

DOCUMENTATION FRONT SHEET					
Cortland Fibron BX Ltd.	Document Category	CFBX Order no:	Total Pages	Document Number	
	Test Report			TR8695	
01	08/09/08	Client comments incorporated	DRS		
00	10/07/08	As Built.	SM ^c Q		
Rev	Date	Reason for issue	Prepared	Checked	Approved

SMD Hydrovision.
PO55156

RM0011 R.O.V. Umbilical.

Test Report.
CFBX WO8695

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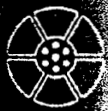
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1. TESTS CARRIED OUT ON DELIVERED PRODUCT

1.1 ELECTRICAL TESTS

1.1.1 FAT ELECTRICAL TESTS



Cortland
FIBRON BX

INTERNAL TEST RECORD SHEET ELECTRICAL

WORKS ORDER NO: 8695

CUSTOMER: Smd

DATE: 2/12/07

LENGTH: 5000m

PART. NO: RM0011

LENGTH:

CERT NO: 6140

TESTED BY: JS

EQUIPMENT SERIAL NOS: *Sublet to R425513*
HMS20-001080

ITEM	COL.	CONDUCTOR RESISTANCE		INSULATION RESISTANCE @ 5kV / kV _{dc}					
		SPEC. (Ω)	ACTUAL (Ω)	CORE / CORE		CORE / SCREEN		SCREEN / SCREEN	
0.22mm 87	red blue yellow white	440	407 20033		> 2g		> 1g		
40mm x4	red	24	21.5		> 2g		> 1g		
//	blue	"	21.5		> 2g		> 1g		
//	green	"	21.3		> 2g		> 1g		
//	white	"	21.3		> 2g		> 1g		
Screen 14	yellow	"	21.3		> 2g		> 1g		
Screen	/		21.2						

TEST ENGINEERS COMMENTS:

1.2 FIBRE-OPTIC TESTS

1.2.1 TESTS CARRIED OUT PRIOR TO CABLE ASSEMBLY

9380

Optical Characteristics Test Results Fiber Optic Cable

Page 1 of 1

Customer: AFL TELECOMMUNICATIONS EUROPE

Job Number: 919180

AFL Reel #: 919180-00

PO Number: 62325

End Cust PO: WO4093/PO9380

Item Code: DNS-0585

Cust Reel #:

Order/Line: 1208947-6

Fiber Specs: Fiber Type

Wave Length Maximum Attn

MM 50

1300

1.20

850

3.50

FutureGuide SR15E

1310

0.50

1550

0.30

Fiber Number	Fiber Type	IOR		Unit Seq	Unit	Fiber Seq	Fiber Color	Test Results (dB/km)	
		1310	1550					1310	1550
1	FutureGuide SR15E	1.4680	1.4686	10	NO PRINT	10	RED	0.34	0.19
Average Attenuation:								0.34	0.19
		850	1300					850	1300
2	MM 50	1.4810	1.4760	10	NO PRINT	10	BLACK	2.69	0.58
Average Attenuation:								2.69	0.58

Customer Request Length

5,700 M

18,701 Ft

Actual Ship Length

5,700 M

18,701 Ft

OTDR Length

5,833 M

19,137 Ft

Certified by:


 Quality Control Manager

Test Date: 8/8/2007

Optical Characteristics Test Results Fiber Optic Cable

Page 1 of 1

Customer: AFL TELECOMMUNICATIONS EUROPE

Job Number: 905609

AFL Reel #: 905609-00

PO Number: 62325

End Cust PO: WO4093/PO9380

Item Code: DNS-0556

Cust Reel #:

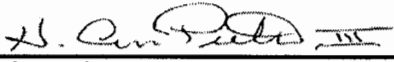
Order/Line: 1208947-1

Fiber Specs: Fiber Type	Wave Length	Maximum Attn
FutureGuide SR15E	1310	0.50
	1550	0.30

Fiber Number	Fiber Type	IOR		Unit Seq	Unit	Fiber Seq	Fiber Color	Test Results (dB/km)	
		1310	1550					1310	1550
1	FutureGuide SR15E	1.4680	1.4686	1	NO PRINT	10	BLUE	0.35	0.21
Average Attenuation:								0.35	0.21

Customer Request Length	5,700 M	18,701 Ft	Actual Ship Length	5,700 M	18,701 Ft
OTDR Length	5,700 M	18,701 Ft			

Certified by:


Quality Control Manager

Test Date: 7/23/2007

Optical Characteristics Test Results Fiber Optic Cable

Page 1 of 1

Customer: AFL TELECOMMUNICATIONS EUROPE

Job Number: 910173

AFL Reel #: 910173-00

PO Number: 62325

End Cust PO: WO4093/PO9380

Item Code: DNS-0563

Cust Reel #:

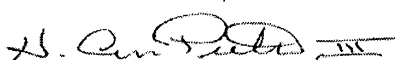
Order/Line: 1208947-3

Fiber Specs: Fiber Type	Wave Length	Maximum Attn
FutureGuide SR15E	1310	0.50
	1550	0.30

Fiber Number	Fiber Type	IOR		Unit Seq	Unit	Fiber Seq	Fiber Color	Test Results (dB/km)	
		1310	1550					1310	1550
1	FutureGuide SR15E	1.4680	1.4686	1	NO PRINT	10	GREEN	0.34	0.22
Average Attenuation:								0.34	0.22

Customer Request Length	5,700 M	18,701 Ft	Actual Ship Length	5,700 M	18,701 Ft
OTDR Length	5,700 M	18,701 Ft			

Certified by:


Quality Control Manager

Test Date: 7/23/2007

Optical Characteristics Test Results Fiber Optic Cable

Page 1 of 1

Customer: AFL TELECOMMUNICATIONS EUROPE
PO Number: 62325
Cust Reel #:

Job Number: 916775
End Cust PO: WO4093/PO9380

AFL Reel #: 916775-00
Item Code: DNS-0564
Order/Line: 1208947-4

Fiber Specs: Fiber Type	Wave Length	Maximum Attn
FutureGuide SR15E	1310	0.50
	1550	0.30

Fiber Number	Fiber Type	IOR	Unit Seq	Unit	Fiber Seq	Fiber Color	Test Results (dB/km)		
		1310	1550				1310	1550	
1	FutureGuide SR15E	1.4680	1.4686	1	NO PRINT	10	WHITE	0.34	0.20
Average Attenuation:							0.34	0.20	

Customer Request Length	5,700 M	18,701 Ft	Actual Ship Length	5,700 M	18,701 Ft
OTDR Length	5,810 M	19,062 Ft			

Certified by:


Quality Control Manager

Test Date: 8/8/2007

Optical Characteristics Test Results Fiber Optic Cable

Page 1 of 1

Customer: AFL TELECOMMUNICATIONS EUROPE

Job Number: 906485

AFL Reel #: 906485-00

PO Number: 62325

End Cust PO: WO4093/PO9380

Item Code: DNS-0565

Cust Reel #:

Order/Line: 1208947-5

Fiber Specs: Fiber Type

Wave Length Maximum Attn

FutureGuide SR15E

1310

0.50

1550

0.30

Fiber Number	Fiber Type	IOR		Unit Seq	Unit	Fiber Seq	Fiber Color	Test Results (dB/km)	
		1310	1550					1310	1550
1	FutureGuide SR15E	1.4680	1.4686	1	NO PRINT	10	YELLOW	0.34	0.19
Average Attenuation:								0.34	0.19

Customer Request Length

5,700 M

18,701 Ft

Actual Ship Length

5,700 M

18,701 Ft

OTDR Length

5,700 M

18,701 Ft

Certified by:


Quality Control Manager

Test Date: 7/23/2007

1.2.2 TESTS CARRIED OUT AT FAT

File

File : fbk.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:21:35 Module : 5026VHD Num. 2739

Configuration

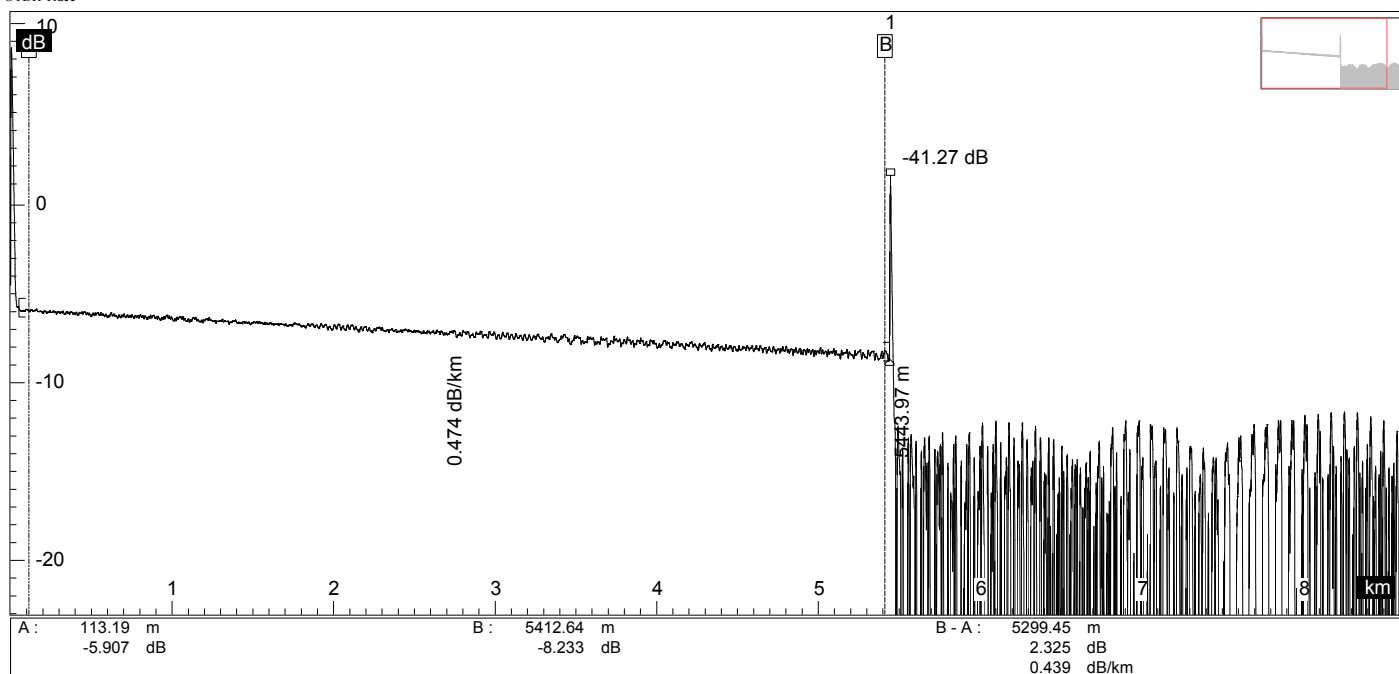
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	No
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	BLACK	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	BLACK	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - BLACK FIBRE 1310nm

Job

OTDR Trace



File

File : fbk.wtk Device : MTS 5100 Num. 2437
 Date : 21/12/2007 16:21:35 Module : 5026VHD Num. 2739

Table

	Event (2)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		5443.97		-41.27	0.474	5443.97	2.548	
2				33.52				

File

File : fbkx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:23:10 Module : 5026VHD Num. 2739

Configuration

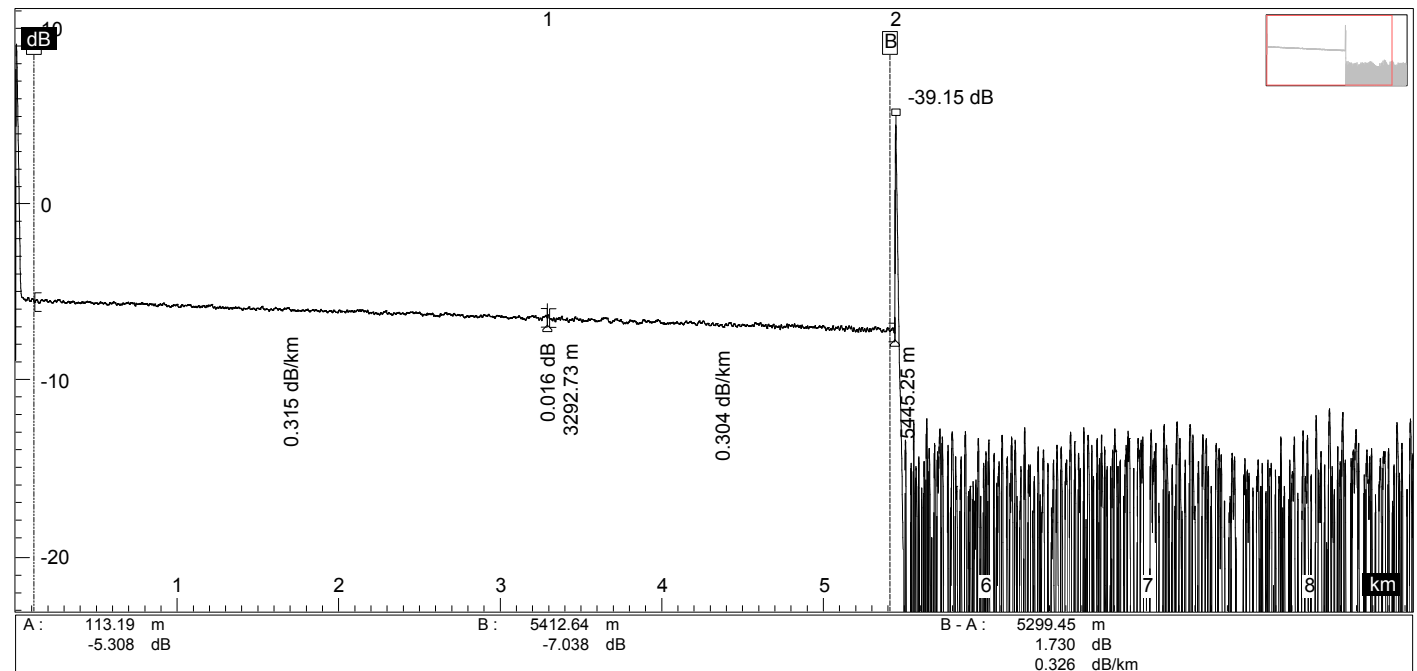
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	BLACK	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	BLACK	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - BLACK FIBRE 1550nm

Job

OTDR Trace



File

File : fbkx.wtk Device : MTS 5100 Num. 2437
 Date : 21/12/2007 16:23:10 Module : 5026VHD Num. 2739

Table

	Event (3)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		3292.73	0.016		0.315	3292.73	1.025	
2		5445.25		-39.15	0.304	2152.52	1.709	
3				34.80				

File

File : fb.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:31:14 Module : 5026VHD Num. 2739

Configuration

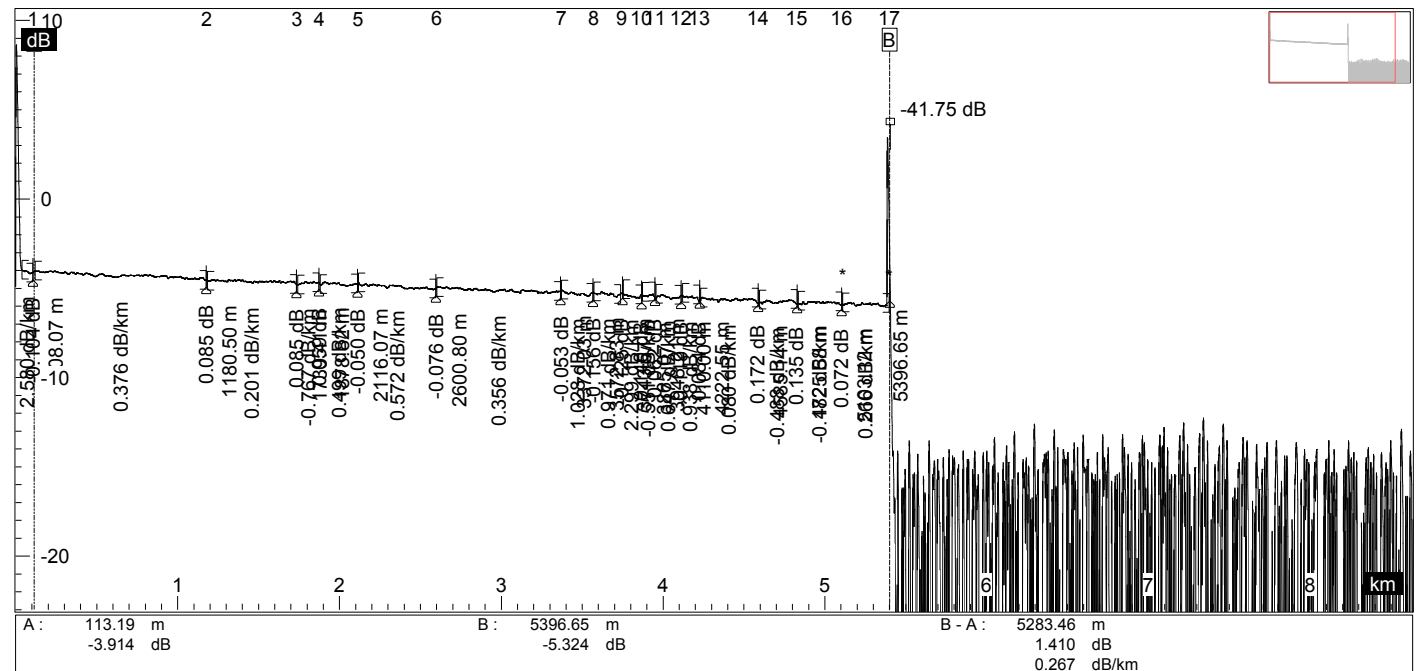
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	BLUE	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	BLUE	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - BLUE FIBRE 0 1310nm

Job

OTDR Trace



File

File : fb.wtk Device : MTS 5100 Num. 2437
 Date : 21/12/2007 16:31:14 Module : 5026VHD Num. 2739

Table

	Event (18)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		108.07	-0.104		2.580	108.07	0.220	
2		1180.50	0.085		0.376	1072.42	0.583	
3		1739.41	0.085		0.201	558.91	0.753	
4		1878.82	0.059		-0.767	139.41	0.770	
5		2116.07	-0.050		0.499	237.25	0.860	
6		2600.80	-0.076		0.572	484.73	1.157	
7		3372.03	-0.053		0.356	771.22	1.321	
8		3572.83	-0.156		1.028	200.80	1.414	
9		3743.57	-0.125		0.971	170.74	1.474	
10		3865.07	-0.140		2.299	121.50	1.650	
11		3948.21	0.062		-0.551	83.13	1.436	
12		4110.00	-0.119		0.647	161.79	1.631	
13		4222.55	0.084		0.938	112.55	1.613	
14		4585.14	0.172		0.080	362.59	1.736	
15		4825.58	0.135		-0.488	240.45	1.810	
16		5103.12	0.072		-0.172	277.54	1.942	
17		5396.65		-41.75	0.266	293.53	2.068	
18				33.57				

File

File : fbx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:32:36 Module : 5026VHD Num. 2739

Configuration

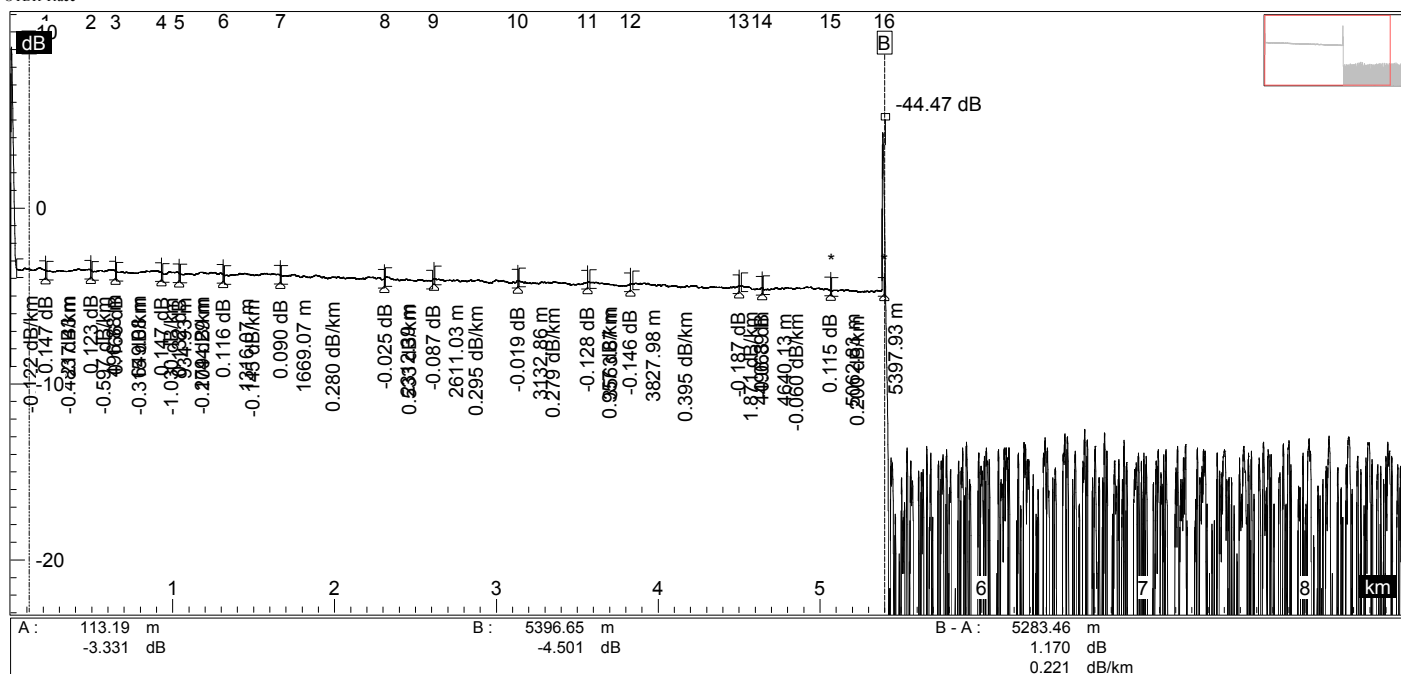
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	BLUE	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	BLUE	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - BLUE FIBRE 1550nm

Job

OTDR Trace



File

File : fbx.wtk Device : MTS 5100 Num. 2437
 Date : 21/12/2007 16:32:36 Module : 5026VHD Num. 2739

Table

	Event (17)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		217.43	0.147		-0.122	217.43	0.003	
2		496.88	0.123		-0.483	279.46		
3		649.08	0.166		-0.597	152.20	0.031	
4		934.93	0.147		-0.315	285.85	0.103	
5		1044.29	0.132		-1.030	109.35	0.160	
6		1316.07	0.116		-0.279	271.78	0.212	
7		1669.07	0.090		-0.145	353.00	0.265	
8		2312.39	-0.025		0.280	643.33	0.503	
9		2611.03	-0.087		0.533	298.64	0.628	
10		3132.86	-0.019		0.295	521.82	0.745	
11		3563.87	-0.128		0.279	431.02	0.800	
12		3827.98	-0.146		0.957	264.11	0.910	
13		4496.89	-0.187		0.395	668.91	1.025	
14		4640.13	-0.063		1.871	143.25	1.119	
15		5062.83	0.115		-0.060	422.70	1.103	
16		5397.93		-44.47	0.200	335.09	1.194	
17				34.44				

```
File :          fg.wtk          Device :          MTS 5100 Num. 2437
Date :          21/12/2007 16:35:28  Module :          5026VHD Num. 2739
```

Configuration :		Way :		Backscatter coeff.:	
Technic. :	JS	O-->E		-79.00 dB	
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	GREEN	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	GREEN	Resolution :	64 cm		

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - GREEN FIBRE 1310nm

[illegible]

File

File : fg.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:35:28 Module : 5026VHD Num. 2739

Table

	Event (19)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		102.96	0.007		-3.058	102.96		
2		375.38	0.054	-69.81	1.214	272.42	0.030	
3		632.45	0.037		-0.726	257.07		
4		816.63	-0.135		0.911	184.17	0.040	
5		963.71	0.121		0.529	147.08	0.058	
6		1082.02	0.166		-1.091	118.31	0.096	
7		1231.66	0.122		-0.256	149.64	0.214	
8		1550.76	0.151		-0.204	319.11	0.260	
9		1836.61	0.119		-0.338	285.85	0.297	
10		2356.52	0.078		0.244	519.90	0.519	
11		2585.45	0.050		-0.203	228.94	0.577	
12		2866.19	-0.144		0.686	280.74	0.782	
13		3657.88	0.201		0.448	791.69	1.054	
14		4042.21	0.100		-0.406	384.33	1.064	
15		4552.52	0.146		0.249	510.31	1.292	
16		4675.94	0.207		-1.901	123.42	1.200	
17		5131.26	0.082		0.194	455.32	1.513	
18		5403.04			-0.239	271.78	1.532	
19				32.88				

File

File : fgx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:36:16 Module : 5026VHD Num. 2739

