NSRP Panel Project PP 25

[ATI CONTRACT 2018-453-035]

15kV MIL-SPEC CABLE DEVELOPMENT FOR U.S. NAVY SHIPS

Greg Keyes II
HII – Ingalls Shipbuilding

May 5, 2026

Agenda

- Project Overview
- Project Development
  - Conductor
  - Insulation Material
  - 1/C Designs
  - 3/C Designs
  - Shipyard Feedback
- Current Status of Project
- Schedule
- Questions?

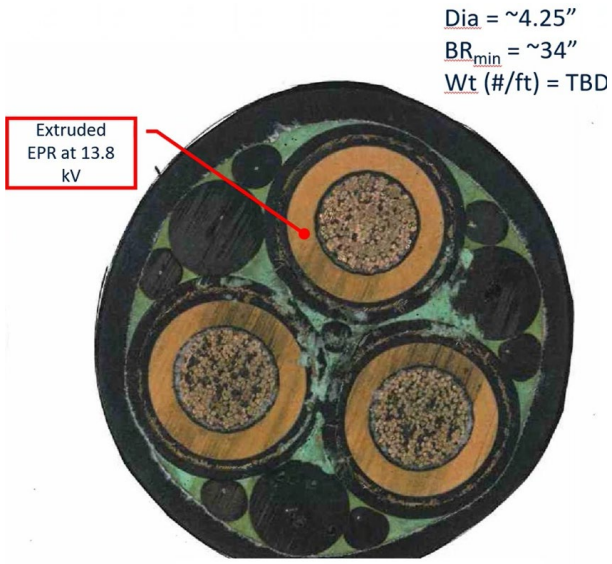
Project Overview

BACKGROUND

- Currently no fully qualified MIL-DTL-24643 compliant 15kV class cable exists for use on U.S. Navy ships.
- A low smoke – zero halogen (LSZH) cable was developed and produced for the U.S. Navy Carrier Program Office that is nearly MIL-DTL-24643 compliant.
- Because the cable does not satisfy all of the requirements, a waiver is required from NAVSEA for use on U.S. Navy Ships.

PROJECT OBJECTIVE & GOALS

- Design, build and test 1C or 3C 400MCM cable rated to 15kV
- Key attributes:
  - In accordance with MIL-DTL-24643D general requirements
  - Circuit integrity using gas flame testing
  - Zero Halogen Materials
  - Waterblocked
  - Flexible to withstand typical installation practices and routings



15kV, T-400 Prototype

Project Team

- **Prime/Lead:**
  - HII – Ingalls Shipbuilding

- **Team Members**:
  - Marmon Aerospace and Defense
  - HII – Newport News
  - GD – Bath Iron Works
  - U.S. Navy: **NAVSEA 05Z33**

- **NSRP Project Manager:**
  - Lydia Szydlo, ATI

- **Program Technical Representative (PTR):**
  - Walt Skalniak (Ashby Co.)

Project Development - Conductor

- Most significant contributor to cable flexibility
- Options limited to equipment capabilities
- Waterblocked constructions are limited to 127 components / strands
- Planning to use 127 components consisting of 7 strand lightly water-blocked subcomponents (24 AWG ASTM Class I)

- **Rationale:** Much higher flexibility and improved water-blocking than currently used non-waterblocked 127 strand rope construction

Project Development – Insulation Material

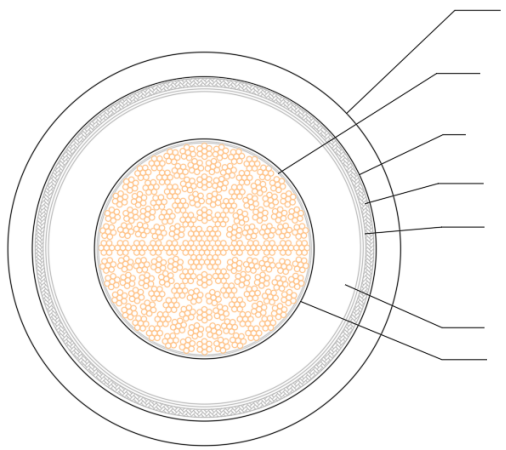
Primary Insulation Options and Key Performance Characteristics

