M	$1M
ROI (all	@100% Implemented	@50% Implemented
Supplier A	20	10
Supplier B	23	12

Technical Approach

- Working to complete all tasking in support of final report / specification

Part One

- Performance Testing
  - Condensation Testing (complete)
  - Hot Touch (complete)
  - Fire, Smoke, Toxicity (working)
  - Acoustic Properties (complete)
  - Adhesion (complete)

Part Two

- Shipboard Use Impact & Analysis
  - Shock and Vibration (working)
  - Weight Impact Analysis (complete)
  - HVAC Design/Trade Off Study ✓
  - Physical Damage Resistance Testing (working)
  - Passageway and Splash Zone Impact (working)
  - Piping System Hanger Impact ✓
- Application Process Definition (working)
  - Environmental Requirements
  - Application Methods/Efficiencies
  - Drying Properties/Final Condition
  - Hybrid Process/Traditional w/TIC

Part Three

- Build Strategy Assessment (working)
- Industrial Infrastructure (complete)
- Requirements (working)
- In-service Test Plan (working)

Task 2 Technical Update/Discussion

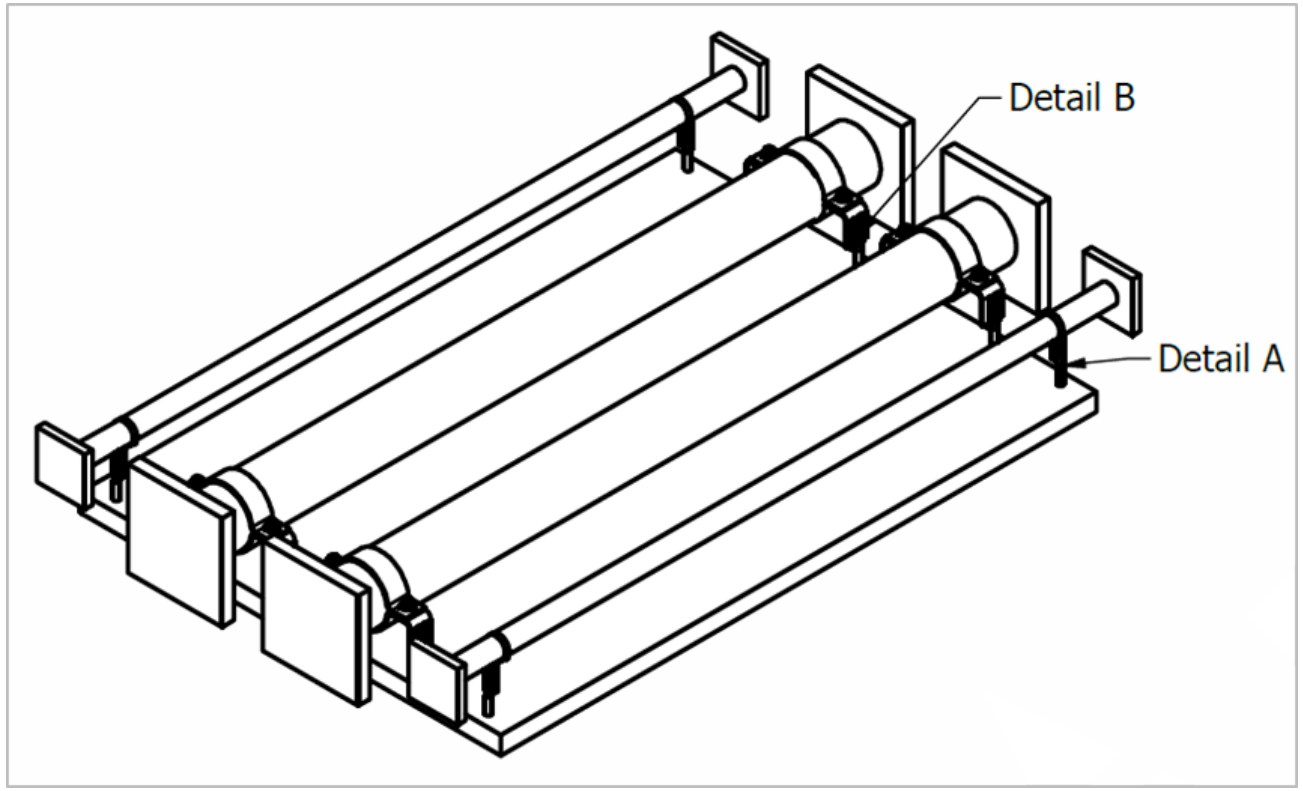
Performance Testing Summary	
Test Performed	Test Result
Condensation	✓ TIC Thermal conductivity confirmed ✓ 3E-Plus modeling confirmed ✓ Performance curve established ✓ Performance within or outside A/C boundaries confirmed
Safe Touch	✓ Safe touch performance confirmed
Acoustic	× No significant acoustic absorption or transmission loss characteristics ✓ Potential damping use × Not viable as a replacement on acoustic boundaries ✓ Remains viable on thermal boundaries
Fire, Smoke, Toxicity (Screening tests based on NAVSEA approved criteria)	✓ FST preliminary requirements defined by TWH (evolving potential – internal vs external test criteria) ✓ Supplier A screening success at multiple thicknesses to required specification ✓ Project defines the requirement – manufacturers committed to meet ✓ Supplier B investigating use of intumescent top coat to improve performance ✓ Supplier A full scale corner/room testing scheduled February 25
Adhesion	✓ Meets expectations for ease of removal

