RVOC
24-26 April 2007

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Woods Hole Oceanographic Institution

Wire Testing and Evaluation

Destructive

- Determination of the load that causes the rope or cable to break

Non-destructive

- Electromagnetic Testing

Systematic Laboratory Testing

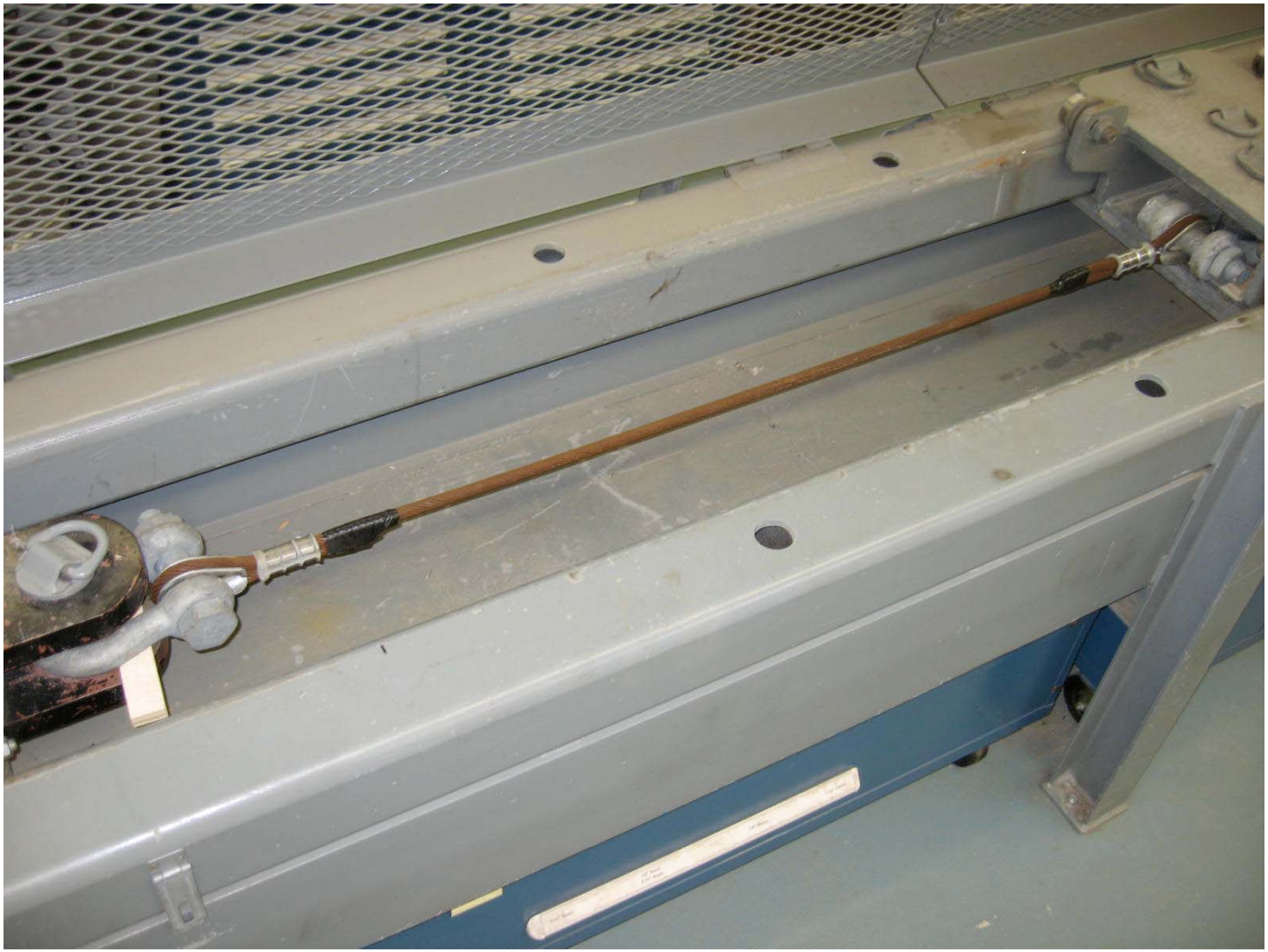
- Controlled variables

Testing Wire Samples Provided by Vessel Operators

Horizontal Tensile Machine

- 30 ft long bed
- 6 ft long hydraulic cyl.
- 150,000 lb proof load capacity
- 112,000 lb break capacity