Material	LSZH	Flexibility	Type of Ash	Fire & CI performance	Voltage Resistance
Polyethylene	Yes	Poor	Conductive	Poor	Excellent
XL EPR	Yes	Medium	Conductive	Fair	Excellent
Silicone	Yes	Flexible	Non-conductive	Very Good	Fair
Silicone/Glass Tape	Yes	Medium	Non-conductive	Outstanding	Poor

- XL EPR and Silicone Rubber are best candidates, but EPR must be enhanced to meet circuit integrity gas flame requirements
- 2 Configurations for mfr and test:
  - **1. XLEPR insulation enhanced with additional layer of silicone-glass tape**
  - **2. Silicone rubber insulation with outer layer of silicone-glass tape**
- **Rationale –**
- Silicone glass tape may enhance the fire performance of the primary EPR insulation while providing better electrical properties than silicone rubber.
- If the EPR/SG sample is not capable of withstanding the flame test, the fallback is a complete silicone rubber solution
- If both configurations fail to meet performance requirements, there is a more complex solution

Project Development – 1/C Designs

1C SILICONE



XLPO

24 AWG COPPER STRANDED CONDUCTOR
889 STRANDS w/ WATER-BLOCKING

POLYESTER TAPE

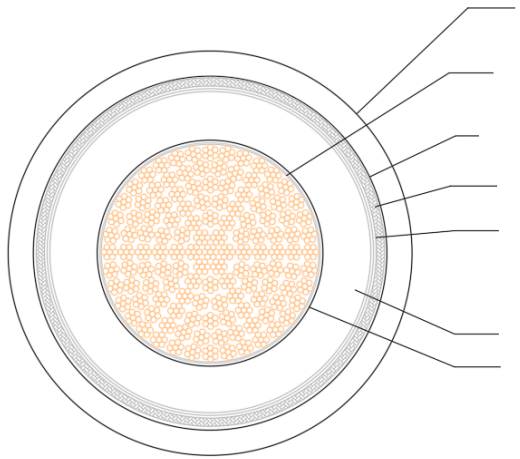
BRAIDED SHIELD

CROSS-LAPPED SILICONE GLASS TAPE
(2 LAYERS)

EXTRUDED SILICONE RUBBER INSUL.

SEMI-CON FABRIC TAPE

1C EPR



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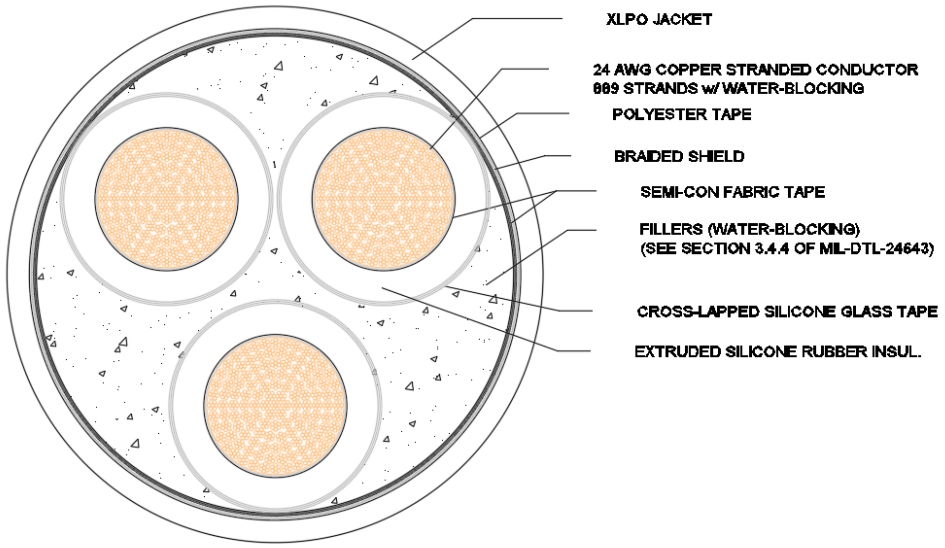
EXTRUDED EPR RUBBER INSUL.

