

# NSRP Panel Project

## *Evaluation of Splice-On Connectors and Termini for Shipboard Applications*

NSRP All Panel Meeting  
Charleston, SC

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# Project Team

Ingalls Shipbuilding (Lead)

Newport News Shipbuilding

Amphenol Fiber Systems International

Naval Surface Warfare Center Dahlgren Division



**INGALLS**  
SHIPBUILDING  
A Division of HII

**Amphenol FSI**



## Project Technical Representative (PTR)

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## NSRP Project Manager

Nick Laney, ATI

# Project Overview

## Opportunity:

- Fiber optic connectors are typically installed shipboard during the construction process
  - Harsh environment not ideal for fiber optic connector quality.
- Splice-on connectors present an opportunity to enable improved performance and efficient installation

## Project Goals:

- To evaluate splice-on fiber optic connectors for applications in the ship construction process
- To determine the feasibility of this connector option in U.S. Navy shipboard applications
  - Will include evaluation of impact to current construction processes, cost savings, and Navy qualification requirements

# Splice-On Connectors Overview

- Splice-on connectors and Quick Connect Termini (QCT) are prefabricated connectors/fiber optic termini
- The connectors/termini are fabricated in a clean, factory environment
- The factory-polished termini are fusion spliced to shipboard cable using standard, Navy approved splicing processes



Standard Installation  
Process



COTS Examples  
(Fuse Connect – Fusion Splice Connectors)



QCT  
(AFSI)



Fusion Splicing



# Project Task Summary

1. Requirements Review
2. Identify Fiber Optic Connectors for Ship Programs
3. Evaluate Feasibility for USN Applications
4. Develop Plan for Qualification and Transition
5. Final Report

# Requirements Impacting Ship Installations

- IPT conducted review of applicable requirements
- Impacts to fiber optic systems and hardware selection identified:
  - System Design
  - Component Selection
  - Installation & Testing

CATEGORY	RQMT DOC	DESCRIPTION	SLANT SHEETS
System Design	Ship Spec Section 408	Ship Specification for Fiber Optic Cable Plant	
	MIL-STD-2052	Fiber Optic System Design	
Installation & Testing	MIL-STD-2042	Fiber Optic Cable Topology Installation Standard Methods for Naval Ships	Part 1 – Cables Part 2 – Equipment Part 3 – Cable Penetrations Part 4 – Cableways Part 5 – Connectors & Interconnections Part 6 – Tests Part 7 – Pier side Connectivity

# Fiber Optic Component Specifications

CATEGORY	RQMT DOC	DESCRIPTION	SLANT SHEETS
Connectors	MIL-PRF-28876	Heavy Duty Connectors	
	MIL-PRF-64266	Next Generation Heavy Duty Connectors	/1 /2 /3 /8 /9 /10 /11 /18
	MIL-C-83522	Light Duty Connectors	/16 (ST, bayonet coupling) /17 (ST, bulkhead panel mount) /18 (ST, PC mounting)
Termini	MIL-PRF-29504	Removable Fiber Optic Connector Termini	/3 /14 /15
	NAVSEA 7648710	Quick Connecting Termini	
Splices	MIL-PRF-24623	General specifications for fiber optic cable splice.	/4 /5 /6
Fiber	MIL-PRF-49291	General specifications for optical fiber	/6 (Type I) /7 (Type II)
Cable	MIL-PRF-85045	General specifications for fiber optic cable	/13, /14, /15, /16, /17, /18, /19, /20, /21, /22, /23, /24, /25, /26, /27, /28, /29

Connectors  
(COTS)

A-A-59940

Commercial Item Description  
Connectors, Fiber Optic, Single or Multiple Fiber  
(epoxy polish, fusion splice on, mechanical splice on)

/1 (LC)  
/2 (SC)  
/3 (ST)

