High-Density Ribbon Fiber Optic Cable & Tooling for Shipboard Installations

Jason Farmer, Ingalls Shipbuilding
John Mazurowski, Penn State ARL

INGALLS SHIPBUILDING
A Division of HII

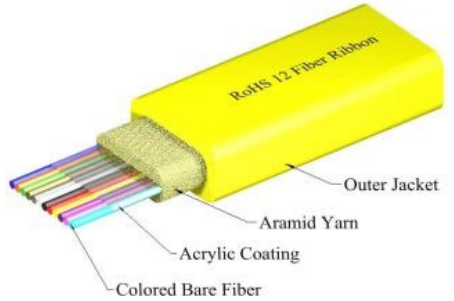
NSRP
NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

Electrical Technologies Panel Meeting

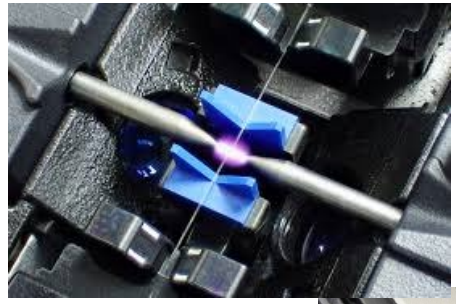
April 3-4, 2024

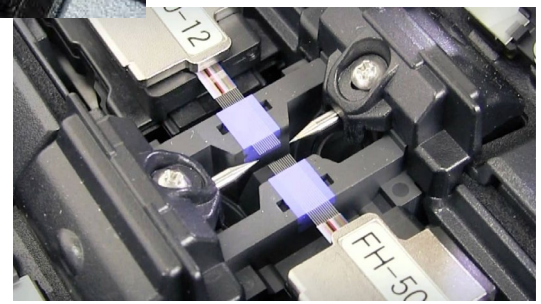
Background

- Shipboard network infrastructure is rapidly evolving and will impact fiber optic cables on future ship programs
- Navy ship programs are planning to use high density fiber optic cable configurations to meet increasing demands of shipboard networks
  - Ribbon fiber facilitates increased signals in smaller package
- This new fiber type is expected to reduce cableway congestion and facilitate the increasing demand on shipboard data networks
- New cable configurations will require new tooling, processes, and training in order to be successfully deployed on Navy ships



TLC Ribbon Cable 12 Fiber - COTS (FIS)


Fusion Splicer Individual Fiber


Fusion Splicer Ribbon Fiber


Standard M85045 Cable Example

Project Overview

Goals & Project Objective:

- To evaluate the impact of new, high-density fiber optic cable configurations for U.S. Navy shipboard applications
- To identify process and tooling impacts of using this new technology

- Study will:
  - Identify shipyard impacts to new cable type
  - Evaluate new fiber and connector technologies
  - Conduct field studies
  - Provide feedback to Navy and manufacturers on field impacts
  - Identify new tooling required for implementation
  - Identify necessary changes and process updates to support successful transition at shipyards

Project Team

Ingalls Shipbuilding (Lead)
Newport News Shipbuilding
Penn State ARL Electro-Optics Center
KITCO Fiber Optics
Naval Surface Warfare Center Dahlgren Division

Project Technical Representative (PTR)

Walt Skalniak, Ashby Co

NSRP Project Manager

Nick Laney, ATI

Task Summary

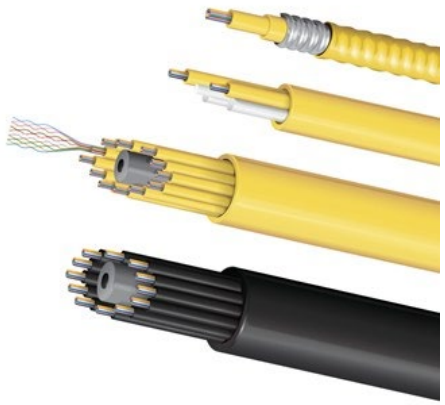
- Task 1 - Review Requirements & Procedures
- Task 2 - Industry Survey: Ribbon Fiber & Tooling
- Task 3 - Hardware Evaluations
- Task 4 - Analysis of Shipyard Impacts
- Task 5 - Final Report & Technology Transition Plan

Project Status

- ✓ Project kick-off meeting
- ✓ Requirements review
  - ➢ Cable
  - ➢ Ribbon (Fusion) Splicer
  - ➢ Ribbon Splice Protector
- ✓ Industry Survey
  - • Cable configurations
  - • Manufacturers
- ✓ Field Trial
- • Final Report *(in process)*