SEMI-CON FABRIC TAPE

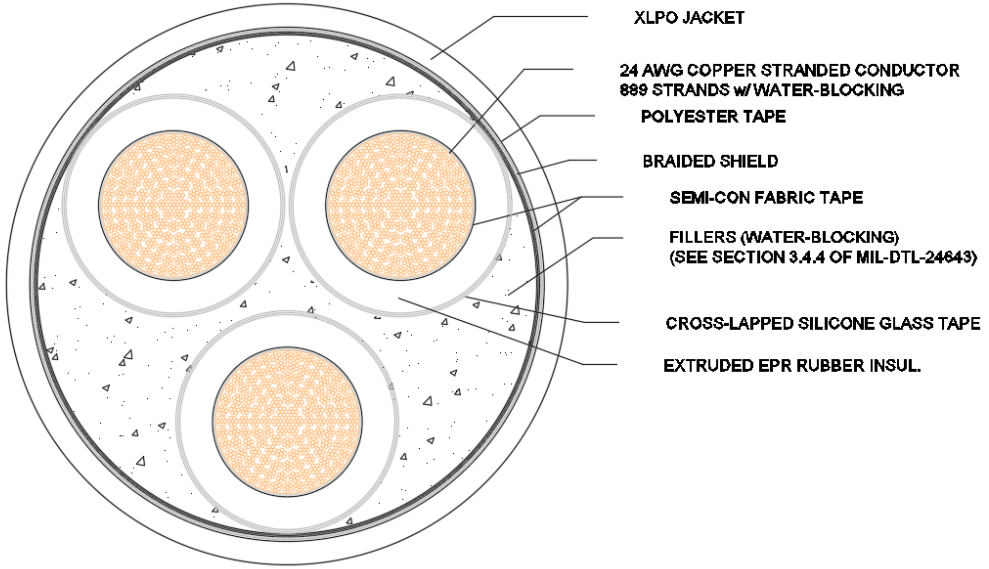
Description	Diameter	Min. Bend Permanent	Min. Bend Installation	Weight (Nom. Lbs/ft)
1C Silicone Ins.	1.485	12″	15″	2.52
1C EPR Ins.	1.485	13″	16″	2.47

Project Development – 3/C Designs

3C SILICONE



3C EPR



Description	Diameter	Min. Bend Permanent	Min. Bend Installation	Weight (Nom. Lbs/ft)
3C Silicone Ins.	3.000	27″	33″	7.10
3C EPR Ins.	3.00	30″	36″	7.05

Project Development – Shipyard Feedback

Shipyard Cable Pullers:

- Consensus w/ production personnel across shipyards is that they prefer the 3-conductor designs
- Concerns of possible transit overload when it comes to the 1-conductor designs
- More cable tagging with 1-conductor

Design Engineers:

- Prefers the 1-conductor over the 3-conductor designs
- Transit overload isn't a concern if cable is installed per the design
- The 3-inch diameter on 3-conductor design would be the largest cable diameter used (current largest is ~2.7 inches), and is not feasible due to current spatial constraints
- Recommends a min. bend radius of 24 inches

Electrical Hazard Safety Department:

- About the same risk profile for both 1-conductor and 3-conductor designs
- Mechanical advantages for straights, but at terminal connections would need to use manual pulling for 3-conductor
- Increased risk when pulling multiple 1-conductor cable
- Elevation when pulling cable a factor when it comes to physical strain
- Number of pullers is a risk factor

MARMON A&D CABLE SAMPE TESTING

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BACKUP

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Current Status of Project

Marmon A&D is producing samples of the 1-conductor designs of the XL EPR and Silicon Glass Tape for testing