9/16” Trawl Wire with Terminations on Both Ends



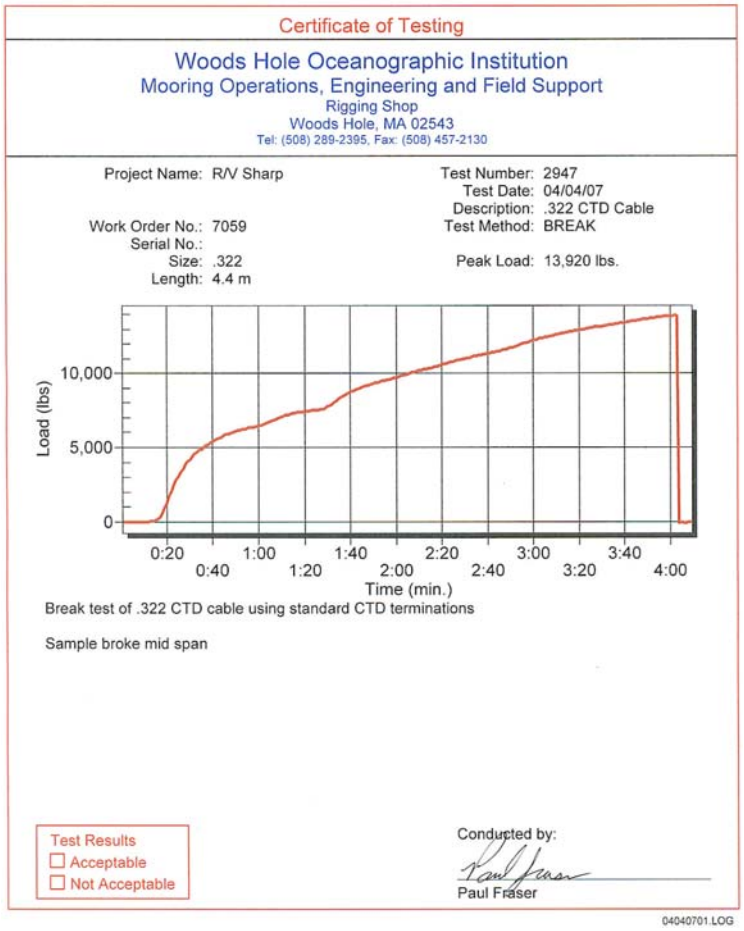
Terminated on only one end

.322 EM Cable
Without Terminations

Termination Options

- How should wire samples be terminated for testing purposes?
  - Terminate using a technique to get a true breaking strength of the wire
    - Maximum load the wire can withstand before failure.
  - Test with terminations that are typical of those that will be used in the field by that particular operator.
    - Maximum load the terminated wire can withstand before failure.

Break Test Report
Provided for each test sample



Certificate of Testing

Woods Hole Oceanographic Institution
Mooring Operations, Engineering and Field Support
Rigging Shop
Woods Hole, MA 02543
Tel: (508) 289-2395, Fax: (508) 457-2130

Project Name: R/V Sharp
Work Order No.: 7059
Serial No.:
Size: .322
Length: 4.4 m

Test Number: 2947
Test Date: 04/04/07
Description: .322 CTD Cable
Test Method: BREAK
Peak Load: 13,920 lbs.

