Proposed 2025 NSRP Panel Project:

EVALUATION OF HIGH STRENGTH LSZH THERMOPLASTIC MATERIALS FOR SHIPBOARD FIBER OPTIC CABLES

Giovanni Tomasi
RSL Fiber Systems, LLC

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PROJECT HISTORY - 2019 SHIPBOARD FIBER OPTIC CABLES DESIGN ENHANCEMENTS PROJECT (Panel Project 2019-477-001)

CONCLUSIONS

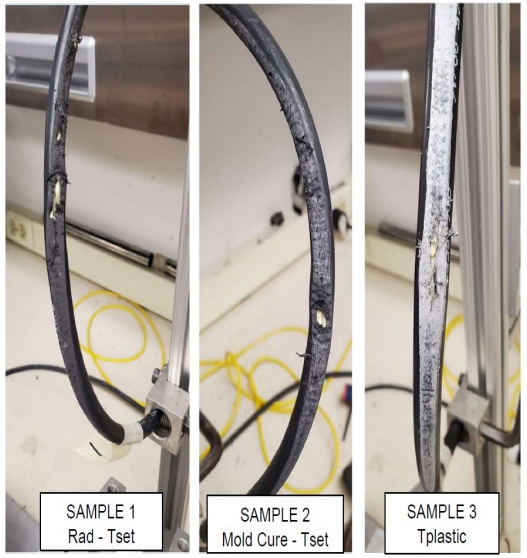
- Baseline cable designs are suited for shipboard environment.
- Most of rework is caused by on-ship fiber terminations.
- **Jacket abrasion** described as a cause of damage at installation.
- Resistance to hot fluids (98-100°C) ranked lowest priority by project participants.

Fluid	Temperature	% T&E Retention
Fuel Oil	98°C – 100°C	≥ 50%
Turbine Fuel	48°C – 50°C	≥ 50%
Lubricating Oil	98°C – 100°C	≥ 50%

PROJECT FINDINGS – CABLE JACKETS

- Use of Thermoset jacket driven primarily by fluids' immersion temperature requirements taken from M24643 power cables specifications.
- Thermoplastic jacket outperformed thermoset jackets in modified scrape abrasion resistance test (10 lbs. weight vs. 1 lb. weight).
- Thermoset jackets may have been preferred for perceived vs. actual abrasion resistance.
- Thermoplastic jackets have potential to:
  - Improve abrasion resistance.
  - Decrease cable cost.
  - Decrease fiber damage.
  - Lower TOC of fiber optic shipboard systems.

Type	Jacket Type	Cable Outer Dia. (mm)	Avg. Wall Thick. (mm)	Results (Scrapes to Failure per mm thickness)
M85045/18	Tset (Radiation)	8.0	1.165	**40%**
M85045/18	Tset (Mold Cure)	8.2	1.39	**94%**
RSL 118052	Tplastic	10.2	1.77	**100%**



RECOMMENDED IMPROVEMENTS

- More strippable buffer.
- Fusion splice pre-terminated connectors vs. field terminations.
- **More durable outer jacket materials for improved resistance to abrasion/cut-through.**

BACKGROUND

NSRP PP 2019-477-003 Shipboard Cable Jackets Performance Enhancements project identified three new (3) LSZH Thermoplastic compounds with high abrasion resistance.

- The three (3) LSZH compounds outperformed M85045/17 and /18 X-Linked cables in scrape abrasion resistance by more than 5X[(1)]
  - Irradiation X-Linked cables failed at or before[(2)] 50 scrape cycles.
  - Mold cured X-Linked cables failed at 50 and 100[(3)] scrape cycles.
  - New Thermoplastic jacketed cables were worn 50% to 75% of the full thickness after 250 scrape cycles.

→ Additional testing is required to confirm the compounds' suitability to shipboard use.

NOTES:

1. Modified Scrape Abrasion to MIL-PRF-85045/MIL-STD-1678-3 with 10 lbs. vs. 1 lb. weight.
2. Failed in less than 50 cycles based on amount of aramid yarn exposed.
3. 8F cable with thicker jacket than other X-Linked cables failed at 100 cycles.