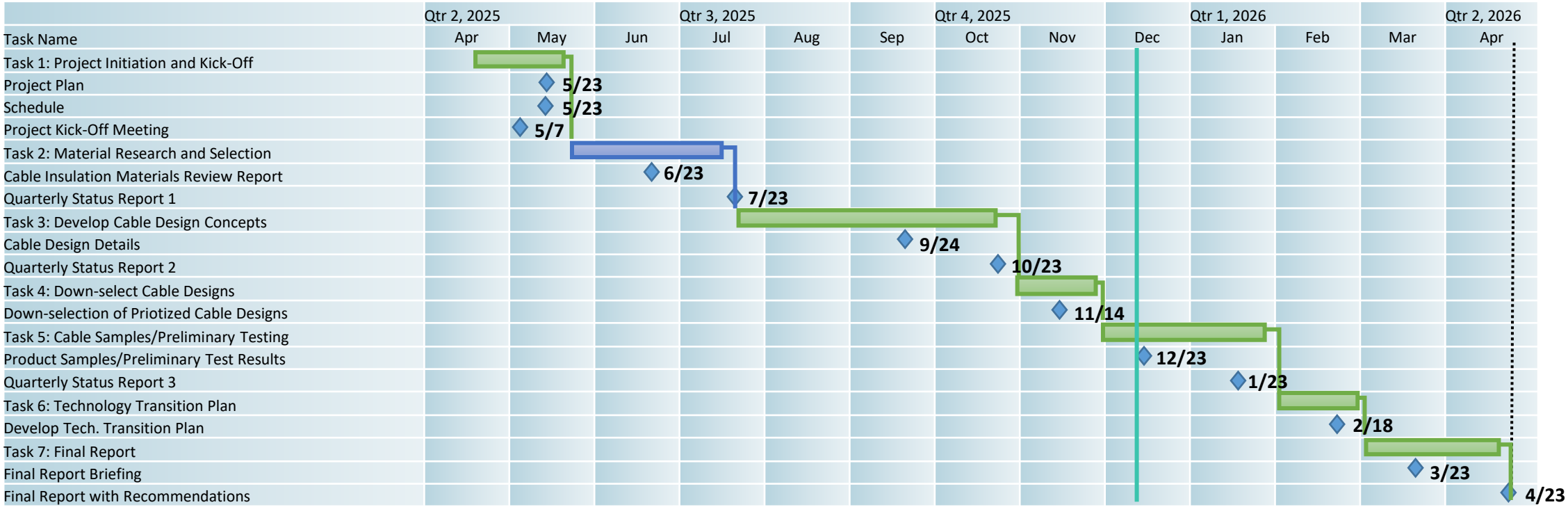
Test schedule for Finished Cable

Primary wires for testing will have a braided shield applied to better approximate finished cable performance

- Physicals
- Gas flame (Circuit Integrity) - Gas flame testing is currently planned at SWRI
- Flame Propagation / Smoke Index
- Watertightness
- Voltage withstand (tested against braided shield)
- Partial Discharge Corona

- In addition, all test parameters in M24643/86 (with voltage adjustment) will be performed
- Samples for installers will be provided to ensure the cables will be flexible enough to be pulled and routed in typical shipboard installations

Schedule


Qtr 2, 2025
Qtr 3, 2025
Qtr 4, 2025
Qtr 1, 2026
Qtr 2, 2026
Task Name
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Task 1: Project Initiation and Kick-Off
Project Plan
5/23
Schedule
5/23
Project Kick-Off Meeting
5/7
Task 2: Material Research and Selection
Cable Insulation Materials Review Report
6/23
Quarterly Status Report 1
7/23
Task 3: Develop Cable Design Concepts
Cable Design Details
9/24
Quarterly Status Report 2
10/23
Task 4: Down-select Cable Designs
Down-selection of Priotized Cable Designs
11/14
Task 5: Cable Samples/Preliminary Testing
Product Samples/Preliminary Test Results
12/23
Quarterly Status Report 3
1/23
Task 6: Technology Transition Plan
Develop Tech. Transition Plan
2/18
Task 7: Final Report
Final Report Briefing
3/23
Final Report with Recommendations
4/23

15kV Cable Development Project Update

May 5, 2026
NSRP Meeting

Marmon Aerospace & Defense Group
A Berkshire Hathaway Company

15kV Cable Development Project Plan

Marmon Aerospace & Defense Group

Goal: Design, build and test 1C 400MCM shielded and jacketed cable rated to 15kV

Key attributes:
- In accordance with MIL-DTL-24643D general requirements
- Circuit integrity using gas flame testing
- Zero Halogen Materials
- Waterblocked
- Flexible to withstand typical installation practices and routings

Scope:

Development of 15kV rated, flexible, water-blocked, single conductor cable that can pass circuit integrity for up to 3 hours. Constructions will be made with two types of thermoset insulation for evaluation: XL-EPR and Silicone Rubber. The three stages are: Design, Manufacture, and Test.