Task 3 Technical Update/Discussion

- Subtasks:
  - 3.1 - Shock and Vibe Testing (upcoming)
  - 3.2 - Weight Impact
  - 3.3 - HVAC design trade-off study
  - 3.4 - Physical Damage Resistance
  - 3.5 - Splash Zone / Impact
  - 3.6 - Hanger Impact
  - 3.7 - Shipboard Use Impact and Analysis Reporting and Updated Business Case Analysis

Task 3 Technical Updates

- 3.1 Shock and Vibe Testing (and 3.6 Hanger Impact) is scheduled for Feb.



Task 3 Technical Updates

- 3.2 Weight Impact Analysis Results
- External treatment
  - Due to thickness required – weight increase – evaluate weight increase vs efficiency and durability
- Pipe systems
  - Positive results – thickness of elastomeric vs reduced TIC thickness to meet service need
- Ventilation
  - Positive results – thickness of polyimide vs reduced TIC thickness to meet service need

Task 3 Technical Updates

- 3.3 HVAC Design Trade-off Study
  - Complete – identified ~200K SQFT where boundary conditions support use of new materials at less than equivalent thickness
- 3.4 & 3.5 Physical Damage & Splash Zone Impact Testing
  - Manufacturers have submitted ASTM test recommendations
  - Current results:
    - Water Absorption - samples were placed into a heated water bath and left for a period of time
      - Slight discoloration
      - All weighed more immediately upon removal from water bath
      - Returned to original weight within 24 hours of removal
    - Fungal Resistance – samples were exposed for a period of time in mildew cabinets and rated in accordance with standard test method
      - No defacement occurred

Task 3 Technical Updates

- 3.4 & 3.5 Physical Damage & Splash Zone Impact Testing
  - Current results (cont.):
    - Impact– samples were subjected to falling weights
      - Free film: Film thickness at anticipated configuration
        - Impacts at various heights dented the surface but did not penetrate through sample.
        - At greater heights, the sample cracked, as seen in the image. Impact of a sample supported on steel may improve the result at the greater height.
      - Steel Panel: Film thickness at anticipated configuration
        - Impacts from various heights deformed the surface but did not penetrate to the primer.
        - Impact from greatest drop height did expose primer in a small spot in the middle of the impact area.
        - Coating failure/deformation was localized to the impact point for all drop heights.

Task 3 Technical Updates

Water Resistance of Coatings Using Water Immersion

<u>Supplier B</u>

Three samples sprayed to configuration thickness on primed aluminum panels were immersed to 3/4 depth in jars full of DI water. The jars were then placed into a heated water bath and were left for a period of time.

Immediate observations after removal: No blisters or cracks were observed after immersion. Slight discoloration was observed.
All three panels weighed more immediately after being removed from their jars due to water uptake during immersion.

24 hours drying observations: ***Panels returned to their original pre-immersion weight within 24 hours of removal from their jars. No changes to coating observed (color, cracks, blisters, etc.)***

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Task 3 Technical Updates

Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by accelerated Four-Week Agar Plate Assay

Rating	Description
10	0% Defacement
9	1-10% Defacement
8	11-20% Defacement
7	21-30% Defacement
6	31-40% Defacement
5	41-50% Defacement
4	51-60% Defacement
3	61-70% Defacement
2	71-80% Defacement
1	81-90% Defacement
0	91-100% Defacement

Supplier B

The samples were exposed for a period of time in the mildew cabinets and rated according to the specification.

Substrate/Base	Period 1	Period 2	Period 3	Period 4
Aluminum	10	10	10	10
Aluminum	10	10	10	10
Aluminum	10	10	10	10
Aluminum	10	10	10	10
Free film	10	10	10	10

Task 3 Technical Updates

Impact Resistance of Pipeline Coatings (Falling Weight Test)

<u>Supplier B</u>

Free film: Film thickness at configuration thickness. Impacts at various heights dented the surface but did not deform the back of the sample, indicating that the weight did not push through the entirety of the sample. At greater heights the sample cracked, as seen in the image. Impact of a sample supported on steel may improve the result at greater drop heights.