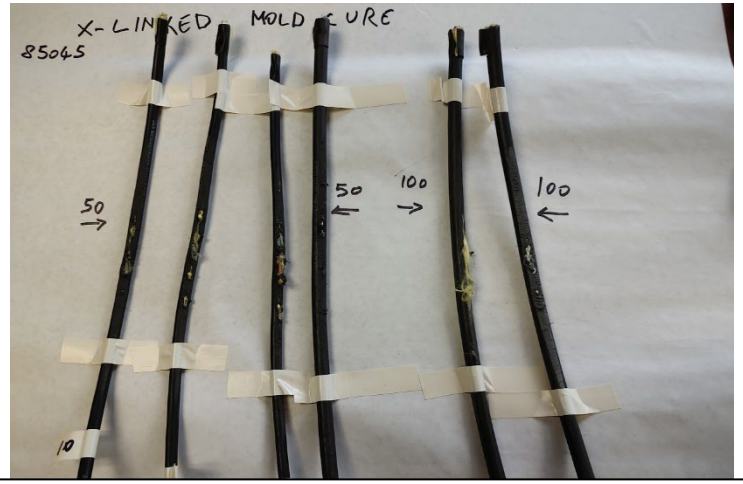
MODIFIED SCRAPE ABRASION TEST RESULTS

SAMPLE NO.	DESCRIPTION	JACKET COLOR	Wall Thick. (mm)	O.D. (mm)	JACKET TYPE	FAILURE AFTER # SCRAPES	Scrapes per mm of jacket thickness
1	/17-01P	Blue	1.45	11.05	TSet (Irrad)	50	34.5
3	/17-02P	Black	1.52	11.20	Tset (Mold Cure)	100	65.8
7	/18-02P	Black	1.20	7.94	TSet (Irrad)	50	41.7
8	/18-01P	Black	1.14	7.96	Tset (Mold Cure)	50	43.9
20	Tplastic Marine 1	Black	1.81	10.30	Tplastic	150	82.9
22	ABS Marine Shipboard	Black	1.93	9.31	Tplastic	250	129.5
23	Tplastic Marine 2	Black	1.80	10.65	Tplastic	50	27.8
27	**Test A**	**Black**	**1.17**	**7.93**	**Tplastic**	**Pass**	
30	**Test B**	**Black**	**1.14**	**7.94**	**Tplastic**	**Pass**	
33	**Test C**	**Black**	**1.09**	**7.77**	**Tplastic**	**Pass**	
36	Test D	Black	1.12	8.15	Tplastic	150	133.9

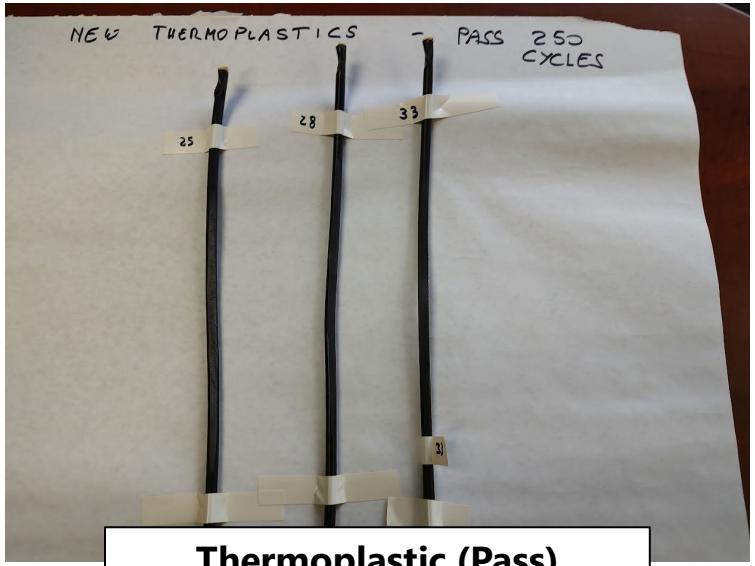
MODIFIED SCRAPE ABRASION TEST RESULTS

Thermoset Irrad X-Link (Fail @ 50 Cycles)

Thermoplastic (Fail @ 50 to 250 Cycles)



Thermoset Mold Cure X-Link (Fail @ 50 to 100 Cycles)



Thermoplastic (Pass)

PROPOSED 2025 PANEL PROJECT OBJECTIVES

Evaluate the new LSZH thermoplastic materials for use as jacketing for shipboard fiber optic cables.