15kV Cable Development Project

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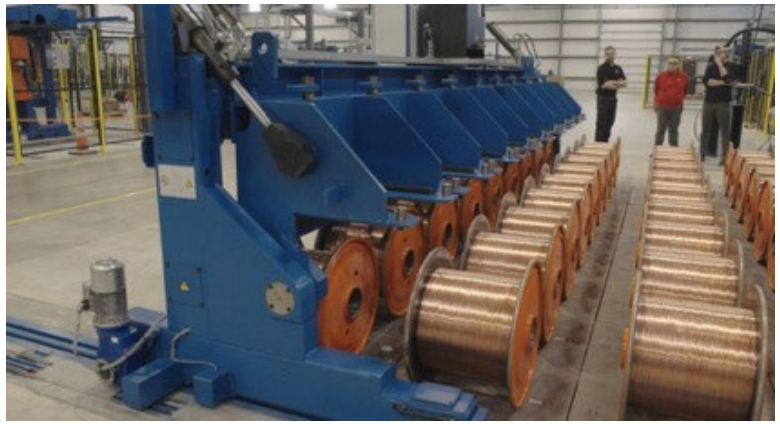
Conductor:

- Most significant contributor to cable flexibility
- Manufacture with 7 strands X 127 groups equals 889 total strands
- Water-block with current system
- Goal is to produce a flexible conductor that is water-blocked
- Results: Much improved flexibility vs. 127 strand, and water-blocking is excellent



15kV Cable Development Project

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Sample Status:

Sample	Drawing	Insulation Type	Strand Conductor	Insulation Extrusion	Cross-link Insulation	SG & Semi Con Tapes	Braid	Block Braid	Jacket Extrusion	Cross-link Jacket	Test	Reports
ES25-133	DN-40740	Silicone	Complete	Complete	Complete	Complete						
ES25-134	DN-40741	XL-EPR	Complete	5/1	5/2-5/3							

15kV Cable Development Project

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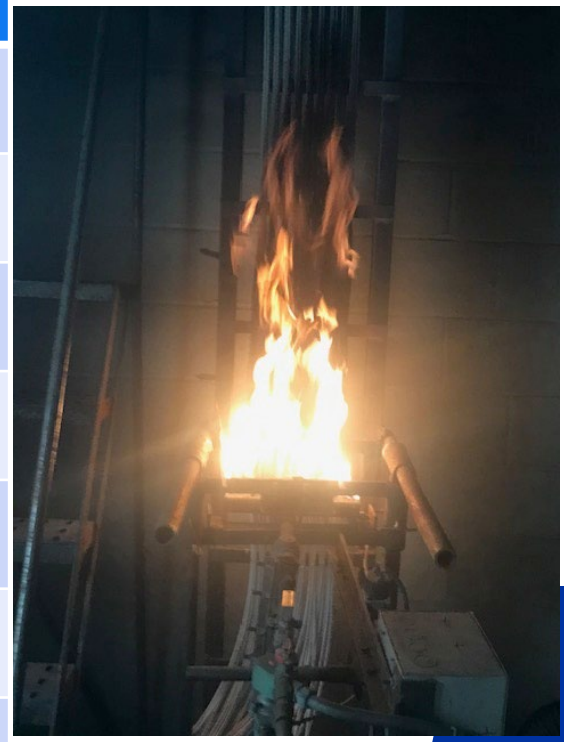
In Process Test Results ES25-133

Test	DN Spec Requirement	/86 (5kV) Requirement	Actual Result	Comments
Conductor Water-Blocking	N/A	N/A	0.050 in³	Almost zero leakage through the conductor
Conductor Resistance (DCR)	0.0273 Ω/kft	0.0273 Ω/kft	0.0301 Ω/kft	Higher than target
Conductor Diameter	0.810”	0.750”*	0.786”	As expected, larger than standard 127 strand
Insulation Wall Thickness	0.175” Min. Average	0.050” Min. Average	0.215” Nom. 0.185” Min.	Nom. is slightly larger than target due to the smaller conductor
Insulation Diameter	1.180”	N/A	1.185”	Pretty spot on
In-Process Spark Test	15 kV	13.5 kV*	15 kV	Pass
Insulation Water-Blocking	11 in³	58 in³* (175 in³ / 3 Legs)	13.5 in³	Little higher than desired, but far lower than /86 allowances



*Blue values are inferred and not hard requirements.

Status

Marmon Aerospace & Defense Group

- Should complete both samples in the next 2 – 3 weeks.
- Internal tests at Marmon-AD should be completed within a few weeks after sample completion.
- Samples will be sent to SWRI for Circuit Integrity as soon as samples are completed (13,500 V).
- Marmon-AD will do Circuit Integrity internally as close to the spec as possible.
- Some testing will be done at Marmon in Milford NH.

Marmon Aerospace & Defense Group

Thank You!