Configuration

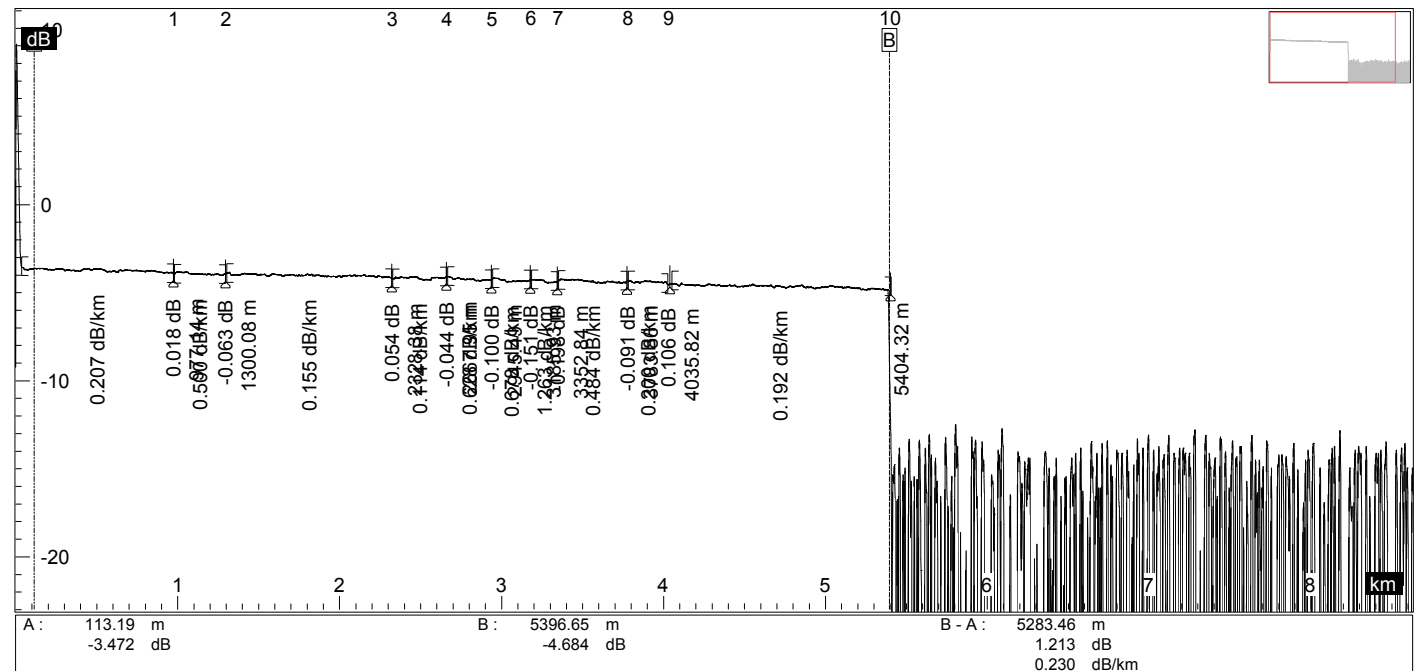
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	GREEN	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	GREEN	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - GREEN FIBRE 0 1550nm

Job

OTDR Trace



File

File : fgx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:36:16 Module : 5026VHD Num. 2739

Table

	Event (11)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		977.14	0.018		0.207	977.14	0.244	
2		1300.08	-0.063		0.500	322.94	0.371	
3		2328.38	0.054		0.155	1028.30	0.495	
4		2667.95	-0.044		0.114	339.57	0.538	
5		2945.49	-0.100		0.628	277.54	0.659	
6		3185.93	-0.151		0.678	240.45	0.717	
7		3352.84	-0.198		1.263	166.91	0.774	
8		3783.86	-0.091		0.484	431.02	0.817	
9		4035.82	0.106		0.200	251.96	0.802	
10		5404.32			0.192	1368.51	1.197	
11				34.99				

File

File : fr.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:16:38 Module : 5026VHD Num. 2739

Configuration

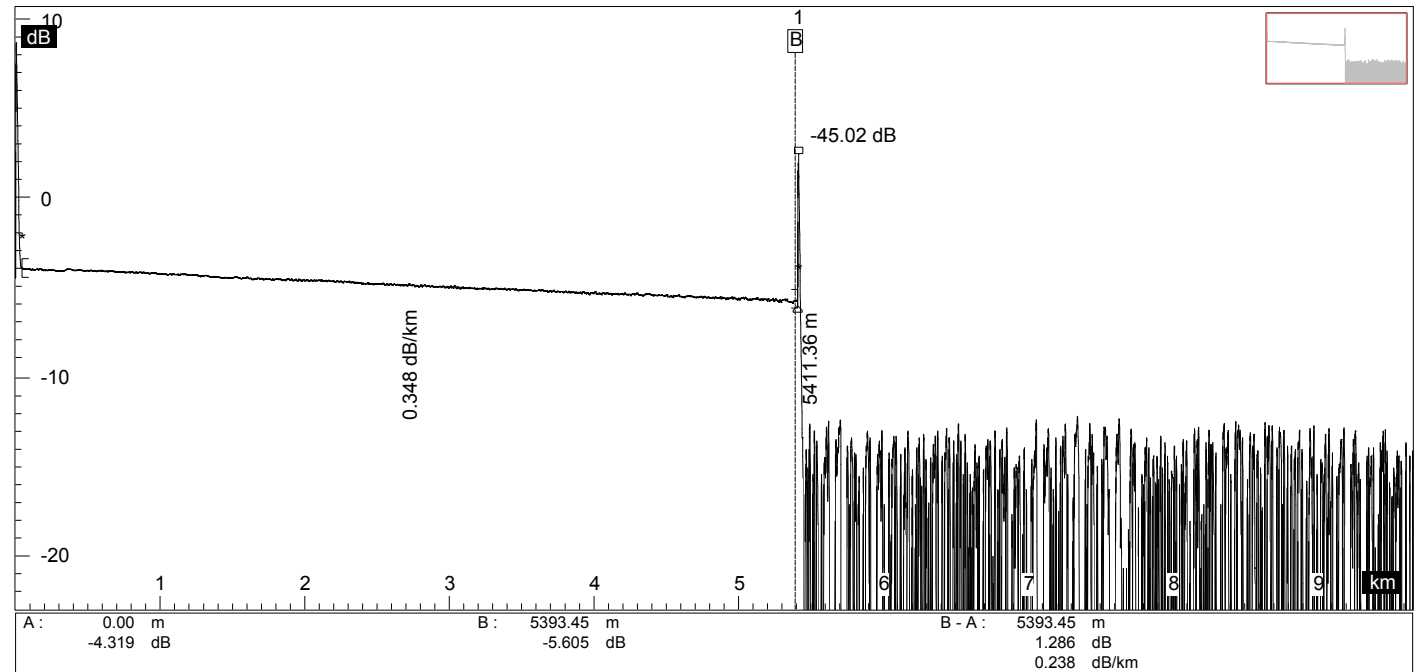
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	RED	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	RED	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - RED FIBRE 1310nm

Job

OTDR Trace



File

File : fr.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:16:38 Module : 5026VHD Num. 2739

Table

	Event (2)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		5411.36		-45.02	0.348	5411.36	1.885	
2				33.27				

File

File : frx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:17:35 Module : 5026VHD Num. 2739

Configuration

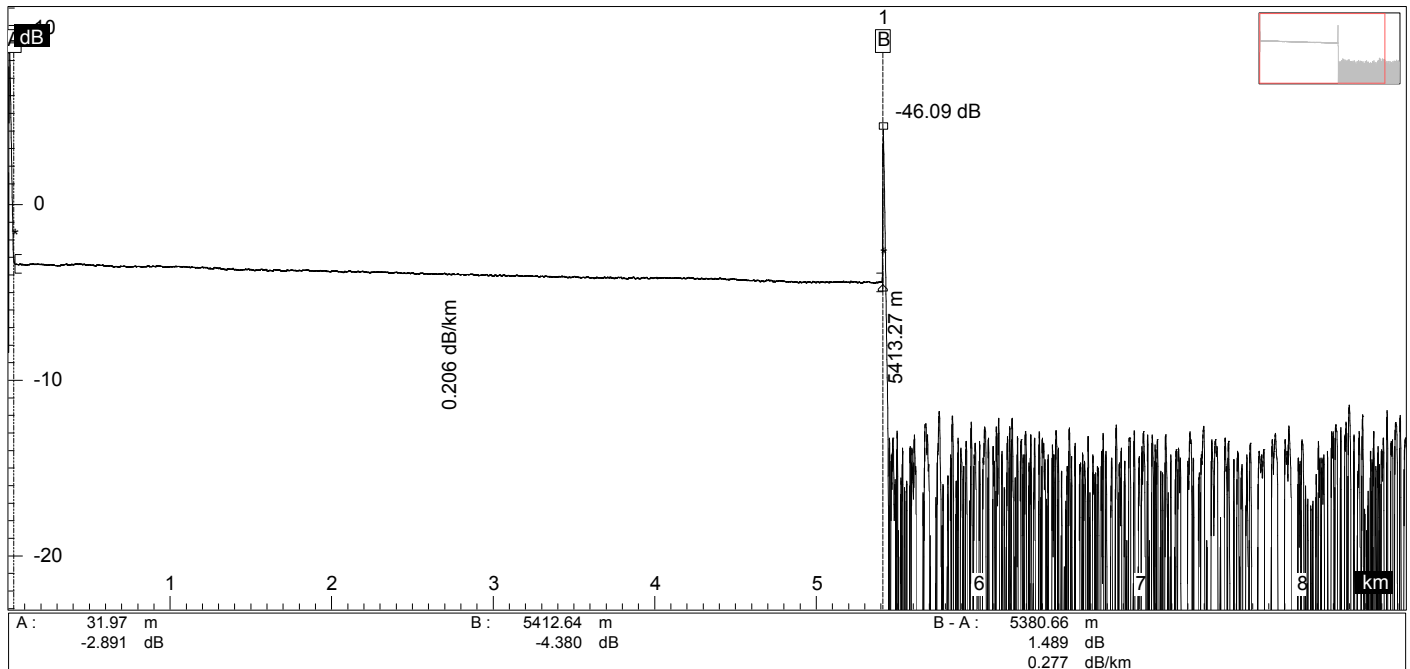
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	RED	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	RED	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - RED FIBRE 1550nm

Job

OTDR Trace



File

File : frx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:17:35 Module : 5026VHD Num. 2739

Table

	Event (2)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		5413.27		-46.09	0.206	5413.27	1.069	
2				34.54				

File

File : fw.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:26:34 Module : 5026VHD Num. 2739

Configuration

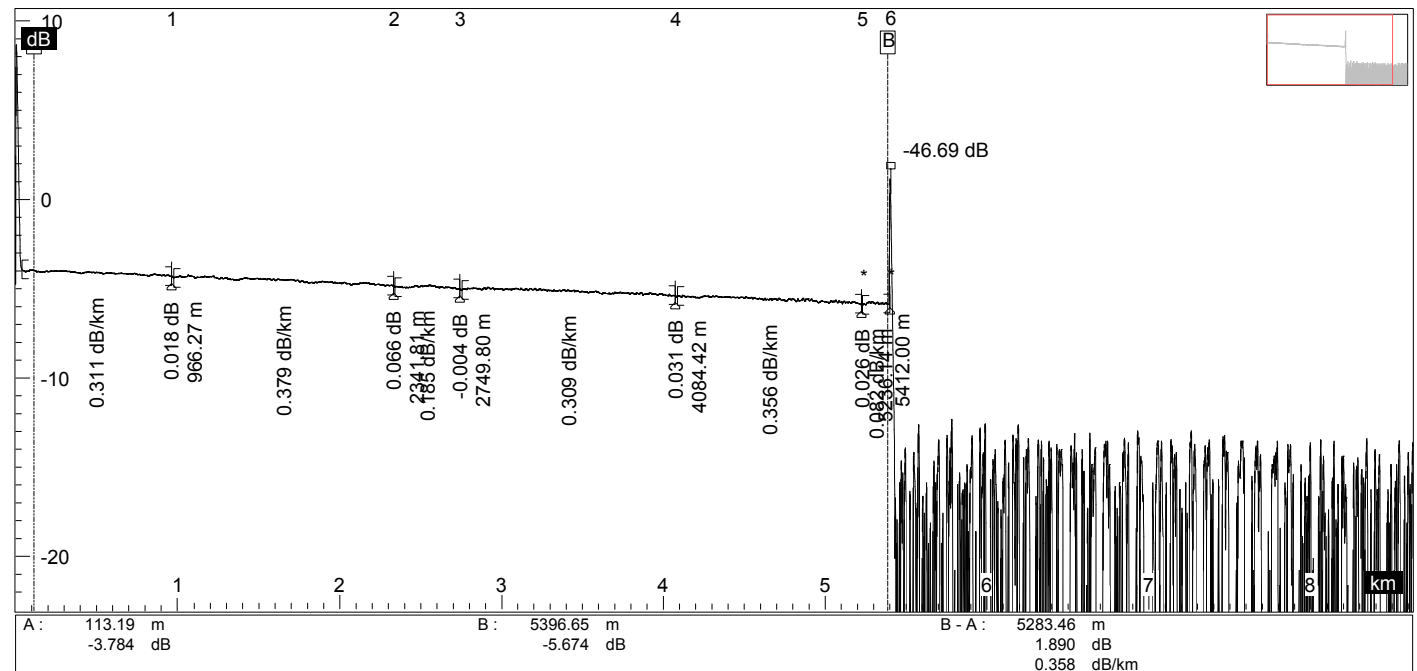
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	WHITE	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	WHITE	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - WHITE FIBRE 1310nm

Job

OTDR Trace



File

File : fw.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:26:34 Module : 5026VHD Num. 2739

Table

	Event (7)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		966.27	0.018		0.311	966.27	0.308	
2		2341.81	0.066		0.379	1375.54	0.857	
3		2749.80	-0.004		0.185	407.99	1.040	
4		4084.42	0.031		0.309	1334.61	1.410	
5		5236.14	0.026		0.356	1151.72	1.850	
6		5412.00		-46.69	0.082	175.86	1.903	
7				33.21				

File

File : fwx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:27:28 Module : 5026VHD Num. 2739

Configuration

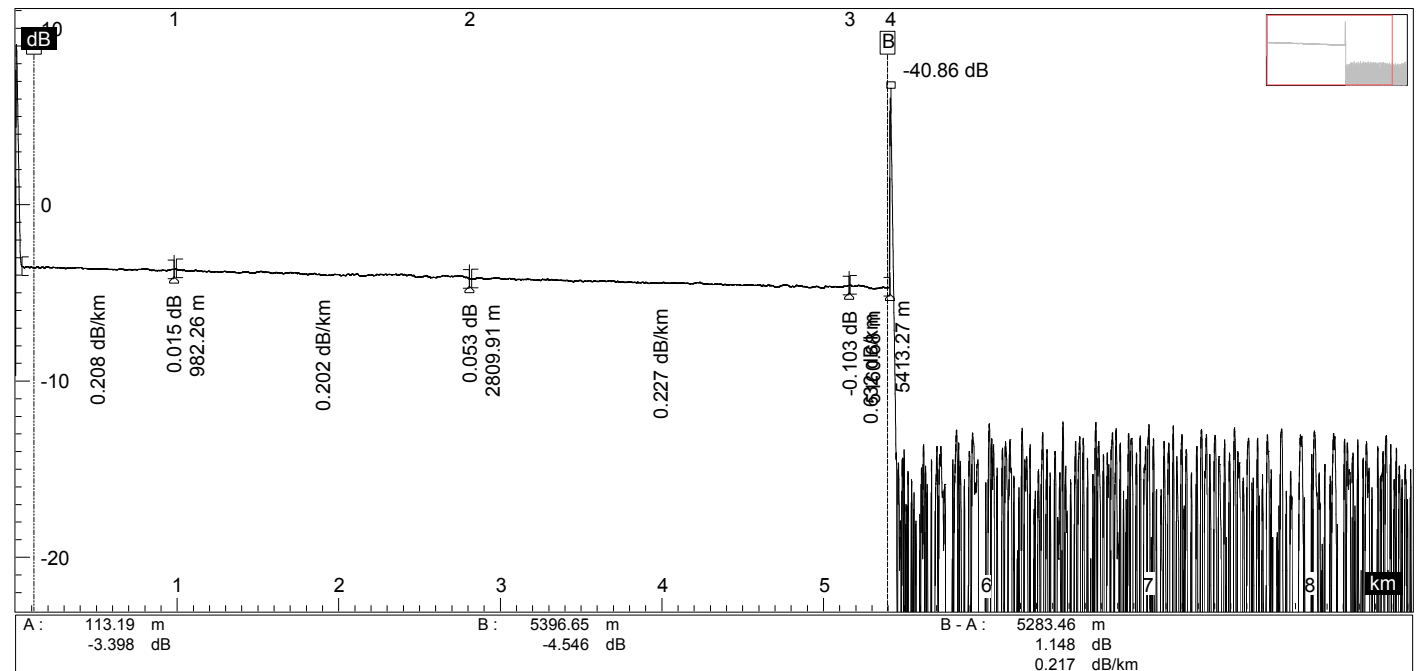
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	WHITE	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	WHITE	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - WHITE FIBRE 1550nm

Job

OTDR Trace



File

File : fwx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:27:28 Module : 5026VHD Num. 2739

Table

	Event (5)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		982.26	0.015		0.208	982.26	0.194	
2		2809.91	0.053		0.202	1827.66	0.561	
3		5160.68	-0.103		0.227	2350.76	1.146	
4		5413.27		-40.86	0.632	252.60	1.189	
5				34.24				

File

File : fy.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:07:35 Module : 5026VHD Num. 2739

Configuration

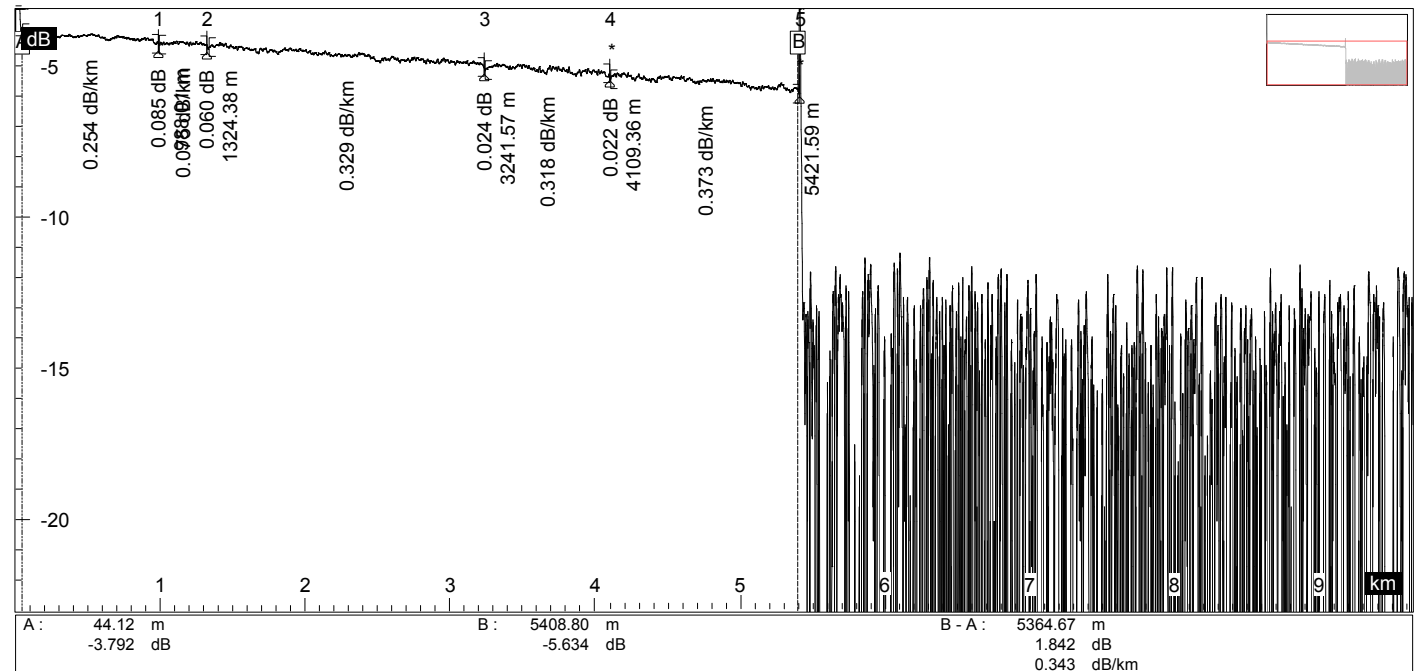
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-79.00 dB
ORIGIN		Origin :		Event detection threshold	No
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1316	Slopes :	0.000 dB/km
Color :	YELLOW	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	YELLOW	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - YELLOW FIBRE 1310nm

Job

OTDR Trace



File

File : fy.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:07:35 Module : 5026VHD Num. 2739

Table

	Event (6)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		988.01	0.085		0.254	988.01	0.279	
2		1324.38	0.060		0.075	336.37	0.399	
3		3241.57	0.024		0.329	1917.19	1.042	
4		4109.36	0.022		0.318	867.79	1.373	
5		5421.59		-53.65	0.373	1312.23	1.881	
6				33.12				

File

File : fyx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:12:31 Module : 5026VHD Num. 2739

Configuration

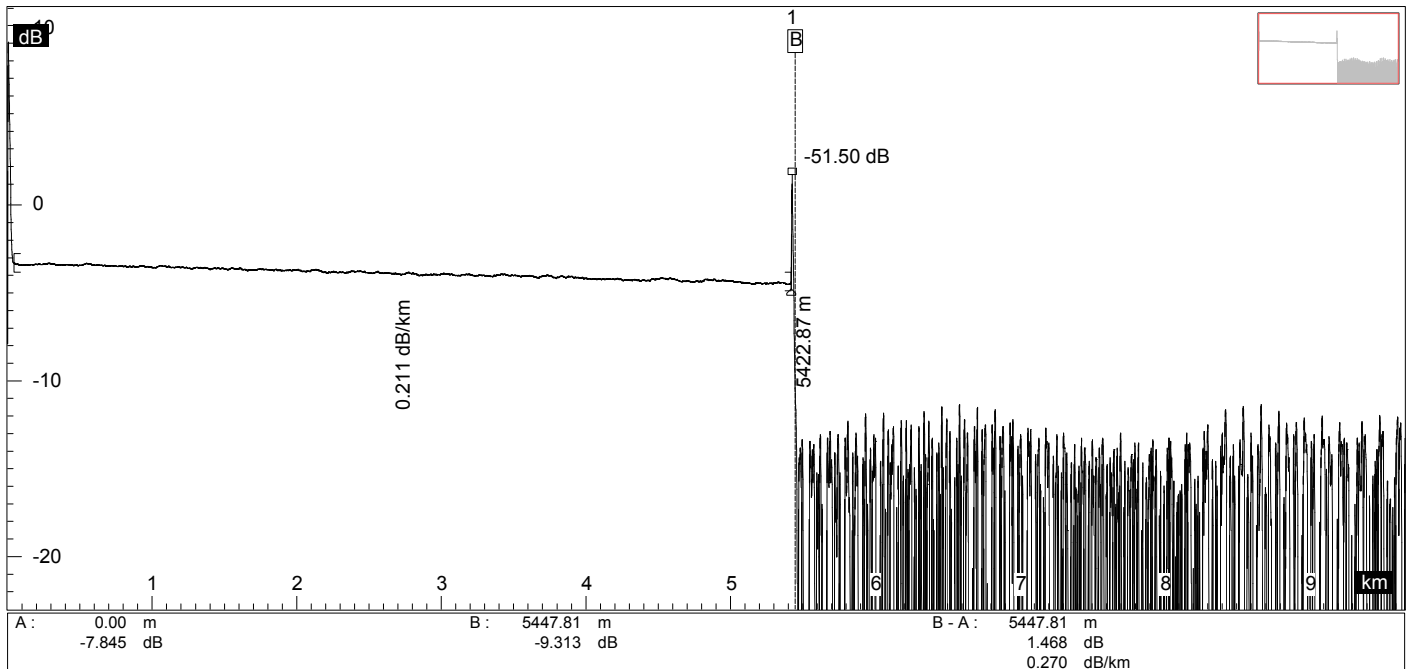
Technic. :	JS	Way :	O-->E	Backscatter coeff.:	-81.00 dB
ORIGIN		Origin :		Event detection threshold	
Cable :	RM0011	End :		Splices :	No
Fiber :	1	Wavelength (nm) :	1536	Slopes :	0.000 dB/km
Color :	YELLOW	Index :	1.465000	Reflectances :	All
END		Pulse (ns) :	10	Alarm threshold	
Cable :	RM0011	Range (km) :	10.000		
Fiber :	1	Acq. time :	10s		
Color :	YELLOW	Resolution :	64 cm		

Comment

Comment : 8695 SMD - RM0011 - FAT 5000 MTRS - YELLOW FIBRE 1550nm

Job

OTDR Trace



File

File : fyx.wtk Device : MTS 5100 Num. 2437
Date : 21/12/2007 16:12:31 Module : 5026VHD Num. 2739

Table

	Event (2)	Distance (m)	Loss (dB)	Reflectance (dB)	Slope (dB/km)	Rel. Dist. (m)	Total loss (dB)	Uncertainty
1		5422.87		-51.50	0.211	5422.87	1.157	
2				34.84				

2. TESTS CARRIED OUT ON SAMPLES

2.1 FIBRE OPTIC TESTS

2.1.1 FIBRE OPTIC HYDROSTATIC TESTS

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA RD. 78238-5166 • P.O. DRAWER 28510 78228-0510 • SAN ANTONIO, TEXAS, USA • (210) 684-5111 • WWW.SWRI.ORG

Mechanical & Materials Engineering Division
October 10, 2007

Mr. Brian Herbst
AFL Telecommunications
150 Ridgeview Circle
Duncan, SC 29334

Subject: "External Hydrostatic Pressure Tests of Fiber Optic Tube Assembly"

Reference: Southwest Research Institute (SwRI®) Project No. 18.18072.01.348
AFL Telecommunications Purchase Order No. 147664

Dear Mr. Herbst:

This letter is to document the external hydrostatic pressure testing conducted at Southwest Research Institute on an AFL Telecommunications singlemode optical fiber that was clad in a stainless steel tube. The fiber optic cable, which was spun onto a spool for the tests, consisted of approximately 1.5 km of 1.17 mm, 304 stainless steel tube with two optical fibers inside the steel tubing. The tests were performed on September 27, 2007.