Fiber Optic Ribbon Cable

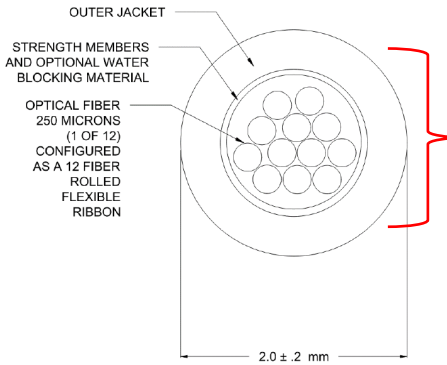
- Ribbon fiber is widely used in commercial markets
- High density configuration facilitates increased signals in smaller package compared to legacy designs



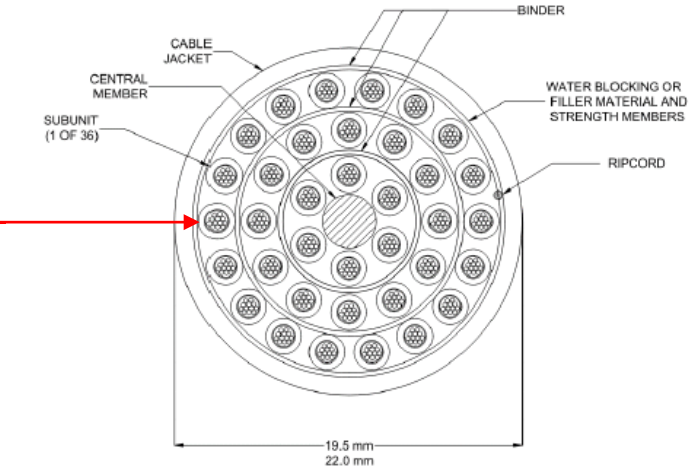
COTS Ribbon Fiber Cable Examples (Belden)

Standard M85045 Cable Example

SPECIFICATION	# SUB UNITS	TOTAL FIBERS
MIL-PRF-85045/33	1	12
MIL-PRF-85045/34	4	48
MIL-PRF-85045/35	8	96
MIL-PRF-85045/36	36	432



12-Fiber Subunit

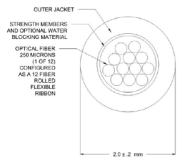


M85045 Ribbon Cable with 36 Subunits

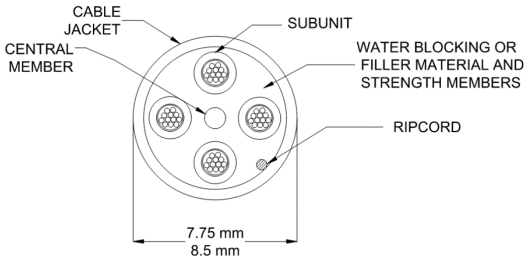
Requirements

- **Ribbon Splicer**: CID A-A-5799 (Rev B updated to include ribbon splicing)
- **Ribbon Splice Protector**: MIL-PRF-24623/8
- **Cable**: MIL-PRF-85045/33 - /36 provides detail on 1, 4, 8, and 36 subunit options
  - MIL-PRF-85045/33: CABLE, FIBER OPTIC, ROLLED FLEXIBLE RIBBON, TWELVE FIBER, SINGLE SUBUNIT, CABLE CONFIGURATION TYPE 4 (RIBBON CABLE), APPLICATIONS A AND B (AIRBORNE AND SHIPBOARD), CABLE CLASS SM AND MM
  - MIL-PRF-85045/34: CABLE, FIBER OPTIC, FOUR SUBUNITS, TWELVE FIBERS ROLLED FLEXIBLE RIBBON SUBUNIT, ENHANCED PERFORMANCE, CABLE CONFIGURATION TYPE 4 (RIBBON CABLE), CABLE CLASS SM AND MM
  - MIL-PRF-85045/35: CABLE, FIBER OPTIC, EIGHT SUBUNITS, TWELVE FIBERS ROLLED FLEXIBLE RIBBON SUBUNIT, ENHANCED PERFORMANCE, CABLE CONFIGURATION TYPE 4 (RIBBON CABLE), CABLE CLASS SM AND MM
  - MIL-PRF-85045/36: CABLE, FIBER OPTIC, THIRTY-SIX SUBUNITS, TWELVE FIBER ROLLED FLEXIBLE RIBBON SUBUNIT, ENHANCED PERFORMANCE, CABLE CONFIGURATION TYPE 4 (RIBBON CABLE), CABLE CLASS SM AND MM