<u>Supplier B</u>

Steel Panel: Film thickness at configuration thickness. Impacts from various heights deformed the surface but did not make it through to the primer. Impact from greater drop height did expose primer in a small spot in the middle of the impact area. Coating failure/deformation was localized to the impact point for all drop heights.

Task 4/5/7 Technical Update/Discussion

- Application Process
  - To be assessed during shock test preparations
- Build Strategy Assessment
  - Apply in Shop
  - Move work off ship
- Industrial Requirements
  - Using Texture Spray Equipment
  - Vent at supplier
  - Pipe in shop
  - Bulkheads on ship

Transition/Implementation

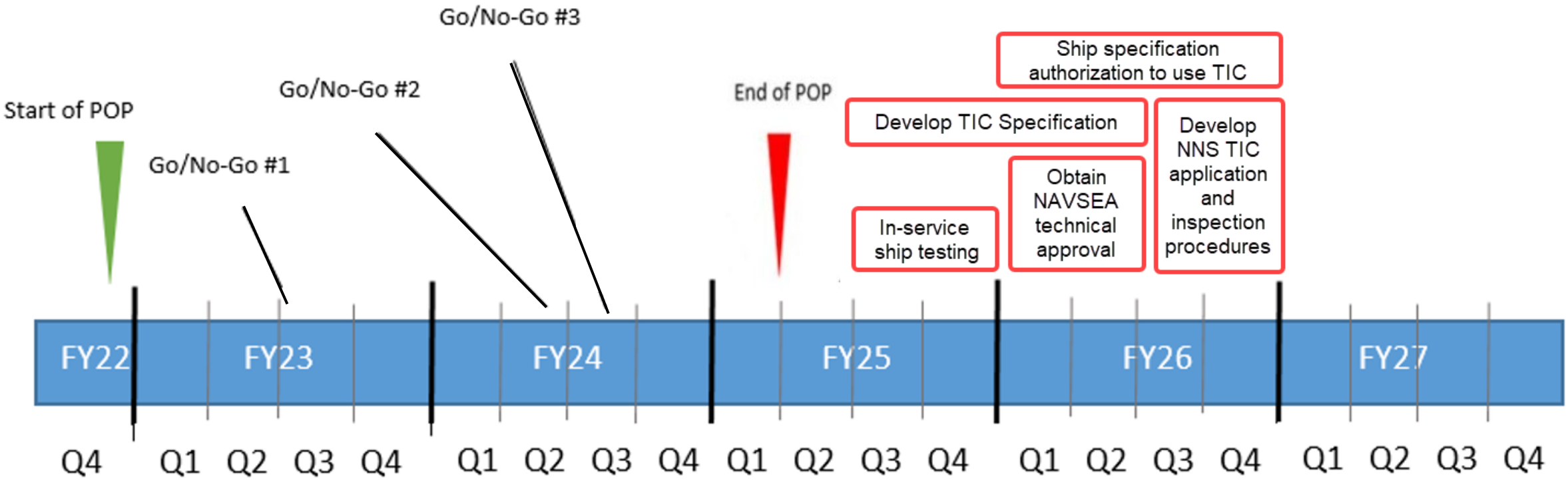
ManTech Deliverables:

- Improved Component Design and Manufacturability (*Task 4*)
- Improved Production Processes (*Task 4*)
- Improved Production Planning, Scheduling, and Tools (*Task 4*)
- Improved Component Design for Life-cycle performance (*Task 5*)
- Improved Component Design for Maintenance performance (*Task 5*)
- Delivery of Knowledge Products:
  - Technical Reports
  - Technical Data Packages
  - Facility Optimization Reports

Transition/Implementation (Continued)

- Required Non-ManTech Transition Investments:
  - Navy: shipboard testing – validation, specification development and issue
  - Shipyards: Reallocation of labor resources, designated facilities, equipment, defined process lanes, and procedures
- Implementation / Implementation Funding:
  - Target: Newport News Shipbuilding
  - Time Period: 3QFY25 ⟹ 4QFY26
  - Implementation Funding Estimate, Source(s), and Status: Project original implementation cost estimated $1M. Projected capital investment significantly less due to lower-than-expected equipment cost. NNS in process of facility upgrades to cover comprehensive coating needs will encompass TIC coating processes.

Transition/Implementation



Next Steps

- Perform Full Scale Corner Test on Suppler A material
- Prepare samples and perform med. weight shock test
- Complete physical damage and impact testing
- Validate assumptions for build strategy assessments during shock test sample preparation.
- Draft proposed “draft” MIL spec.

Questions?