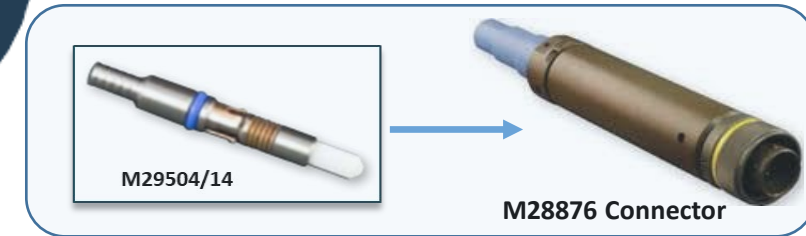
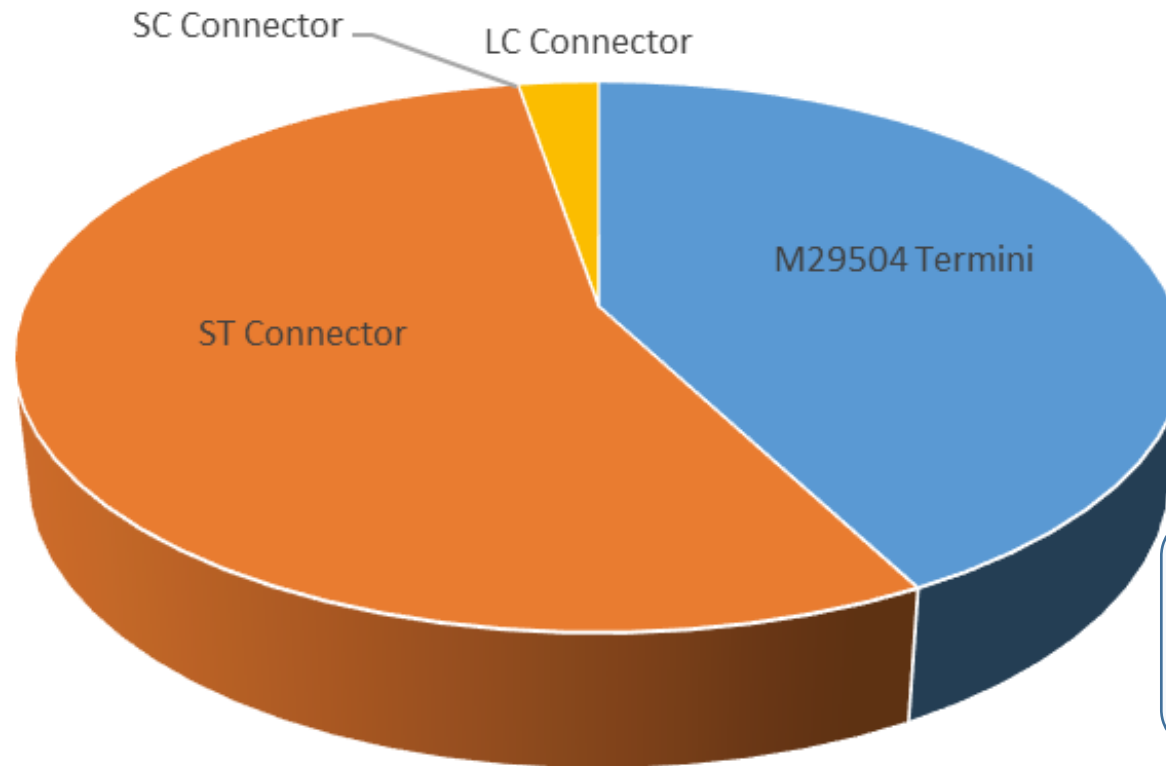
# Approach

- Study evaluating the following:
  - COTS Splice On Connectors (Single Channel)
  - QCTs- Splice On Termini for Multi-Pin Circular (M28876) Connectors
- Gaps to be evaluated
  - Availability of commercial options
  - Development needs for M29504 termini option
  - Splice machine requirements and availability



# Connector Types – USN Applications

- Survey conducted to identify connector types and usage
- Preliminary data includes DDG, LHA, CVN ships
  - Others in process
- Primary usage includes M29504 termini and ST connectors



# Connector Types – USN Applications (Single Channel)

- Single channel connectors include MIL and COTS options
  - ST widely used
  - Others in very small quantities