Break test of .322 CTD cable using standard CTD terminations

Sample broke mid span

Test Results
☐ Acceptable
☐ Not Acceptable

Conducted by:
Paul Fraser

04040701.LOG

- Wire break tests conducted for:
  - R/V Sharp
  - R/V Oceanus
  - R/V Knorr
  - R/V Atlantis

Non-destructive testing

- Electromagnetic Inspection
  - Utilized by SIO
  - Loss of metallic Cross Sectional Area
    - Corrosion
    - Internal and External abrasion
  - Localized faults
    - Broken wires due to fatigue or mechanical damage
  - Interpretation of data issue
  - Do we want to purchase equipment and experiment with the technique even though the interpretation of results may be difficult?

Systematic Wire Testing
One Possible Scenario

Purpose

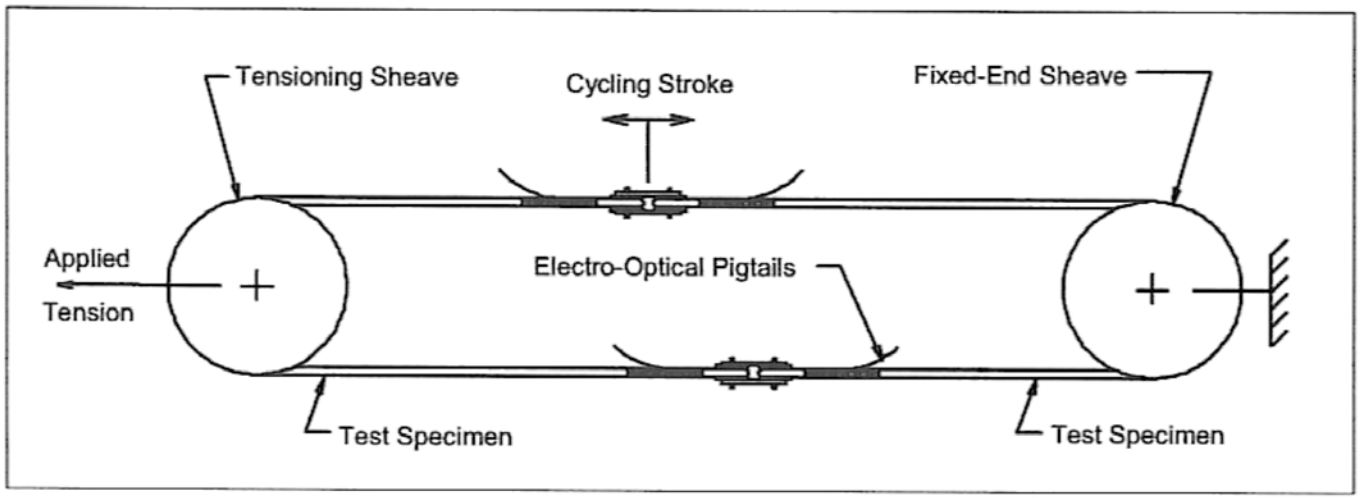
To collect the data necessary to relate wire bending fatigue life to tension and sheave diameter.

Method

- Conduct a series of CBOS tests to collect bending fatigue life data to estimate maximum rope fatigue life for various combinations of rope tensions and sheave sizes.
- The relationship between loading and sheave diameter would be expressed in terms of a “life factor”.

CBOS

- Cyclic Bend over Sheave Tests (CBOS) provide the number of bend cycles a rope can withstand when cycled around a pair of sheaves of a particular diameter while tensioned to a particular load.



