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Investigation Procedure

Monterey Bay Aquarium Research Institute (MBARI)

Electrical Fault Investigation ROV Umbilical RM0011

70m Returned Section



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1. INTRODUCTION

This document details the procedure that must be followed when dissecting the 70m sample of RM0011 ROV umbilical returned to Cortland Fibron BX for analysis. This sample was removed from a 5000m length of RM0011 manufactured in January 2009.

The fault was reported as a short from the white and blue power cores to each other and the screen. This section of cable has been removed from the 1460m point (measured from the vehicle end of the ROV umbilical).

2. OPERATION 1 – SAMPLE DISSECTION

Carefully remove the armour layers and outer sheath from the sample. Slide a 50mm length of white heat shrink sleeving over each end of the cable. Position the sleeving 100mm from the cable ends (to allow the cores to be exposed for testing later in the procedure) and shrink in place. Mark the white sleeving with the letter A on one end and the letter B on the other end using a black permanent marker.	Confirm that the armour layers and outer jacket have been removed and that the heat shrink sleeving and marking have been applied to the sample.	YES/NO
Carry out a visual inspection of the exposed ROV umbilical assembly. Photograph any areas of interest and note the length measurement by placing a card with the length measurement in the photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix A	Confirm that visual inspection is complete and documented in appendix A.	YES/NO
Confirm that the ROV umbilical assembly is identical to the colour code drawing contained in appendix B (core and optical fibre colours and position in the assembly).	Confirm that colour code drawing in appendix B is correct.	YES/NO Bk multi-mode fibre missing from the drawing.

Cut 28 x 20mm lengths of clear heat shrink tubing from a coil of stock tubing. Strip back the copper tape screen from both ends of the ROV umbilical sample, for a distance of 100mm, to expose the insulated cores and fibre optic cables. Place an adhesive letter tag A on each power core, each fibre optic, the central quad assembly and each outer layer assembly drain wire, on end A of the ROV umbilical assembly. Place a clear heat-shrink sleeve over each letter tag and shrink in place. Repeat the above procedure on end B of the assembly.	Confirm markings have been applied.	YES/NO
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3. OPERATION 2 – 1ST ELECTRICAL TEST

Carry out a TDR test on each 4mm² power core from end A. Adjust the VP on the TDR to ensure the length reading matches the measured length of ROV umbilical assembly. Print out and label each trace with the power core colour, the VP value and the end that the trace was taken from.	Confirm that TDR tests have been carried out and the traces labelled.	YES – attached to Appendix C /NO
Carry out a TDR test on each 4mm² power core from end B. Adjust the VP on the TDR to ensure the length reading matches the measured length of ROV umbilical assembly. Print out and label each trace with the power core colour, the VP value and the end that the trace was taken from.	Confirm that TDR tests have been carried out and the traces labelled.	YES – attached to Appendix C /NO
Carry out the following tests on the ROV umbilical assembly:- Conductor resistance High Voltage Insulation resistance OTDR trace on each optical fibre Record the results on the sheets included in appendix C.	Confirm electrical tests have been carried out and the results logged in appendix C.	YES/NO

4. OPERATION 3 – 2ND ELECTRICAL TEST

The tests carried out in operation 2 coupled with the visual inspection should allow the faults in the white and blue cores to be located. Remove the copper screening tape from these locations to expose the faults. Photograph the faults and note the length measurement by placing a card with the length measurement in the	Confirm that photographs have been taken and documented in appendix D.	YES/NO Fault in White core found. Unable to locate fault in Blue core
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photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix D		
Birdcage the outer layer of power cores by gripping the cable on one side of the fault and rotating the cable on the other side of the fault. Clean the location of the fault with alcohol to remove any carbon deposits. Carefully examine the area for signs of mechanical damage. Photograph the faults and note the length measurement by placing a card with the length measurement in the photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix E.	Confirm that photographs have been taken and documented in appendix E.	YES/NO
Repair the faults in the White and Blue cores by wrapping the faults with 1 layer of mylar (polyester) tape followed by a layer of electrical insulation tape. Reinstate the screen over the areas containing the faults by wrapping the area with copper polyester tape (foil side downwards).	Confirm that tapes have been applied.	YES/NO
Repeat the following electrical tests on the Power cores in the ROV umbilical assembly to confirm that the faults have disappeared. This test is being carried out to prove that no other faults exist in the insulated power cores:- High Voltage test Insulation resistance Record the results on the sheets included in appendix F.	Confirm electrical tests have been carried out and the results logged in appendix F.	YES/NO

5. OPERATION 4 – ASSEMBLY DISSECTION

Carefully remove the polyester and copper polyester tapes from the ROV umbilical assembly. Keep the binder tapes in case they are required for examination at a later date. Apply a wrap of PVC tape to the ends of the ROV umbilical sample, as the binder tape is being removed, to prevent the umbilical sample lay length from being disturbed.	Confirm that the tapes have been removed and that the PVC tape has been applied to the sample ends.	YES/NO
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Carry out a visual inspection of the exposed ROV umbilical inner bundle assembly. Photograph any areas of interest and note the length measurement by placing a card with the length measurement in the photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix G	Confirm that visual inspection is complete and documented in appendix G	YES/NO	
Measure the pitch of the ROV umbilical assembly at three points along the sample length.	Record pitch measurements in adjacent column	Pitch Measurement	
		73mm	
		72.9mm	
		73mm	
Measure the diameter of the umbilical in two planes, 90° apart. Measurements to be taken at three points along the sample length.	Record diameter measurements in adjacent column	X - Plane	Y- Plane
		9.7mm	9.7mm
		9.7mm	9.7mm
		9.7mm	9.7mm
Remove the drain wires from the ROV umbilical assembly. Coil, label and place in a safe location for possible inspection at a later date. Note the drain wires should still have the A & B tags attached (from operation 1)	Confirm drain wires have been removed and placed to one side.	YES/NO	
Remove the fibre optics from the ROV umbilical assembly. Coil, label and place in a safe location for possible inspection at a later date. Note the fibre optics should still have the A & B tags attached (from operation 1)	Confirm fibre optics have been removed and placed to one side.	YES/NO	
Remove the power cores from the ROV umbilical assembly. Coil, label and place in a safe location for possible inspection at a later date. Note the power cores should still have the A & B tags attached (from operation 1)	Confirm power cores have been removed and placed to one side.	YES/NO	
Coil the remaining signal quad, label and place in a safe location for possible inspection at a later date. Note the signal quad should still have the A & B tags attached (from operation 1)	Confirm the signal quad has been removed and placed to one side.	YES/NO	

6. OPERATION 5 – WATER TEST

Place the Red power core in a water tank with the ends out of the water. Carry out a high voltage test on the power core followed by an IR test. Record the results in appendix H	Confirm that the test has been carried out and the results recorded in appendix H.	YES/NO
Place the Green power core in a water tank with the ends out of the water. Carry out a high voltage test on the power core followed by an IR test. Record the results in appendix H	Confirm that the test has been carried out and the results recorded in appendix H.	YES/NO
Place the Yellow power core in a water tank with the ends out of the water. Carry out a high voltage test on the power core followed by an IR test. Record the results in appendix H	Confirm that the test has been carried out and the results recorded in appendix H.	YES/NO
Place the Blue power core in a water tank with the ends and the section containing the fault out of the water. Carry out a high voltage test on the power core followed by an IR test. Record the results in appendix H	Confirm that the test has been carried out and the results recorded in appendix H.	YES/NO Note previously located fault repaired with a heat shrink sleeve.
Place the White power core in a water tank with the ends and the section containing the fault out of the water. Carry out a high voltage test on the power core followed by an IR test. Record the results in appendix H	Confirm that the test has been carried out and the results recorded in appendix H.	YES/NO Note previously located fault repaired with a heat shrink sleeve.

7. OPERATION 6 – FAULT ANALYSIS

Remove the PVC and mylar tapes from the area containing the fault on the white core. Use a hot air gun to melt the insulation from the core in this area to expose the copper conductor. When cooled visually inspect the copper for riding or broken strands. Photograph the area and note the length measurement by placing a card with the length measurement in the photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix I.	Confirm that photographs have been taken and documented in appendix I.	YES/NO
Remove the PVC and mylar tapes from the area containing the fault on the Blue core. Use a hot air gun to melt the insulation from the core in this area to expose the copper conductor. When cooled visually inspect the copper for riding or broken strands. Photograph the area and note the length measurement by placing a card with the length measurement in the photograph. Length measurements to be taken from end A. Download the photographs to a PC and clearly title the photographs (title to include the date). Record observations made during the visual inspection in appendix I.	Confirm that photographs have been taken and documented in appendix I.	YES/NO

APPENDIX A

Visual Inspection Observations – Armour layers and outer jacket removed

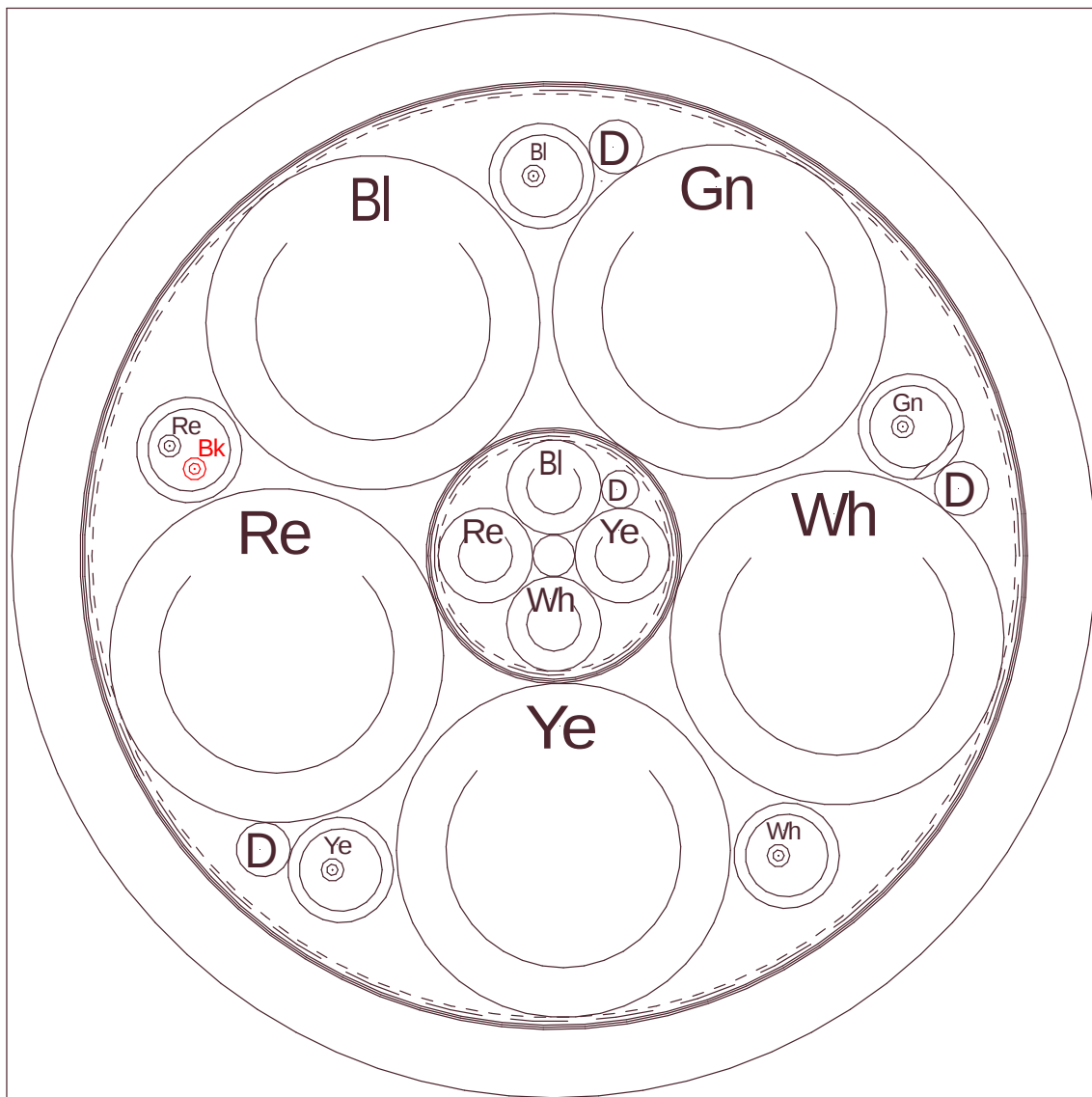
Observation	Location	Photograph Reference
Generally the copper tape is in good condition however a small burn in the copper tape is visible.	3.1m from end A	Photograph A



