NSRP Panel Project 24-11

National Shipbuilding Research Program (NSRP) FY24 Panel Project (PP24-11) "Verification of Fire Protection of Shipboard Electric Cables Using Intumescent Coating"
Milestone 11. Final Report

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Government Participants: Naval Surface Warfare Center Carderock Division

Project Overview

Hepburn and Sons LLC (Hepburn) teamed with Fincantieri Marinette Marine (FMM), STI, Naval Surface Warfare Center-Carderock (NSWC-CD), and Southwest Research Institute (SWRI) to test and verify a domestic source of electric cable fire protection intumescent coating. The project period of performance was 19 months. The problem addressed in this project was controlling the spread of fire and reducing the impact that electrical cables during shipboard fires on both submarines and surface ships. Electric cables on ships provide fuel for fires to propagate from compartment to compartment. The "USS Bonhomme Richard (LHD 6) Major Fire Review" report issued by the Navy in October 2021 identified potential implementation of fire-prevention materials as one of their initiatives, with "the use of intumescent paint (especially in the highest risk areas of ships)" listed first. This project tested the performance of STI's Marine Cable Coating (MCC) using basic flame spread testing and characterization testing at NSWC-CD and SWRI. A major benefit to shipyards and alignment to the mission of the Electrical Technologies Panel and Sustainment Panel is that the STI MCC can be applied by shipyard workers, the ship's force, or local paint contractors. Improving the lifecycle of electrical cables and mitigating fire propagation will save Navy ships and improve the overall sustainment of electrical equipment and cabling. The results of this project may lead to a follow-on effort to pursue NAVSEA approval for shipyards to use MCC onboard Navy ships.

The project goals and objectives were to test and verify the domestic source, STI's intumescent MCC, through testing at NSWC-CD and SWRI. The testing sought to ensure the MCC performs as expected to mitigate electrical cables becoming fuel during fire events. The MCC will greatly enhance in-service ships with PVC cables and new construction ships using approved MIL-DTL-24643 low smoke, zero halogen cables. The MCC, by direct flame contact, starts to produce a light char, which is a poor conductor of heat, thus retarding heat transfer. Hydrates within the coating release during a fire, i.e., water vapor is released, which has a cooling effect. The intumescent coating delays the ignition and prevents fire spreading. The following outline provides a breakdown of the work activities accomplished in this project. Hepburn and Sons managed all aspects of the project as prime contractor, while STI provided production and design knowledge:

1. Project Kickoff meeting
2. Engaged with the tech warrant holder community early on for alignment with expectations supporting inclusion as qualified product
3. Provided sample cable sections for coating and for control group
4. Developed Test Plan with NSWC-CD and SWRI
5. Ordered raw materials for test fixturing as required
6. Coated cables and aged as necessary to emulate in-service application
7. Provided coated cables to NSWC-CD and SWRI for test set up
8. Conducted fire testing (Initial draft test list recommended by NSWC-CD Fire Protection and SWRI Fire Technology Department
    a. ASTM D6113 Cone Calorimeter (measures Heat Release Rate, Smoke Release

rate, Mass Loss Rate)
   b. Flame Propagation UL 1666 (154 kW fire exposure, vertical orientation of samples) worst case scenario test
9. Received test report results and provided to FMM for review and comment
10. Wrote final test report (NSWC-CD, SWRI, and Hepburn to write Final Test Report)

Project Results

Project Kick-Off
The project began with the Kickoff Meeting held on Wednesday, March 27th, 2024, at 1030 EST via Microsoft Teams. In attendance was the Program Manager from ATI, the Project Technical Representative (PTR), Government Stakeholders from NSWC Carderock Division, interested parties from General Dynamics Bath Iron Works, and team members from Hepburn and Sons, STI Firestop, and Southwest Research Institute.

Test and Evaluation Plan Development
In April 2024, the team developed and delivered the Test and Evaluation Plan, which outlined what testing and evaluation methods to utilize for the intumescent coating by the teams at NSWC Carderock in their Fire Protection Group and at Southwest Research Institute in their Fire Technology Department. The test plan laid out the testing details, including the samples, coating material and application, how test samples will be identified and prepared, test conditions, monitoring and controlling, inspection and evaluation, evaluation completion and reporting, and sample disposal.

Cable Procurement and Preparation
The teams at STI, FMM, NSWCCD, and SwRI began material procurement in preparation for their respective test events following development of the Test and Evaluation plan in April 2024. Following some slight delays in procuring the cables due to personnel changes at FMM, the sample cable sections were shipped to STI for coating using the MCC in May 2024.