Life Factor

Life Factor = df(D/d)

df = design factor (Actual breaking strength / load)

D= Sheave Diameter

d = rope diameter

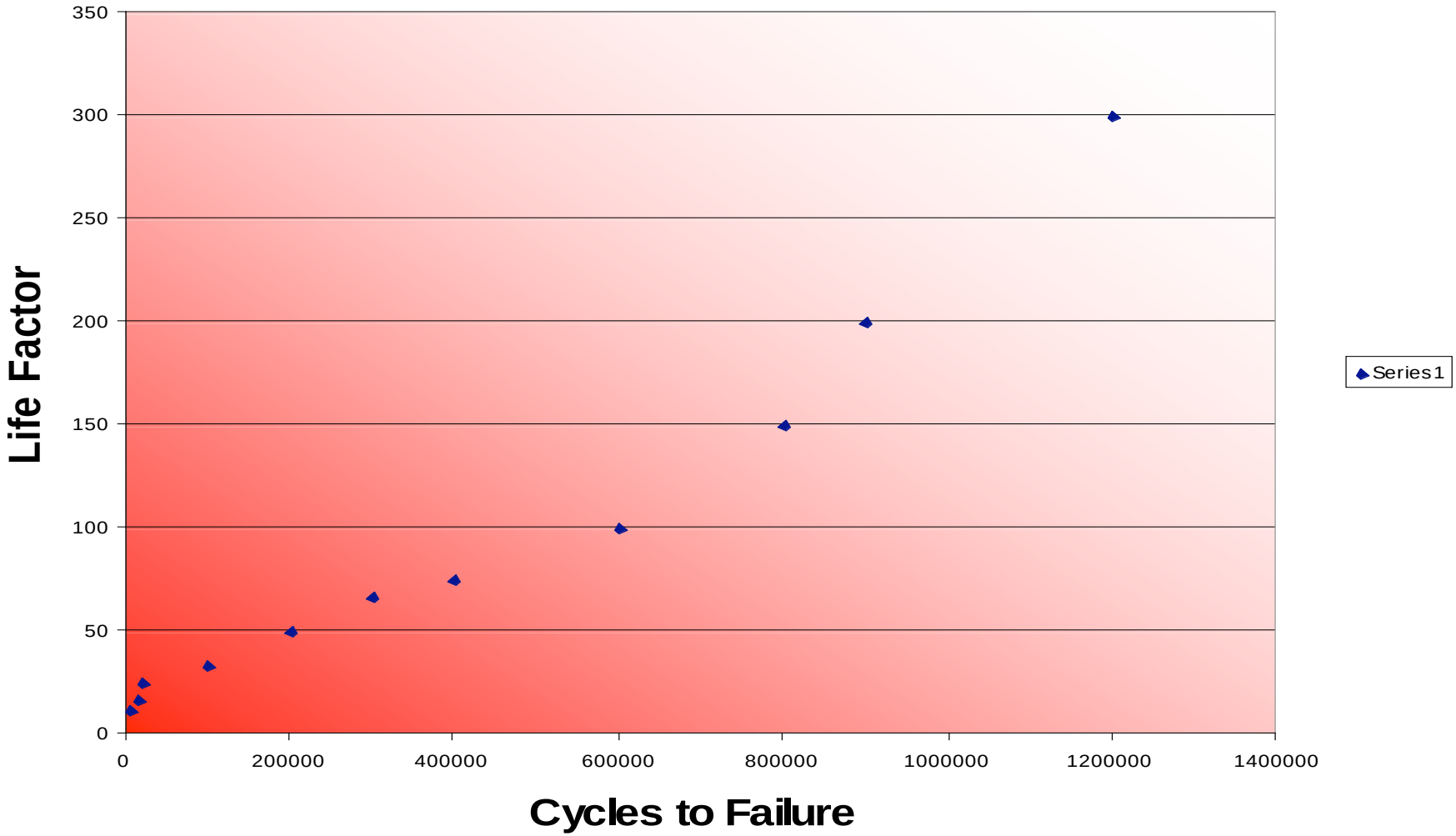
Therefore:

Configurations resulting in large values for Life Factors would be associated with small loads relative to the breaking strength and large sheave diameters which presumably results in a longer wire life.