- Use the materials identified by the Shipboard Cable Jackets Performance Enhancements project (2019-477-003) as baseline.
  - Down-select one (1) or two (2) materials to apply over 4F or 8F cable design to M85045/18 or /17.
- Perform select tests in the M85045 document to evaluate the most resilient cable jacket material.
- Propose Enhanced M85045 shipboard cable document(s) to lower ships' TOC by reducing cable damage at installation and in-service.
- Utilize the jacketing material identified in other critical fiber optic applications (remote source lighting, distributed sensing, power over fiber, non-electric topside, laser power delivery…)

PROPOSED M85045/18 (or /17) TESTS

Group	Qualification inspection	Req. Par.	Test Par.	Cable length 1/, 2/	Notes for NSRP Panel Project
III	Temperature cycling	3.7.1	5/	Two samples, 0.5 km each 4/ (One on reel, one off)	One sample on reel.
	Fungus resistance	3.8.4	4.8.4	Two specimens, 0.5 m each 7/	
	Cable element removability	3.6.18	4.7.5.18	Two specimens, 0.5 m each 7/	
IV	Thermal shock	3.7.2	4.7.6.2	One specimen, 0.49 km each 4/ (on reel)	
	Weathering	3.7.8	4.7.6.8	One specimen, 2 m 11/ and three material samples 12/	
	Fluid immersion	3.7.9	4.7.6.9	One specimen, 2 m 11/ and three material samples 12/ for each specified fluid	Fuel oil (68 to 70 °C vs. 98 - 100 °C), turbine fuel (48 to 50 °C), and lubricating oil (68 to 70 °C vs. 98 - 100 °C).
	Paint susceptibility	3.7.15	4.7.6.15	Two specimens, 2 m each 13/	
	Jacket self-adhesion or blocking	3.7.11	4.7.6.11	One specimen, 30 m 11/	
V	Dripping	3.6.13	4.7.5.13	One specimen, 30 cm 11/	
	Cable jacket tear strength	3.6.14	4.7.5.14	Five flat extruded jacket material strips 15/	
	Cable jacket material tensile strength and elongation	3.6.15	4.7.5.15	Five specimens 16/	
	Flame extinguishing and smoke generation	3.7.12.2	4.7.6.12.2	One specimen, 50 m 11/	
	Water absorption	3.7.14	4.7.6.14	Two specimens, extruded jacket material strips 16/	
VI	Acid gas generation	3.8.1	4.8.1	1 specimen, 1 m 18/	
	Halogen content	3.8.2	4.8.2	1 specimen, 1 m 18/	
	Toxicity index	3.8.3	4.8.3	1 specimen, 1 m 18/	
	Smoke index	3.8.5	4.8.6	1 specimen, 1 m 18/	

NOTE: Input from Team requested to define tests to evaluate outer jacket material.

ROI ESTIMATES

Est. Annual FO Cable Usage (2019 Data): 7,800,000 feet (2,377 Km)

CABLE TYPE	% OF TOTAL[1]	Sell Price ($/ft) [2]	Est. Tplastic Price[3]	Difference
M85045/18-01 (4F MM)	70%	$3.32	$2.85	$0.48
M85045/18-02 (4F SM)	22%	$3.51	$2.85	$0.66
M85045/17-01 (8F MM)	6%	$5.81	$5.11	$0.69
M85045/17-02 (8F SM)	2%	$7.82	$5.11	$2.70
OTHER	>1%			
Average Cable price[4]		$3.55	$2.99	$0.56
Estimated Total Cable Cost		$27,687,384	$23,284,537	$4,402,847

NOTES:

(1) From Newport News Shipbuilding cable usage by type.

(2) From Defense Logistics Agency 2024 IDIQ Contracts Data.

(3) Optical Cable Corporation ABS LSZH Marine Cables with **25% cost adder** for M85045 periodic requalification.

(4) Weighted average based on quantity usage.

2025 Panel Project - EVALUATION OF LSZH THERMOPLASTICS FOR SHIPBOARD FIBER OPTIC CABLES

PROJECT INFORMATION	OBJECTIVE
Prime/Lead: **RSL Fiber Systems, LLC** Team Members: -SUPSHIP GC -INGALLS SHIPBUILDING -Chempro Technologies Duration: 12 Months	• Continue the evaluation of highly abrasion resistant LSZH materials identified under previous NSRP panel project. • Identify material(s) with favorable processing methods for cable jacketing. • Perform M85045 tests that indicate jacket suitability to shipboard environment. • Propose Enhanced M85045 shipboard cable document to lower ships' TOC by reducing cable damage at installation and in-service.
DELIVERABLES/BENEFITS/ROI	**FINANCIAL**
• **DELIVERABLES:** Identification of most durable thermoplastic material that can be used for shipboard fiber optic cables to Enhanced M85045 requirements. • **BENEFITS/ROI:** Potential savings: 1. Savings from Thermoset to Thermoplastic: **$ 4.4M /year** 2. Thermoplastic w/50% reduction in damage: **$ 6.3M / year**	Program Funds: $ 200,000 Cost Share: $ 0

NOTE: Team members listed have not committed to participation.

QUESTIONS?