Photograph A

APPENDIX B

Viewed from end A



APPENDIX C

Electrical Tests

Conductor Resistance Test

4mm² Power Cores

	Recorded value (Ω)
Red	0.3
Blue	0.3
Green	0.3
White	0.3
Yellow	0.3
Outer Drain wire 1	1.3
Outer Drain wire 2	1.3
Outer Drain wire 3	1.3

0.22mm² Screened Signal Quad

	Recorded value (Ω)
Red	6.2
Blue	6.1
Yellow	6.2
White	6.1
Screen	4.8

High Voltage Test

4mm² Power Cores – 19.2 kV DC core to core & core to screen, held for 5 minutes

Red	PASS/FAIL
Blue	PASS/FAIL
Green	PASS/FAIL
White	PASS/FAIL
Yellow	PASS/FAIL

0.22mm² Screened Signal Quad 1.0 kV DC core to core & core to screen, held for 5 minutes

Red	PASS/FAIL
Blue	PASS/FAIL
Yellow	PASS/FAIL
White	PASS/FAIL

Insulation Resistance Test @ 500V DC – after 1 minute

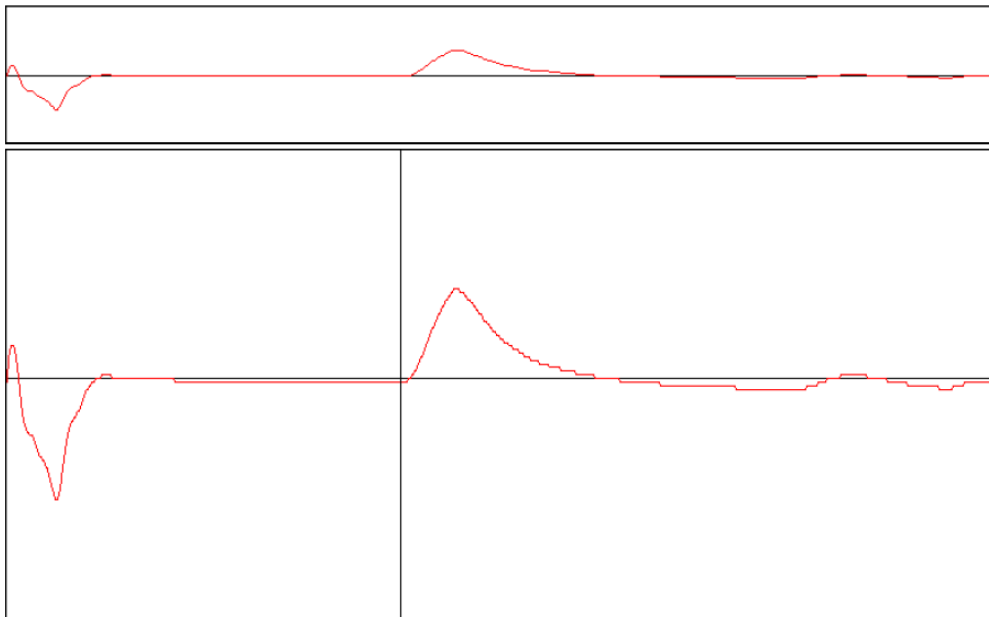
4mm² Power Cores

	Red	Blue	Green	White	Yellow	Screen
Red		100G Ω	100G Ω	100G Ω	100G Ω	50G Ω
Blue			100G Ω	Fail	100G Ω	Fail
Green				100G Ω	100G Ω	50G Ω
White					100G Ω	Fail
Yellow						50G Ω

0.22mm² Screened Signal Quad

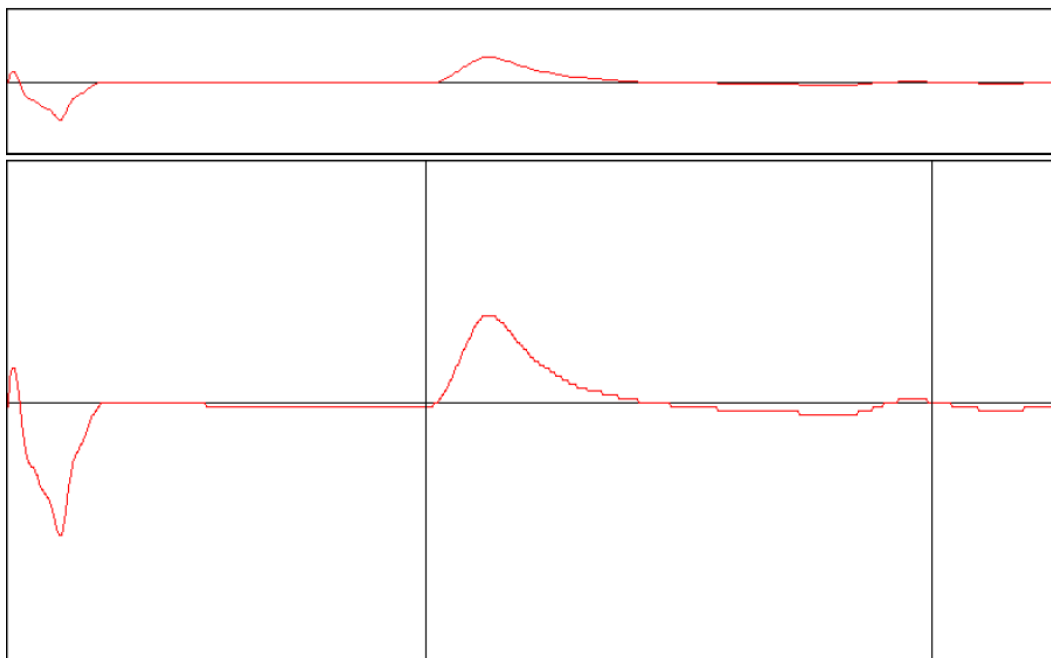
	Red	Blue	Yellow	White	Screen
Red		100GΩ	100GΩ	100GΩ	20GΩ
Blue			100GΩ	100GΩ	20GΩ
Yellow				100GΩ	20GΩ
White					20GΩ