The external hydrostatic pressure testing was performed in SwRI's 30-inch I.D., 10,000 psig test chamber using fresh water at ambient temperature as the test medium. A Hardy Instruments Model HI2151WC digital pressure indicator and a Dynisco Model G831-300-15M pressure transducer were used to monitor the test chamber pressure. Prior to testing, all pressure measuring instrumentation was calibrated on a SI Barnet dead weight tester which has calibrations traceable to the National Institute of Standards and Technology (NIST). A Soltec Model 1243 chart recorder was used to produce a permanent record of the test pressure versus time. A copy of the recording is enclosed with this report.

Prior to performing the pressure tests, the fiber optic cables were molded onto an SwRI fabricated high-pressure penetrator (Figure 1). The cable penetrator was used for the purpose of penetrating the optical fibers through the test chamber lid and facilitate the performance of optical measurements on the cable assembly while at test depth. The tubing was not penetrated through the lid and was left open along with the opposite end of the fiber/tube assembly to the test chamber water. Once the molded feed-thru was installed, the assembly was secured in the test chamber and made ready for testing (Figures 2 and 3).

The test consisted of subjecting the spool of optical fiber/tube to one (1) external hydrostatic pressure cycle to 6,000 +10/-0 psig. This maximum test pressure was maintained for a period of six (6) hours. Attenuation measurements were performed at each 1,000 psig increment during pressurization, at 1-hour intervals during the six-hour hold period at test pressure, and at 1,000 psig decrements during depressurization.



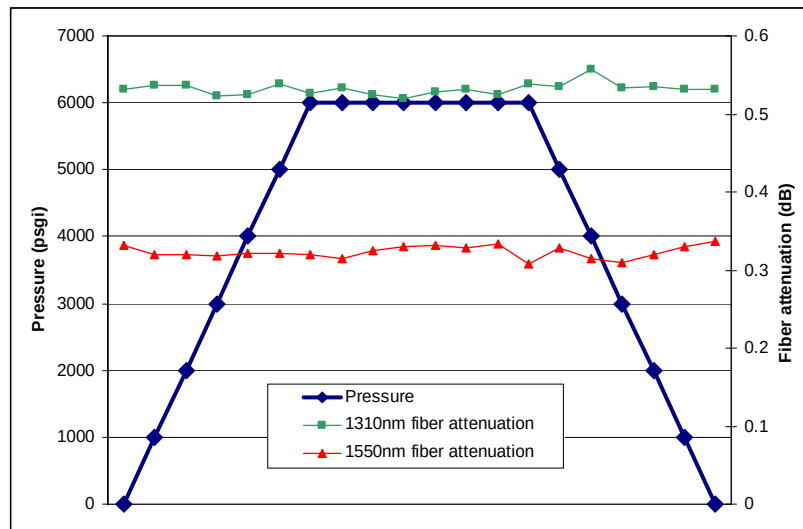
DETROIT, MICHIGAN (248) 353-2550 • HOUSTON, TEXAS (713) 977-1377 • WASHINGTON, DC (301) 881-0226

The pressurization and depressurization rates for the tests were approximately 100 psig per minute in accordance with AFL test procedures. At the conclusion of the six hour hold period at maximum test pressure, the test pressure in the chamber was reduced to 0 psig.

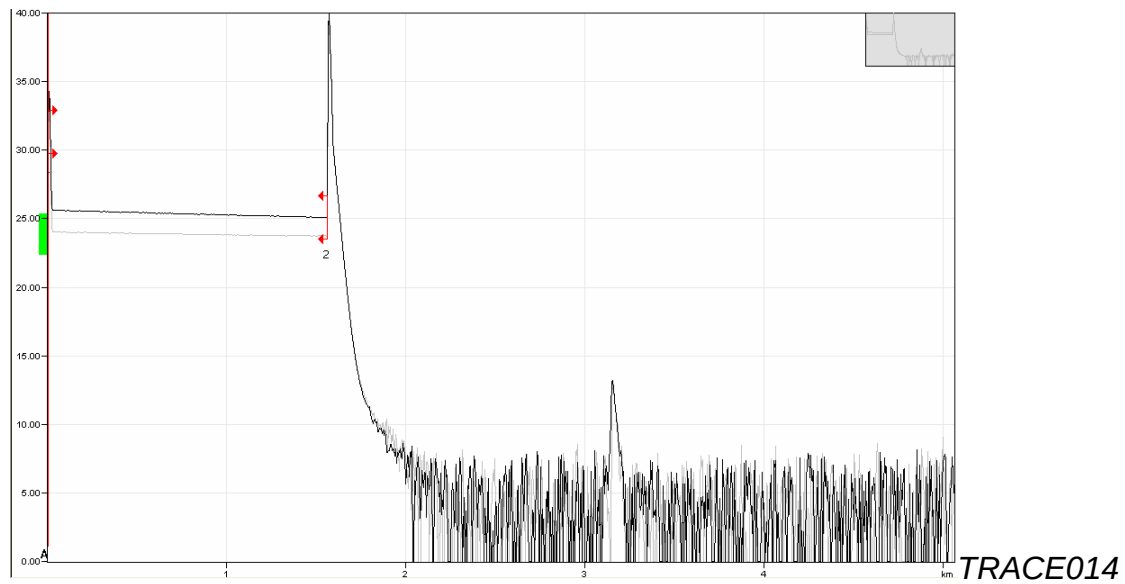
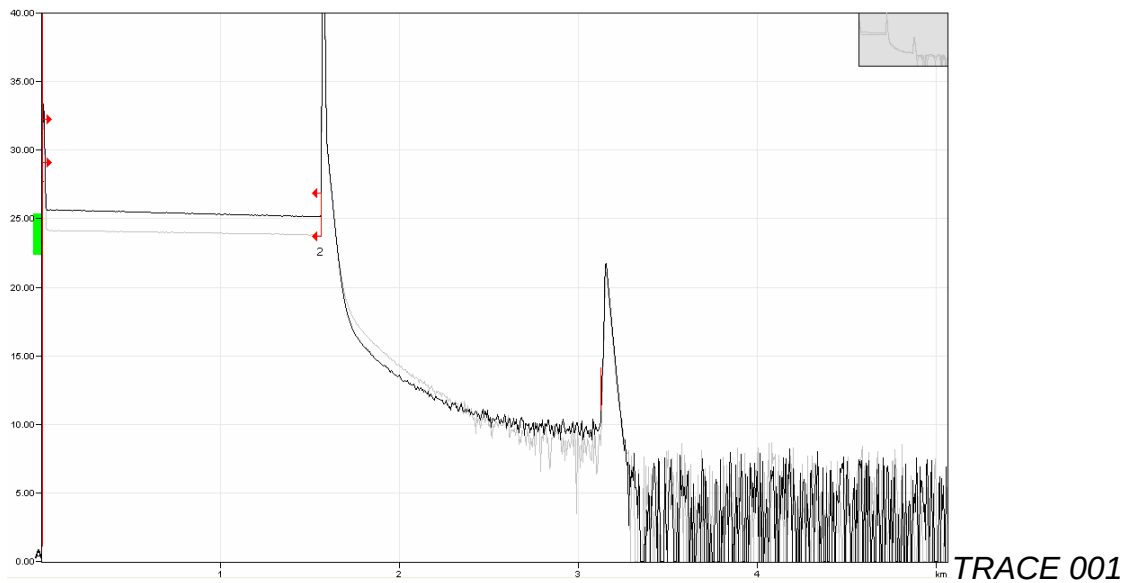
Fiber Optic Pressure Testing Results

The measurements on the optical fiber were conducted using an EXFO Model FTB-100B Optical Time Domain Reflectometer (OTDR). This instrument measures the optical attenuation in an optical fiber, measuring reflections from scattering, bends, breaks or endfaces. It can be used with singlemode or multimode fiber and measures at multiple wavelengths.

The OTDR was connected to an optical fiber, and measurements were recorded. Measurements were recorded at each pressure interval (every 1,000 psig) while the pressure was increased to 6,000 psig, then once per hour while the pressure was maintained for six hours. As pressure in the chamber was decreased, measurements were recorded at every 1,000 psig until the pressure in the test chamber was at 0 psig. The attenuation measurements for the fibers are shown in the graphs included in this report. Page 3 of this report shows two data captures from the OTDR screen showing the loss trace. These traces show the distance along the fiber where an event occurs and the measured loss over a given section. Between points 1 and 2 marked with the red arrows, the loss gradually increases. This is the fiber. Then the spike indicates reflection from the end of the fiber which the instrument measured to be at about 1.56 km. A second spike at exactly twice this distance is simply an echo from the back reflection bouncing back from the first face of the fiber.



Plot of the measured fiber attenuation over time during the pressure testing with the vessel pressure for each measurement shown in the thick blue line.



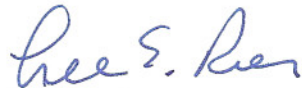
OTDR traces for the optical fiber at 1,310nm (dark line) and 1,550nm (lighter line). The top trace (TRACE 001) is at the starting time with no pressure applied while the bottom trace (TRACE 014) is after six hours at 6,000 psig.

The first OTDR trace was taken before the test began (point 1), and the second trace is from the last measurement at 6,000 psig (point 15). The dark line is 1,310nm, and the lighter line is 1,550nm. As seen from the plot on the previous page, there is very little effect on attenuation of the fibers with the increases in pressure. The observed fluctuations may simply be system noise. No extra loss locations were seen in the OTDR traces.

Mr. Brian Herbst
AFL Telecommunications
SwRI Project Number 18.18072.01.348
October 10, 2007
Page 4

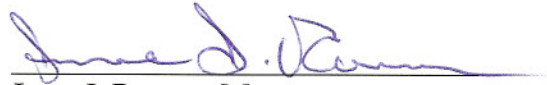
SwRI appreciates the opportunity to provide this testing service and if you have any questions or if we may be of further assistance in the future, please do not hesitate to call.

Sincerely,



Lee E. Ries
Principal Engineering Technologist

Reviewed and Approved by:



Jesse I. Ramon, Manager
Test and Evaluation Section

C:\Documents and Settings\aschutte\My Documents\Ries\18072.348.RPT.doc/as

Enclosures

cc: Record Copy B
A. Schutte

CEHART NO. 0012-01-25-20M

END TEST

6:37 P

10:22 A

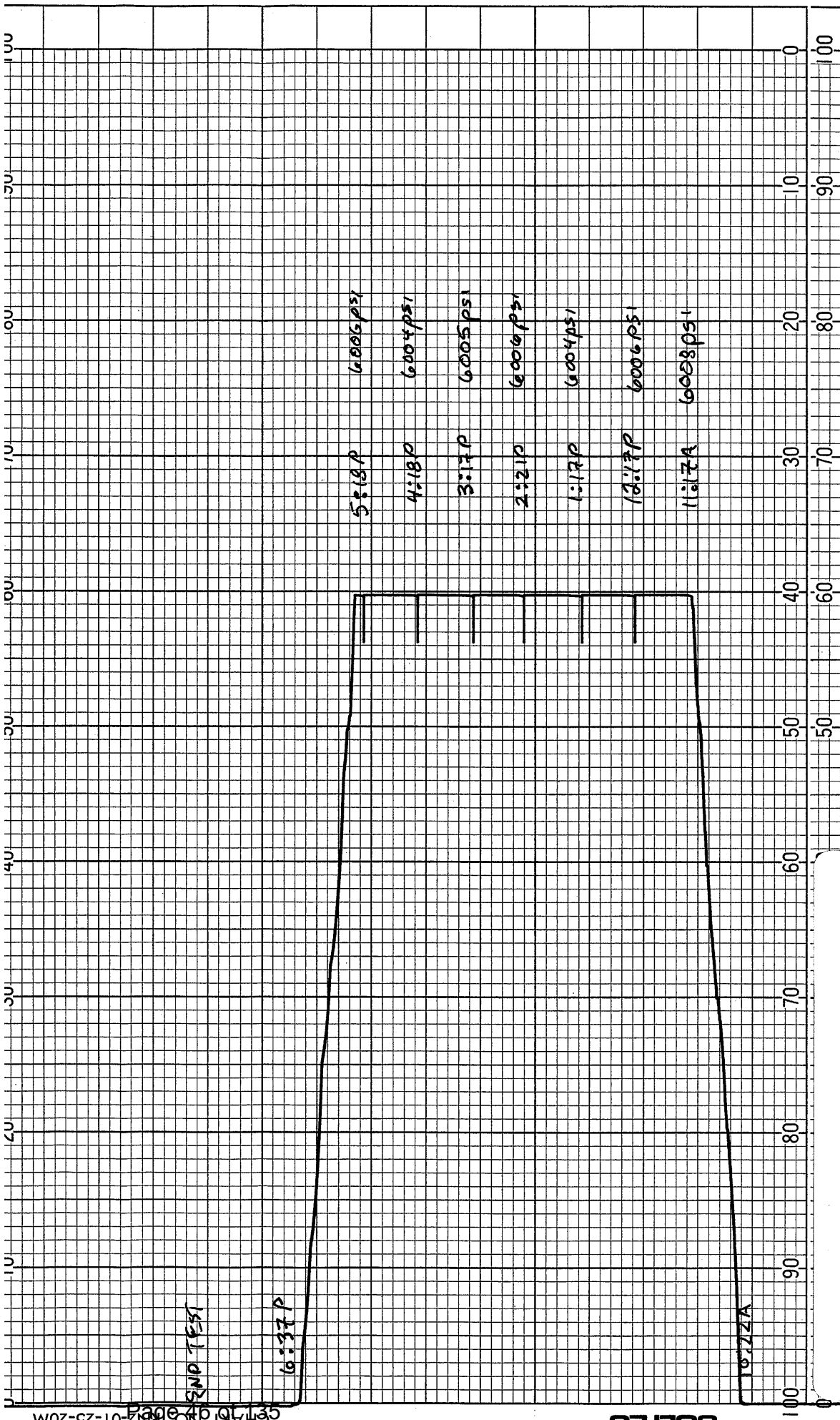
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SAN ANTONIO, TEXAS USA



AFL Telecommunications
External Hydro Test
1 ea. 1.5 km Multimode Fiber in SS Tube
Test Date: 9/27/07
SwRI Project No. 18.18072.01.348

820cm



SCALE: 0-10,000 PSI (PSI)
CHART SPEED 10 MM/HR

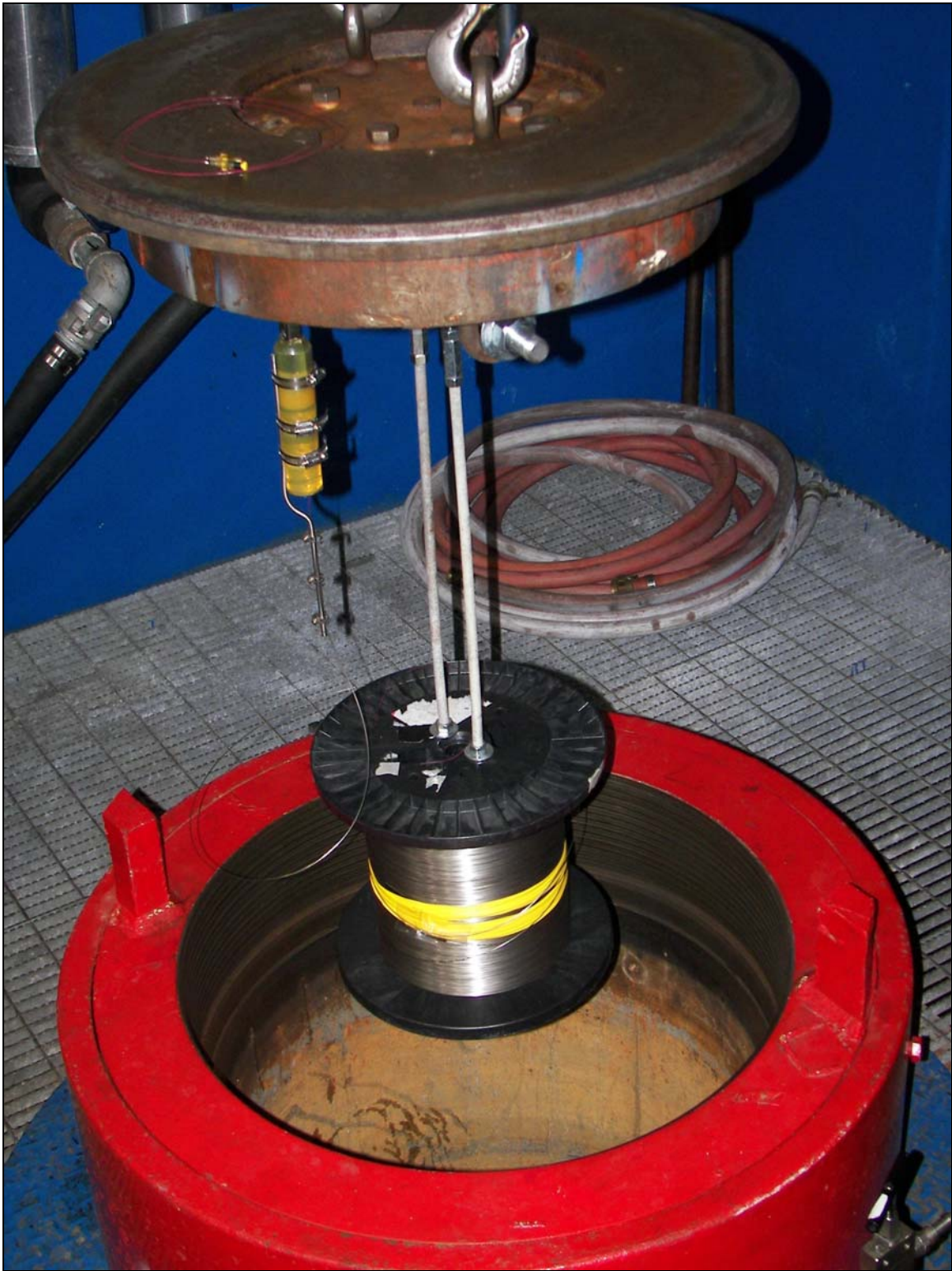


Figure 1.

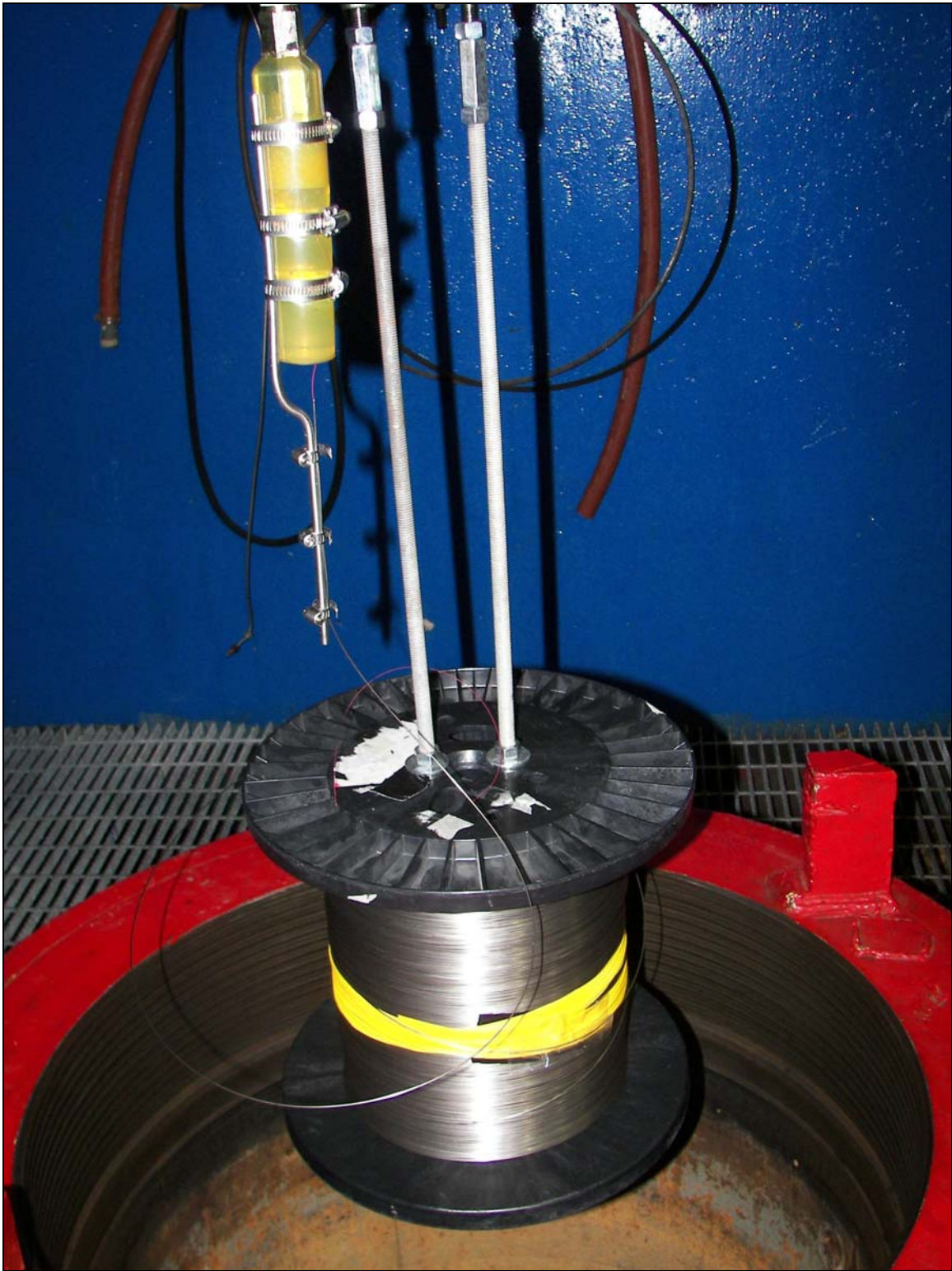


Figure 2.

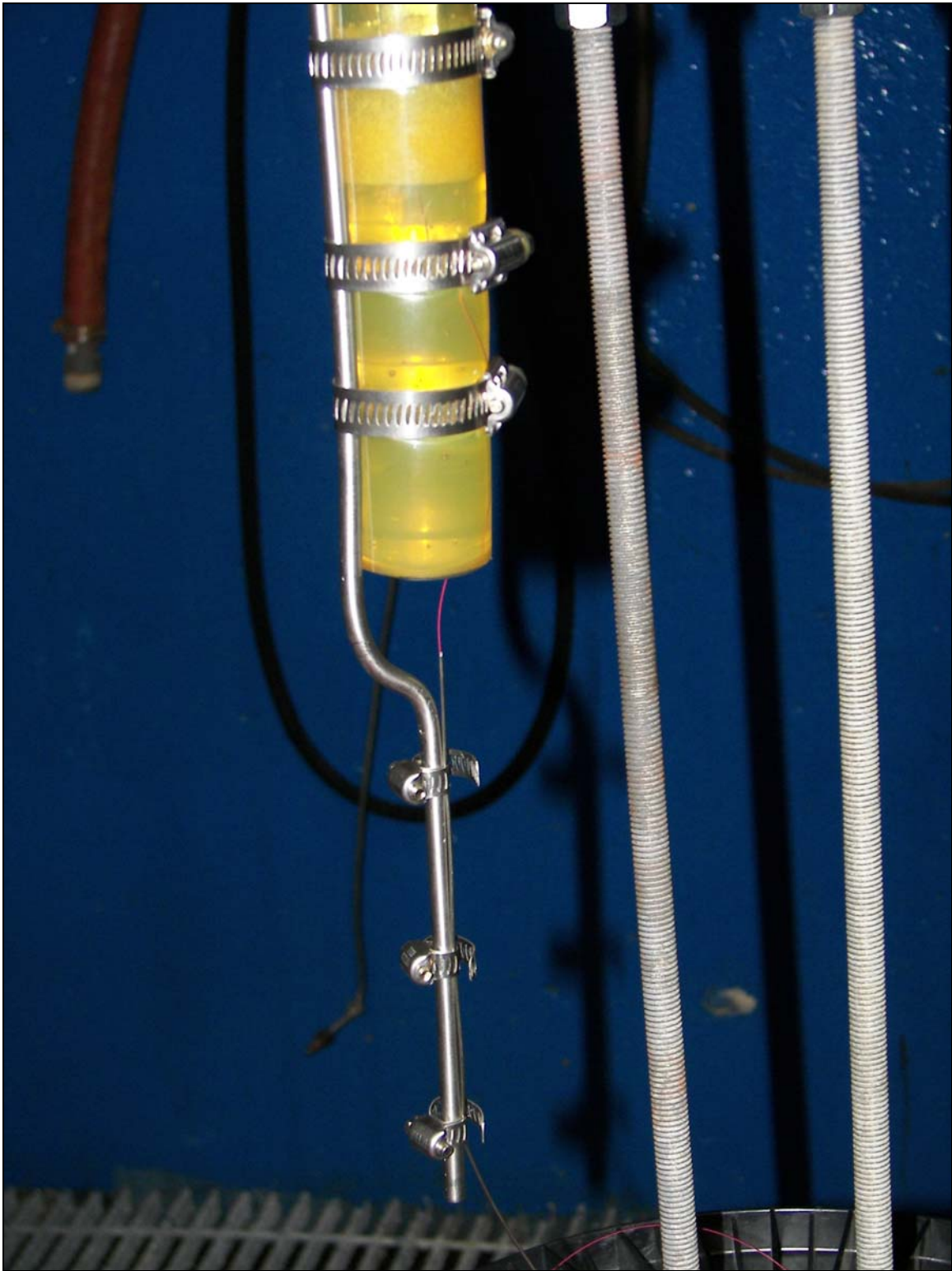


Figure 3.