ST Connectors

CONNECTOR TYPE	MIL STD/COTS	MIL-STD/CID	PN
ST	MIL-STD	MIL-C-83522	M83522/16DNX M83522/16-DNY
ST	COTS	A-A-59940	MSTC2100 MSTC1101 MSTC2100 MSTC2101 MSTC1110
SC	COTS	A-A-59940	5503948-1 6588714-1
LC	COTS	A-A-59940	XPLC2-MM

*\*COTS connectors are only permitted for use within shock isolated enclosures/equipment.*

# Connector Types – Single Channel

*(General Overview of COTS Options)*



- ST (Straight Tip)
- LC (Lucent Connector)
- SC (Subscriber Connector)
- FC (Ferrule Connector)

Specifications for Fiber Optic Connectors			
Connector Type	Singlemode (9/125) Insertion Loss (dB)	Multimode Insertion Loss (dB)	Return Loss (dB)
ST Connector	≤0.5	≤0.5	≥40
LC Connector	≤0.25	N/A	≥40
SC Connector	≤0.25	≤0.5	≥50
FC Connector	≤0.25	≤0.5	≥50

# COTS Splice-On Connectors

- Over 100 commercially available options identified
- Technical evaluation being conducted
  - Sample Hardware
  - Technical Documentation
- Some considerations in evaluation process:
  - Connector Type
  - Fiber Type
  - Cable Compatibility
  - Splice Machine Compatibility
  - Durability
  - Assembly Process

# COTS Splice-On Connectors

*(Some Options...)*

- AFL
- Belden
- Corning
- Clearfield
- Diamond
- FiberFox
- Fibernet
- FIS
- Infinium
- OFS/Fitel
- Panduit
- Siemon
- Sumitomo
- UCL/Isintech



Sumitomo Lynx-CustomFit



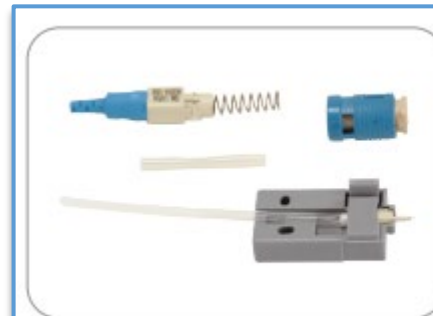
Belden FX Fusion



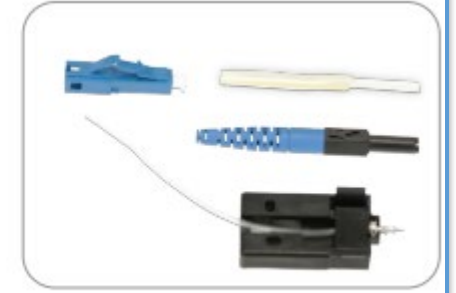
FUSEConnect Connectors (SC, FC, LC, ST)



Fusion Crocodile



FUSEConnect Kits—ST (blue), SC (green), LC (blue)



# Connector Types – USN Application (Circular)



CONNECTOR TYPE	MIL STD/COTS	MIL-STD/CID	PN
Multi-Pin, Circular	MIL-STD	MIL-DTL-28876	M28876/1B1S1 M28876/11B1S1 M28876/6B1S1 M28876/1C1S1 M28876/11C1S1 M28876/6C1S1

# QCT Apparatus Status

- Existing QCT system uses Fujikura 70S
  - Last updated 2014
  - Currently in EOL phase by Fujikura
  - Spares etc. available through existing stock
- No current support for existing termini assembly and packaging
  - AFL original partner
  - No current support/manufacturer for existing design
- Current design/process still documented and available for use