AVO TraceMaster: MBARI TDR M01.csv



White 4mm² Power Core – Shot From End A

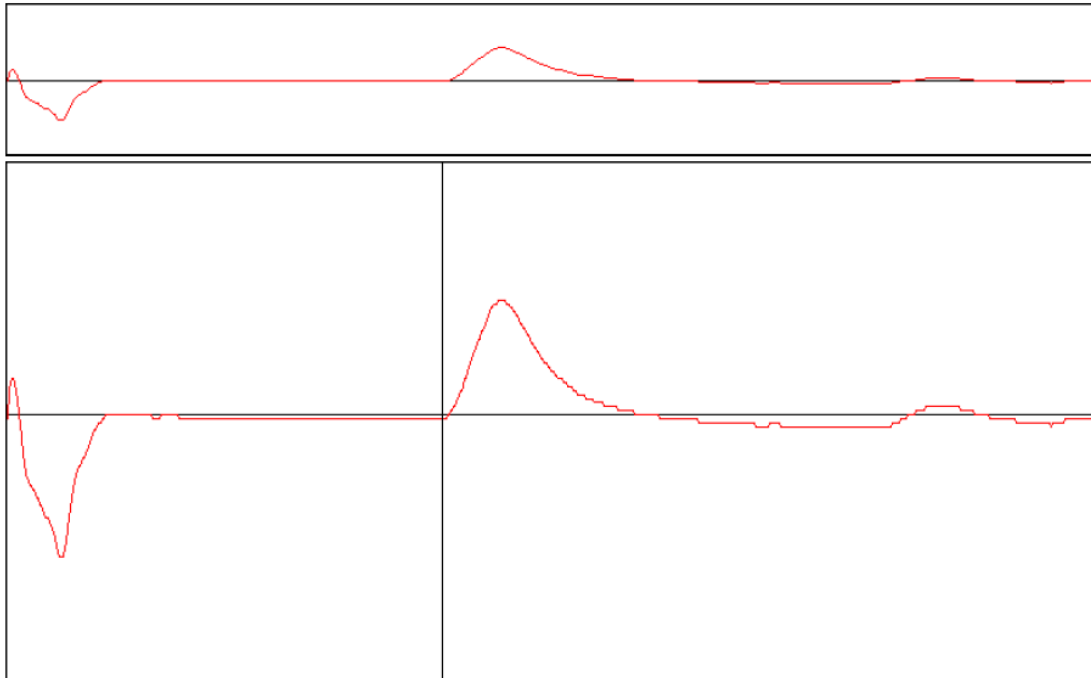
AVO TraceMaster: MBARI TDR M02.csv



A Range: 2 μ S Cursor 1: 71 m Cursor 2: 156.8 m C1<->C2: 85.80 m

Yellow 4mm² Power Core – Shot From End A

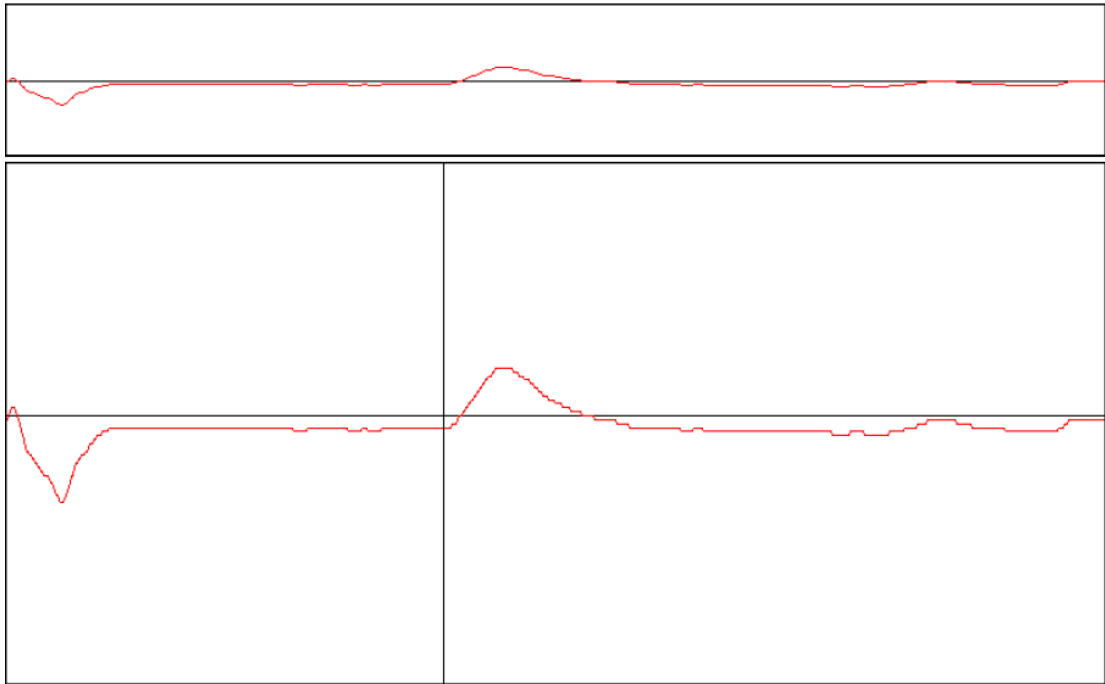
AVO TraceMaster: MBARI TDR M03.csv



Range: 2 μ S Cursor 2: 71 m

Red 4mm² Power Core – Shot From End A

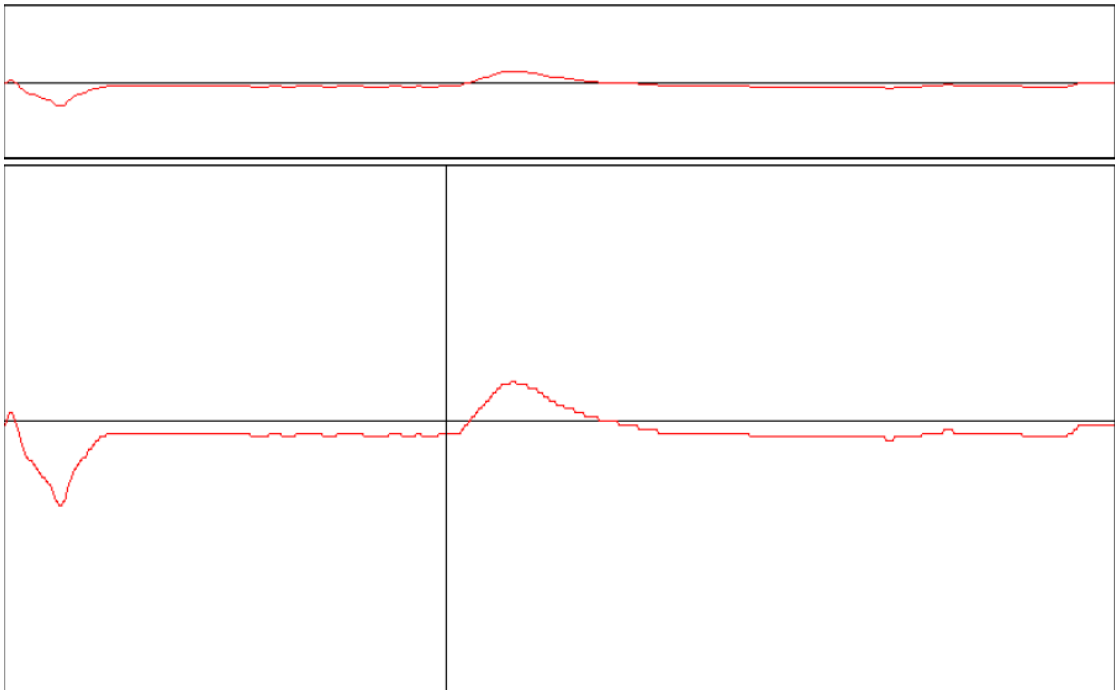
AVO TraceMaster: MBARI TDR M04.csv



Range: 2 μ S Cursor 2: 71 m

Blue 4mm² Power Core – Shot From End A

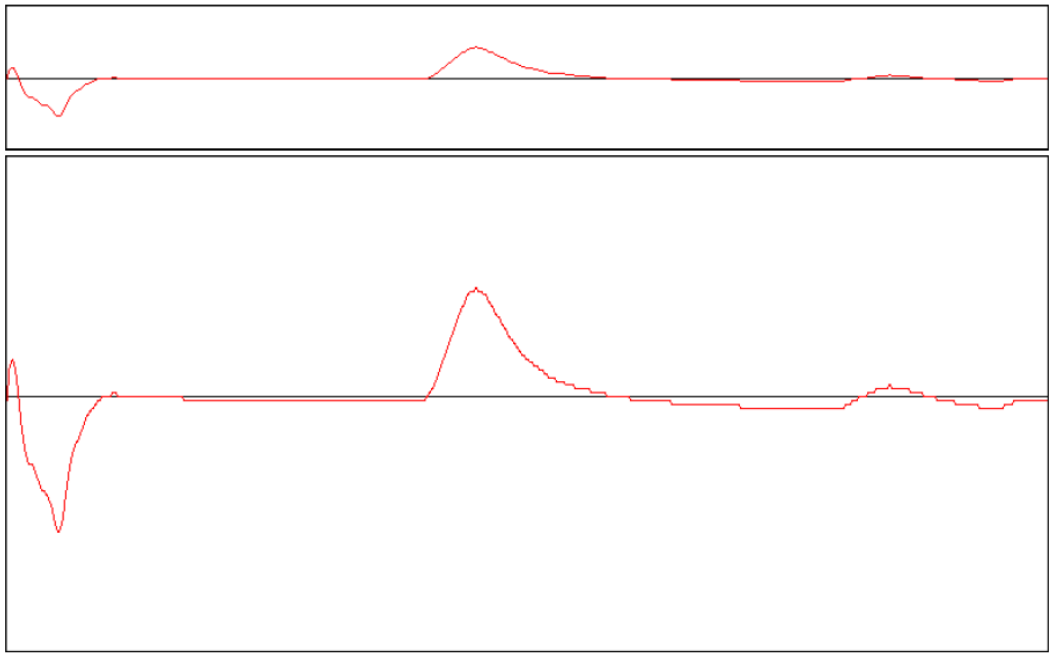
AVO TraceMaster: MBARI TDR M05.csv



Range: 2 μ S Cursor 2: 71 m

Green 4mm² Power Core – Shot From End A

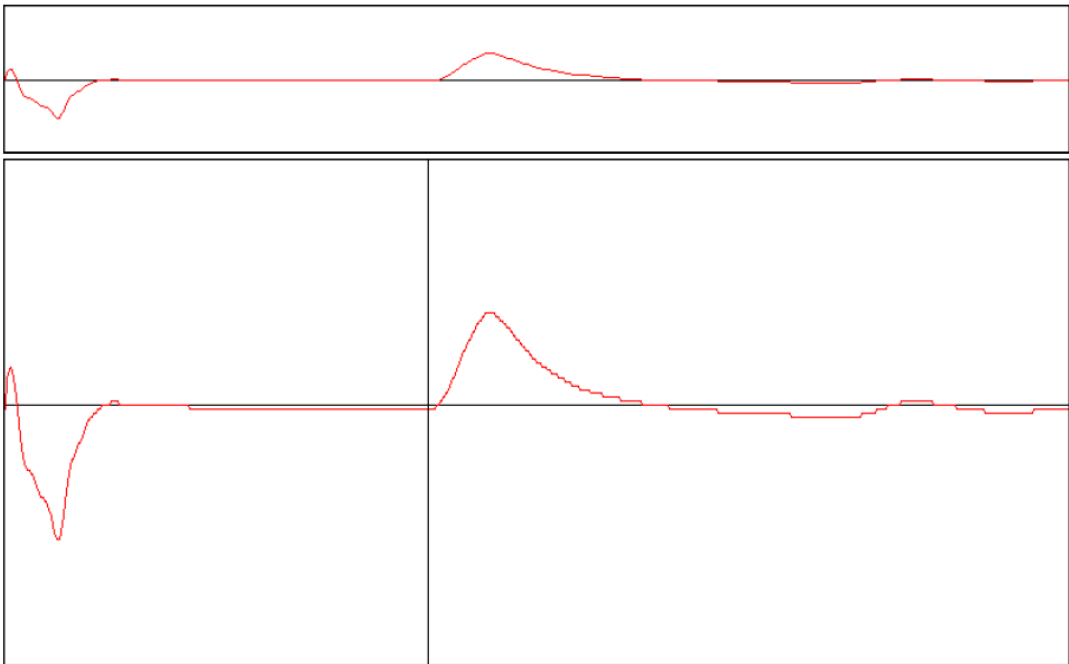
AVO TraceMaster: MBARI TDR M06.csv



Range: 2 μ S

White 4mm² Power Core – Shot From End B

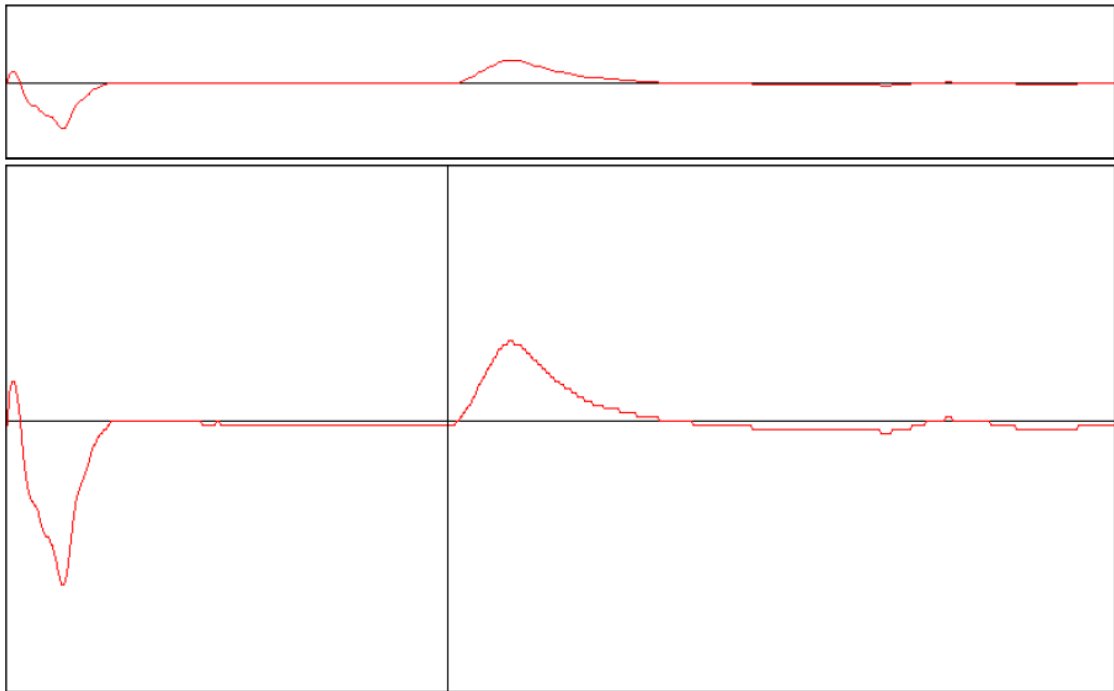
AVO TraceMaster: MBARI TDR M07.csv



Range: 2 μ S Cursor 2: 71 m

Yellow 4mm² Power Core – Shot From End B

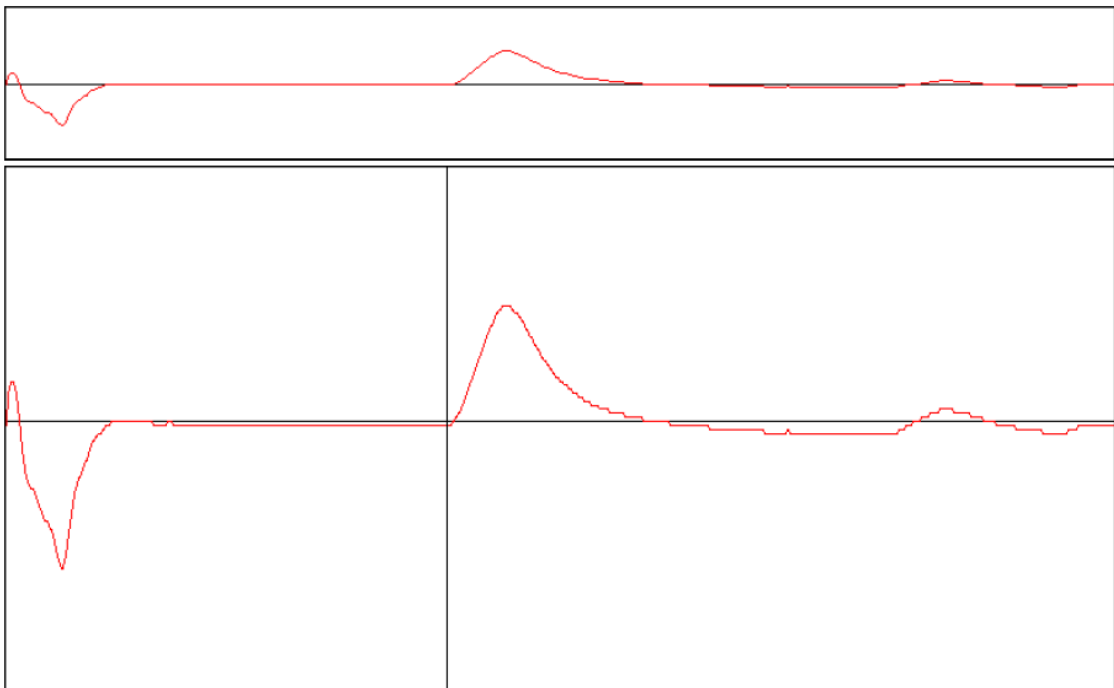
AVO TraceMaster: MBARI TDR M08.csv



Range: 2µS Cursor 2: 71 m

Red 4mm² Power Core – Shot From End B

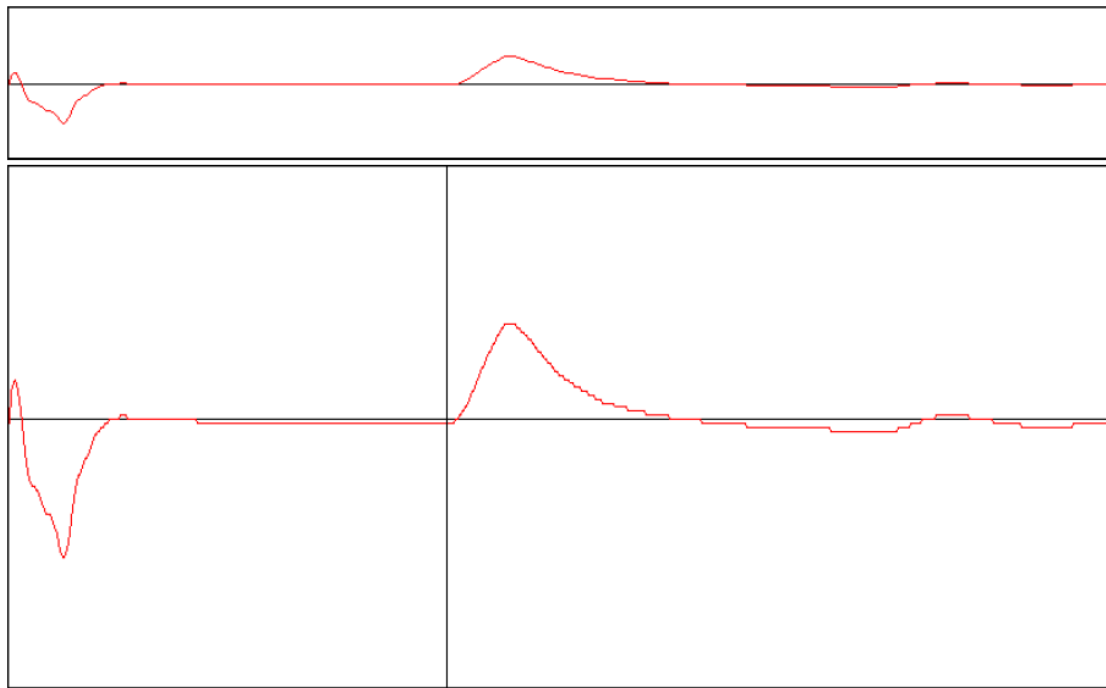
AVO TraceMaster: MBARI TDR M09.csv



Range: 2µS Cursor 2: 71 m

Blue 4mm² Power Core – Shot From End B

AVO TraceMaster: MBARI TDR M10.csv



Range: 2 μ S Cursor 2: 71 m

Green 4mm² Power Core – Shot From End B

File : blsm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:35:21 Module : 5026VHD Num. 2739

Configuration

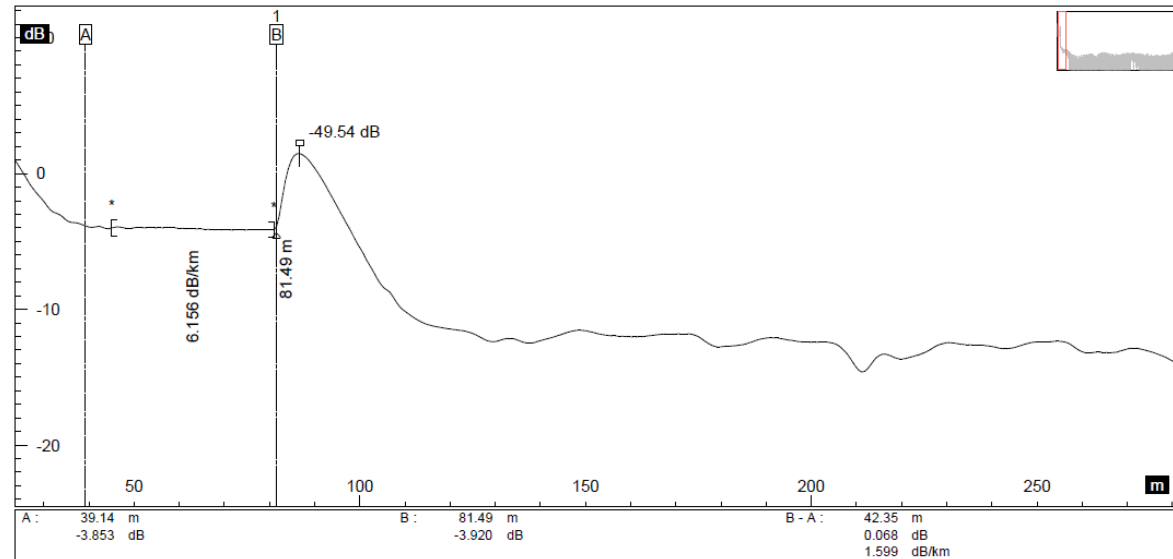