2.2 MECHANICAL TESTS

2.2.1 LOAD ELONGATION & ROTATION TESTS

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE

TEST SPECIFICATION

Customer Specification



Report No. 0755

GLOBAL MARINE SYSTEMS LIMITED

TEST FACILITY – TECHNICAL REPORT

Cortland Fibron

RM0011 R.O.V Umbilical

**THIS SAMPLE
CONFORMED TO
THE TEST
SPECIFICATION
REQUIREMENTS**

Test Facility
Global Marine Systems Limited
1 Winsford Way
Boreham Interchange
Chelmsford
Essex CM2 5PD

DOCUMENT

Sample No. CSQ 0616

Document Issue No 1

Start Date: 27.02.2008

Global Marine Systems Limited - Test Facility

Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

CONTENTS

1. FLOW CHART & INTRODUCTION
2. CUSTOMER'S DOCUMENTS
3. TEST DETAILS
4. TEST RESULTS
5. CALIBRATION DETAILS

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 1 - FLOW CHART & INTRODUCTION**FLOW CHART**

The sample was subjected to the following tests:-

Specification No.	CFBX W08695	Issue 00	Section
			3.2 Load/ Elongation
			3.3 Rotation
			3.4 Cycle Reeling Test

INTRODUCTION

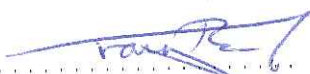
The samples were tested in accordance with Specification No. CFBX W08695 Issue 00.

DOCUMENT COMPILED AND
REVIEWED BY G.KARDOS

AUTHORISED FOR RELEASE BY
ENGINEERING MANAGER C BEECH


.....

DATE 24/04/08


.....

DATE 23/04/08

DOCUMENT

Sample No. CSQ 0616

Document Issue No 1

Start Date: 27.02.2008

Global Marine Systems Limited - Test Facility

Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 2**CUSTOMER'S DOCUMENTS**

TEST DATA DOCUMENT

SAMPLE No	CSQ0616	REVISION :	2	PROJECT CODE:	VKKA073
PROJECT	CORTLAND FIBRON				
CABLE	RM0011 R.O.V. Umbilical		CABLE No		

OPTICAL MONITORING	YES	NUMBER OF FIBRES	TBD
--------------------	-----	------------------	-----

BUILD DOCUMENT REF	N/A	ISS		ISS		ISS	
ASSEMBLY PARTS REF:	N/A	ISS		ISS		ISS	

TEST PROGRAMME	CFBX WO8695	ISSUE NO.	00
----------------	-------------	-----------	----

BUILD COMMENTS

Samples to be terminated with potted sockets and electrical and optical monitor loops connected

SAMPLE 1

3.2 LOAD/ELONGATION	increase to 60kN reduce to 0 for 10 complete cycles. 0 to 90kN in 10kN steps. Increase to failure	Pre-test Electrical continuity	
		TIME v LOAD, RAM POSITION	
		Post-test Electrical continuity	
		PASS	FAIL

SAMPLE 2

3.3 ROTATION	Sample to be tested horizontally with swivel. Increase to 60kN and then released to zero.	Pre-test Electrical continuity	
		TIME v LOAD, ROTATION	
		Post-test Electrical continuity	
		PASS	FAIL

SAMPLE 3

3.4 CYCLE REELING TEST	10,000 passes around Ø0.45 metre sheave at 60kN. Sample to travel 0.75 metres for each pass.	Pre-test Electrical continuity	
		TIME v LOAD	
		Post-test Electrical continuity	
		PASS	FAIL

TEST COMMENTS

PREPARED BY	C. BEECH	AUTHORISED		DATE	29/01/08
-------------	----------	------------	--	------	----------

HISTORY OF CHANGE

1	INITIAL ISSUE	29/01/08
---	---------------	----------

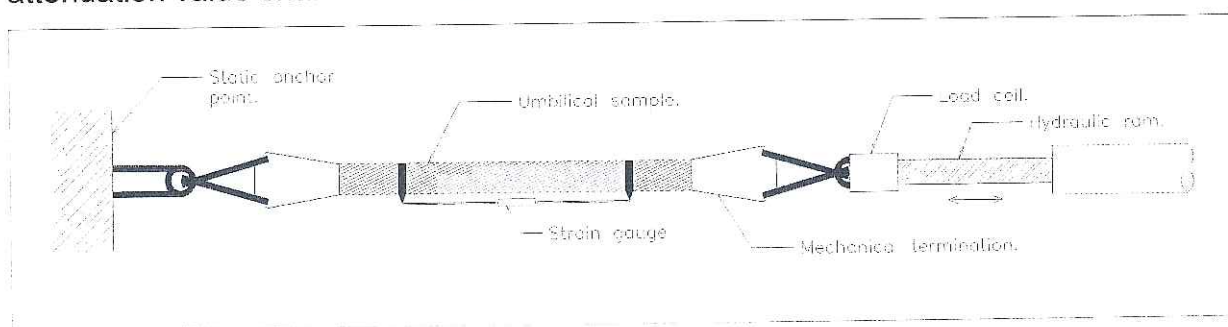
3.2 LOAD/ELONGATION TEST

Appropriate mechanical terminations, representative of those used in service (e.g. Wirelock potted socket) shall be installed on each end of a suitable length of umbilical sample.

The sample shall be installed in a tensile test rig, generally as depicted below, of rating greater than the. A means of monitoring umbilical load (e.g. load cell) shall be in line with the sample.

All electrical conductors shall be "daisy-chained" in series and connected to an electrical continuity monitor.

All optical fibres (excepting the 1 off multi-mode fibre) shall be "daisy-chained" in series and connected to a suitable optical light source & power meter or OTDR. The output of this may be data-logged if possible, otherwise manual recording will be sufficient. Initial attenuation value shall be recorded.



Increase the load on the umbilical at a steady rate to 60 kN (SWL) monitoring load vs. elongation, then release load to minimum tension. This process shall be repeated a minimum of ten times or until the load vs. elongation curve approximates well to linear.

The load be increased to 90 kN in 10 kN increments. Cable diameter (at centre of sample), elongation, optical attenuation and electrical continuity shall be measured and recorded at each increment.

The load will then, without measurement of cable diameter, elongation, optical attenuation and electrical continuity, be steadily increased until sample breakage occurs. Peak load prior to break shall be recorded.

Acceptance criteria:

- 1) No significant change in optical attenuation up to 90 kN load.
- 2) No loss of electrical continuity up to 90 kN load.
- 3) MBL in excess of 180 kN.

APPROVED		WITNESSED	
TEST ENGINEER	TEST RESPONSIBLE		

3.3 ROTATION

Appropriate mechanical terminations, representative of those used in service (e.g. resin potted socket) shall be installed on each end of a suitable length of umbilical sample.

The sample shall be suspended vertically. A load of 60 kN will then be applied to the lower end of the sample and released a minimum of 10 times.

Pointers or some form of rotation gauge shall be installed on the sample. A load of 60 kN shall again be applied to the sample and rotation measured.

Note: an alternative method of assessing umbilical rotation may be considered if preferred.

Acceptance criteria:

- 1) Rotation less than 1° per metre @ 60 kN load.

APPROVED		WITNESSED	
TEST ENGINEER	TEST RESPONSIBLE		

3.4 CYCLIC REELING TEST

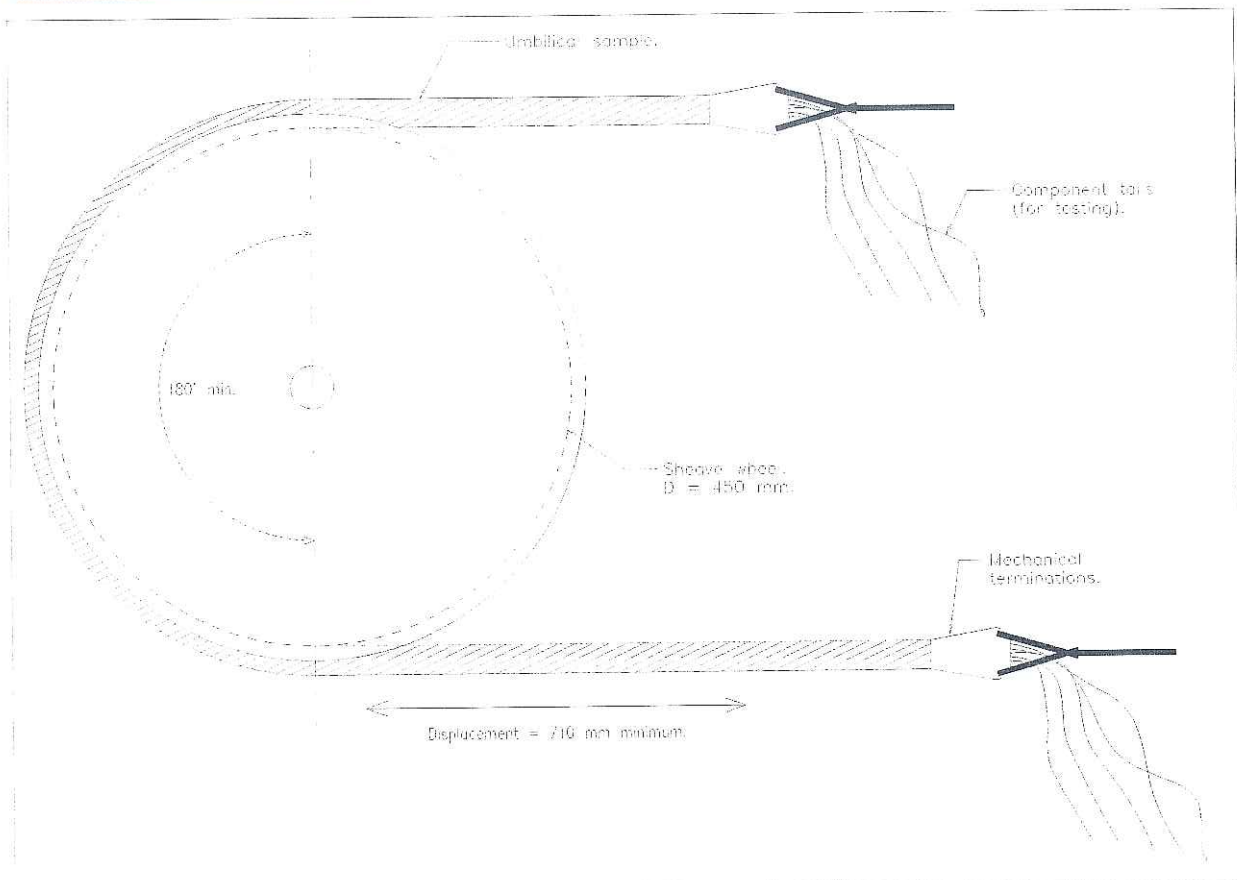
Appropriate mechanical terminations, representative of those used in service (e.g. Wirelock potted socket) shall be installed on each end of a suitable length of umbilical sample.

The sample shall be installed in a test rig, generally as depicted below. The tensile rating of the rig shall be greater than 60 kN. A means of monitoring umbilical load (e.g. load cell) shall be in line with the sample.

All electrical conductors shall be "daisy-chained" in series and connected to an electrical continuity monitor.

All optical fibres (excepting the 1 off multi-mode fibre) shall be "daisy-chained" in series and connected to a suitable optical light source & power meter or OTDR. The output of this may be data-logged if possible, otherwise manual recording will be sufficient. Initial attenuation value shall be recorded.

TEST DATA DOCUMENT



60 kN load shall be applied to the sample. The umbilical shall then be subjected to 5,000 reeling cycles under tension. A cycle is defined as two complete displacements, one in each direction.

Upon completion of 5,000 cycles, the sample shall be removed from the test rig and the insulation resistance of all cores measured.

Acceptance criteria:

- 1) No significant change in optical attenuation after 5,000 cycles.
- 2) No loss of electrical continuity after 5,000 cycles.
- 3) Insulation resistance as follows:
 - 0.22 mm² (x 4): 1,000 MΩ.km minimum @ 1.0 kV_{dc}.
 - 4.0 mm² (x 5): 1,000 MΩ.km minimum @ 5.0 kV_{dc}.

APPROVED		WITNESSED	
TEST ENGINEER	TEST RESPONSIBLE		

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 3 - TEST DETAILS

Specification No. CFBX W08695

Section 3.2

Load/ Elongation

EQUIPMENT DETAILS:**Optical**

PERKIN ELMER STRAIN MEASURING EQUIPMENT
WAVELENGTH 1550nm
Number Of Fibres In Circuit: 6

Serial No. 1305
Limits ± 2 dB, $\pm 2\%$
Excursive Loss Limit 0.6 dB
Residual Loss Limit 0.3 dB

OTHER EQUIPMENT:

1 MN Tensile Machine
300 kN Ram

Serial No. Mar 91654

Parameters Monitored: Load, Ram Position, Continuity & Optical Loss.

START DATE – 08/03/08

METHOD:

- a. Install the cable sample in the 1MN tensile machine using the 300kN ram.
- b. Apply a nominal load to measure the sample length.

TEST1:

FOR RECORDING PURPOSES "THE TEST" SHALL BE DEEMED TO START AND FINISH TEN MINUTES BEYOND THE ACTUAL OPERATION.

- c. Apply a tensile load of **7kN** to the cable sample.
- d. Increase load to **60kN** and cycle 10 times between these loads.
- e. Reduce load to zero.

TEST 2:

- f. Apply a nominal load to measure the sample length.
- g. Increased the load in 10kN steps to 90kN hold the for 2 min
- h. At a ramp rate of 10kN per minute apply an increasing tensile load until sample failure occurs.
Note the failure occurs 140.0kN

Next Test – Rotation

DEVIATION FROM THE ABOVE METHOD CAN ONLY BE PERMITTED WITH THE WRITTEN APPROVAL OF THE PROJECT MANAGER. NON COMPLIANCE WITH REASONS MUST BE DETAILED OVERLEAF. HE MUST ALSO BE NOTIFIED OF ANY ABNORMAL RESULTS OR FAILURES ON COMPLETION OF THE TEST.

TEST SCHEDULE APPROVED

TESTS PERFORMED AS PER SPECIFICATION

C Beech
Global Marine Systems Limited

 Initial

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 3 - TEST DETAILS

Specification No. CFBX W08695

Section 3.3

Rotation

EQUIPMENT DETAILS:**Optical**

PERKIN ELMER STRAIN MEASURING EQUIPMENT
WAVELENGTH 1550nm
Number Of Fibres In Circuit: 6

Serial No. 1305
Limits ± 2 dB, $\pm 2\%$
Excursive Loss Limit 0.6 dB
Residual Loss Limit 0.3 dB

OTHER EQUIPMENT:

1 MN Tensile Machine
300 kN Ram

Serial No. Mar 91654

Parameters Monitored: Load, Rotation, Continuity & Optical Loss.

START DATE – 27/02/08

METHOD:

- a. Install the cable sample in the 1MN tensile machine using the 300kN ram.
- b. Apply a nominal load to measure the sample length.

TEST1:

FOR RECORDING PURPOSES "THE TEST" SHALL BE DEEMED TO START AND FINISH TEN MINUTES BEYOND THE ACTUAL OPERATION.

- c. Apply a tensile load of **7kN** to the cable sample.
- d. Increase load to **60kN** then reduce to zero and cycle 10 times between these loads.

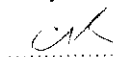
Next Test – Cycle Reeling Test

DEVIATION FROM THE ABOVE METHOD CAN ONLY BE PERMITTED WITH THE WRITTEN APPROVAL OF THE PROJECT MANAGER. NON COMPLIANCE WITH REASONS MUST BE DETAILED OVERLEAF. HE MUST ALSO BE NOTIFIED OF ANY ABNORMAL RESULTS OR FAILURES ON COMPLETION OF THE TEST.

TEST SCHEDULE APPROVED

C Beech
Global Marine Systems Limited

TESTS PERFORMED AS PER SPECIFICATION

 Initial

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 3 - TEST DETAILS

Specification No. CFBX W08695

Section 3.4**Cyclic Reeling Test****EQUIPMENT DETAILS:****Optical**

PERKIN ELMER STRAIN MEASURING EQUIPMENT
WAVELENGTH 1550nm
Number Of Fibres In Circuit: 6

Serial No. 1305
Limits ± 2 dB, $\pm 2\%$
Excursive Loss Limit 0.6 dB
Residual Loss Limit 0.3 dB

Other Equipment

RTS Winches

Serial Nos MAR91652 & MAR91653

Parameters Monitored: Load, Continuity and Optical

START DATE – 09/03/2008

METHOD:

- a. Install the cable sample around the ampersand facility
- b. A sketch of the test set up is shown in figure 1.

TEST1:

FOR RECORDING PURPOSES "THE TEST" SHALL BE DEEMED TO START AND FINISH TEN MINUTES BEYOND THE ACTUAL OPERATION.

- c. Apply a tensile load of **60kN** to the cable sample.
- d. Operate the winch controls to pull the cable, around the Ø0.45m sheave. Stop the winches when the cable end is approximately 0.75 metres from the sheave. Reverse the direction of pull and haul the cable back to the original start position, stop the winches.
- e. Repeat the above procedure a further 4,999 times to complete 5,000 cycles giving a total of 10,000 passes.

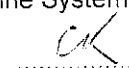
Next Test – Returned to Customer

DEVIATION FROM THE ABOVE METHOD CAN ONLY BE PERMITTED WITH THE WRITTEN APPROVAL OF THE PROJECT MANAGER. NON COMPLIANCE WITH REASONS MUST BE DETAILED OVERLEAF. HE MUST ALSO BE NOTIFIED OF ANY ABNORMAL RESULTS OR FAILURES ON COMPLETION OF THE TEST.

TEST SCHEDULE APPROVED

C Beech
Global Marine Systems Limited

TESTS PERFORMED AS PER SPECIFICATION

 Initial

DOCUMENT

Sample No. CSQ 0616

Document Issue No 1

Start Date: 27.02.2008

Global Marine Systems Limited - Test Facility

Customer: Cortland Fibron

IN CONFIDENCE

TEST SPECIFICATION

Customer Specification

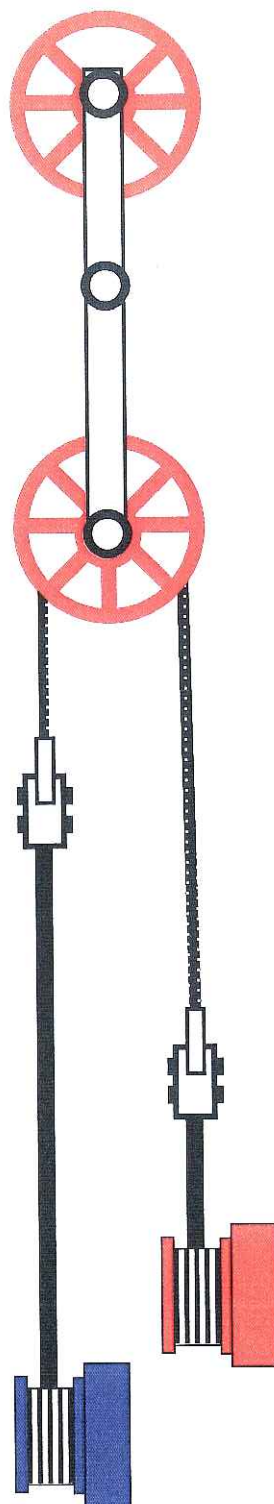


Figure 1
Cyclic Reeling Test

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 4 - TEST RESULTS

<u>Specification No.</u>	<u>CFBX W08695 Issue 00</u>	<u>Section 3.2</u>	<u>Load/ Elongation</u>
Graph 1 shows	Load plotted against time. Continuity plotted against time Ram Position plotted against time Optical loss plotted against time		
<u>Specification No.</u>	<u>CFBX W08695 Issue 00</u>	<u>Section 3.3</u>	<u>Rotation</u>
Graph 2 shows	Load plotted against time. Continuity plotted against time Optical loss plotted against time Rotation plotted against time		
<u>Specification No.</u>	<u>CFBX W08695 Issue 00</u>	<u>Section 3.4</u>	<u>Cyclic Reeling Test</u>
Graph 3 shows	Load plotted against time. Continuity plotted against time		
Graph 4 shows	Load plotted against time. Continuity plotted against time		
Graph 5 shows	Load plotted against time. Continuity plotted against time		
Graph 6 shows	Load plotted against time. Continuity plotted against time		
Graph 7 shows	Load plotted against time. Continuity plotted against time		
Graph 8 shows	Load plotted against time. Continuity plotted against time		
Graph 9 shows	Load plotted against time. Continuity plotted against time		
Graph 10 shows	Load plotted against time. Continuity plotted against time		
Graph 11 shows	Load plotted against time. Continuity plotted against time		
Graph 12 shows	Load plotted against time. Continuity plotted against time		
Graph 13 shows	Load plotted against time. Continuity plotted against time		

DOCUMENT

Sample No. CSQ 0616
Document Issue No 1
Start Date: 27.02.2008
Global Marine Systems Limited - Test Facility
Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

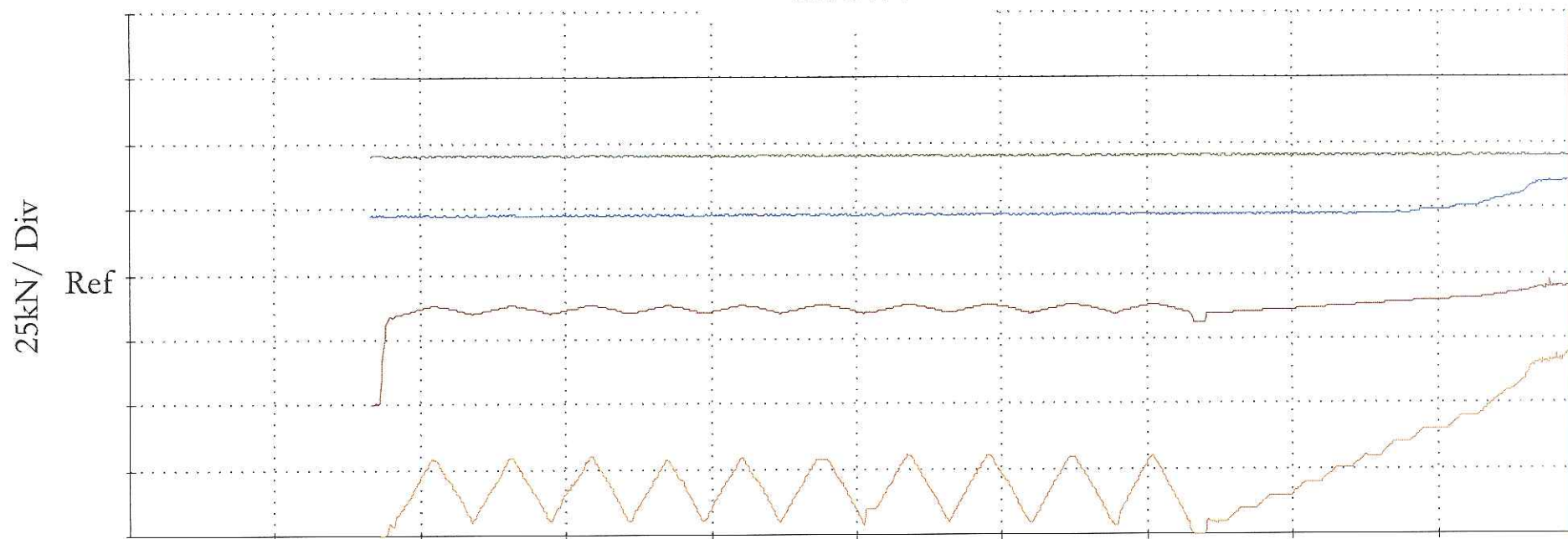
Customer Specification

CONCLUSION

The samples have performed to the specification CFBX W08695 issue 00. On the cycle reeling test optics were loss after 2834 passes and electrical continuity was lost at approximately 9180 Passes.