The FMM team was reassigned another POC for the project, who was the acting paint manager in their Paint shop at FMM. FMM stated that they struggled to locate the cable that the previous POC had confirmed was set aside for the project. The Paint shop manager later expressed an interest in completing the effort, however stated that the cables reserved for the program were not available as of October 2024.

The challenges in procuring and coating cables at FMM continued from around September 2024 into the beginning of calendar year 2025 due to holiday shutdowns at the shipyard. On 4 February 2025, the project team met and concluded that a 6-month No Cost Extension request would be appropriate given the significant delays. The NCE request was submitted on 6 February 2025, requesting to extend the end of the Period of Performance to 1 September 2025.

The FMM team procured and cut the cables needed for testing, with plans to have the STI team

travel to the shipyard in late March 2025, but due to not having the required spray tip and Wet Film Thickness gauge, the cable coating was postponed to April 2025.

During preparations for coating in April 2025, FMM encountered an issue in which 3 of the 5 different coating configurations set to undergo cone calorimetry testing at NSWC-CD involved using both the MCC and a MIL-PRF-24596 coating, as recommended by NSWC-CD. FMM's current stock of this MIL-PRF-24596 coating was tied to the FFG program, and they were unable to order more at that time. The manufacturer had a serious contamination issue at their facility. A replacement coating was ordered, but it took another week before the product would be delivered.

After the significant delays due to personnel and logistical challenges at FMM, the team completed coating of the cables during the week of 16 April 2025 in preparation for testing at SwRI and NSWC-CD. Below is a summary of both the coated and cables to be shipped from FMM to SwRI and NSWC-CD:

- 21 cables of 15ft length have been coated and 4 cables of 4ft length have been coated
- 16 cables of 15ft length were uncoated and 1 cable of 4ft length have been left uncoated

NSWC-CD confirmed receipt of the cables for testing on 02 July 2025. The coated and uncoated cables going to SwRI were received on 20 June 2025 (See Figure 1. Below)

Figure 1: Crate of Coated/Uncoated Cables at SwRI

Testing Preparation and Execution

As the cable coating delays continued, the team worked on coordination of schedule and shipping for testing at SwRI and NSWCCD in parallel. Due to a full test schedule at SwRI, testing could not be scheduled until the week of 25 August 2025. Testing at NSWCCD was scheduled for the week of 11 August. With the end of the Period of Performance approaching (1 September 2025), the project team, with agreement from the PTR and ATI, requested and was granted an additional project extension to 24 October 2025, to complete testing, receive the test reports, and provide comprehensive final reporting.

The Hepburn team received preliminary and final test reports from Southwest Research Institute. Hepburn has received a preliminary report from NSWCCD but continue to wait for the final test report. Additionally, the NSWCCD report is expected to be marked "Distribution D". Hepburn has requested that the report be reviewed so that it can be marked "Distribution A" to allow public release. A summary of the test events and their results are provided below.

ASTM D6113 Cone Calorimeter Testing at NSWC Carderock Division (NSWCCD)

ASTM D6113 Cone Calorimeter testing at NSWCCD was conducted in September 2025 after several delays due to challenges identifying viable sections of the cable to test and test equipment issues. The Fire Protection Group (FPG) at NSWCCD needed to identify the most uniformly coated cables to reduce the amount of variability/potentially anomalous behavior in the test results. NSWCCD also experienced delays due to broken parts at the FPG facility that were needed to conduct the testing. New parts were ordered which caused a three-week delay.

As proposed for this effort, NSWCCD received 5 cables – 4 of which were coated and 1 of which was bare. They cut to create a quantity of nine 4-inch test samples. The 9 samples were grouped into 3 groups of 3 samples: one group of bare cables, two group of STI MCC coated cables.

The samples all underwent the ASTM E1354 testing, where a multitude of parameters were recorded, the 4 main ones being:

- Time to Ignition (s)
- Peak Heat Release Rate (HRR) (kW/m^2)
- Total Heat Released per Area (MJ/m^2)
- Specific Area Extinction (m^2/kg)

The Hepburn team is currently awaiting the finalized test report from NSWCCD, which will be provided at a later date as an addendum to this Final Report. That will include a full summary and assessment of test results and comparison of performance of coated vs. non-coated samples.