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	---	Index :	1.460000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

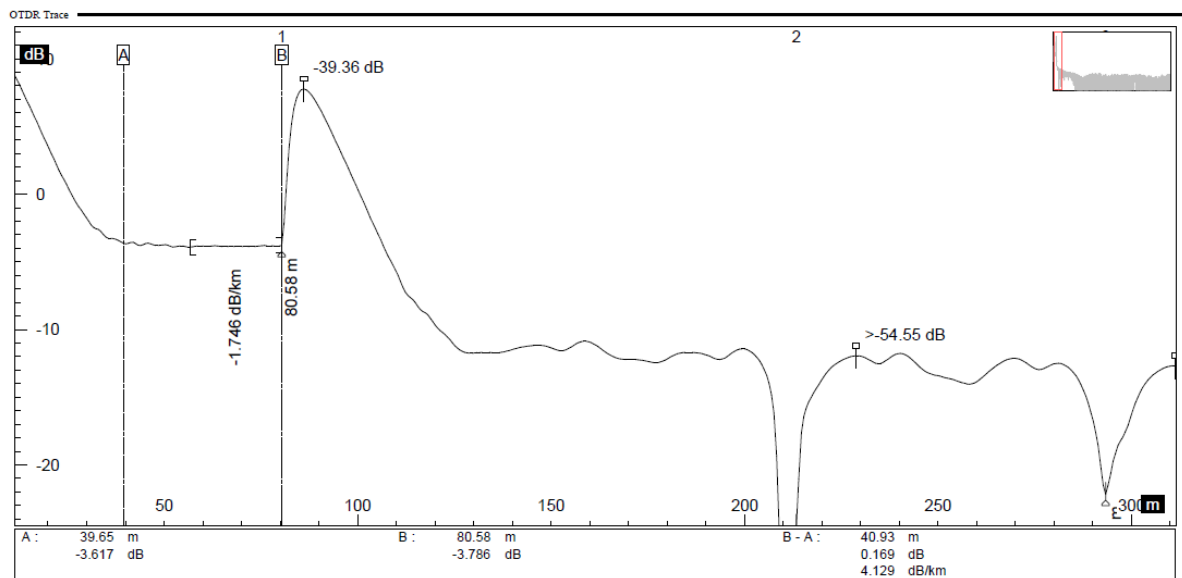
Job

OTDR Trace



Blue Single Mode 1310nm

File			
File :	bismx.wtk	Device :	MTS 5100 Num. 2437
Date :	01/02/1998 10:37:00	Module :	5026VHD Num. 2739
Configuration			
Technic. :	MS	Way :	O-->E
ORIGIN		Origin :	
Cable :	RM0011	End :	
Fiber :	1	Wavelength (nm) :	1536
Color :	---	Index :	1.465000
END		Pulse (ns) :	10
Cable :	RM0011	Range (km) :	5.000
Fiber :	1	Acq. time :	10s
Color :	---	Resolution :	64 cm
Backscatter coeff.:			
-81.00 dB			
Event detection threshold			
Splices :			
No			
Slopes :			
0.000 dB/km			
Reflectances :			
All			
Alarm threshold			
Comment			
Comment :	71MTRS	W/O 9879	MBARI INVESTIGATION
Job			



Blue Single Mode 1550nm

File : gnsm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:45:39 Module : 5026VHD Num. 2739

Configuration

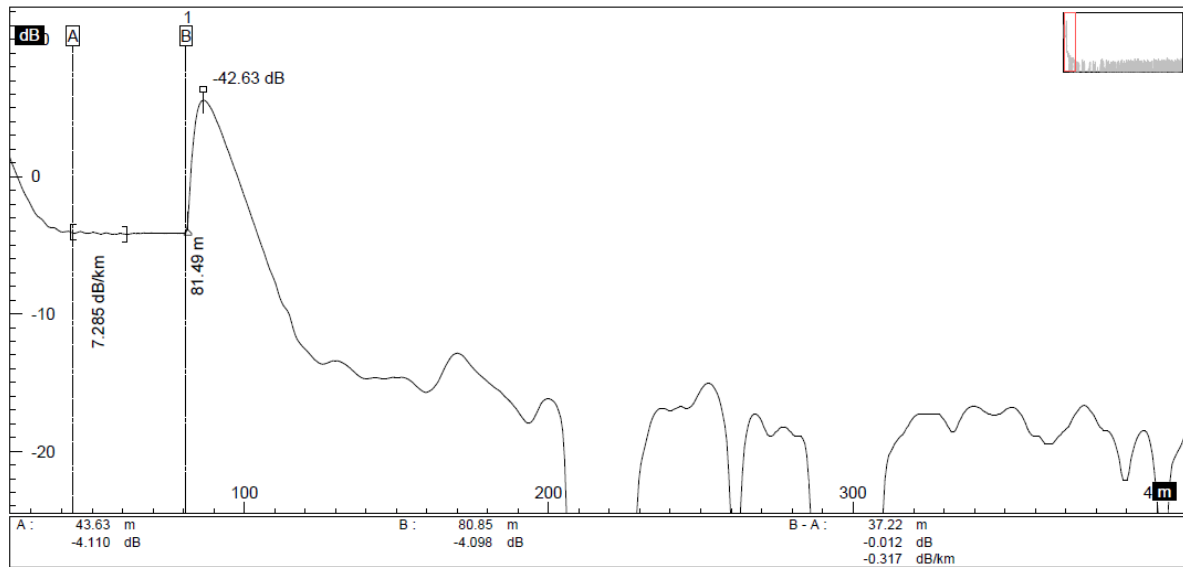
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	---	Index :	1.460000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Green Single Mode 1310nm

File : gnsmx.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:47:35 Module : 5026VHD Num. 2739

Configuration

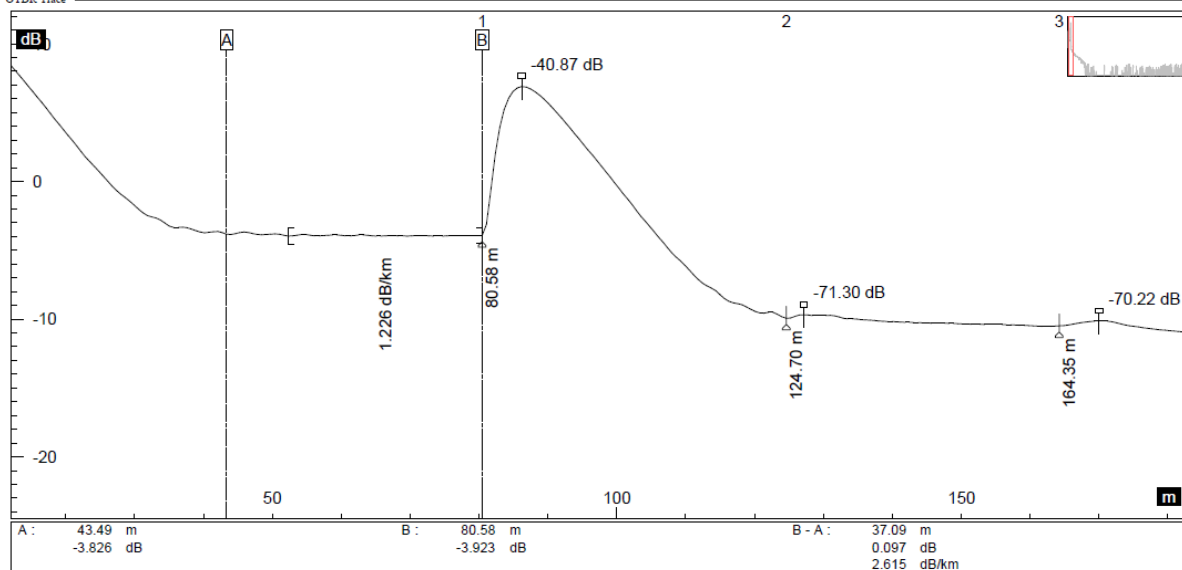
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	---	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Green Single Mode 1550nm

File : whsm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:53:16 Module : 5026VHD Num. 2739