CSQ 0616 08/03/08

GRAPH 1



Before Scan

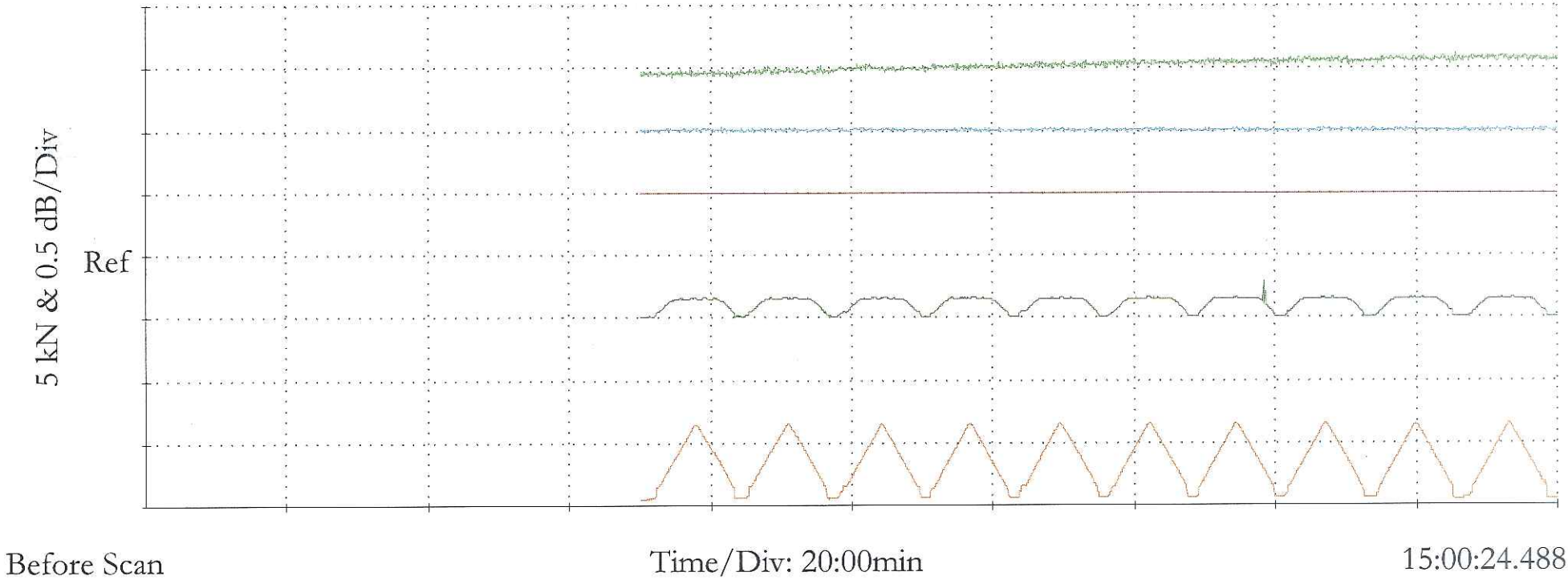
Time/Div: 10:00min

15:56:08.047

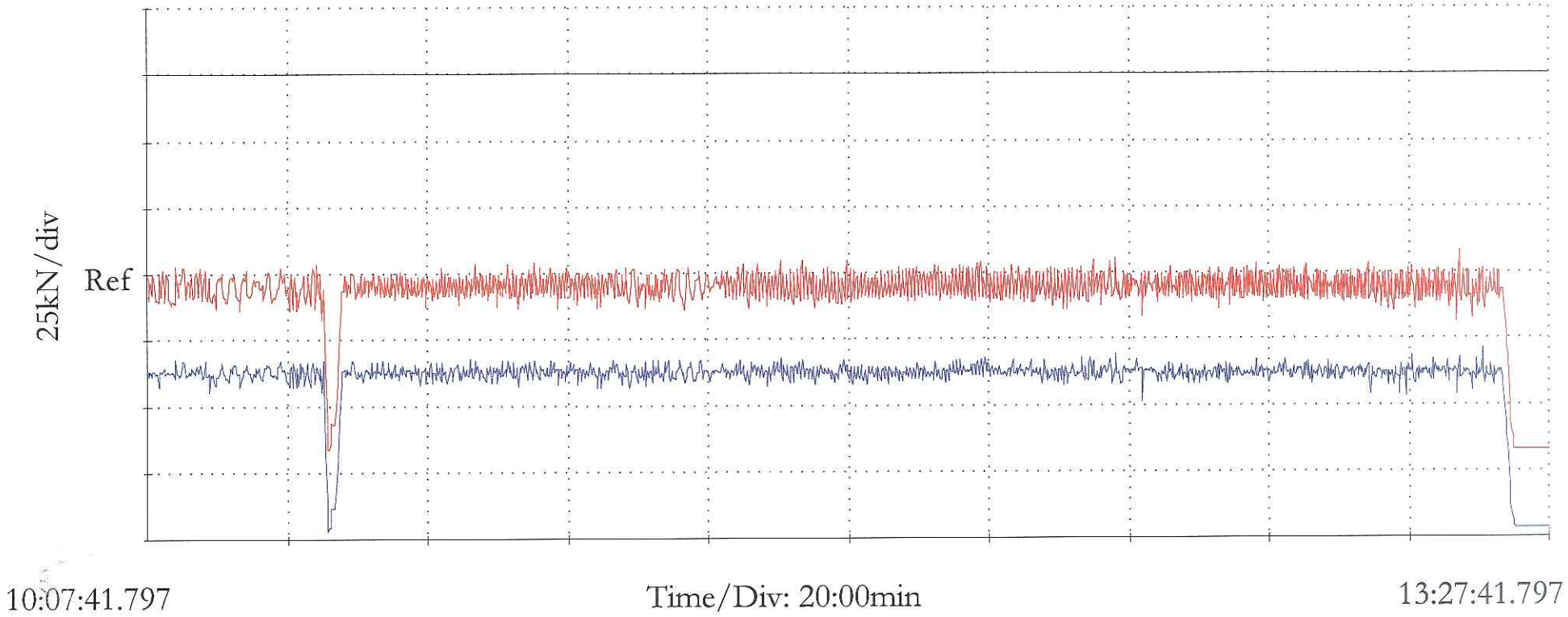
	Channel Name	Units/Div	Reference	Marker: 1	Marker: 2	
1	<900>50kN x Units/div	1.000000	4.000000	On	Off	
2	<912>Continutivity	5.000000	-6.000000	Off	Off	
3	<906>(400)0.5dBxUnits/div	1.000000	-1.800000	Off	Off	
4	<907>(400)E0.5%xUnits/div	1.000000	-0.900000	Off	Off	
5	<910>Pos0.25m x Units/div	1.000000	2.800000	Off	Off	
Time/Div 10:00min y2:(Off) y1:(900) Delta y: t2:(Off) t1:(900) Delta t: 2.812905 15:55:22.128						

CSQ 0616 CORTLAND 27/2/08

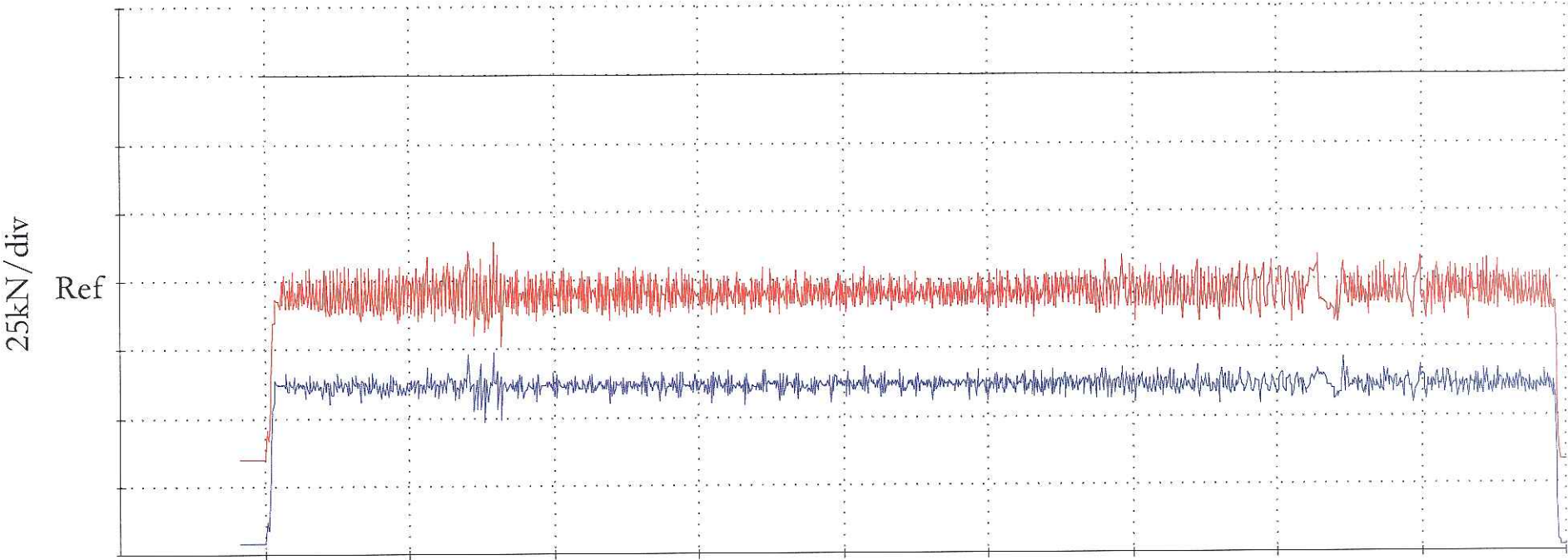
GRAPH 2



	Channel Name	Units/Div	Reference	Marker: 1	Marker: 2	
1	<900>50kN x Units/div	1.000000	3.900000	Off	Off	
2	<906>(400)0.5dBxUnits/div	1.000000	-2.900000	Off	Off	
3	<907>(400)E0.5%xUnits/div	1.000000	-2.000000	Off	Off	
4	<912>Continutivity	1.000000	-1.000000	Off	Off	
5	<909>360 deg x Units/div	0.200000	-0.080000	Off	Off	
Time/Div 20:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y:		Delta t:		



	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y:		Delta t:		



Before Scan

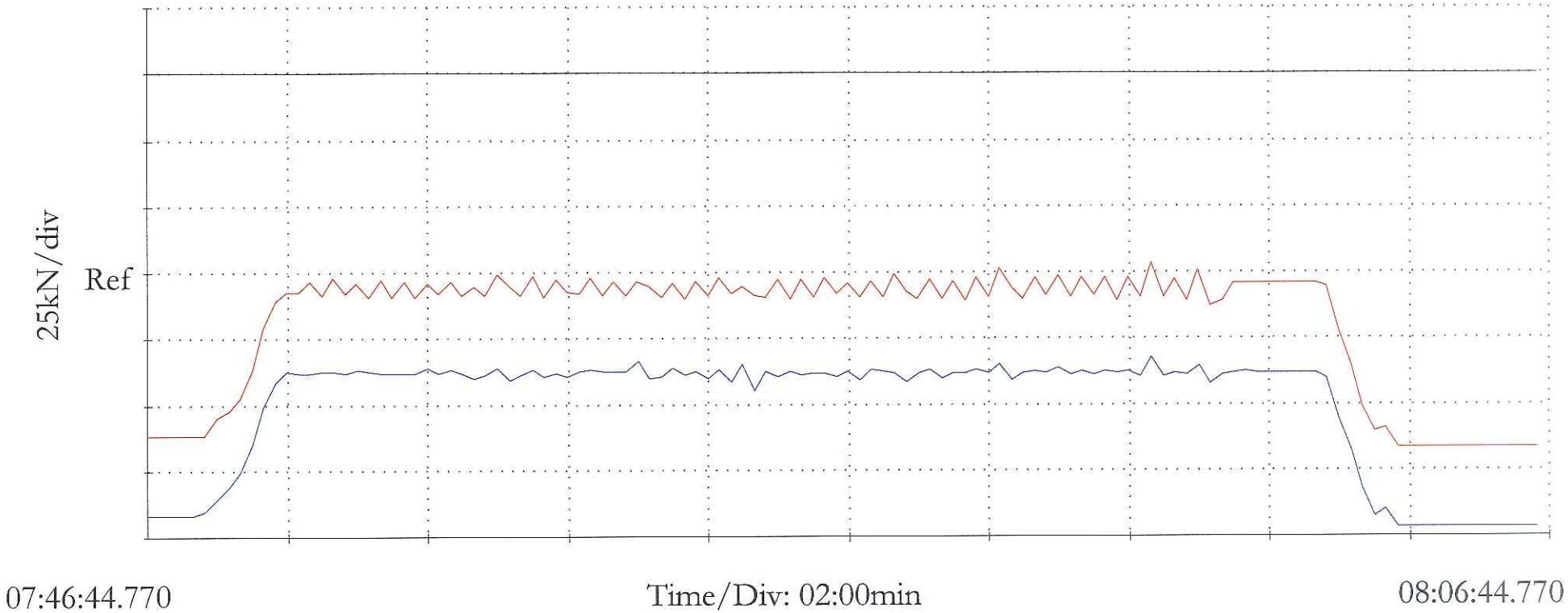
Time/Div: 20:00min

10:36:36.814

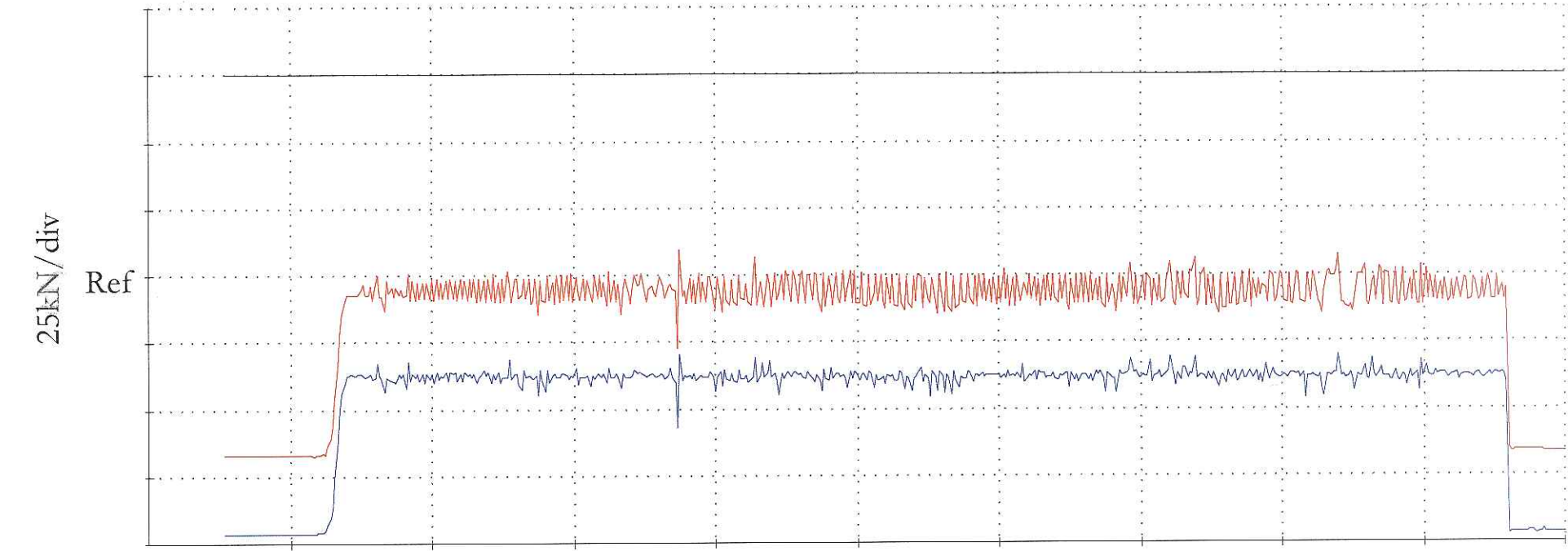
	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min y2:(Off) y1:(Off) Delta y: t2:(Off) t1:(Off) Delta t:						

CSQ 616 Cortland 09/03/08

GRAPH 5



	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 02:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y		Delta t		



Before Scan

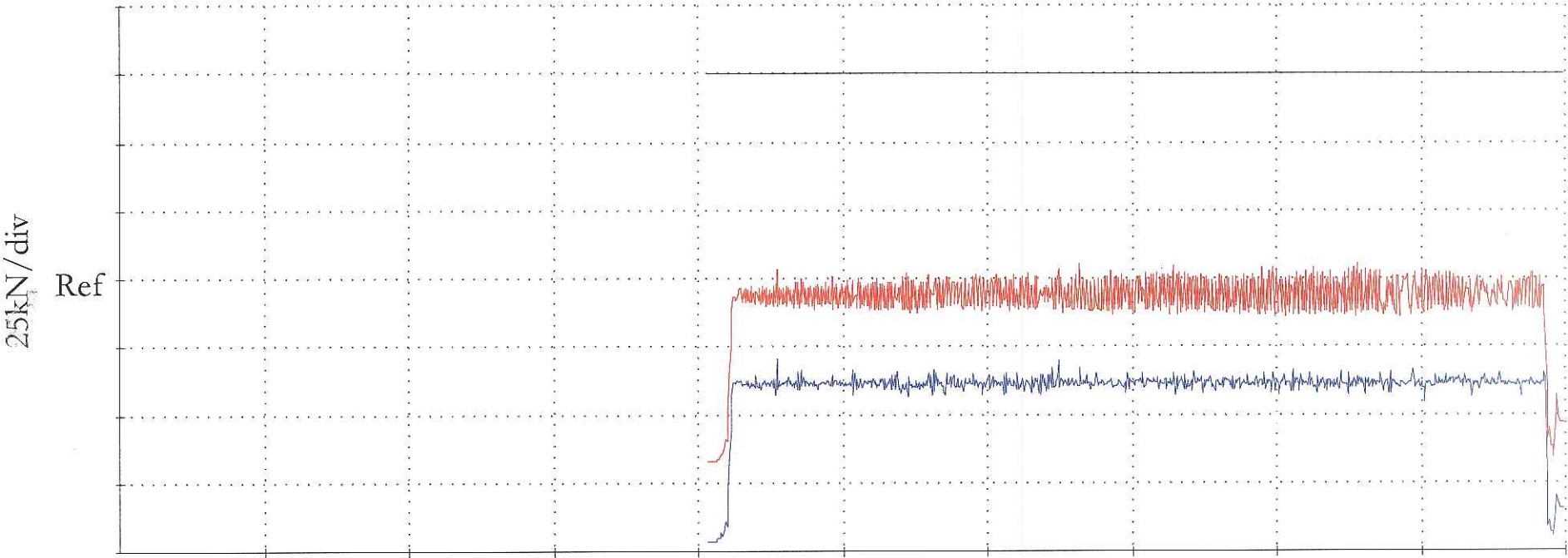
Time/Div: 10:00min

13:27:58.925

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 10:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y		Delta t		

CSQ 616 Cortland 09/03/08

GRAPH 7

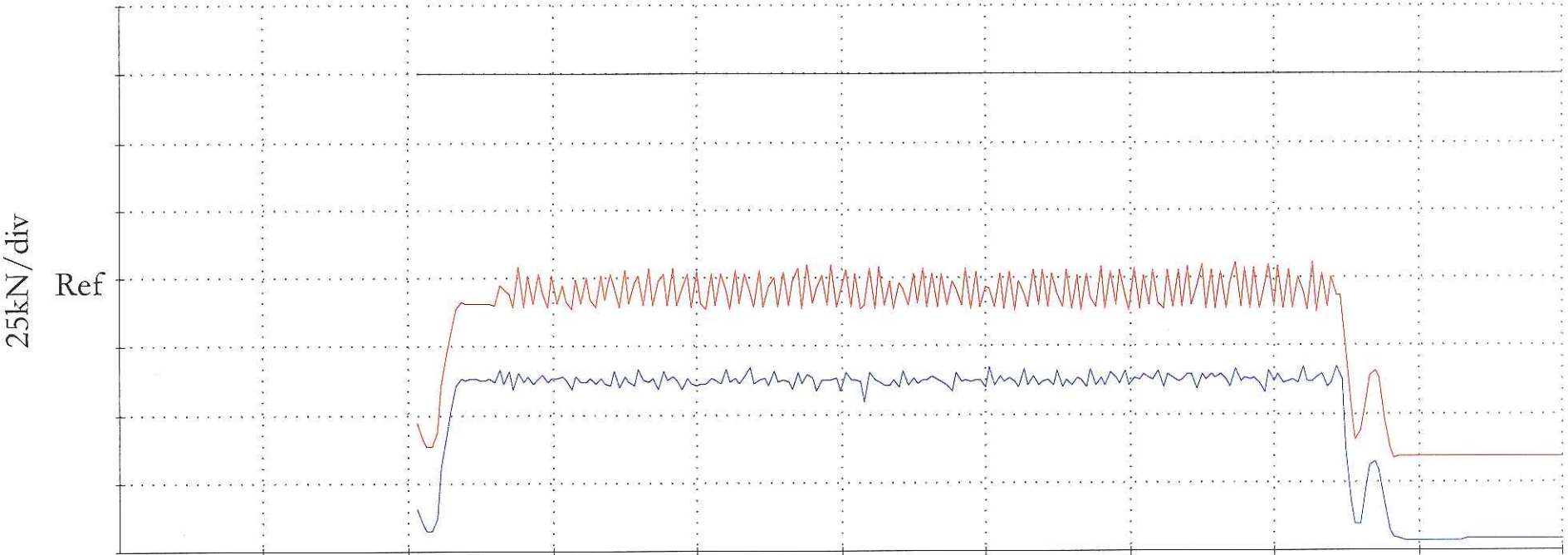


Before Scan

Time/Div: 20:00min

10:12:19.203

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
	y2:(Off)		t2:(Off)			
	y1:(Off)		t1:(Off)			
	Delta y		Delta t			



Before Scan

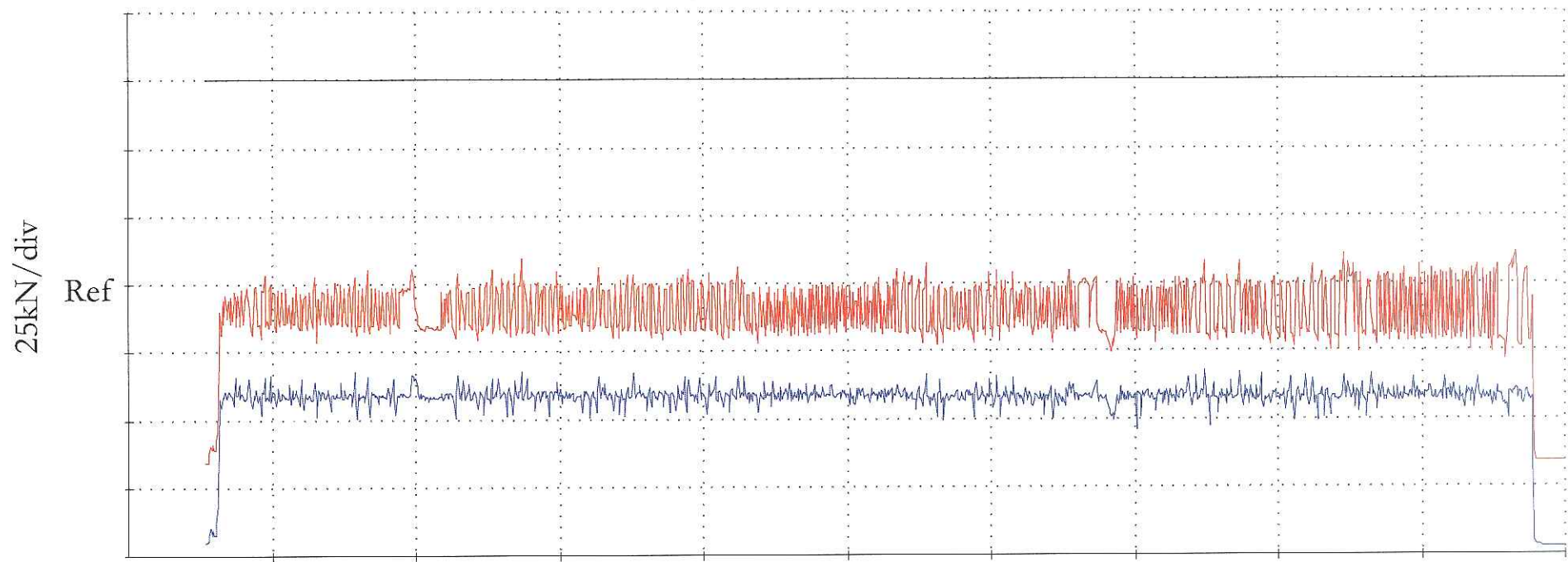
Time/Div: 05:00min

10:53:27.307

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 05:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y		Delta t		

CSQ 616 Cortland 09/03/08

GRAPH 9



Before Scan

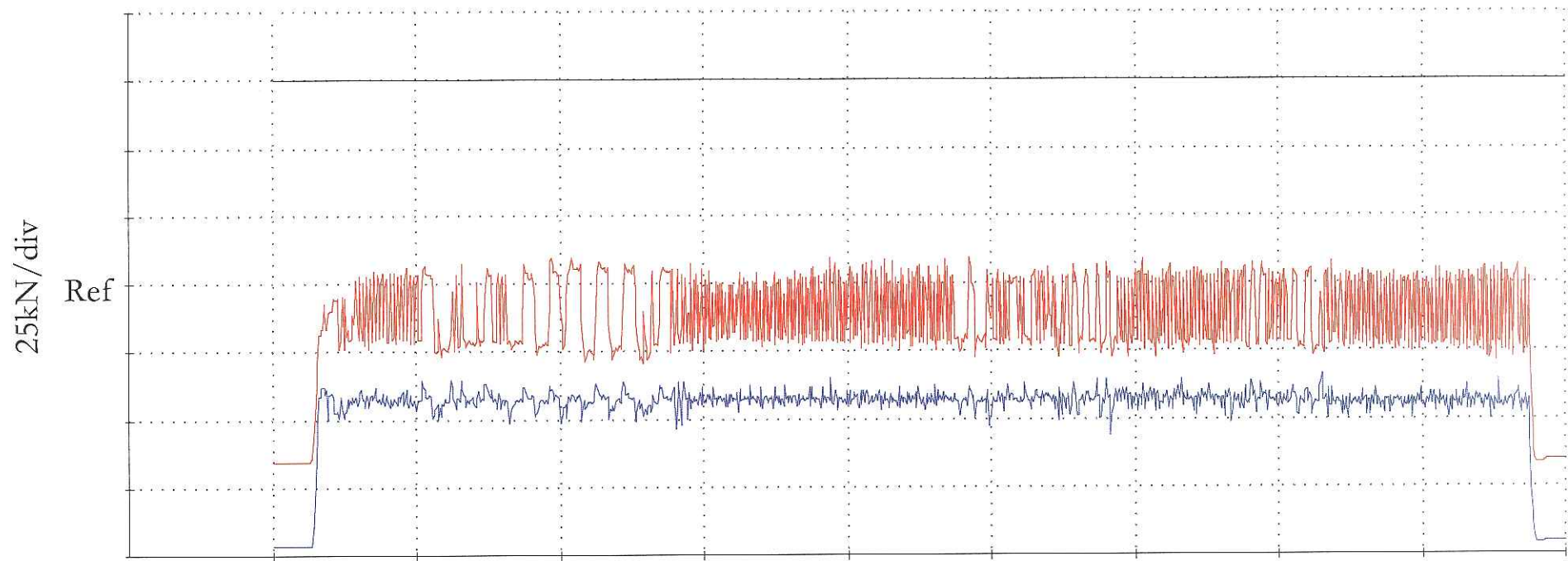
Time/Div: 20:00min

10:44:34.410

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
y2:(Off)			t2:(Off)			
y1:(Off)			t1:(Off)			
Delta y.			Delta t.			