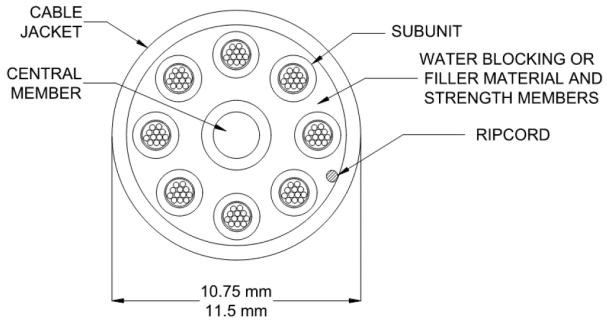
Ribbon Cable Configurations



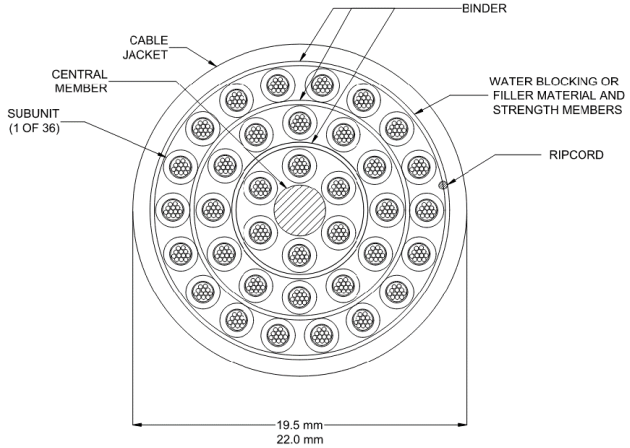
1 Subunit Cable
MIL-PRF-85045/33
(12 fibers)



4 Subunit Cable
MIL-PRF-85045/34
(48 fibers)



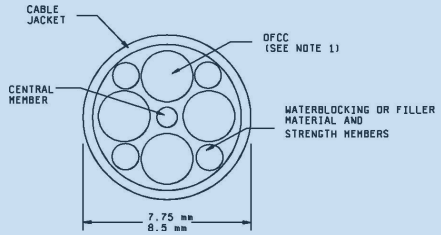
8 Subunit Cable
MIL-PRF-85045/35
(96 fibers)



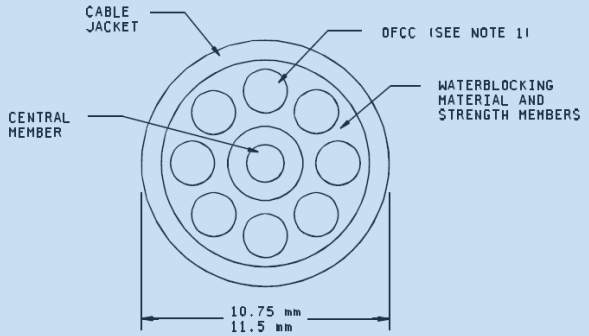
36 Subunit Cable
MIL-PRF-85045/36
(432 fibers)

Cable Comparisons

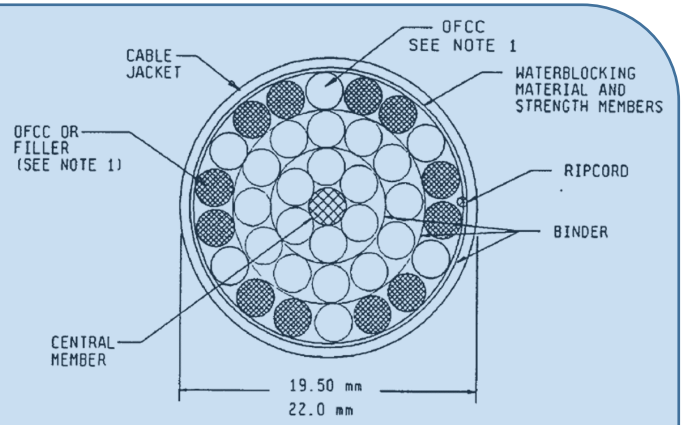
Current Cable Designs (Single Fiber)



4 OFCC Cable
MIL-PRF-85045/18
(4 fibers)



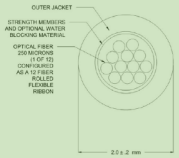
8 OFCC Cable
MIL-PRF-85045/17
(8 fibers)