Configuration

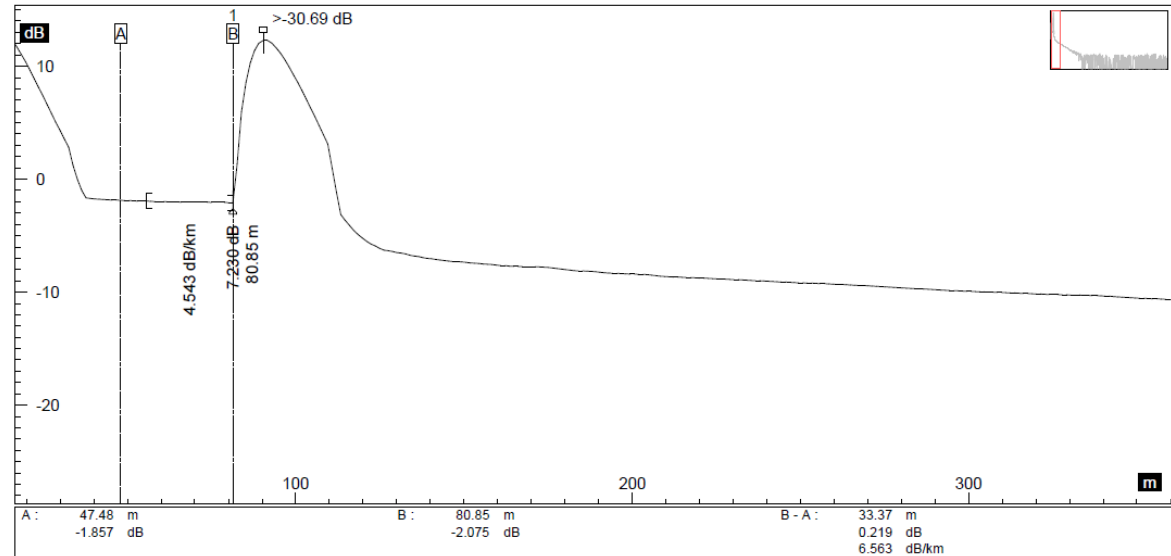
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	---	Index :	1.460000	Reflectances :	All
END		Pulse (ns) :	30	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	1.25 m		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



White Single Mode 1310nm

File : whsmx.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:59:53 Module : 5026VHD Num. 2739

Configuration

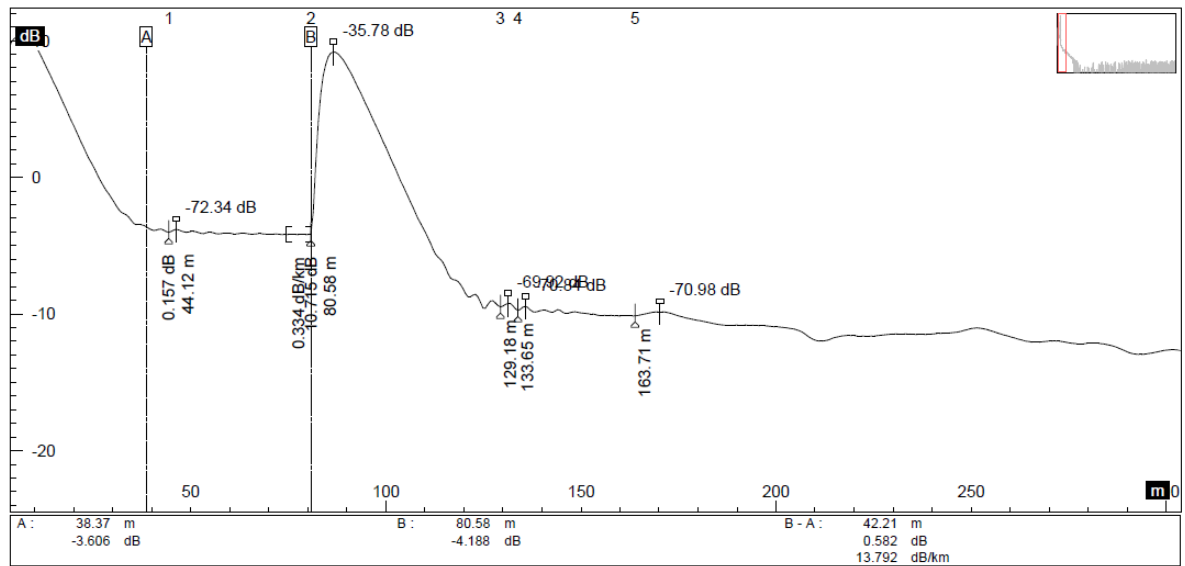
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	---	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



White Single Mode 1550nm

File : yesm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 11:04:59 Module : 5026VHD Num. 2739

Configuration

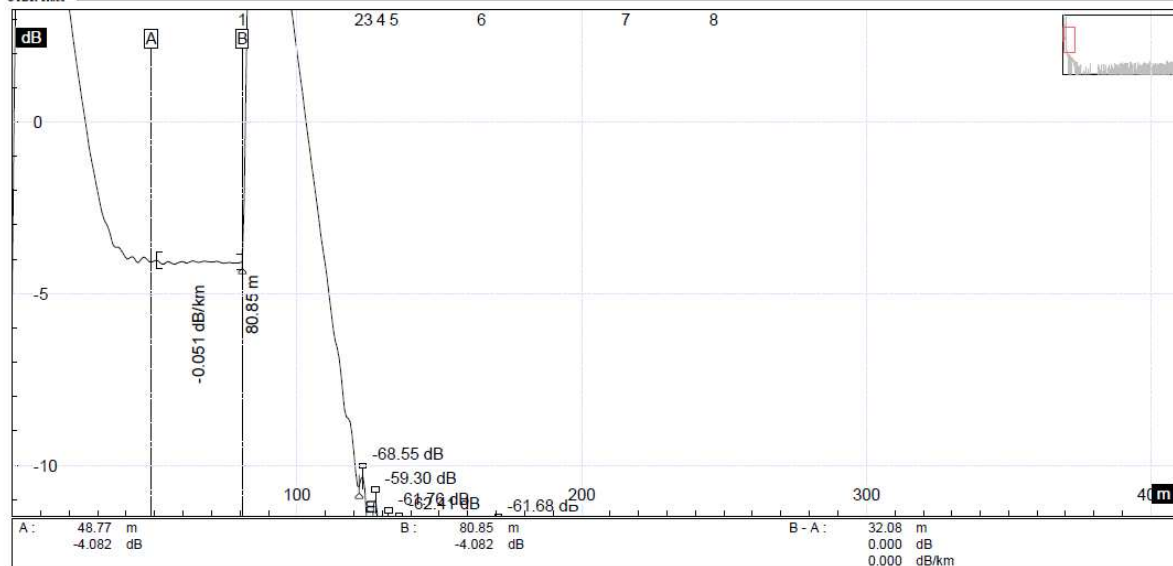
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	---	Index :	1.460000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Yellow Single Mode 1310nm

File : yesmx.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 11:08:59 Module : 5026VHD Num. 2739

Configuration

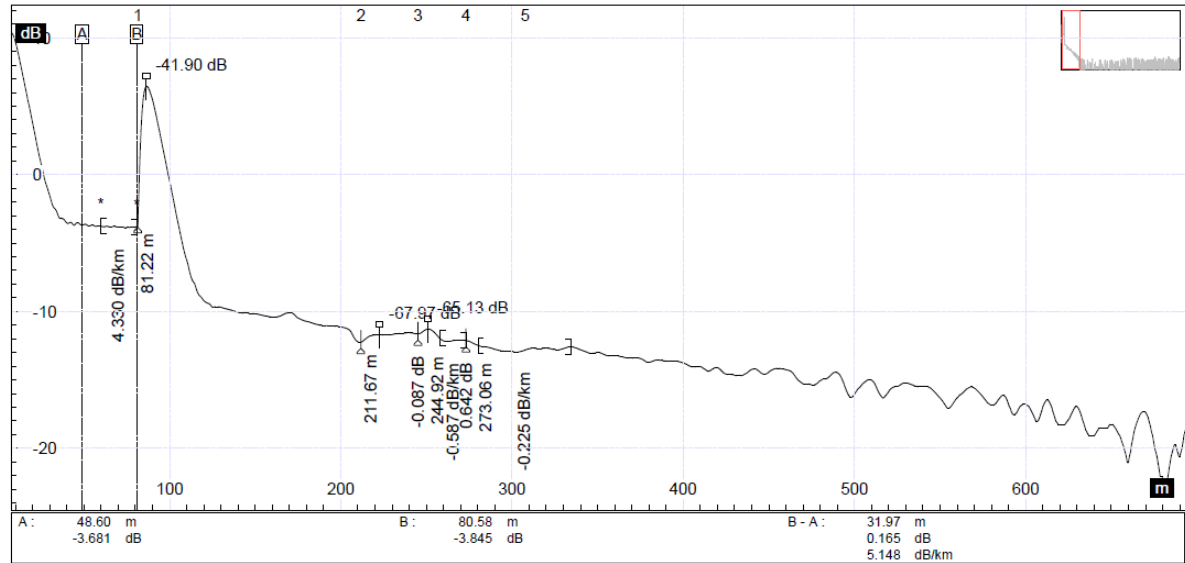
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	---	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Yellow Single Mode 1550nm

File : resm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:22:24 Module : 5026VHD Num. 2739

Configuration

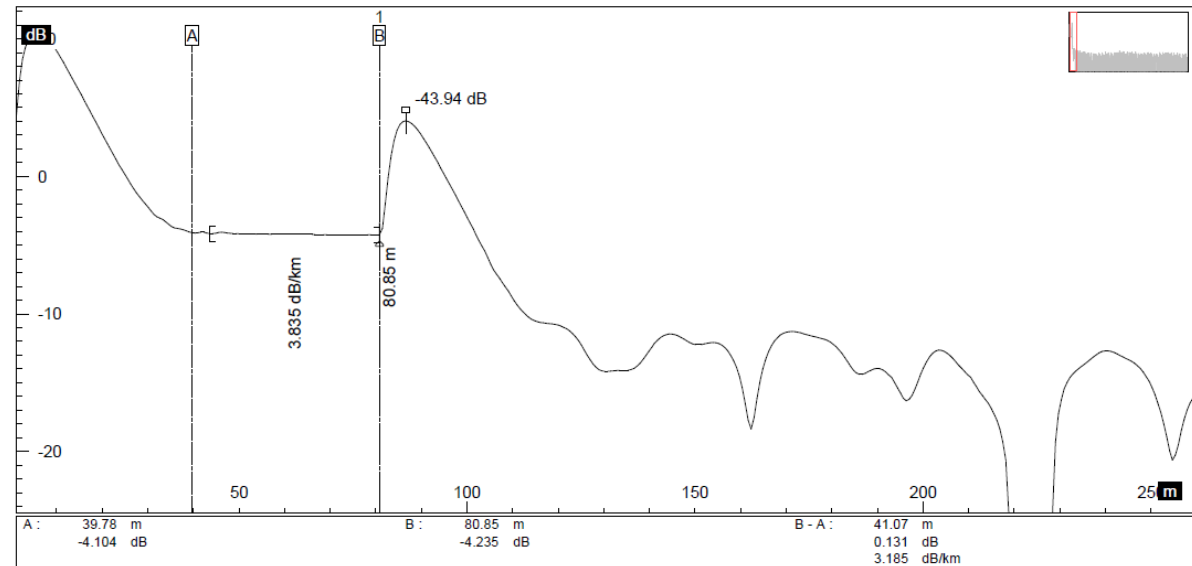
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	---	Index :	1.460000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Red Single Mode 1310nm

File : resmx.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:24:45 Module : 5026VHD Num. 2739