CSQ 616 Cortland 09/03/08

GRAPH 10

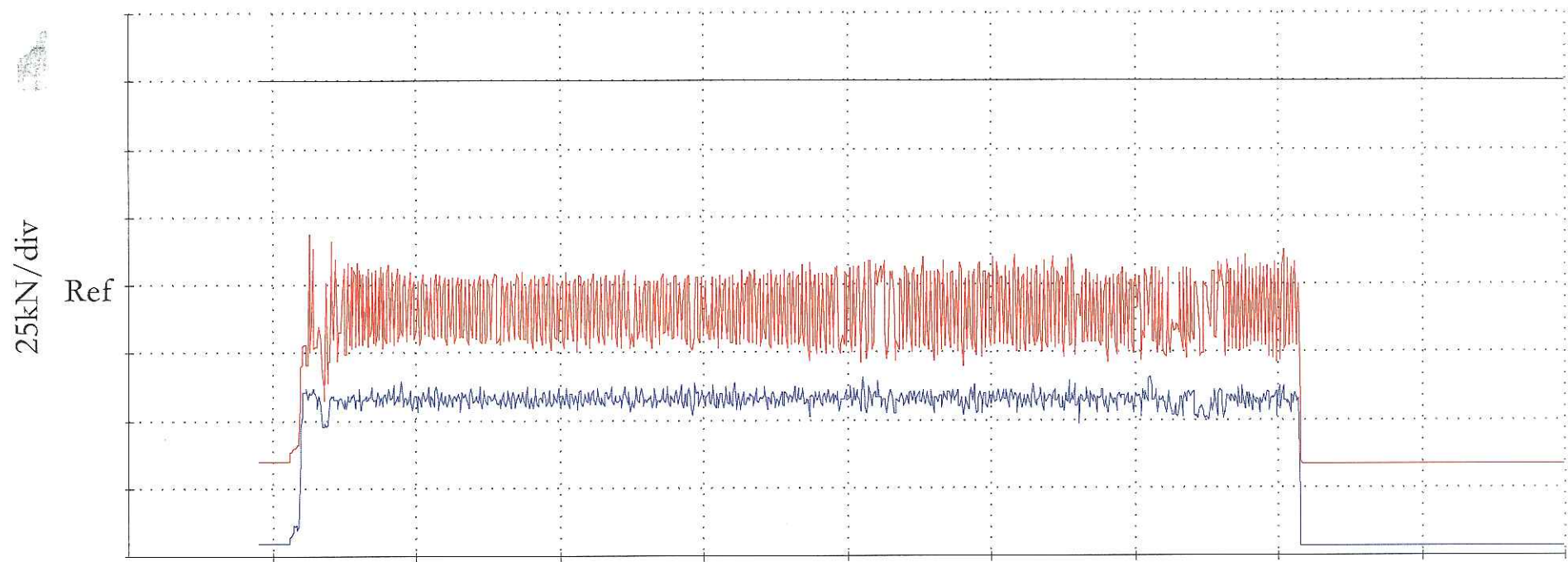


Before Scan

Time/Div: 20:00min

15:05:59.209

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
	y2:(Off)		t2:(Off)			
	y1:(Off)		t1:(Off)			
	Delta y:		Delta t:			



Before Scan

Time/Div: 20:00min

10:30:12.916

	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
	y2:(Off)		t2:(Off)			
	y1:(Off)		t1:(Off)			
	Delta y		Delta t			

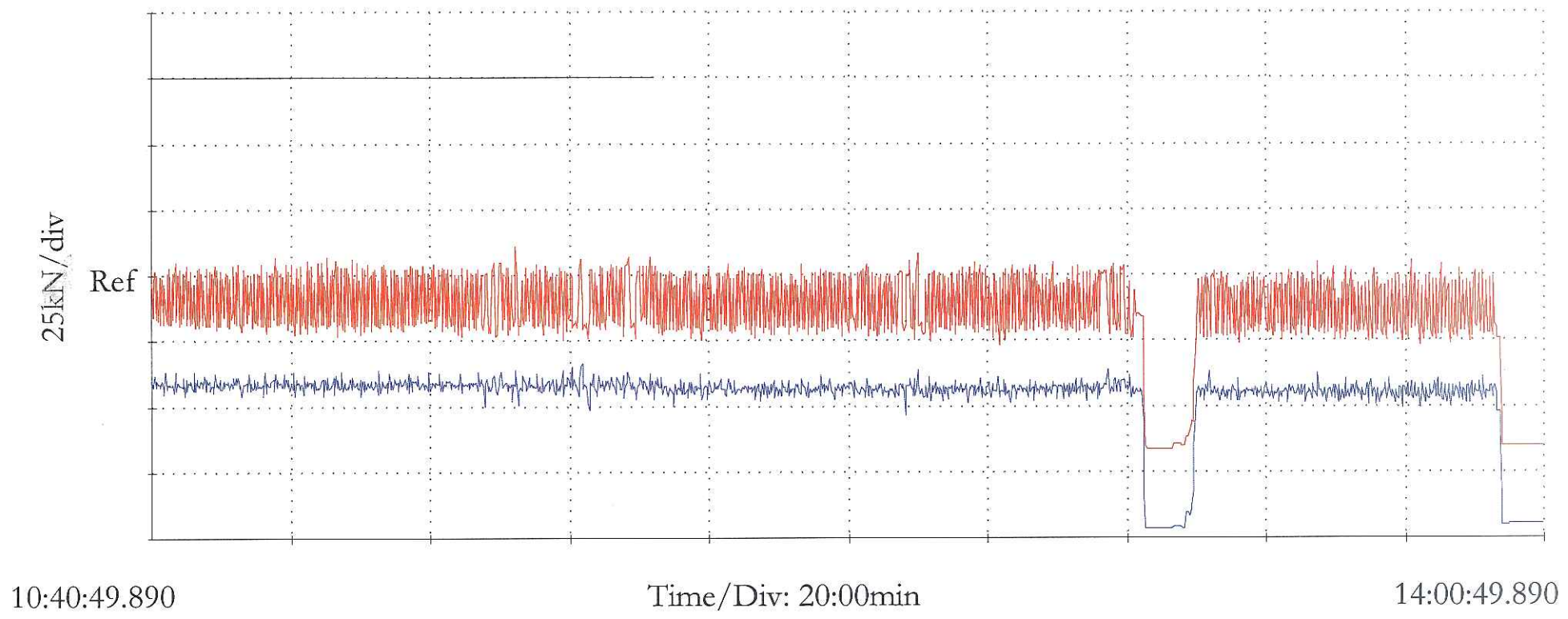


Before Scan

Time/Div: 20:00min

10:40:40.588

	Channel Name	Units/Div	Reference	Marker:	Marker:	
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2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
		y2:(Off)		t2:(Off)		
		y1:(Off)		t1:(Off)		
		Delta y		Delta t		



	Channel Name	Units/Div	Reference	Marker:	Marker:	
1	<900>R,50kN x Units/div	0.500000	1.350000	Off	Off	
2	<901>B,50kN x Units/div	0.500000	1.950000	Off	Off	
3	<915>Continuity Ohms	1E+008	-3E+008	Off	Off	
Time/Div 20:00min						
	y2:(Off)		t2:(Off)			
	y1:(Off)		t1:(Off)			
	Delta y		Delta t			

CERTIFICATE OF CALIBRATION

ISSUED BY: **SERCAL MATERIALS TESTING MACHINES SERVICES LTD - REDDITCH**

DATE OF ISSUE: **13 August 2007**

SERIAL NUMBER: **28211**



0375

SERCAL

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Page 1 of 3 Pages

APPROVED SIGNATORY

JIM SWANN

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE DESCRIPTION: **300kN Integrated Systems Horizontal Tensile**

TYPE REFERENCE: **RTS Rig**

SERIAL NUMBER: **MAR 91653 / Blue Winch**

MEASURING SYSTEM DESCRIPTION: **4 strain gauged shear pin load cells with a single range digital display**

DATE OF CALIBRATION: **9 August 2007**

AMBIENT TEMPERATURE: **20°C**

LOCATION: **Integrated Test Facility – Outdoor Cable Test Area - RTS**

REPORT:

This testing machine has been verified to the procedures of: BS EN ISO 7500-1 tension testing machines - Verification and calibration of the force measuring system.

MEASUREMENTS:

The measured results show the testing machine satisfies the requirements of BS EN ISO 7500-1 in respect to the relevant error of accuracy, repeatability, zero and resolution (see table 2 of the specification) as follows:

No adjustments were made prior to verification.

Range Description	Mode	Maximum Force	Minimum Force	Class	Resolution @ 0 Force
300kN	Tension	300kN	30kN	2	0.1kN

Certified

The reported expanded uncertainty is based on a standard uncertainty, multiplies by a coverage factor $k=2$, proving a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standard, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28211

Page 2 of 3

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE SETTING-UP PROCEDURE:

To recommendations of the Manufacturer with the calibration figures set as follows:

Load Cell	Cal Figure Actual	Zero Error	Cal Figure Calculated
1	57.55	-2.15	59.70
2	55.93	-3.71	59.64
3	56.56	+3.14	53.42
4	64.16	+6.08	58.08

CALIBRATION PROCEDURE:

Accessories:

Description	Type	Serial Number	Status
Strainstall Shear Pin Load Cell	459	27033 (1)	Calibrated
Strainstall Shear Pin Load Cell	459	27036 (2)	Calibrated
Strainstall Shear Pin Load Cell	3405	54205 (3)	Calibrated
Strainstall Shear Pin Load Cell	459	27032 (4)	Calibrated

(With reference to Clause 6.4.5 of the Standard)

The verification was completed using the constant indicated method of verification over a series of measurements taken at five test forces at approximately equal intervals over each scale range.

Additional static test forces below 20% of the scale maximum, in compliance with Clause 6.4.5 of the Standard, were taken down to a limit of compliance or the lower limit of verification.

TABLE OF MEASURED RESULTS:

Range Description Force Indicated (kN)	Tension	
	Average Actual Applied Force (kN)	Relative Uncertainty of Mean (%)
300kN range:		
15	14.95	0.78
30	30.55	0.47
45	45.72	0.44
60	60.87	0.41
120	120.81	0.41
180	180.84	0.41
240	240.38	0.39
300	300.42	0.39

NB. A negative Mean Error shows the machine's indicator to lag the true force applied.

Certified

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28211

Page 3 of 3

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

INFORMATIVE NOTES:

Intervals between Verifications:

(With reference to Clause 9 of the Standard)

The time between two verifications depend upon the type of testing machine, the standard of maintenance and the amount of use. Unless otherwise specified it is recommended that the verification be carried out at intervals not exceeding twelve months. The machine shall in any case be verified if it is moved to a new location, necessitating dismantling or subject to major repairs or adjustments.

FORCE-PROVING INSTRUMENTS USED:

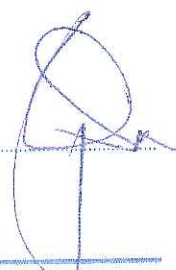
Description	Serial Number	Certificate Number	Date Verified	Class	Average Temperature
Load Cell	600/3U	0478 / E07010354/1	06.02.2007	1	20°C

Alignment of the force-proving instruments satisfied Clause 6.4.1 of the Standard with reference to ISO 376.

(With reference to BS EN ISO 7500-1 Clause 6.1)

The verification equipment used is in accordance with ISO 376. The class of the verification equipment was equal to or superior to the class determined for the testing machine.

NB. The expiry date of certificates of calibration used for the force-proving instruments recorded above is, 26 months for load cells and 5 years for masses.

Certified 

CERTIFICATE OF CALIBRATION

ISSUED BY: **SERCAL MATERIALS TESTING MACHINES SERVICES LTD - REDDITCH**

DATE OF ISSUE: **13 August 2007**

SERIAL NUMBER: **28210**



0375

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Page 1 of 3 Pages

APPROVED SIGNATORY

JIM SWANN

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE DESCRIPTION: **300kN Integrated Systems Horizontal Tensile**

TYPE REFERENCE: **RTS Rig**

SERIAL NUMBER: **MAR 91652 / Red Winch**

MEASURING SYSTEM DESCRIPTION: **4 strain gauged shear pin load cells with a single range digital display**

DATE OF CALIBRATION: **8 August 2007**

AMBIENT TEMPERATURE: **21°C**

LOCATION: **Integrated Test Facility – Outdoor Cable Test Area - RTS**

REPORT:

This testing machine has been verified to the procedures of: BS EN ISO 7500-1 tension testing machines - Verification and calibration of the force measuring system.

MEASUREMENTS:

The measured results show the testing machine satisfies the requirements of BS EN ISO 7500-1 in respect to the relevant error of accuracy, repeatability, zero and resolution (see table 2 of the specification) as follows:

No adjustments were made prior to verification.

Range Description	Mode	Maximum Force	Minimum Force	Class	Resolution @ 0 Force
300kN	Tension	300kN	60kN	3	0.1kN

Certified

The reported expanded uncertainty is based on a standard uncertainty, multiplies by a coverage factor $k=2$, proving a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standard, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28210

Page 2 of 3

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE SETTING-UP PROCEDURE:

To recommendations of the Manufacturer with the calibration figures set as follows:

Load Cell	Cal Figure Actual	Zero Error	Cal Figure Calculated
1	56.78	-0.49	57.27
2	50.63	-2.26	52.89
3	57.94	-0.41	58.35
4	55.95	+1.66	54.29

CALIBRATION PROCEDURE:

Accessories:

Description	Type	Serial Number	Status
Strainstall Shear Pin Load Cell	459	27034 (1)	Calibrated
Strainstall Shear Pin Load Cell	3405	49037 (2)	Calibrated
Strainstall Shear Pin Load Cell	459	27035 (3)	Calibrated
Strainstall Shear Pin Load Cell	3405	49038 (4)	Calibrated

(With reference to Clause 6.4.5 of the Standard)

The verification was completed using the constant indicated method of verification over a series of measurements taken at five test forces at approximately equal intervals over each scale range.

Additional static test forces below 20% of the scale maximum, in compliance with Clause 6.4.5 of the Standard, were taken down to a limit of compliance or the lower limit of verification.

TABLE OF MEASURED RESULTS:

Range Description Force Indicated (kN)	Tension	
	Average Actual Applied Force (kN)	Relative Uncertainty of Mean (%)
300kN range:		
15	13.95	0.79
30	28.84	0.76
45	43.56	0.45
60	58.42	0.47
120	117.99	0.43
180	180.65	0.43
240	242.44	0.39
300	304.80	0.39

NB. A negative Mean Error shows the machine's indicator to lag the true force applied.

Certified

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28210

Page 3 of 3

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

INFORMATIVE NOTES:

Intervals between Verifications:

(With reference to Clause 9 of the Standard)

The time between two verifications depend upon the type of testing machine, the standard of maintenance and the amount of use. Unless otherwise specified it is recommended that the verification be carried out at intervals not exceeding twelve months. The machine shall in any case be verified if it is moved to a new location, necessitating dismantling or subject to major repairs or adjustments.

FORCE-PROVING INSTRUMENTS USED:

Description	Serial Number	Certificate Number	Date Verified	Class	Average Temperature
Load Cell	600/3U	0478 / E07010354/1	06.02.2007	1	21°C

Alignment of the force-proving instruments satisfied Clause 6.4.1 of the Standard with reference to ISO 376.

(With reference to BS EN ISO 7500-1 Clause 6.1)

The verification equipment used is in accordance with ISO 376. The class of the verification equipment was equal to or superior to the class determined for the testing machine.

NB. The expiry date of certificates of calibration used for the force-proving instruments recorded above is, 26 months for load cells and 5 years for masses.

Certified

The following Instrument and Options have been calibrated to the manufacturers published specifications.

MODEL No : SPL400

SERIAL No : 1305

CERTIFICATE No : 1305/2008

OPTION	DESCRIPTION	CONDITION	DATE OF CAL	NEXT CAL DUE
CD409/ST	STRAIN	A	10/01/2008	JA ~ 2009
CD409/A	ATTENUATION	A	10/01/2008	JA ~ 2009
	LENGTH	A	10/01/2008	JA ~ 2009

CONDITION :

A : All measurements were within specification - No adjustment was made.

B : All measurements were within specification - Minor adjustments were made to optimise results.

C : Not all measurements were within specification - See comments below.

R : A repair was carried out - See comments below.

COMMENTS :

CALIBRATION EQUIPMENT USED :

CD313: 960207

Attenuator: JE012813

Frequency Counter: 131554

Calibration for the above instruments is traceable to the UK National Physical Laboratories unless otherwise indicated.

For PE.fiberoptics :

AD

Print Name :

...ADRIAN EVANS...

Position :

...OPERATIONS DIRECTOR...

Date :

10/01/2008

CERTIFICATE OF CALIBRATION

ISSUED BY: **SERCAL MATERIALS TESTING MACHINES SERVICES LTD - REDDITCH**

DATE OF ISSUE: **13 August 2007**

SERIAL NUMBER: **28213**



0375

SERCAL

MATERIALS TESTING MACHINES SERVICES LTD

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Page 1 of 3 Pages

APPROVED SIGNATORY

JIM SWANN

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE DESCRIPTION: **300kN Integrated Systems Horizontal Tensile**

TYPE REFERENCE: **Cable Test**

SERIAL NUMBER: **MAR 91655**

MEASURING SYSTEM DESCRIPTION: **Single range digital display**

DATE OF CALIBRATION: **7 August 2007**

AMBIENT TEMPERATURE: **22°C**

LOCATION: **Integrated Test Facility**

REPORT:

This testing machine has been verified to the procedures of: BS EN ISO 7500-1 tension testing machines - Verification and calibration of the force measuring system.

MEASUREMENTS:

The measured results show the testing machine satisfies the requirements of BS EN ISO 7500-1 in respect to the relevant error of accuracy, repeatability, zero and resolution (see table 2 of the specification) as follows:

No adjustments were made prior to verification.

Range Description	Mode	Maximum Force	Minimum Force	Class	Resolution @ 0 Force
300kN	Tension	300kN	20kN	1	0.1kN

Certified

The reported expanded uncertainty is based on a standard uncertainty, multiplies by a coverage factor $k=2$, proving a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standard, and to units of measurement realised at the National Physical Laboratory. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28213

Page 2 of 3

ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

MACHINE SETTING-UP PROCEDURE:

To recommendations of the Manufacturer with the calibration figure set as follows:

kN range	295.2	With the calibration resistor connected to the red and white test points.
----------	-------	---

CALIBRATION PROCEDURE:

Accessories:

Description	Type	Serial Number	Status
75 000lbf Strainert Load Cell	FL25U	07278-1	Calibrated

(With reference to Clause 6.4.5 of the Standard)

The verification was completed using the constant indicated method of verification over a series of measurements taken at five test forces at approximately equal intervals over each scale range.

Additional static test forces below 20% of the scale maximum, in compliance with Clause 6.4.5 of the Standard, were taken down to a limit of compliance or the lower limit of verification.

TABLE OF MEASURED RESULTS:

Range Description Force Indicated (kN)	Tension	
	Average Actual Applied Force (kN)	Relative Uncertainty of Mean (%)
300kN range:		
20	19.98	0.50
30	30.02	0.44
45	45.06	0.41
60	60.09	0.40
120	119.87	0.39
180	180.01	0.39
240	240.17	0.39
300	300.07	0.39

NB. A negative Mean Error shows the machine's indicator to lag the true force applied.

Certified

CERTIFICATE OF CALIBRATION

SERCAL MATERIALS TESTING MACHINES SERVICES LTD

UKAS ACCREDITED CALIBRATION LABORATORY No. 0375

13 August 2007

SERIAL NUMBER
28213

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ISSUED TO: **GLOBAL MARINE SYSTEMS LIMITED - CHELMSFORD - CM2 5PD**

INFORMATIVE NOTES:

Intervals between Verifications:

(With reference to Clause 9 of the Standard)

The time between two verifications depend upon the type of testing machine, the standard of maintenance and the amount of use. Unless otherwise specified it is recommended that the verification be carried out at intervals not exceeding twelve months. The machine shall in any case be verified if it is moved to a new location, necessitating dismantling or subject to major repairs or adjustments.

FORCE-PROVING INSTRUMENTS USED:

Description	Serial Number	Certificate Number	Date Verified	Class	Average Temperature
Load Cell	600/3U	0478 / E07010354/1	06.02.2007	1	22°C

Alignment of the force-proving instruments satisfied Clause 6.4.1 of the Standard with reference to ISO 376.

(With reference to BS EN ISO 7500-1 Clause 6.1)

The verification equipment used is in accordance with ISO 376. The class of the verification equipment was equal to or superior to the class determined for the testing machine.

NB. The expiry date of certificates of calibration used for the force-proving instruments recorded above is, 26 months for load cells and 5 years for masses.

Certified

DOCUMENT

Sample No. CSQ 0616

Document Issue No 1

Start Date: 27.02.2008

Global Marine Systems Limited - Test Facility

Customer: Cortland Fibron

IN CONFIDENCE**TEST SPECIFICATION**

Customer Specification

SECTION 5 - CALIBRATION DETAILS

Equipment	Type	Serial No.	Calibration Date
Blue Winch	Colt – 585	MAR 91653	08.08.07
Red Winch	Colt – 586	MAR 91652	08.08.07
Perkin Elmer Strain Measuring Equipment	SPL 400	1305	10/01/2008
1 MN Tensile Rig 300 kN RAM	Cable Test	MAR 91655	07.08.07

The above items are calibrated annually.

2.2.2 MINIMUM BREAK LOAD TEST

**CERTIFICATE OF TEST OF WIRE ROPE
EN 10204 TYPE 3.1****Test Certificate Number** S75022/R8302419/2007**Purchaser Name and Address**Cortland Fibron BX
Unit C Belcon Industrial Est
Bingley Road
Hoddesdon
Herts
EN11 0NX**Purchase Order Number**

9454

Supplier Name and AddressBridon International Ltd
Carr Hill
Doncaster
South Yorkshire
DN4 8DG**Bridon International Order number**

R8302419

Description of wire rope

17.3mm 1 x 128 EMC 2260 Galvanised RH MBL 18.16tf

Rope number

S75022

Quantity and rope length

1 x 5000m

Date of manufacture

18 December 2007

Detail of test

Method of test

ISO3108

Date of test

18 December 2007

Breaking load

18.16tf

Safe working load at a coefficient of utilisation of 5*

3.63tf

Declaration

I certify that the above particulars are correct.

Name M.J.Clarke
Tester

Signed

Date 18 December 2007

Other information

Testing machine calibrated to BSEN10002-2

Bridon product code :17.31128SCZZ01

Actual diameter :17.52mm

Actual breaking load :18.60tf

*If the rope is required to be used at a coefficient of utilisation different from the example above it should be re-rated by a competent person.

The above complies with all the applicable requirements of the Machinery Directive. Before use read our publication 'Instruction and warnings on the use of steel wire rope'.

2.2.3 BEND FATIGUE TEST

DOCUMENTATION FRONT SHEET

Cortland FIBRON BX (CFBX)	Document Category:	CFBX Order no:	Total Pages:	Document Number:	
	Report	8695	6	TR8695-001	
00	02/05/08	For Review	AC	DRS	
Rev	Date	Reason for issue	Prepared	Checked	Approved

Works Order 8695

Bend Fatigue Test Report.

MBARI Umbilical.

Customer: SMD Hydrovision

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Contents

1.0	INTRODUCTION.....	3
2.0	GLOBAL MARINE TEST.....	3
3.0	BRIDON TEST.....	4
4.0	CONCLUSION.....	6

1.0 INTRODUCTION

Two bend fatigue tests have been carried out on the RM0011 ROV Umbilical for SMD Hydrovision. The first test was carried out at the Global Marine test facility in Chelmsford and the second at the Bridon test facility in Willington Quays. The first test at Global Marine failed and on subsequent investigation it was found that the set up and equipment used by Global Marine was inappropriate and failure had occurred for this reason. The second test, performed at the Bridon facility, passed.

2.0 GLOBAL MARINE TEST

This test was reported by Global Marine in their report number 0755. An explanation of the test set up and results obtained is provided within their report. Optical failure occurred after 2834 passes and electrical continuity after 9180 passes.

The test rig and set up were subsequently reviewed and a number of observations have been made, which are as follows:

1. Load was applied to the cable via two large steel ropes (connected to either end of the umbilical) and from two winch drums. The size and accuracy was applicable to very large umbilicals. The system was inappropriate for this small umbilical. Transient loads at reversal points would have been very high.
2. The sheave wheel was flat, non-circular and in poor condition. There was, therefore, no lateral support for the umbilical. The transients which occurred could have resulted in the umbilical lifting off the sheave wheel at the reversal points.
3. Global Marine had not determined the correct travel length for the diameter of sheave wheel used. The sheave wheel diameter was 450mm which is a circumference of 1414mm. The travel was 750mm and less than 50% of the cable was in contact with the sheave wheel (estimate approx 40%). The definition of a cycle is straight – bent – straight. Hence, with this set up a cycle is completed in one pass. Global Marine had intended, and had state in their report, that two passes were required for one cycle, but in fact, one pass resulted in the umbilical doing one cycle.
4. Connection of the steel rope to the umbilical was via a trolley on inflated wheels, once again introducing other transients particularly at reversal points.