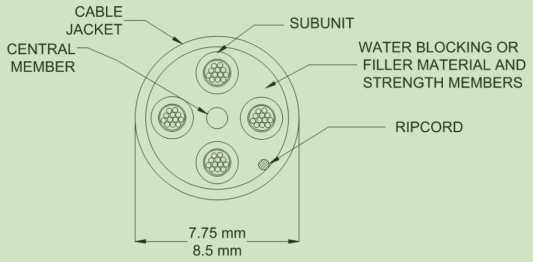
36 OFCC Cable
MIL-PRF-85045/20
(36 fibers)

Ribbon Fiber

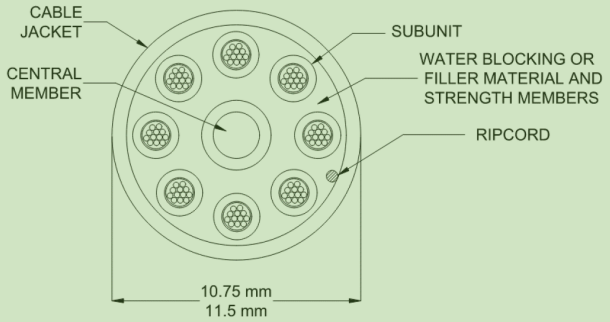
12x fiber Increase in same cable OD



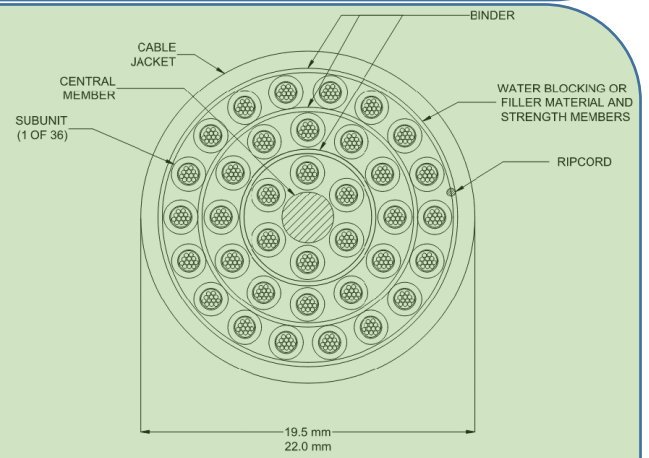
1 Subunit Cable
MIL-PRF-85045/33
(12 fibers)



4 Subunit Cable
MIL-PRF-85045/34
(48 fibers)



8 Subunit Cable
MIL-PRF-85045/35
(96 fibers)



36 Subunit Cable
MIL-PRF-85045/36
(432 fibers)

Shipboard Applications

- Use Cases
  - Space constrained ship designs
  - Need for future growth
- Benefits
  - Density (12x increased fiber count in same cable OD)
  - Reduced installation time
  - Future growth
- Shipboard Termination
  - Splicing Options
    - Cable to cable splice
    - Splice on connector
    - Fanout kit
  - Enclosure Options
    - Inside equipment
      - Fiber Interconnection Box (FIB)
    - Enclosure mounted to exterior of equipment
      - Fusion Splice Enclosure at Equipment*
    - FOICB/other enclosure mounted in compartment near equipment

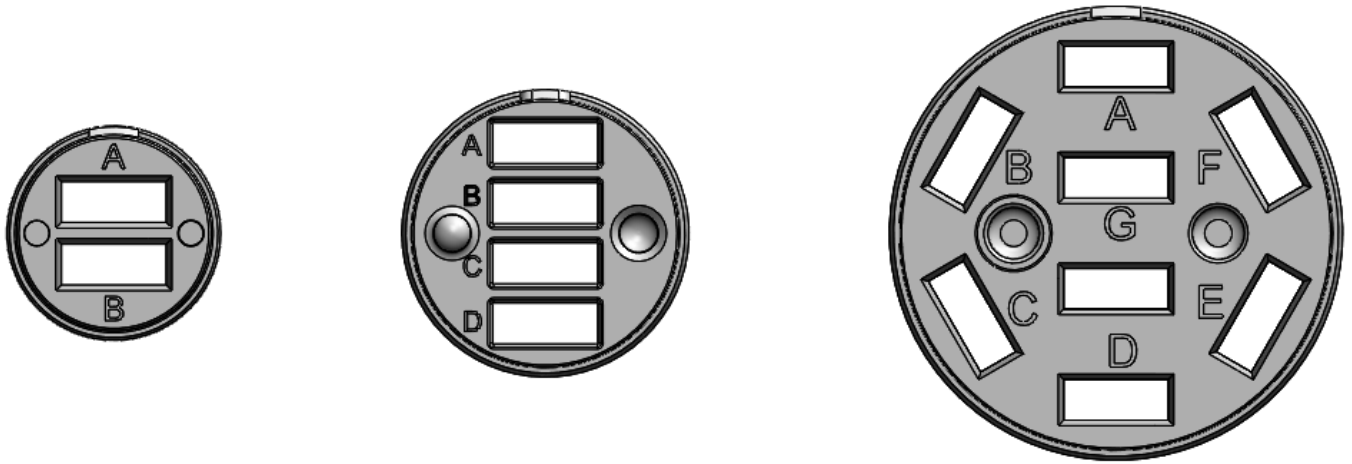
Fanout Kit
(examples)