Configuration

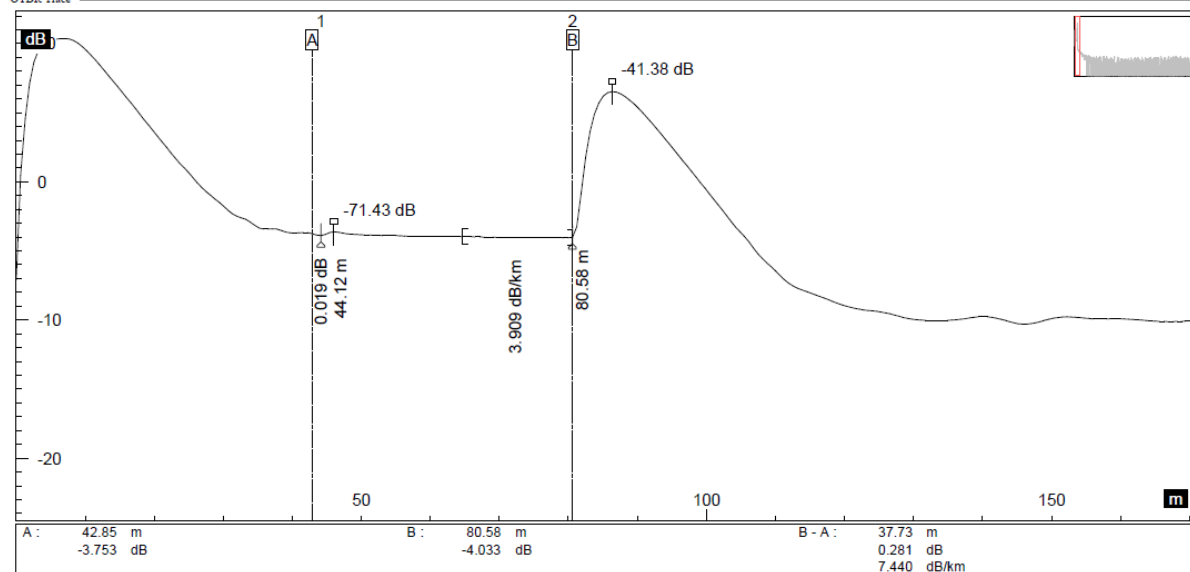
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	---	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	5.000		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	64 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

Job

OTDR Trace



Red Single Mode 1550nm

File : bkmm.wtk Device : MTS 5100 Num. 2437
Date : 01/02/1998 10:08:35 Module : 5023MM Num. 1235

Configuration

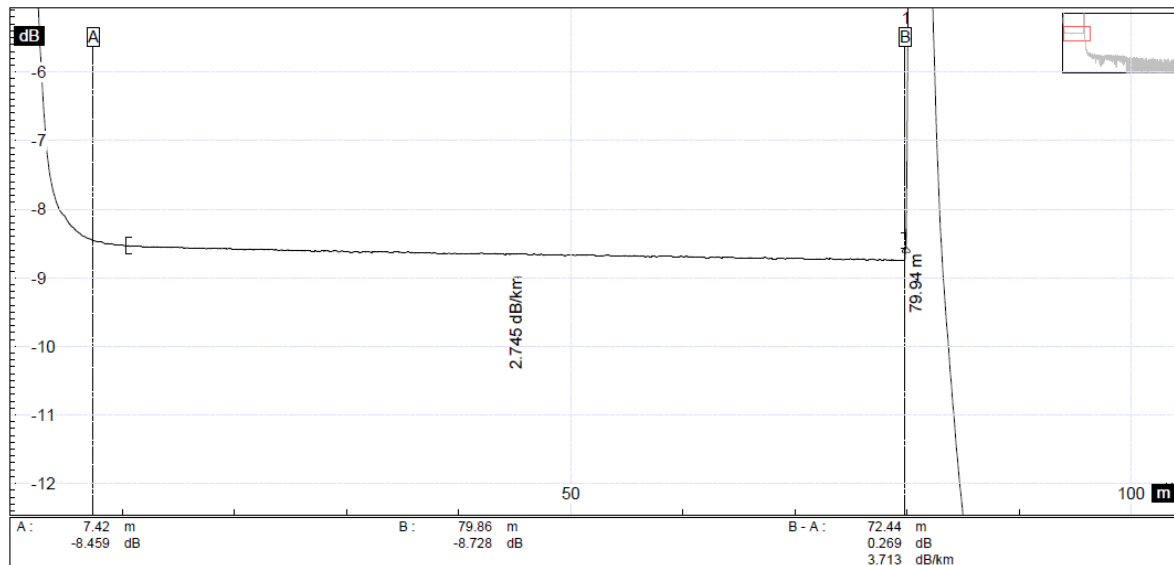
Technic. :	MS	Way :	O-->E	Backscatter coeff.:	-70.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	843	Slopes :	0.000 dB/km
Color :	---	Index :	1.484000	Reflectances :	All
END		Pulse (ns) :	3	Alarm threshold	
Cable :	RM0011	Range (km) :	0.500		
Fiber :	1	Acq. time :	10s		
Color :	---	Resolution :	8 cm		

Comment

Comment : 71MTRS W/O 9879 MBARI INVESTIGATION

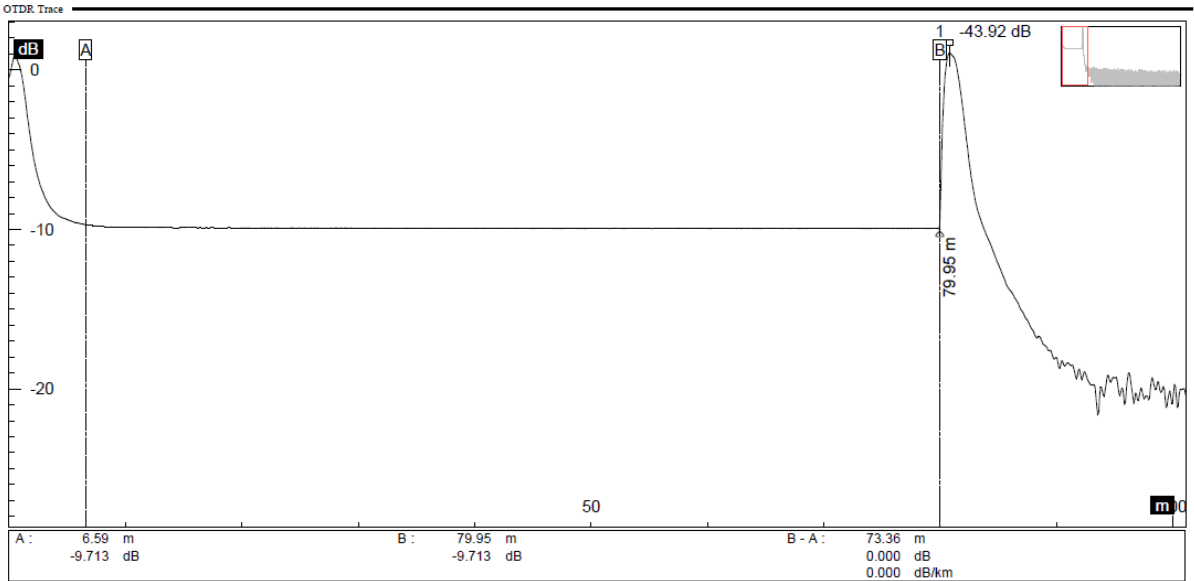
Job

OTDR Trace



Black Multi-Mode 850nm

File :	bkmmx.wtk	Device :	MTS 5100 Num. 2437
Date :	01/02/1998 10:13:52	Module :	5023MM Num. 1235
Configuration			
Technic. :	MS	Way :	O-->E
ORIGIN		Origin :	
Cable :	RM0011	End :	
Fiber :	1	Wavelength (nm) :	1312
Color :	---	Index :	1.475000
END		Pulse (ns) :	3
Cable :	RM0011	Range (km) :	0.500
Fiber :	1	Acq. time :	10s
Color :	---	Resolution :	8 cm
Backscatter coeff.: -75.00 dB			
Event detection threshold			
Splices : No			
Slopes : 0.000 dB/km			
Reflectances : All			
Alarm threshold			
Comment			
Comment : 71MTRS W/O 9879 MBARI INVESTIGATION			
Job			

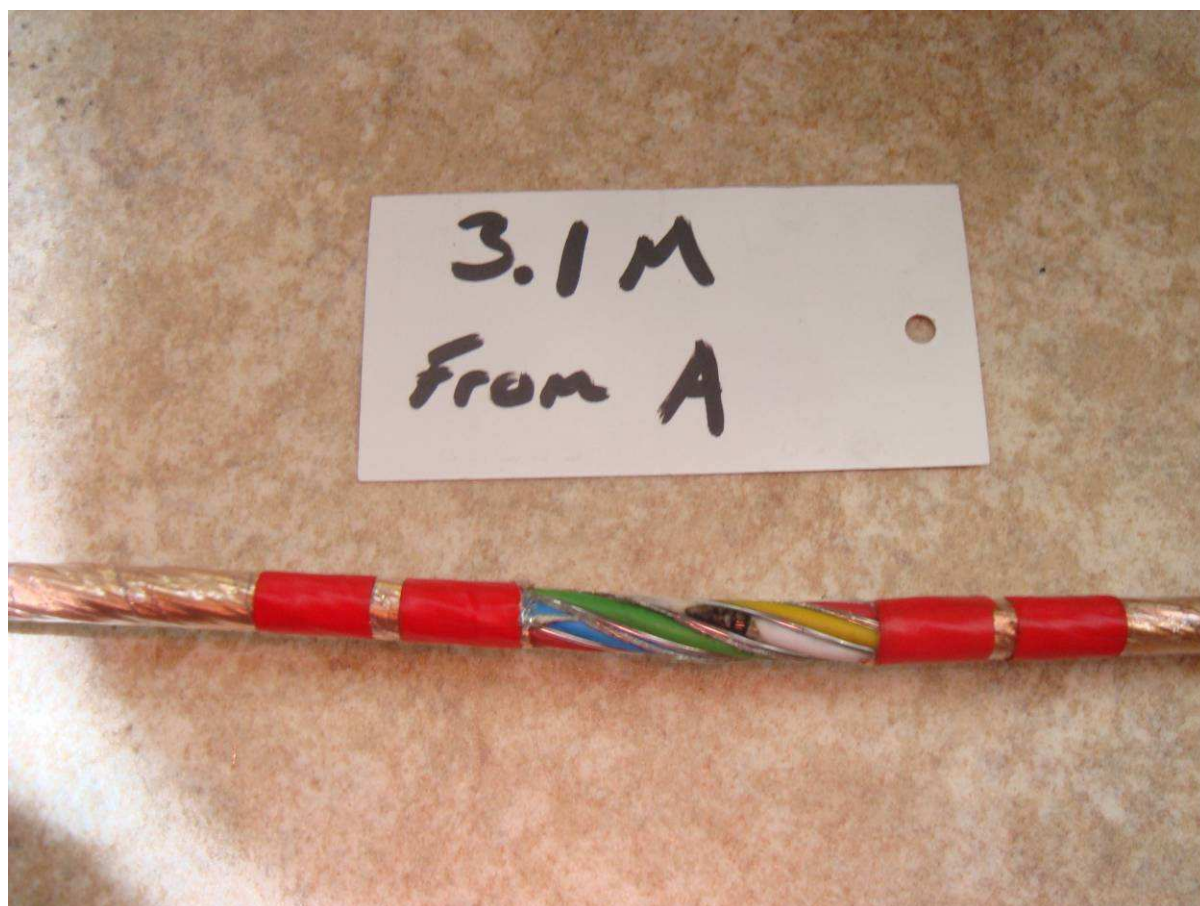


Black Multi-Mode 1300nm

APPENDIX D

Visual Inspection Observations – Faults in White & Blue Power cores

Observation	Location	Photograph Reference
Fault in white core located. Unable to locate fault in blue core (no obvious marking in copper tape to show location).	3.1m from end A	Photograph B