Flame Propagation UL 1666 at Southwest Research Institute

SwRI tested both coated and uncoated cable samples against the UL 1666-2012 Flame Propagation standard test from 25 - 27 August 2025. Prior to testing, Fincantieri Marinette Marine shipped SwRI LS2SWU-12 18-AWG cables, 16 of which were uncoated and 21 of which were pre-coated at FMM with STI. While the coated cables were coated upon arrival at SwRI, a representative from STI also was present to perform touch-up and repairs to the coating that was damaged during shipping the week prior to testing. Figures 2 and 3 below depict the uncoated and coated cables, respectively, as arrived on 20 June 2025.

Figure 2: Pre-test photo of uncoated cables

Figure 3: Pre-test photo of coated cables

For both sets of cable samples, they were exposed to a 154-kW burner flame in a modified 24-ft high concrete fire test chamber constructed from Type X gypsum wallboard. For both coated and uncoated testing, the chambers consisted of three cells and 17-ft cables. Figure 4 below provides an overall view of the testing room.

Figure 4: Overall View of Test Room at SwRI

For both coated and uncoated cable testing, there were 32 cables tested in total. 16 cables were utilized for each coated and uncoated sample set, which were then divided evenly into two test groups of 8. For execution of the test, the eight cables that were tested at a time were clamped at the top and secured by a bolt through the top end to hold them in place. Once the exhaust flow was established, data collection and video recording began. A one-minute data baseline was taken, then the gas flow to the burner was initiated and the burner was ignited by a butane torch. The gas flow to the burner continued for 30 minutes, during which, the flame height was visually observed and recorded. After 30 minutes, gas flow was discontinued, and the cables were manually extinguished and allowed to cool before cables were removed from the test room and evaluated for damage. Below are images during and after the test events.

Figure 5: Uncoated Cable Run 1, 15 min into test

Figure 6: Uncoated Cable Run 2 – Burner off, end of test prior to extinguishment

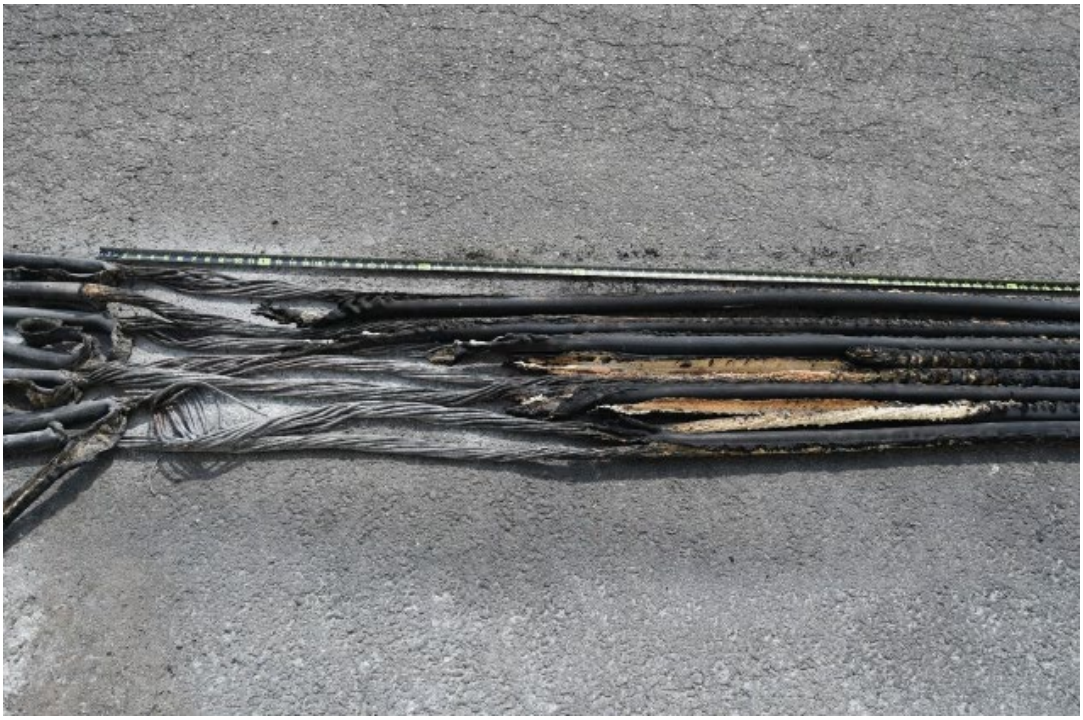

Figure 7: Uncoated Cable Run 1 – Post-test view of lower portion of cables

Figure 8: Uncoated Cable Run 2 – Post-test view of upper portion of cables

Figure 9: Coated Cable Run 2 - 12 min into test

Figure 10: Coated Cable Run 1 - Burner off, end of test prior to extinguishment

Figure 11: Coated Cable Run 1 – Post-test view of lower portion of cables

Figure 12: Coated Cable Run 2 – Post-test view of upper portion of cables

Key parameters that were recorded included flame height, temperature, and cable damage. Tables 1 and 2 provide a summary of test results for the uncoated and coated samples.