Numerous cyclic reeling tests have been performed on similar products with no problems, thus it was concluded that this test rig was inappropriate and had induced faults, causing premature failure.

3.0 BRIDON TEST

This test was performed at the Bridon Willington Quays facility on Tuesday 15 April 2008. It was performed on a test machine designed for steel rope of a similar diameter to this umbilical and by Bridon personnel who are very experienced in doing this type of work. Catherine Toleman of SMD and Alan Clark of Cortland Fibron witnessed part of the testing.

Some photographs of the test rig with the umbilical install into it are shown below:



The sheave wheel had a pitch circle diameter of 347.3mm and a root diameter of 330mm which was less than the diameter of the Global Marine sheave wheel which had a 450mm root diameter. Thus, in theory, the Bridon test should have been more onerous.

The groove in the sheave was $17.3 + 7.5\%$ (18.6mm).

A load of 60kN (6.1T) was applied and it was cycled at approximately 9 cycles per min.

Ovality was monitored every 250 cycles, but optical and electrical continuity could not be performed until the test was completed.

The optical testing, electrical continuity and visual examination were performed at the Cortland Fibron factory after completion of the cycle test.

Optical and electrical continuity were tested and both passed.

Ovality on load varied between 17.26mm and 17.02mm in one plane and between 16.83mm and 16.6mm in the opposite plane.

The optics and electrical units showed no discernable change from the virgin state.

Photographs of each dissection stage are provided below.

	Sample of the umbilical at the transition section that had been on and off sheave wheel (i.e. cycled) and that which had not.
	Section of the umbilical with the armour removed.
	Section of the umbilical with outer jacket removed. Discoloured portion is the area that had seen bending.

	Copper polyester tape removed from the umbilical. Signs of the tape cracking. This is typical on a cable that has undergone 5000 cycles.
	View of the assembly. Shows the assembly in good order with no evidence of mechanical damage to the component parts.
	View of the central quad. Again in good order with no signs of damage to the component parts

Although there was clear evidence that the cable had undergone a 5000 cycle test there were no visual signs of any degradation to the component parts.

As expected the cable had convincingly passed the cycle test.

4.0 CONCLUSION

The umbilical passed the 5000 cycle test on the Bridon test rig. There were deficiencies with the Global Marine test rig and set up that had resulted in premature failure.

2.3 Dimensional Checks

2.3.1 SAMPLE DIMENSIONAL LOGGING SHEETS



DIMENSIONAL CHECK RECORD SHEET

WORKS ORDER NO: 8695

CUSTOMER: SMD.

DATE: 08-01-08

LENGTH: SAMPLE

PART. NO: RUC011

LENGTH:

CHECKED BY: 19

RESULTS:

Item	Specification	Actual Measurement
0.22mm ² QUAD:		
OD RED	1.05mm +/- 0.05mm.	1.09
OD BLUE	—— " ——	1.05
OD YELLOW	—— " ——	1.09
OD WHITE.	—— " ——	1.09
IPS. RED	NOM. 0.23mm MID 0.18mm	0.2 MID
IPS. BLUE	—— " ——	0.2 MID
IPS. YELLOW	—— " ——	0.2 MID
IPS. WHITE	—— " ——	0.2 MID.
LAY LENGTH	17.0mm +/- 0.5mm.	17.0mm.
4mm ² PAPER CORES:		
OD GREEN	3.70 +/- 0.20	3.70.
OD WHITE	—— " ——	3.70
OD YELLOW	—— " ——	3.70
OD RED	—— " ——	3.70
OD BLUE	—— " ——	3.70.
IPS. GREEN	NOM. 0.55mm MID 0.44	0.51 MID.
IPS. WHITE	—— " ——	0.50 MID.
IPS. YELLOW	—— " ——	0.51 MID
IPS. RED.	—— " ——	0.51 MID
IPS. BLUE.	—— " ——	0.49 MID.
ASSEMBLY LAY LENGTH	70.0mm +/- 1.4mm.	71.0mm.



WORKS ORDER NO: 8695

CUSTOMER: SHD.

DATE: 08-01-08

LENGTH: SAME

PART. NO: 240011

LENGTH:

CHECKED BY: 19

RESULTS:

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2.4 MATERIAL COMPATIBILITY

2.4.1 COMPATIBILITY REPORT – THERMOPLASTICS USED AGAINST ROYAL PURPLE OIL

Materials Technology Ltd.

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Chapel Lane, Southampton SO40 9NA

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Web: www.mtechltd.co.uk

**Swell Tests Performed on Polyethylene
and Polypropylene Granules in Royal
Purple Hydraulic Fluid**

Mr A. Clarke
Cortland Fibron Ltd.
Unit 2 RD Park
Stephenson Close
Hoddesdon
Herts EN11 0BW

September 23, 2008

Job No: A88555

Introduction

This report details swell tests performed on a sample of polyethylene and two samples of polypropylene granules immersed in Royal Purple hydraulic fluid. The tests were performed for 7 days at 50°C.

The hydraulic fluid and polymers were supplied by Cortland Fibron Ltd.

The samples were identified as follows:

1. Polyethylene granules (PEH3366)
2. Polypropylene granules (PP553)
3. Polypropylene granules (PP4821)

Method & Results

Discs approximately 30mm in diameter and 2-3mm thick were pressed from each of the materials. The samples were then immersed in the Royal Purple test fluid for 7 days and maintained in an oven at 50°C. Following the test the discs were washed and dried prior to weighing.

The results are given below:

	PE (PEH3366) Disc	PP (PP553) Disc	PP (4821) Disc
Test solution	Royal Purple		
Test Temp	50°C		
Test duration 7 days	7 days		
wt pre test	2.9543	2.737	4.2723
wt post test	2.9617	2.8221	4.5534
Difference	0.0074	0.0851	0.2811
% change	0.25%	3.11%	6.58%
Visible differences post test	No visible changes		Sample has yellowed & possibly softened slightly.

Justin Bates

2.4.2 MATERIAL COMPATIBILITY DATA – POLYPROPYLENE



Polypropylene Chemical Resistance Table Polypropylene

Introduction

The table in this document summarises the data given in a number of polypropylene chemical resistance tables at present in use in various countries, derived from both practical experience and test results.

Source: ISO/TR 10358

The table contains an evaluation of the chemical resistance to a number of fluids judged to be either aggressive or not towards polypropylene. This evaluation is based on values obtained by immersion of polypropylene test specimens in the fluid concerned at 20, 60 and 100°C and atmospheric pressure, followed in certain cases by the tensile characteristics.

A subsequent classification will be established with respect to a restricted number of fluids deemed to be technically or commercially more important, using equipment which permits testing under pressure and the determination of the "coefficient of chemical resistance" for each fluid. These tests will thus furnish more complete indications on the use of polypropylene piped for the transport of stated fluids, including their use under pressure.

Scope and Field Application

This document establishes a provisional classification of the chemical resistance of polypropylene with respect to about 180 fluids. It is intended to provide general guidelines on the possible utilisation of polypropylene piping for the conveyance of fluids:

- at temperatures up to 20, 60 and 100°C
- in the absence of internal pressure and external mechanical stress
(for example flexural stresses, stresses due to thrust, rolling loads etc).

Definitions, Symbols and Abbreviations

The criteria of classifications, definitions, symbols and abbreviations adopted in this document are as follows:

S = Satisfactory

The chemical resistance of polypropylene exposed to the action of a fluid is classified as "satisfactory" when the results of test are acknowledged to be "satisfactory" by the majority of the countries participating in the evaluation.

L = Limited

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BOREALIS



Polypropylene

Chemical Resistance Table Polypropylene

The chemical resistance of polypropylene exposed to the action of fluid is classified as "limited" when the results of tests are acknowledged to be "limited" by the majority of the countries participating in the evaluation.

Also classified as "limited" are the resistances to the action of chemical fluids for which judgements "S" and "NS" or "L" are pronounced to an equal extent.

NS = Not satisfactory

The chemical resistance of polypropylene exposed to the action of a fluid classified as "not satisfactory" when the results of test are acknowledged to be "not satisfactory" by the majority of the countries participating in the evaluation.

Also classified as "not satisfactory" are materials for which judgement "L" and "NS" are pronounced to an equal extent.

Sat.sol Saturated aqueous solution, prepared at 20°C

Sol Aqueous solution at a concentration higher than 10 % but not saturated

Dil.sol Dilute aqueous solution at a concentration equal to or lower than 10 %

Work.sol Aqueous solution having the usual concentration for industrial use

Solution concentrations reported in the text are expressed as a percentage by mass. The aqueous solutions of sparingly soluble chemicals are considered, as far as chemical action towards polypropylene is concerned, as saturated solutions.

In general, common chemical names are used in this document.

The table is made as a first guideline for user of polypropylene. If a chemical compound is not to be found or if there is an uncertainty on the chemical resistance in an application, please contact Borealis for advice and proposal on testing.



BOREALIS



Polypropylene

Chemical Resistance Table Polypropylene

Chemical Resistance of Polypropylene, Not Subjected to Mechanical Stress, to Various Fluids at 20, 60 and 100°C

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Acetic acid	Up to 40 %	S	S	-
Acetic acid	50 %	S	S	L
Acetic acid, glacial	> 96 %	S	L	NS
Acetic anhydride	100 %	S	-	-
Acetone	100 %	S	S	-
Acephenone	100 %	S	L	-
Acrylonitrile	100 %	S	-	-
Air		S	S	S
Allyl alcohol	100 %	S	S	-
Almond oil		S	-	-
Alum	Sol	S	S	-
Ammonia, aqueous	Sat.sol	S	S	-
Ammonia, dry gas	100 %	S	-	-
Ammonia, liquid	100 %	S	-	-
Ammonium acetate	Sat. sol	S	S	-
Ammonium chloride	Sat.sol	S	S	-
Ammonium fluoride	Up to 20 %	S	S	-
Ammonium hydrogen carbonate	Sat.sol	S	S	-
Ammonium metaphosphate	Sat.sol	S	S	S
Ammonium nitrate	Sat.sol	S	S	S
Ammonium persulphate	Sat.sol	S	S	-
Ammonium phosphate	Sat.sol	S	-	-
Ammonium sulphate	Sat.sol	S	S	S
Ammonium sulphide	Sat.sol	S	S	-
Amyl acetate	100 %	L	-	-
Amyl alcohol	100 %	S	S	S
Aniline	100 %	S	S	-
Apple juice		S	-	-
Aqua regia	HCl/HNO ₃ =3/1	NS	NS	NS
Barium bromide	Sat.sol	S	S	S
Barium carbonate	Sat.sol	S	S	S
Barium chloride	Sat.sol	S	S	S

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BOREALIS



Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Barium hydroxide	Sat.sol	S	S	S
Sulphide	Sat.sol	S	S	S
Beer		S	S	-
Benzene	100 %	L	NS	NS
Benzoic acid	Sat.sol	S	S	-
Benzyl alcohol	100 %	S	L	-
Borax	Sol	S	S	-
Boric acid	Sat.sol	S	-	-
Boron trifluoride	Sat.sol	S	-	-
Bromine, gas		NS	NS	NS
Bromine, liquid	100 %	NS	NS	NS
Butane, gas	100 %	S	-	-
Butanol	100 %	S	L	L
Butyl acetate	100 %	L	NS	NS
Butyl glycol	100 %	S	-	-
Butyl phenols	Sat.sol	S	-	-
Butyl phthalate	100 %	S	L	L
Calcium carbonate	Sat.sol	S	S	S
Calcium chlorate	Sat.sol	S	S	-
Calcium chloride	Sat.sol	S	S	S
Calcium hydroxide	Sat.sol	S	S	S
Calcium hypochlorite	Sol	S	-	-
Calcium nitrate	Sat.sol	S	S	-
Camphor oil		NS	NS	NS
Carbon dioxide, dry gas		S	S	-
Carbon dioxide, wet gas		S	S	-
Carbon disulphide	100 %	S	NS	NS
Carbon monoxide, gas		S	S	-
Carbon tetrachloride	100 %	NS	NS	NS
Castor oil	100 %	S	S	-
Caustic soda	Up to 50 %	S	L	L
Chlorine, aqueous	Sat.sol	S	L	-
Chlorine, dry gas	100 %	NS	NS	NS
Chlorine, liquid	100 %	NS	NS	NS
Chloroacetic acid	Sol	S	-	-



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Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Chloroethanol	100 %	S	-	-
Chloroform	100 %	L	NS	NS
Chlorosulphonic acid	100 %	NS	NS	NS
Chrome alum	Sol	S	S	-
Chromic acid	Up to 40 %	S	L	NS
Citric acid	Sat.sol	S	S	S
Coconut oil		S	-	-
Copper (II) chloride	Sat.sol	S	S	-
Copper (II) nitrate	Sat.sol	S	S	S
Copper (II)	Sat.sol	S	S	-
Corn oil		S	L	-
Cottonseed oil		S	S	-
Cresol	Greater than 90 %	S	-	-
Cyclohexane	100 %	S	-	-
Cyclohexanol	100 %	S	L	-
Cyclohexanone	100 %	L	NS	NS
Decalin (decahydronaphthalene)	100 %	NS	NS	NS
Dextrin	Sol	S	S	-
Dextrose	Sol	S	S	S
Dibutyl phthalate	100 %	S	L	NS
Dichloroacetic acid	100 %	L	-	-
Dichloroethylene (A and B)	100 %	L	-	-
Diethanolamine	100 %	S	-	-
Diethyl ether	100 %	S	L	-
Diethylene glycol	100 %	S	S	-
Diglycolic acid	Sat.sol	S	-	-
Diisooctyl	100 %	S	L	-
Dimethyl amine, gas		S	-	-
Dimethyl formamide	100 %	S	S	-
Diethyl phthalate	100 %	L	L	-
Dioxane	100 %	L	L	-
Distilled water	100 %	S	S	S
Ethanolamine	100 %	S	-	-
Ethyl acetate	100 %	L	NS	NS

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Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Ethyl alcohol	Up to 95 %	S	S	S
Ethyl chloride, gas		NS	NS	NS
Ethylene chloride (mono and di)		L	L	-
Ethyl ether	100 %	S	L	-
Ethylene glycol	100 %	S	S	S
Fertic chloride	Sat.sol	S	S	S
Formaldehyde	40 %	S	-	-
Formic acid	10 %	S	S	L
Formic acid	85 %	S	NS	NS
Formic acid, anhydrous	100 %	S	L	L
Fructose	Sol	S	S	S
Fruit juice		S	S	S
Gasoline, petrol (aliphatic hydrocarbons)		NS	NS	NS
Gelatine		S	S	-
Glucose	20 %	S	S	S
Glycerine	100 %	S	S	S
Glycolic acid	30 %	S	-	-
Heptane	100 %	L	NS	NS
Hexane	100 %	S	L	-
Hydrobromic acid	Up to 48 %	S	L	NS
Hydrochloric acid	Up to 20 %	S	S	S
Hydrochloric acid	30 %	S	L	L
Hydrochloric acid	From 35 to 36 %	S	-	-
Hydrofluoric acid	Dil.sol	S	-	-
Hydrofluoric acid	40 %	S	-	-
Hydrogen	100 %	S	-	-
Hydrogen chloride, dry gas	100 %	S	S	-
Hydrogen peroxide	Up to 10 %	S	-	-
Hydrogen peroxide	Up to 30 %	S	L	-
Hydrogen sulphide, dry gas	100 %	S	S	-
Iodine, in alcohol		S	-	-
Isoctane	100 %	L	NS	NS


BOREALIS



Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Isopropyl alcohol	100 %	S	S	S
Isopropyl ether	100 %	L	-	-
Lactic acid	Up to 90 %	S	S	-
Lanoline		S	L	-
Linseed oil		S	S	S
Magnesium carbonate	Sat.sol	S	S	S
Magnesium chloride	Sat.sol	S	S	-
Magnesium hydroxide	Sat.sol	S	S	-
Magnesium sulphate	Sat.sol	S	S	-
Malic acid	Sat.sol	S	S	-
Mercury (II) chloride	Sat.sol	S	S	-
Mercury (II) cyanide	Sat.sol	S	S	-
Mercury (I) nitrate	Sol	S	S	-
Mercury	100 %	S	S	-
Methyl acetate	100 %	S	S	-
Methyl alcohol	5 %	S	L	L
Methyl amine	Up to 32 %	S	-	-
Methyl bromide	100 %	NS	NS	NS
Methyl ethyl ketone	100 %	S	-	-
Methylene chloride	100 %	L	NS	NS
Milk		S	S	S
Monochloroacetic acid	>85 %	S	S	-
Naphtha		S	NS	NS
Nickel chloride	Sat.sol	S	S	-
Nickel nitrate	Sat.sol	S	S	-
Nickel sulphate	Sat.sol	S	S	-
Nitric acid	Up to 30 %	S	NS	NS
Nitric acid	From 40 to 50 %	L	NS	NS
Nitric acid, fuming (with nitrogen dioxide)		NS	NS	NS
Nitrobenzene	100%	S	L	-
Oleic acid	100 %	S	L	-
Oleum (sulphuric acid with 60 % of SO ₃)		S	L	-

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Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Olive oil		S	S	L
Oxalic acid	Sat.sol	S	L	NS
Oxygen, gas		S	-	-
Paraffin oil (FL65)		S	L	NS
Peanut oil		S	S	-
Peppermint oil		S	-	-
Perchloric acid	(2 N) 20 %	S	-	-
Petroleum ether (ligroine)		L	L	-
Phenol	5 %	S	S	-
Phenol	90 %	S	-	-
Phosphine, gas		S	S	-
Phosphoric acid	Up to 85 %	S	S	S
Phosphorus oxychloride	100 %	L	-	-
Picric acid	Sat.sol	S	-	-
Potassium bicarbonate	Sat.sol	S	S	S
Potassium borate	Sat.sol	S	S	-
Potassium bromate	Up to 10 %	S	S	-
Potassium bromide	Sat.sol	S	S	
Potassium carbonate	Sat.sol	S	S	
Potassium chlorate	Sat.sol	S	S	
Potassium chlorite	Sat.sol	S	S	
Potassium chromate	Sat.sol	S	S	
Potassium cyanide	Sol	S	-	
Potassium dichromate	Sat.sol	S	S	S
Potassium ferricyanide	Sat.sol	S	S	-
Potassium fluoride	Sat.sol	S	S	-
Potassium hydroxide	Up to 50 %	S	S	S
Potassium iodide	Sat.sol	S	-	-
Potassium nitrate	Sat.sol	S	S	-
Potassium perchlorate	10 %	S	S	-
Potassium permanganate	(2 N) 30 %	S	-	-
Potassium persulphate	Sat.sol	S	S	-
Potassium sulphate	Sat.sol	S	S	-
Propane, gas	100 %	S	-	-
Propionic acid	>50 %	S	-	-


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Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Pyridine	100 %	L	-	-
Seawater		S	S	S
Silicon oil		S	S	S
Silver nitrate	Sat.sol	S	S	L
Sodium acetate	Sat.sol	S	S	S
Sodium benzoate	35 %	S	L	-
Sodium bicarbonate	Sat.sol	S	S	S
Sodium carbonate	Up to 50 %	S	S	L
Sodium chlorate	Sat.sol	S	S	-
Sodium chloride	Sat.sol	S	S	-
Sodium chlorite	2 %	S	L	NS
Sodium chlorite	20 %	S	L	NS
Sodium dichromate	Sat.sol	S	S	S
Sodium hydrogen carbonate	Sat.sol	S	S	S
Sodium hydrogen sulphate	Sat.sol	S	S	-
Sodium hydrogen sulphite	Sat.sol	S	-	-
Sodium hydroxide	1 %	S	S	S
Sodium hydroxide	From 10 to 60 %	S	S	S
Sodium hypochlorite	5 %	S	S	-
Sodium hypochlorite	10 % - 15 %	S	-	-
Sodium hypochlorite	20 %	S	L	-
Sodium metaphosphate	Sol	S	-	-
Sodium nitrate	Sat.sol	S	S	-
Sodium perborate	Sat.sol	S	S	-
Sodium phosphate (neutral)		S	S	S
Sodium silicate	Sol	S	S	-
Sodium sulphate	Sat.sol	S	S	-
Sodium sulphide	Sat.sol	S	-	-
Sodium sulphite	40 %	S	S	S
Sodium thiosulphate (hypo)	Sat.sol	S	-	-
Soybean oil		S	L	-
Succinic acid	Sat.sol	S	S	-
Sulphuric acid	Up to 10 %	S	S	S
Sulphuric dioxide, dry or wet	100 %	S	S	-

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Polypropylene

Chemical Resistance Table Polypropylene

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Sulphur acid	From 10 to 30 %	S	S	-
Sulphuric acid	50 %	S	L	L
Sulphuric acid	96 %	S	L	NS
Sulphuric acid	98 %	L	NS	NS
Sulphurous acid	Up to 30 %	S	-	-
Tartaric acid	Sat.sol	S	S	-
Tetrahydrofuran	100 %	L	NS	NS
Tetralin	100 %	NS	NS	NS
Thiophene	100 %	S	L	-
Tin (IV) chloride	Sol	S	S	-
Tin (II) chloride	Sat.sol	S	S	-
Toluene	100 %	L	NS	NS
Trichloroacetic acid	Up to 50 %	S	S	-
Trichloroethylene	100 %	NS	NS	NS
Triethanolamine	Sol	S	-	-
Turpentine		NS	NS	NS
Urea	Sat.sol	S	S	-
Vinegar		S	S	-
Water brackish, mineral, potable		S	S	S
Whiskey		S	S	-
Wines		S	S	-
Xylene	100 %	NS	NS	NS
Yeast	Sol	S	S	S
Zinc chloride	Sat.sol	S	S	-
Zinc sulphate	Sat.sol	S	S	-


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2.4.3 MATERIAL COMPATIBILITY DATA – POLYETHYLENE



Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Introduction

The table in this document summarises the data given in a number of chemical resistance tables at present in use in various countries, derived from both practical experience and test results.

Source: ISO/TR 7472, 7474; Carlowitz: "Kunststofftabellen-3. Auflage".

The table contains an evaluation of the chemical resistance of a number of fluids judged to be either aggressive or not towards low and high density polyethylene. This evaluation is based on values obtained by immersion of low and high density polyethylene test specimens in the fluid concerned at 20 and 60°C and atmospheric pressure, followed in certain cases by the determination of tensile characteristics.

A subsequent classification will be established with respect to a restricted number of fluids deemed to be technically or commercially more important, using equipment which permits testing under pressure and the determination of the coefficient of chemical resistance for each fluid. These tests will thus furnish more complete indications on the use of low and high density polyethylene products for the transport of stated fluids, including their use under pressure.

Scope and Field Application

This document establishes a provisional classification of the chemical resistance of low and high density polyethylene with respect to about 300 fluids. It is intended to provide general guidelines on the possible utilisation of low and high density polyethylene.

- at temperatures up to 20 and 60°C
- in the absence of internal pressure and external mechanical stress
(for example flexural stresses, stresses due to twist, rolling loads etc).

Definitions, Symbols and Abbreviations

The criteria of classification, definitions, symbols and abbreviations adopted in this document are as follows:

S = Satisfactory

The chemical resistance of low and high density polyethylene exposed to the action of a fluid is classified as "satisfactory" when the results of test are acknowledged to be satisfactory by the majority of the countries participating in the evaluation.

L = Limited

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Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

The chemical resistance of low and high density polyethylene exposed to the action of a fluid is classified as "limited" when the results of tests are acknowledged to be "limited" by the majority of the countries participating in the evaluation.

Also classified as "limited" is the resistance to the action of chemical fluids for which judgements "S" and "NS" or "L" are pronounced to an equal extent.

NS = Not satisfactory

The chemical resistance of low and high-density polyethylene exposed to the action of a fluid is classified as "not satisfactory" when the results of tests are acknowledged to be "not satisfactory" by the majority of the countries participating in the evaluation.

Also classified as "not satisfactory" are materials for which judgements "L" and "NS" are pronounced to an equal extent.

Sat.sol Saturated aqueous solution, prepared at 20°C

Sol Aqueous solution at a concentration higher than 10%, but not saturated

Dil.sol Dilute aqueous solution at a concentration equal to or lower than 10%

Work.sol Aqueous solution having the usual concentration for industrial use

Solution concentrations reported in the text are expressed as a percentage by mass. The aqueous solution of sparingly soluble chemicals are considered, as far as chemical action towards low or high-density polyethylene is concerned, as saturated solutions.

In general, common chemical names are used in this document.

The table is made as a first guideline for user of polyethylene. If a compound is not to be found or if there is an uncertainty on the chemical resistance in an application, please contact Borealis for advice and proposal on testing.



Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical resistance of polypropylene, not subjected to mechanical stress, to various fluids at 20, 60 and 100°C

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Acetaldehyde	100 %	L	NS	S	L
Acetanilide	-			S	S
Acetic acid	10 %	S	S	S	S
Acetic acid	60 %	S	L	S	S
Acetic acid, glacial	Greater than 96 %	L	NS	S	L
Acetic anhydride	100 %	L	NS	S	L
Acetone	100 %	L	NS	L	L
Acrylnirile	-	S	S	S	S
Acetylsilicacid	-	S	S	S	S
Adipic acid	Sat.sol	S	S	S	S
After shave	-	NS	NS	NS	NS
Aliphatic hydrocarbons	-	L	NS	L	L
Allyl acetate	-	S	L	S	L
Allyl alcohol	100 %	L	NS	-	-
Allyl alcohol	96 %	-	-	S	S
Aluminum chloride	-	L	NS	L	NS
Aluminum fluoride	Sat.sol	S	S	S	S
Aluminum hydroxide	Sat.sol	S	S	S	S
Aluminum nitrite	Sat.sol	S	S	S	S
Aluminum oxychloride	Sat.sol	S	S	S	S
Aluminum sulphate	Sat.sol	S	S	S	S
Aluminum sulphate	Sat.sol	S	S	S	S
Alums	Sol	S	S	S	S
Aminobenzoic acid	-	S	S	S	S
Ammonia, dry gas	100 %	S	S	S	S
Ammonia liquid	100 %	L	L	S	S
Ammonia aqueous	Dil.sol	S	S	S	S
Ammonium acetate	-	S	S	S	S
Ammonium carbonate	Sat.sol	S	S	S	S
Ammonium chloride	Sat.sol	S	S	S	S
Ammonium fluoride	Sol	S	-	S	S
Ammonium hexafluorosilicate	Sat.sol	S	S	S	S
Ammonium hydrogen caronate	Sat.sol	S	S	S	S

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Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Ammonium hydroxide	10 %	S	S	S	S
Ammonium hydroxide	30 %	S	S	S	S
Ammonium metaphosphate	Sat.sol	S	S	S	S
Ammonium nitrate	Sat.sol	S	S	S	S
Ammonium oxalate	Sat.sol	S	S	S	S
Ammonium phosphate	Sat.sol	S	S	S	S
Ammonium persulphate	Sat.sol	S	S	S	S
Ammonium sulphate	Sat.sol	S	S	S	S
Ammonium sulphide	Sol	S	S	S	S
Ammonium thiocyanate	Sat.sol	S	S	S	S
Amyl acetate	100 %	NS	NS	L	L
Amyl alcohol	100 %	L	L	S	L
Amyl chloride	100 %	NS	NS	-	-
Amyl phthalate	-	L	L	S	L
Aniline	100 %	NS	NS	S	L
Anilinchlorohydrate	-	L	-	-	-
Antimony (III) chloride	90 %	-	-	S	S
Antimony (III)	Sat.sol	S	S	S	S
Antimony trichloride	Sol	S	S	S	S
Apple juice	Sol	-	-	S	L
Aqua regia	HCl/HNO ₃ =3/1	NS	NS	NS	NS
Aromatic hydrocarbons	-	NS	NS	NS	NS
Arsenic acid	Sat.sol	S	S	S	S
Asorbic	10 %	S	S	S	S
Barium bormide	Sat.sol	S	S	S	S
Barium carbonate	Sat.sol	S	S	S	S
Borium chloride	Sat.sol	S	S	S	S
Barium hydroxide	Sat.sol	S	S	S	S
Barium sulphate	Sat.sol	S	S	S	S
Barium sulphide	Sat.sol	S	S	S	S
Beer	-	S	S	S	S
Benzaldehyde	100 %	L	NS	S	L
Benzene	100 %	NS	NS	L	L
Benzoic acid	Sat.sol	S	S	S	S
Benzoylchloride	-	S	L	S	L





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Benzyl alcohol	-	S	L	S	S
Benzylsulphonic acid	10 %	S	S	S	S
Bismuty carbonate	Sat.sol	S	S	S	S
Bitumen	-	S	L	S	S
Bleach lye	10 %	S	S	S	S
Borax	Sat.sol	S	S	S	S
Boric acid	Sat.sol	S	S	S	S
Boron trifluoride	-	L	NS	L	NS
Brake fluid	-	L	NS	L	NS
Brine	-	S	S	S	S
Bromine, dry gas	100 %	NS	NS	NS	NS
Bromine, liquid	100 %	NS	NS	NS	NS
Bromoform	100 %	NS	NS	NS	NS
Butandiol	10 %	S	S	S	S
Butandiol	60 %	S	S	S	S
Butandiol	100 %	S	S	S	S
Butane, gas	100 %	-	-	S	S
Butanol	100 %	S	L	S	S
Butter	-	S	S	S	S
Butyl acetate	100 %	S	L	S	L
Butyl alcohol	100 %	S	S	S	S
Butyl chloride	-	S	-	S	-
Bytylene glycol	10 %	S	S	S	S
Bytylene glycol	60 %	S	S	S	S
Bytylene glycol	100 %	S	S	S	S
Butyraldehyde	-	-	-	S	L
Butyric acid	100 %	L	L	S	L
Calcium arsenate	-	S	S	S	S
Calcium benzoate	-	S	S	S	S
Calcium bisulphide	-	S	S	S	S
Calcium bromate	10 %	S	S	S	S
Calcium bromide	Sat.sol	S	S	S	S
Calcium carbonate	Sat.sol	S	S	S	S
Calcium chlorate	Sat.sol	S	S	S	S
Calcium chloride	Sat.sol	S	S	S	S

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Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Calcium chromate	40 %	S	S	S	S
Calcium cyanide	-	S	S	S	S
Calcium hydrosulphide	Sol	S	S	S	S
Calcium hydroxide	Sat.sol	S	S	S	S
Calcium hypochlorite	Sol	S	S	S	S
Calcium nitrate	Sat.sol	S	S	S	S
Calcium oxide	Sat.sol	S	S	S	S
Calcium perchlorate	1 %	S	-	S	S
Calcium permanganate	20 %	S	S	S	S
Calcium persulphate	Sol	S	S	S	S
Calcium sulphate	Sat.sol	S	S	S	S
Calcium sulphide	Dil.sol	-	-	L	L
Camphor oil	-	NS	NS	L	L
Carbon dioxide, dry gas	100 %	-	-	S	S
Carbon dioxide, wet	-	S	S	S	S
Carbon disulphide	100 %	NS	NS	L	NS
Carbon monoxide	100 %	S	S	S	S
Carbon tetrachloride	100 %	NS	NS	L	NS
Carbonic acid		S	S	S	S
Castor oil	Sol	S	S	S	S
Chlorine, water	2 % sat.sol	L	L	S	S
Chlorine, aqueous	Sat.sol	NS	NS	L	NS
Chlorine, dry gas	100 %	NS	NS	L	NS
Chloroacetic acid	Sol	-	-	S	S
Chlorobenzene	100 %	NS	NS	NS	NS
Chloroethanol	100 %	S	S	S	S
Chloroform	100 %	NS	NS	NS	NS
Chloromethane, gas	100 %	L	-	L	-
Chlorosulphonic acid	100 %	NS	NS	NS	NS
Chloropropene	-	NS	-	L	-
Chrome alum	Sol	S	S	S	S
Chrome acid	Sat.sol	S	S	-	-
Chrome acid	20 %	-	-	S	L
Chrome acid	50 %	-	-	S	L
Chromium VI oxide	Sat.sol	S	S	S	S
Cider	-	S	S	S	S





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Citric acid	Sat.sol	S	S	S	S
Citric acid	10 %	S	S	S	S
Citric acid	25 %	S	S	S	S
Coconut oil alcoholic	-	S	S	S	S
Coffee	-	S	S	S	S
Copper (II) chloride	Sat.sol	S	S	S	S
Copper cyanide	Sat.sol	S	S	S	S
Copper (II) fluoride	Sat.sol	S	S	S	S
Copper (II) fluoride	2 %	S	S	S	S
Copper (II) nitrate	Sat.sol	S	S	S	S
Copper (II) sulphate	Sat.sol	S	S	S	S
Corn oil	-	S	S	S	S
Cottonseed oil	-	S	S	S	S
Cresylic acid	Sat.sol	-	-	L	-
Crotonaldehyde	Sat.sol	L	-	-	-
Cyclanone	-	S	S	S	S
Cyclohexane	-	NS	NS	NS	NS
Cyclohexanol	Sat.sol	L	NS	-	-
Cyclohexanol	100 %	-	-	S	S
Cyclohexanone	100 %	NS	NS	S	L
Decahydronaphthalene	100 %	L	NS	S	L
Decane	-	NS	NS	L	NS
Decalin	100 %	-	-	S	L
Detergents, synthetic	-	S	S	S	S
Developers (photographic)	Work.conc	-	-	S	S
Dextrin	Sol	S	S	S	S
Dextrose	Sol	S	S	S	S
Diacetone alcohol	-	L	L	L	L
Diazo salts	-	S	S	S	S
Dibutyl amine	-	NS	NS	L	NS
Dibutyl ether	-	NS	NS	L	-
Dibutylphthalate	-	L	L	S	L
Dichlorobenzene	-	NS	NS	NS	NS
Dichloropropylene	-	NS	NS	NS	NS
Diesel oil	-	S	NS	S	L

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Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Diethyl ether	100 %	NS	NS	L	-
Diethyl ketone	-	L	NS	L	L
Diethylene glycol	-	S	S	S	S
Diglycolic acid	-	S	S	S	S
Diisobutylketone	100 %	S	L	S	L
Dimethyl amine	100 %	NS	NS	-	-
Dimethyl formamid	-	S	L	S	S
Diocetyl phtalate	100 %	L	NS	S	L
Dioxan	100 %	-	-	S	S
Dipentene	-	NS	NS	NS	NS
Disodium phosphate	-	S	S	S	S
Drano, plumbing cleaner	-	S	S	S	S
Emulsions, photographic	-	S	S	S	S
Ehtandiol	100 %	S	S	S	S
Ethanol	40 %	S	L	S	L
Ethanol	96 %	L	L	-	-
Ethyl acetate	100 %	L	NS	S	NS
Ethyl acrylate	100 %	NS	NS	L	NS
Ethyl alcohol	35 %	S	S	S	S
Ethyl alcohol	100 %	S	S	S	S
Ethyl benzene	-	NS	NS	NS	NS
Ethyl chloride	100 %	NS	NS	NS	NS
Ethylene chloride	100 %	NS	NS	NS	NS
Ethylene diamine	100 %	S	L	S	S
Ethyl ether	-	NS	NS	NS	NS
Ethylene glycol	100 %	S	S	S	S
Ethyl mercaptan	-	NS	NS	NS	NS
Ferric chloride	Sat.sol	S	S	S	S
Ferric nitrite	Sat.sol	S	S	S	S
Ferric sulphate	Sat.sol	S	S	S	S
Ferrous chloride	Sat.sol	S	S	S	S
Ferrous sulphate	Sat.sol	S	S	S	S
Fich solubles	Sol	S	S	S	S
Fluoboric acid	-	S	S	S	S





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Fluorine gas	100 %	L	NS	NS	NS
Fluorine gas, dry	100 %	NS	NS	NS	NS
Fluorine gas, wet	100 %	NS	NS	NS	NS
Fluorosilic acid	Conc	S	L	S	L
Fluorosilic acid	40 %	S	S	S	S
Formaldehyde	40 %	S	S	S	S
Formic acid	40 %	S	S	S	S
Formic acid	98 to 100 %	S	S	S	S
Fructose	Sat.sol	S	S	S	S
Fruit pilps	Sol	S	S	S	S
Furfural	100 %	NS	NS	NS	NS
Furfural alcohol	100 %	L	NS	S	L
Gallic acid	Sat.sol	S	S	S	S
Gasoline, petrol	-	L	NS	L	L
Gelatine	-	S	S	S	S
Glucose	Sat.sol	S	S	S	S
Glycerine	100 %	S	S	S	S
Glycerol	100 %	S	S	S	S
Glycolic acid	30 %	S	L	-	-
Glycolic acid	Sol	-	-	S	S
n-Heptane	100 %	NS	NS	L	NS
Hexachlorobenzene	-	S	S	S	L
Hexachlorophene	-	NS	NS	L	L
Hexamethylenetrimer	40 %	S	-	S	-
Hexane	-	S	L	S	L
Hexanol, tertiary	-	S	S	S	S
Hydrobromic acid	50 %	S	S	S	S
Hydrobromic acid	Up to 100 %	S	S	S	S
Hydrobromic acid	Up to 36 %	S	S	S	S
Hydrobromic acid	Conc	S	S	S	S
Hydrochlorous acid	Conc	S	S	S	S
Hydrocyanic acid	10 %	S	S	S	S
Hydrocyanic acid	Sat.sol	S	S	S	S
Hydrofluoric acid	40 %	S	S	S	S

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Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Hydrofluoric acid	60 %	S	L	S	L
Hydrogen	100 %	S	S	S	S
Hydrogen chloride	Dry gas	S	S	S	S
Hydrogen peroxide	30 %	S	L	S	S
Hydrogen peroxide	90 %	S	NS	S	NS
Hydrogen sulphide gas	100 %	S	S	S	S
Hydroquinone	Sat.sol	S	S	-	-
Hydroxylamine	Up to 12 %	S	S	S	S
Inks	-	S	S	S	S
Iodine (in potassium sil)	-	L	NS	NS	NS
Iodine (in alcohol)	-	NS	NS	NS	NS
Iron (II) chloride	Sat.sol	S	S	S	S
Iron (II) sulphate	Sat.sol	S	S	S	S
Iron (III) chloride	Sat.sol	S	S	S	S
Iron (II) nitrate	Sol	S	S	S	S
Iron (III) sulphate	Sat.sol	S	S	S	S
Iso octane	100 %	S	NS	S	L
Iso pentane	-	NS	NS	NS	NS
Isopropanol	-	S	S	S	S
Isopropyl amine	-	NS	NS	NS	NS
Isopropyl ether	100 %	L	NS	S	NS
Kerosene	-	NS	NS	NS	NS
Lactic acid	10 %	S	S	S	S
Lactic acid	28 %	S	S	S	S
Lactic acid	Up to 100 %	S	S	S	S
Latex	-	S	S	S	S
Lead acetate	Dil.sol	S	S	S	S
Lead acetate	Sat.sol	S	S	S	S
Lead arsenate	-	S	S	S	S
Lubricating oil	-	S	S	S	S
Lysol	-	NS	NS	L	NS





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Magnesium carbonate	Sat.sol	S	S	S	S
Magnesium chloride	Sat.sol	S	S	S	S
Magnesium hydroxide	Sat.sol	S	S	S	S
Magnesium nitrite	Sat.sol	S	S	S	S
Magnesium sulphate	Sat.sol	S	S	S	S
Maleic acid	Sat.sol	S	S	S	S
Mercury	-	S	S	S	S
Mercury (I) nitrite	Sol	S	S	S	S
Mercury (II) chloride	Sat.sol	S	S	S	S
Mercury (II) Cyanide	Sat.sol	S	S	S	S
Mercury	100 %	S	S	S	S
Methanol	100 %	S	L	S	S
Methyl alcohol	100 %	S	L	S	S
Methyl benzoic acid	Sat.sol	NS	NS	L	-
Methyl bromide	100 %	NS	NS	NS	NS
Methyl chloride	100 %	NS	NS	NS	NS
Methylcyclohexane	-	L	NS	L	NS
Methyl ethyl ketone	100 %	-	-	S	L
Methylene chloride	-	NS	NS	NS	NS
Methoxybutanol	100 %	S	L	S	L
Milk	-	S	S	S	S
Milk of Magnesia	-	S	L	S	L
Mineral oils	-	L	NS	S	L
Molasses	Work.conc	S	S	S	S
Motor oil	-	S	L	S	S
Naphtha	-	L	NS	L	NS
Naphtahalene	-	NS	NS	L	-
Nickel chloride	Sat.sol	S	S	S	S
Nickel nitrate	Sat.sol	S	S	S	S
Nickel sulphate	Sat.sol	S	S	S	-
Nicotine	Dil.sol	S	S	S	S
Nicotinic acis	Dil.sol	L	L	S	-
Nitric acid	25 %	S	S	S	S
Nitric acid	50 %	S	L	S	L
Nitric acid	70 %	S	L	S	L

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Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Nitric acid	95 %	NS	NS	NS	NS
Nitric acid	100 %	NS	NS	NS	NS
Nitrobenzene	100 %	NS	NS	NS	NS
Nitroethane	100 %	S	NS	S	NS
Nitromethane	100 %	S	-	S	-
Nitrotoluene	-	NS	NS	NS	NS
n-Octane	-	S	S	S	S
Octyl alcohol	-	S	NS	S	NS
Oil and fats		L	NS	S	L
Oleic acid	100 %	L	NS	S	S
Oleum (H ₂ SO ₄ + 10 % SO ₃)		NS	NS	NS	NS
Oleum (H ₂ SO ₄ + 50 % SO ₃)		NS	NS	NS	NS
Olive oil	-	S	NS	S	NS
Orthophosphoric acid	50 %	S	S	S	S
Orthophosphoric acid	95 %	S	L	S	L
Oxalic acid	Sat.sol	S	S	S	S
Oxygen	100 %	S	-	S	L
Ozone	100 %	NS	NS	L	NS
Paraffin oil	-	S	L	S	S
n-Pentane	-	NS	NS	NS	NS
Pentane-2	-	NS	NS	NS	NS
Perchloric acid	20 %	S	S	S	S
Perchloric acid	50 %	S	L	S	L
Perchloric acid	70 %	S	NS	S	NS
Perchloroethylene	-	NS	NS	NS	NS
Phenol	Sol	L	NS	S	S
Phosphine	100 %	S	S	S	S
Phosphoric acid	Up to 25 %	S	S	S	S
Phosphoric acid	25 to 50 %	S	S	S	S
Phosphoric (III) chloride	100 %	S	L	S	L
Phosphorous (II) chloride	100 %	-	-	S	L
Phosphorous pentoxide	100 %	S	S	S	S
Phosphorous trichloride	100 %	S	L	S	L
Photographic solutions	-	S	S	S	S





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Phtalic acid	50 %	S	S	S	S
Picric acid	Sat.sol	S	L	S	-
Plating solutions	-	S	S	S	S
Potassium acetate	-	S	S	S	S
Potassium aluminium sulphate	Sat.sol	S	S	S	S
Potassium bezoate	-	S	S	S	S
Potassium bicarbonate	Sat.sol	S	S	S	S
Potassium borate	Sat.sol	S	S	S	S
Potassium bromate	Sat.sol	S	S	S	S
Potassium bromide	Sat.sol	S	S	S	S
Potassium carbonate	Sat.sol	S	S	S	S
Potassium chlorate	Sat.sol	S	S	S	S
Potassium chloride	Sat.sol	S	S	S	S
Potassium chromate	Sat.sol	S	S	S	S
Potassium cyanide	Sol	S	S	S	S
Potassium dichromate	Sat.sol	S	S	S	S
Potassium fluoride	Sat.sol	S	S	S	S
Potassium hexacyanoferrate (III)	Sat.sol	S	S	S	S
Potassium hexacyanoferrate (II)	Sat.sol	S	S	S	S
Potassium hexafluorosilicate	Sat.sol	S	S	S	S
Potassiumhydrogen carbonate	Sat.sol	S	S	S	S
Potassium hydrogen sulphate	Sat.sol	S	S	S	S
Potassium hydrogen sluphide	Sol	-	-	S	S
Potassium hydroxide	10 %	S	S	S	S
Potassium hydroxide	Sol	S	S	S	S
Potassium hypochlorite	Sol	S	L	S	L
Potassium iodate	10 %	S	S	S	S
Potassium iodate	Sat.sol	S	S	S	S
Potassium nitrate	Sat.sol	S	S	S	S
Potassium orthophosphate	Sat.sol	S	S	S	S
Potassium oxalate	Sat.sol	S	S	S	S
Potassium perchlorate	Sat.sol	S	S	S	S
Potassium permanganate	20 %	S	S	S	S
Potassium persulphate	Sat.sol	S	S	S	S
Potassium phosphate	Sat.sol	S	S	S	S
Potassium sulphate	Sat.sol	S	S	S	S

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Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Potassium sulphide	Sol	S	S	S	S
Potassium sulphite	Sat.sol	S	S	-	-
Potassium thiocyanate	Sat.sol	S	S	S	S
Potassium thiosulphate	Sat.sol	S	S	S	S
Propargul alcohol	-	S	S	S	S
n-Propyl alcohol	-	S	S	S	S
Propionic acid	50 %	-	-	S	S
Propionic acid	100 %	-	-	S	L
Propylene dichloride	100 %	NS	NS	NS	NS
Propylene glycol	-	S	S	S	S
Pyridine	100 %	-	-	S	L
Quinol (hydroquinone)	Sat.sol	S	S	S	S
Salicylic	Sat.sol	S	S	S	S
Sea water	-	S	S	S	S
Selenic acid	-	S	S	S	S
Silicon oil	-	S	S	S	S
Silver acetate	Sat.sol	S	S	S	S
Silver cyanide	Sat.sol	S	S	S	S
Silver nitrate	Sat.sol	S	S	-	-
Sop solution	100 %	S	S	S	S
Soduim acetate	Sat.sol	S	S	-	-
Soduim antimonate	Sat.sol	S	S	S	S
Soduim arsenite	Sat.sol	S	S	S	S
Soduim benzoate	Sat.sol	S	S	S	S
Soduim bicarbonate	Sat.sol	S	S	S	S
Soduim bisulphate	Sat.sol	S	S	S	S
Soduim bisulphite	Sat.sol	S	S	S	S
Soduim borate	-	S	S	S	S
Soduim bromide	Sat.sol	S	S	S	S
Soduim carbonate	Sat.sol	S	S	S	S
Soduim chlorate	Sat.sol	S	S	S	S
Soduim chloride	Sat.sol	S	S	S	S
Soduim chlorite	Sat.sol	L	-	-	-
Soduim cyanide	Sat.sol	S	S	S	S



Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Soduim dichromate	Sat.sol	S	S	S	S
Soduim fluoride	Sat.sol	S	S	S	S
Soduim hexacyanoferrate (III)	Sat.sol	-	-	S	S
Soduim hexacyanoferrate (II)	Sat.sol	-	-	S	S
Soduim hexafluorosilicate	Sat.sol	S	S	S	S
Soduim hydrogen carbonate	Sat.sol	S	S	S	S
Soduim hydrogen sulphate	Sat.sol	S	S	S	S
Soduim hydrogen sulphite	Sol	S	S	S	S
Soduim hydroxide	40 %	S	S	S	S
Soduim hydroxide	Sol	-	-	S	S
Soduim hypochloride	-	L	NS	S	S
Soduim hypochlorite	15 % available Cl	-	-	S	S
Soduim iodate	10 %	S	S	S	S
Soduim iodite	Sat.sol	S	S	S	S
Soduim nitrate	Sat.sol	S	S	S	S
Soduim nitrite	Sat.sol	S	S	S	S
Soduim ortophosphate	Sat.sol	S	S	S	S
Soduim oxalate	Sat.sol	S	S	S	S
Soduim phosohate	Sat.sol	S	S	S	S
Soduim silicate	Sol	S	S	S	S
Soduim sulphate	Sat.sol	S	S	S	S
Soduim sulphide	Sat.sol	S	S	S	S
Sodium sulphite	Sat.sol	S	S	S	S
Sodium thiocyanate	Sat.sol	S	S	S	S
Stannic chloride	Sat.sol	S	S	S	S
Stannous chloride	Sat.sol	S	S	S	S
Starch solution	Sat.sol	S	S	S	S
Stearic acid	Sat.sol	S	L	S	-
Styrene	Sol	L	NS	L	NS
Sulphur dioxide, dry	100 %	S	S	S	S
Sulpur trioxide	100 %	NS	NS	NS	NS
Sulphur acid	10 to 50 %	S	S	S	S
Sulphuric acid	10 %	S	S	S	S
Sulphuric acid	50 %	S	S	S	S
Sulphuric acid	70 %	S	L	S	L
Sulphuric acid	80 %	S	NS	S	NS

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Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Sulphuric acid	98 %	L	NS	S	NS
Sulphuric acid	Fuming	NS	NS	NS	NS
Sulphurous acid	30 %	S	S	S	S
Sulphurous acid	Sol	S	S	S	S
Tallow	-	S	L	S	L
Tannic acid	Sol	S	S	S	S
Tartaric acid	Sat.sol	S	S	S	S
Tartaric acid	Sol	-	-	S	S
Tetrachloroethylene	100 %	NS	NS	NS	NS
Tetrachloromethane	100 %	NS	NS	L	NS
Tetradecane	-	NS	NS	NS	NS
Tetrahydrofuran	-	NS	NS	NS	NS
Tetrahydronaphthalene	100 %	L	NS	S	L
Thionyl chloride	100 %	NS	NS	NS	NS
Tin (II) chloride	Sat.sol	S	S	S	S
Tin (IV) chloride	Sol	-	-	S	S
Tin (IV) chloride	Sat.sol	S	S	S	S
Titanium tetrachloride	Sat.sol	NS	NS	NS	NS
Toluene	100 %	NS	NS	L	NS
Tribromomethane	-	NS	NS	NS	NS
Trichloroacetaldehyde	-	S	-	S	-
Trichlorobenzene	-	NS	NS	-	-
Trichloroethylene	100 %	NS	NS	NS	NS
Triethanolamine	100 %	S	-	S	-
Triethanolamine	Sol	-	-	S	L
Triethylene glycol	-	S	S	S	S
Trisodium phosphate	Sat.sol	S	S	-	-
Turpentine	-	NS	NS	NS	NS
Urea	Up to 30 %	S	S	S	S
Urea	Sol	S	S	S	S
Urine	-	S	S	S	S
Vanilla extract	-	S	S	S	S
Vaseline	-	S	L	S	S





Polyethylene

Chemical Resistance Table Low Density and High Density Polyethylene

Chemical or Product	Concentration	LD °C		HD °C	
		20	60	20	60
Vegetables oils		S	L	S	S
Vinegar		S	S	S	S
Water		S	S	S	S
Wetting agents	-	S	S	S	S
Wines and spirits		S	S	S	S
Xylene	100 %	NS	NS	L	NS
Yeast	Sol	S	S	S	S
Zinc bromide	Sat.sol	S	S	S	S
Zinc carbonate	Sat.sol	-	-	S	S
Zinc chloride	Sat.sol	S	S	S	S
Zinc oxide	Sat.sol	S	S	S	S
Zinc stearate	-	S	S	S	S
Zinc sulphate	Sat.sol	S	S	S	S
o-Zylene		NS	NS	NS	NS
p-Zylene	-	NS	NS	NS	NS

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