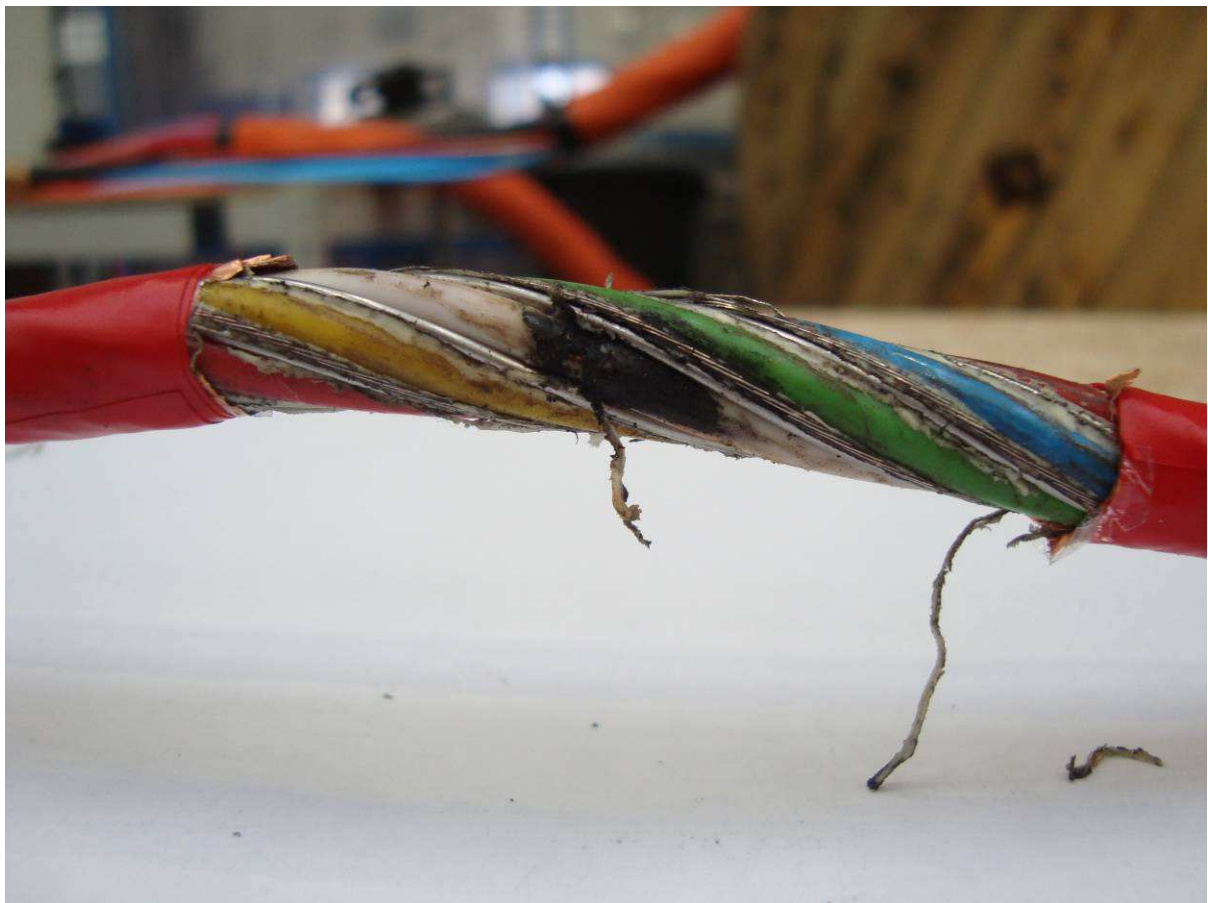


Photograph B

APPENDIX E

Visual Inspection Observations – Faults in White & Blue Power cores after cleaning with alcohol

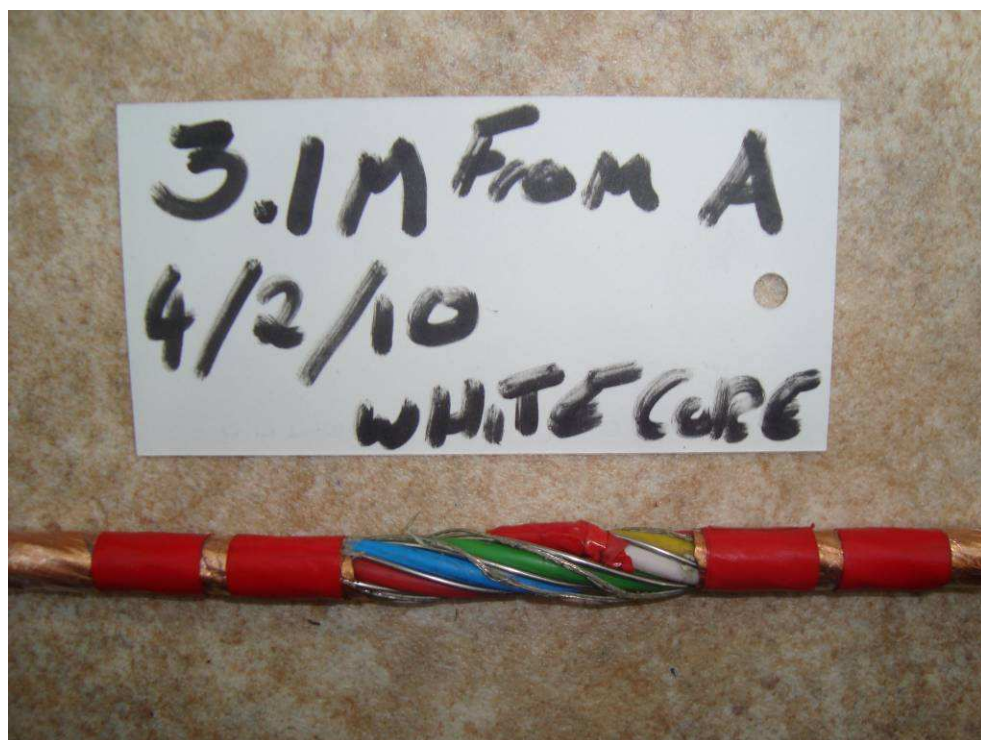
Observation	Location	Photograph Reference
Fault in white core exposed. Unable to locate fault in blue core (no obvious marking in copper tape to show location).	3.1m from end A	Photograph C
Assembly bird caged to expose fault.	3.1m from end A	Photograph D
Repaired fault in white core.	3.1m from end A	Photograph E
Reinstated copper tape screen.	3.1m from end A	Photograph F



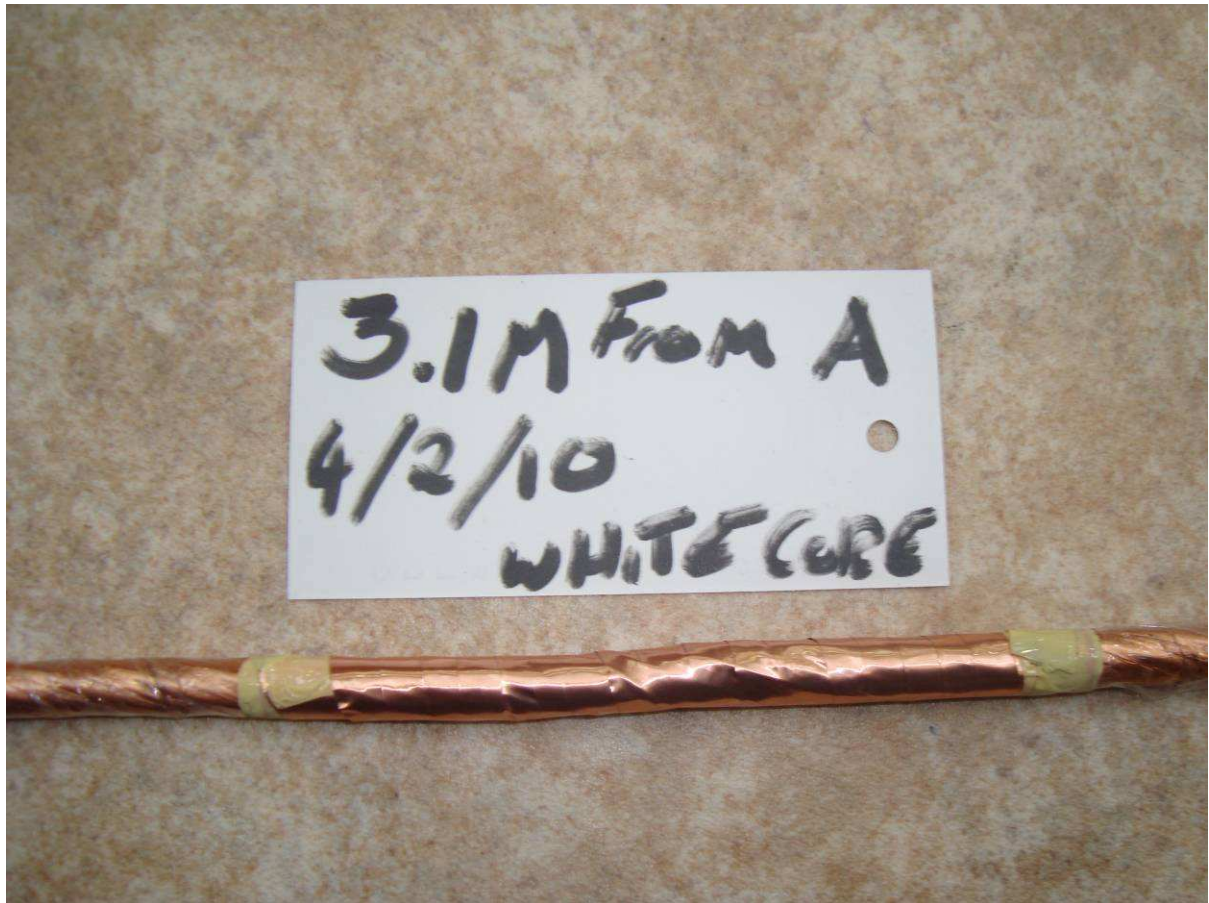
Photograph C



Photograph D



Photograph E



Photograph F

APPENDIX F

Electrical Tests – after faults have been repaired

High Voltage Test

4mm² Power Cores – 19.2 kV DC core to core & core to screen, held for 5 minutes

Red	PASS/FAIL
Blue	PASS/FAIL (fault not found at this stage so no repair made)
Green	PASS/FAIL
White	PASS/FAIL (tape repair not capable of withstanding the test voltage)
Yellow	PASS/FAIL

Insulation Resistance Test @ 500V DC – after 1 minute

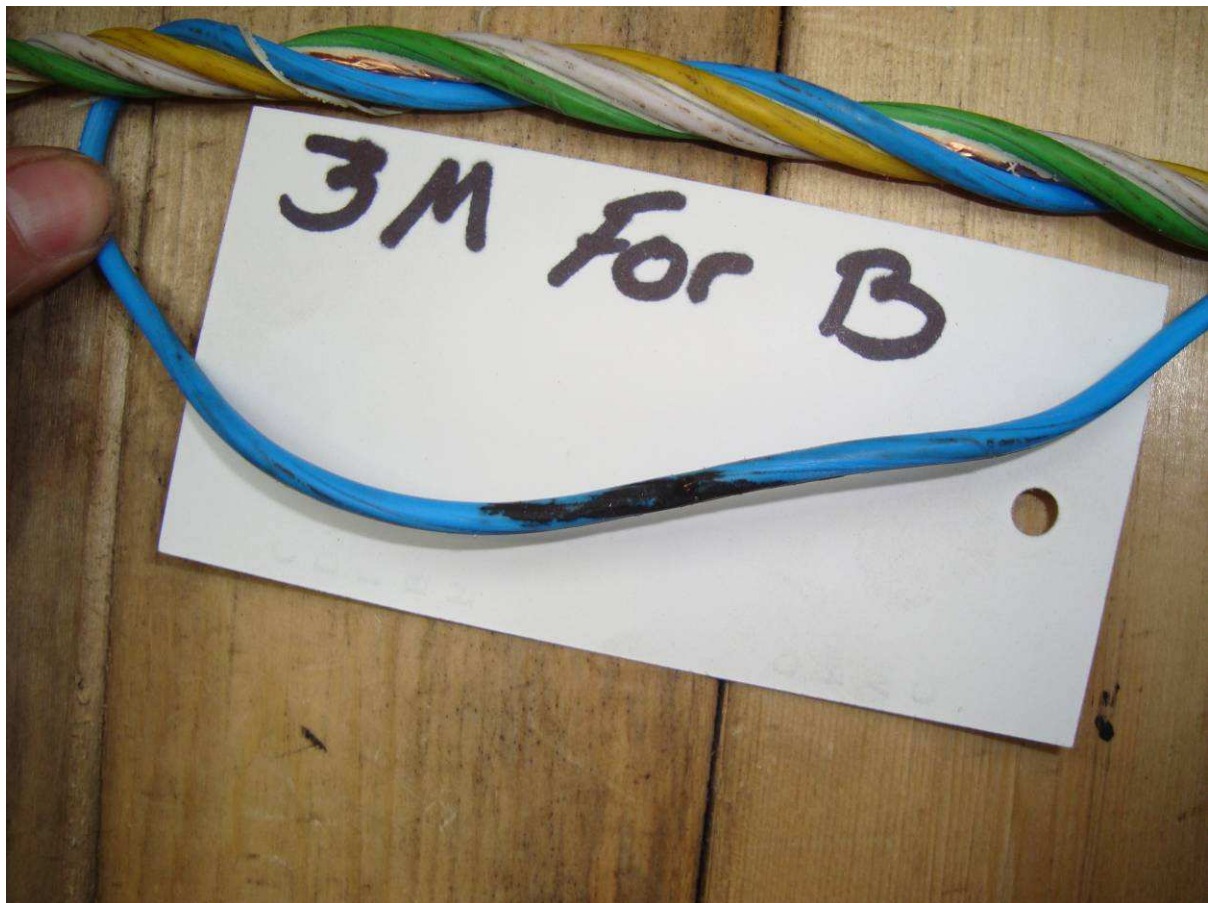
4mm² Power Cores

	Red	Blue	Green	White	Yellow	Screen
Red		100GΩ	100GΩ	100GΩ	100GΩ	50GΩ
Blue			100GΩ	100GΩ	100GΩ	Fail
Green				100GΩ	100GΩ	50GΩ
White					100GΩ	50GΩ
Yellow						50GΩ