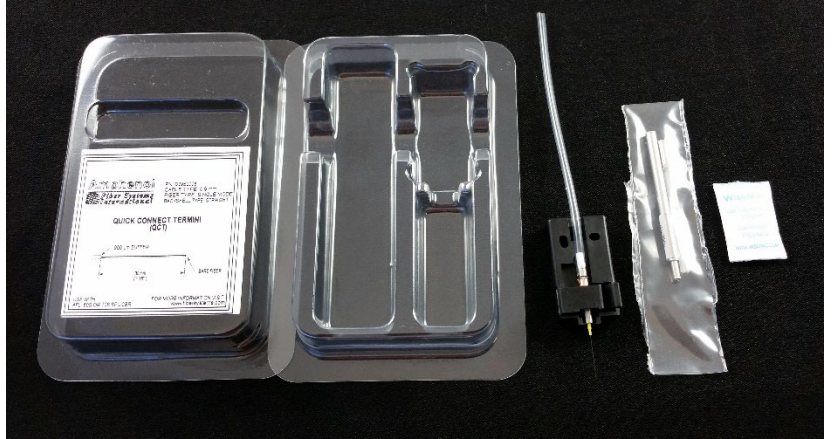
# QCT Apparatus Status



24 Inches

12 Inches

Large footprint



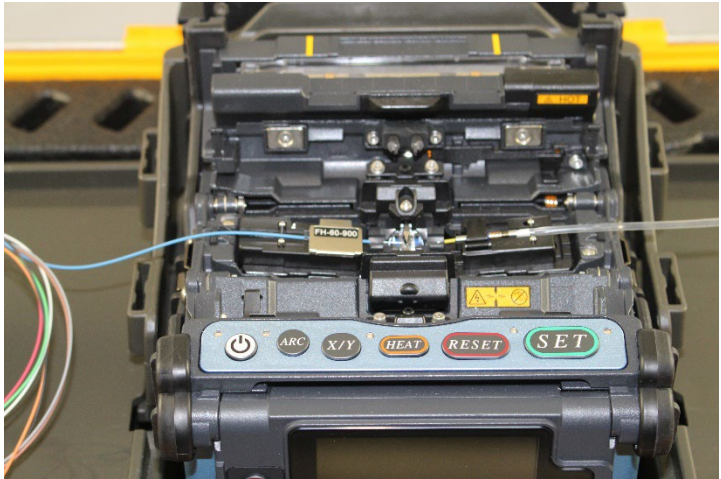
Need moisture resistant packaging



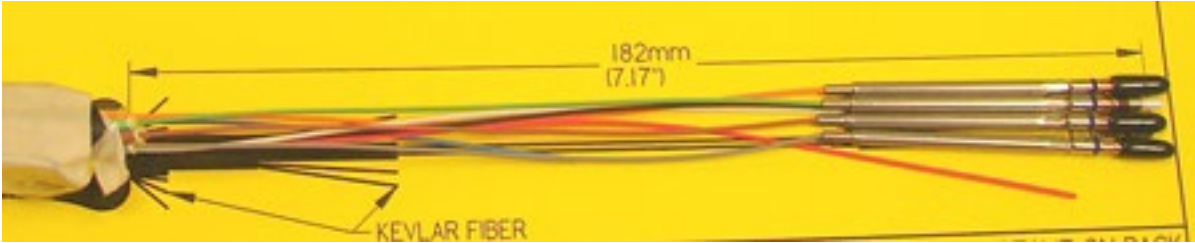
# QCT Current Issues

- 70S support in EOL stage (existing inventory only)
  - Currently out of production by Fujikura
  - 70S+ in use at current facilities
- Need to find new supplier of pre-made splice assemblies
- Better fiber storage and protection (moisture)
- Practically limited to 8 fiber connectors
- Approximately 4" of clearance (straight) required from connector for protective shell
- Minimum of  $1\frac{5}{32}$ " (12mm) of fiber needed for splice operation
  - Main driver for 4" splice protector requirement
- Workspace
  - Need a few feet of level, linear clearance for proper splice operation
  - Need approximately 2' x 3' equipment setup area

# QCT Current Issues



Several inches of splice clearance needed



# QCT Improvement Recommendations

- Upgrade to newer splicer with smaller footprint and less required work area
  - Need to be able to get into tight/awkward workspaces
  - Down select to a couple vendors
  - Verify they are willing to work with us long term
  - Select unit with smaller splice dimensions (clearance, strip length, etc.)
- Improved packaging
  - Need to keep moisture out for better shelf life
- Develop shorter termination/splice length

# Next Steps...

- Continue evaluation of COTS options
- Continue development of QCT improvements
- Down-select options
- Evaluate feasibility for shipboard applications
- Technology transition planning

# Project Team POCs

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# Questions