Table 1. Summary of Test Results for Uncoated Cables

Test No.	Ambient Temp. at Start	Ambient RH at Start	Maximum Flame Height Observed	Measured Cable Damage Posttest	Maximum Temp. at 2nd Floor
1	73.3 °F	83%	7 ft	7 ft 4 in.	564 °F
2	75.8 °F	55%	11–12 ft	13 ft	926 °F

Table 2. Summary of Test Results for Coated Cables

Test No.	Ambient Temp. at Start	Ambient RH at Start	Maximum Flame Height Observed	Measured Cable Damage Posttest	Maximum Temp. at 2nd Floor
1	73.0 °F	79%	9 ft	12 ft	867 °F
2	78.5 °F	64%	> 12 ft	Full length	1,617 °F

The acceptable criteria required for the cable sets to comply with were as follows:

- Flame propagation height of each set shall not equal or exceed 12 ft.
- Temperature of any thermocouple shall not exceed 850 degrees F.

Because the testing was conducted in general accordance with UL 1666, SwRI could make no official determination of a pass or fail status against the acceptable criteria. However, in assessing the results for the test conducted, the results show unfavorable results of the coated cables for both maximum flame propagation height and maximum temperature recorded compared to those of the uncoated cables.

Technology Transfer

Throughout the duration of the project, the team continued efforts to expand awareness of the coating technology and involve members of the technical community. In April 2024, the team provided an update to the TWH for Fire Protection Systems - Ships, Dan Berkoski. The Fire Protection Group at NSWC Carderock Division was heavily involved in the initial discussions and planning the project moving forward. This team consists of Chris Mealy, Wes Duchenne, and Ravi Singh.

The team also utilized The Navy League's Sea Air Space symposium not only as an opportunity to showcase the technology itself but engage with key stakeholders. During the Sea Air Space 2024 symposium, the team met with Chris Nemarich who provides technical support for Chris

Abadilla, the tech warrant holder for Machinery - Electrical System Protection, Safety, Distribution, and Instrumentation – Ships. This meeting included briefing on the need for intumescent coatings, the risk of just paint applied to cables alone, and the project plan. The team, including the STI Firestop, also briefed the division director for Fire Safety Risk and Performance Analysis within the Industrial Fire Safety Assurance Group (SEA 00FS), Joe Praydis, on the need for the coating, the project plan, and future efforts.

Additionally, the team presented the overall project and status at the NSRP Sustainment Panel meetings at the 2024 and 2025 ASNE Fleet Maintenance and Modernization Symposium (FMMS).

Conclusions and Recommendations

The overall objectives of the project to test and verify a domestic source of electric cable fire protection intumescent coating, as well as engage with the TWH community were met by the conclusion of this effort. During the testing of the candidate coating, it was found that the coating did *not* perform as expected in protecting electrical cables or reducing fire spread.

Major challenges of the effort fell more on the logistical and schedule side, revolving around the procurement of cables samples by FMM and schedule availability for testing execution at SwRI and equipment failure at NSWCCD. Obtaining No-Cost Extensions allotted for the additional time needed to accommodate the schedule slippage and allowed for testing and comprehensive final reporting to be completed during the period of performance.

As this effort comes to a conclusion, the need for shipboard fire protection technologies, such as intumescent cable coatings, still remains paramount. This need was exemplified most recently as the Navy experienced a 12-hour long shipboard fire aboard the USS New Orleans while at anchor in Okinawa, Japan on August 20th, 2025. While the full investigation and assessment of damages is still underway, analyst and former Navy captain, Carl Schuster, stated that the damage experienced by this fire could “leave the New Orleans out of action of 60 to 120 days,” (Lendon, 2025). While the magnitude was not as severe as that which was experienced by the USS Bonhomme Richard back in 2020, it is critical for our ships to be equipped with technologies that can combat these instances of fire in order to prevent major damage, maintain battle readiness, and ultimately, keep our warfighters safe.

Sources

Lendon, B. (2025, August 20). *Fire burns for 12 hours on US Navy warship off Okinawa*. CNN.

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