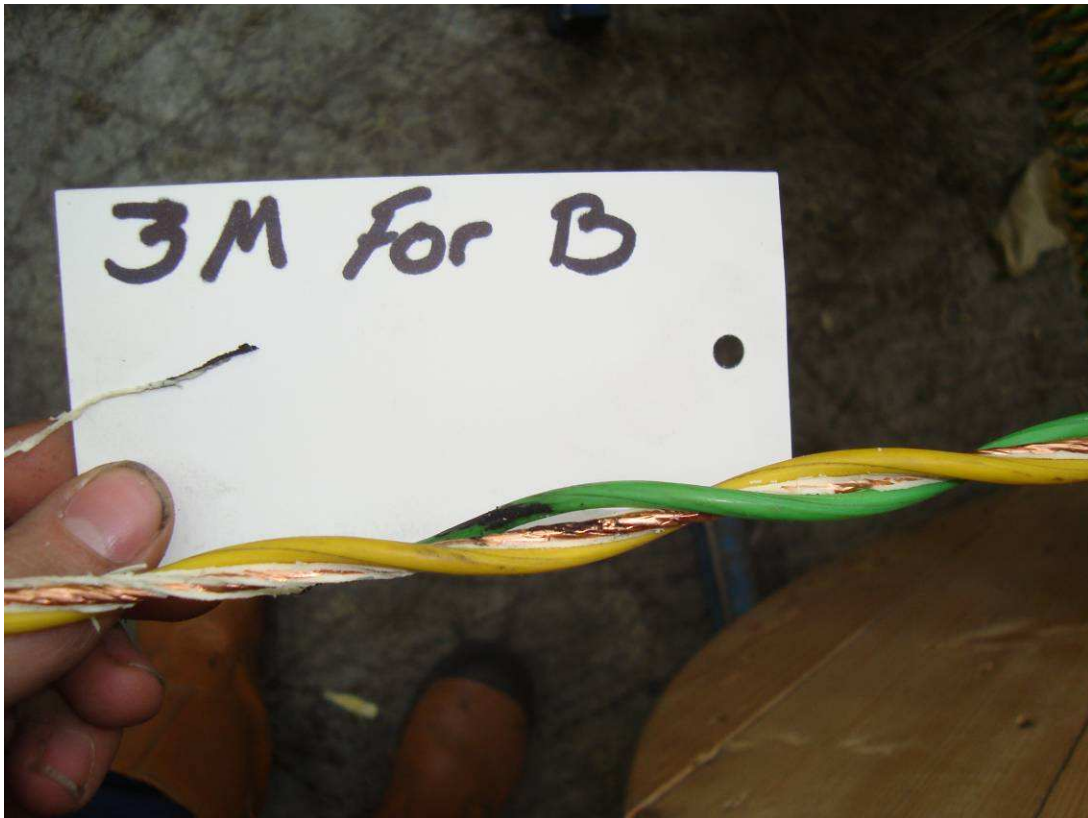
APPENDIX G

Visual Inspection Observations – ROV umbilical assembly with outer tapes removed

Observation	Location	Photograph Reference
Fault in blue core exposed.	3.0m from end B	Photograph G
Scorch mark on green core caused by blue core fault.	3.0m from end B	Photograph H
Close up of blue core fault.	3.0m from end B	Photograph I



Photograph G



Photograph H



Photograph I

APPENDIX H

Electrical Tests – Power cores immersed in water

High Voltage Test

4mm² Power Cores – 19.2 kV DC core to water, held for 5 minutes

Red	PASS/FAIL
Blue	PASS/FAIL (with heat shrink placed over fault)
Green	PASS/FAIL
White	PASS/FAIL (with heat shrink placed over fault)
Yellow	PASS/FAIL

Insulation Resistance Test @ 500V DC – after 1 minute

4mm² Power Cores

	Water
Red	>50 GΩ
Blue	>50 GΩ
Green	>50 GΩ
White	>50 GΩ
Yellow	>50 GΩ

APPENDIX I

Visual Inspection Observations – Fault locations on Blue and White cores after removal of insulation

Observation	Location	Photograph Reference
Close up photograph of fault in white core.	3.1m from end A	Photograph J
Close up photograph of fault in blue core.	3.0m from end B	Photograph K
Close up scorch mark on green core caused by blue core fault.	3.0m from end B	Photograph L
Photograph of fault in white core with insulation removed.	3.1m from end A	Photograph M
Close up photograph of fault in white core with insulation removed.	3.1m from end A	Photograph N
Photograph of fault in blue core with insulation removed.	3.0m from end B	Photograph O
Close up photograph of fault in blue core with insulation removed.	3.0m from end B	Photograph P



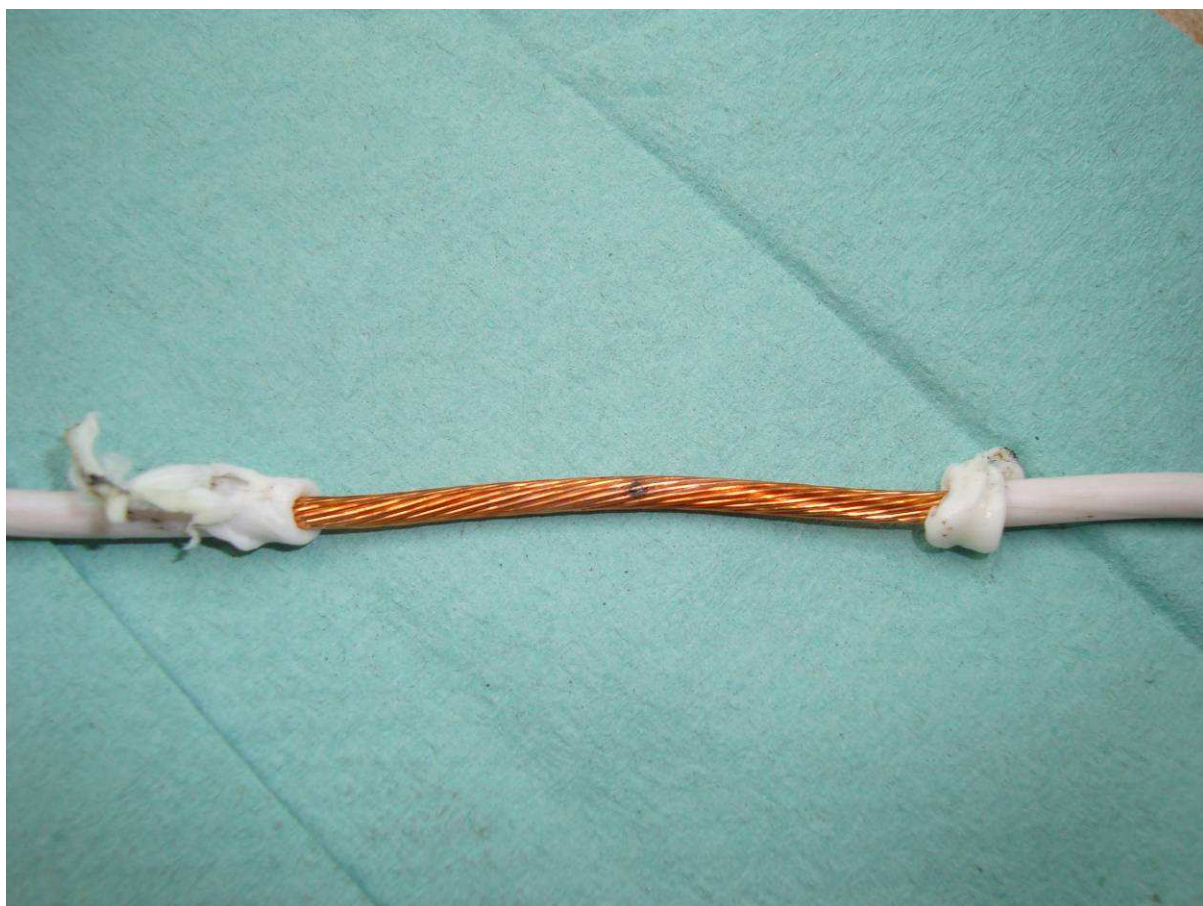
Photograph J



Photograph K



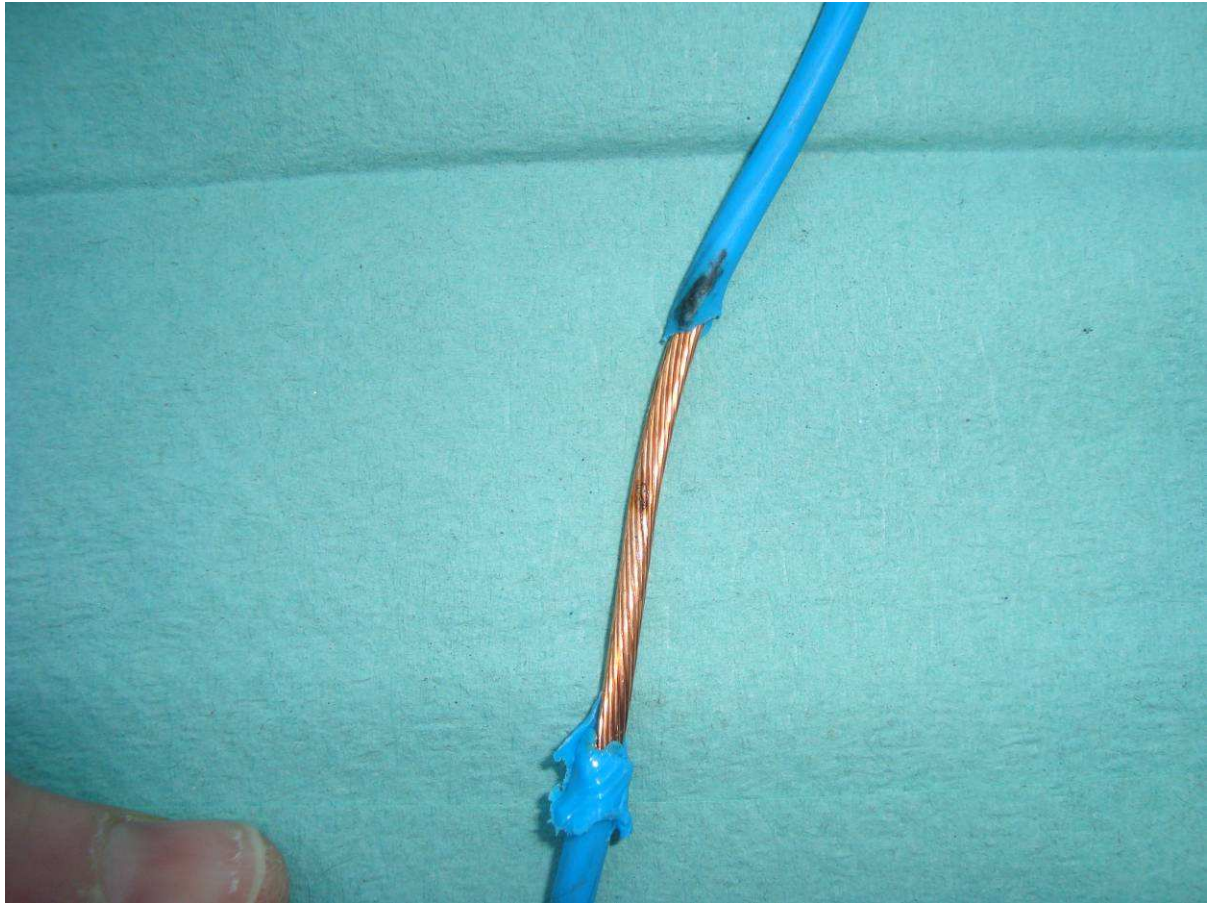
Photograph L



Photograph M



Photograph N



Photograph O



Photograph P