MT Connector

MT Connectors

- AFSI THDM Series MT Connector
- 3 Configurations
  - Up to 192 Channels
- Backshell options include:
  - Straight
  - 45^0
  - 90^0

Amphenol FSI THDM Series MT Connector System



MT Position Layout Options

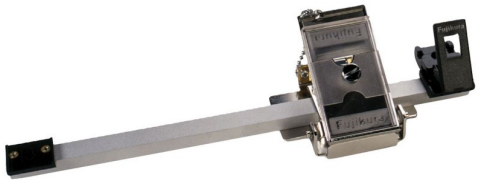
Tools

- Fusion Splicer Kit
  - Fusion Splicer
  - Cleaver
  - Fiber Holders
  - Cleaning Kit
- Thermal Stripper
- Ribbonizer/Fiber Arrangement Tools

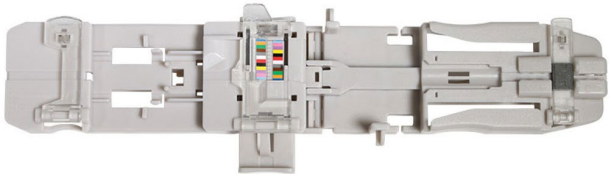
Ribbon Fiber Holders

AFL 90R Fusion Splicer

Thermal Stripper



AFL Fiber Arrangement Tool



AFL Ribbonizing Tool

Sumitomo Fiber Arrangement Tools

Shipyard Evaluations

- Field Trials conducted at Ingalls Shipbuilding January 23-24, 2024
- Goals/Objectives:
  - Familiarization of Ribbon Fiber Technology
  - Training on Ribbon Splice Tools and Process
  - Evaluate technology in shipboard environment
- Event supported by:
  - Ingalls Shipbuilding
  - KITCO Fiber Optics
  - Marmon Aerospace and Defense
  - Naval Surface Warfare Center Dahlgren Division
  - Penn State Applied Research Lab
  - Prysmian Group
  - Sumitomo Electric Lightwave
- The following were included:
  - COTS Fiber products
  - MIL Ribbon Fiber products
  - New tools
  - New processes
- Evaluation provided feedback on subunit configurations, tools, and process in shipboard environment

Next Steps

- Finalize Hardware Evaluations
  - Analysis of Laboratory Test Results
- Final Report

Project Team

	ORGANIZATION	POC	CONTACT
Project Lead/Prime	Ingalls Shipbuilding	Jason Farmer	(228) 935-7573 Jason.Farmer@HII-Ingalls.com
Team Members	Penn State ARL	John Mazurowski	(724) 295-7000 jsm23@arl.psu.edu
	KITCO Fiber Optics	Dan Morris	(757) 216-2220 dan.morris@kitcofo.com
	Newport News Shipbuilding (NNS)	David Ellis	(757) 688-6086 david.ellis@hii-nns.com
Participating Government Stakeholder	NSWC-Dahlgren Division (NSWCDD)	Chris Good	(540) 653-0627 christopher.a.good8.civ@us.navy.mil
NSRP Project Technical Representative (PTR)	NSRP Electrical Technologies Panel	Walter Skalniak	(757) 309-6344 Walter.Skalniak@panduit.com
NSRP Program Manager	ATI	Nick Laney	(843)760-3485 nicholas.laney@ati.org

Acknowledgements

- Special thanks to the following individuals and organizations who provided significant contribution to the success of the field trial event:
  - Chis Powell, KITCO Fiber Optics
  - Michael Reilly, Penn State University Applied Research Laboratory
  - Cedric Lindsey, Prysmian Group
  - Bruce Sinnott, Marmon Aerospace and Defense
  - Brandon Nelson, Naval Surface Warfare Center Dahlgren Division
  - William Urbanic, Naval Surface Warfare Center Dahlgren Division
  - Andrew DeGidio, Sumitomo Electric Lightwave
  - Greg Heard, Sumitomo Electric Lightwave

Questions?

NSRP
NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level