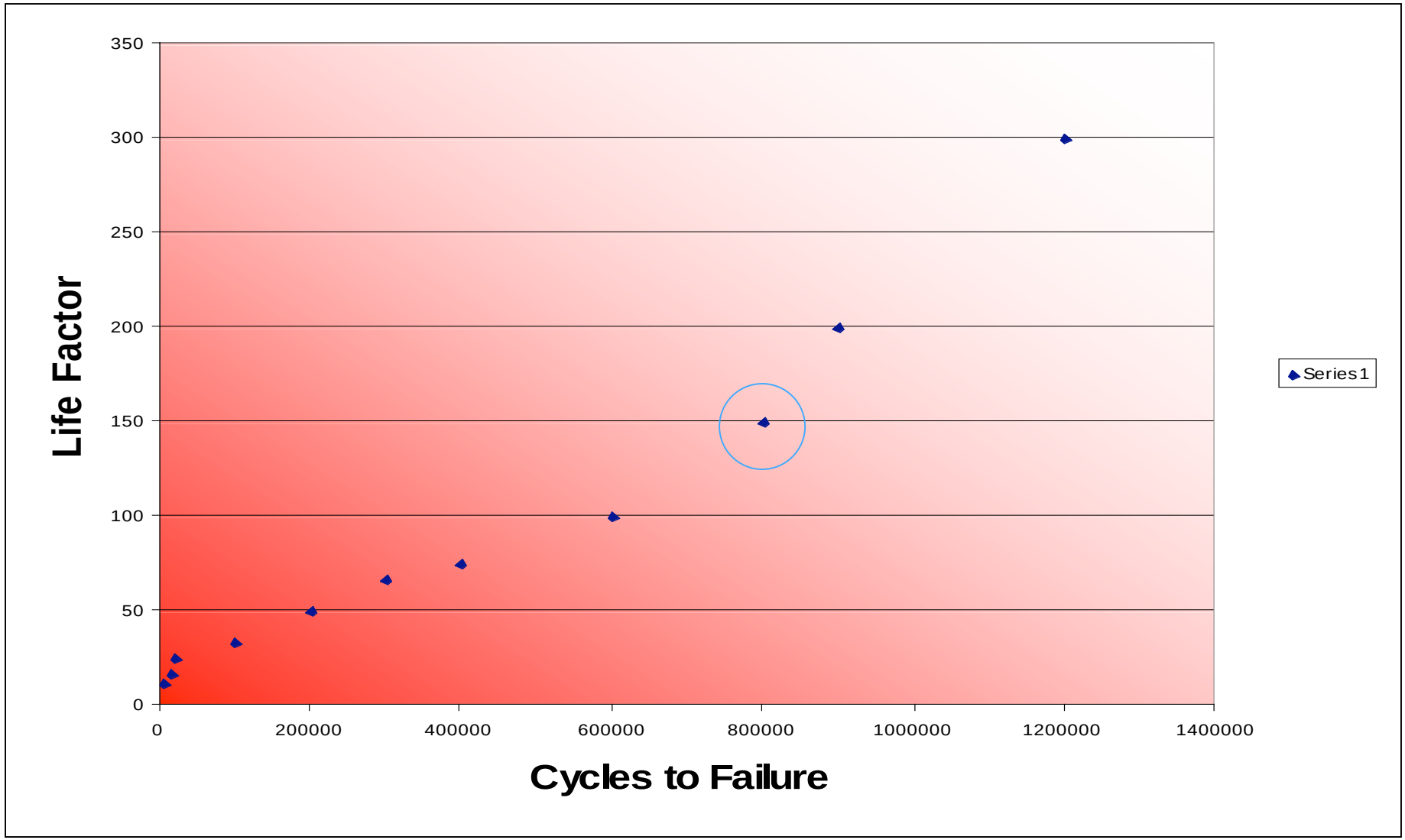
Configurations with small Life Factors (Short life) would be associated with large loads relative to the breaking strength and small sheave diameters.

Proposed Test Matrix

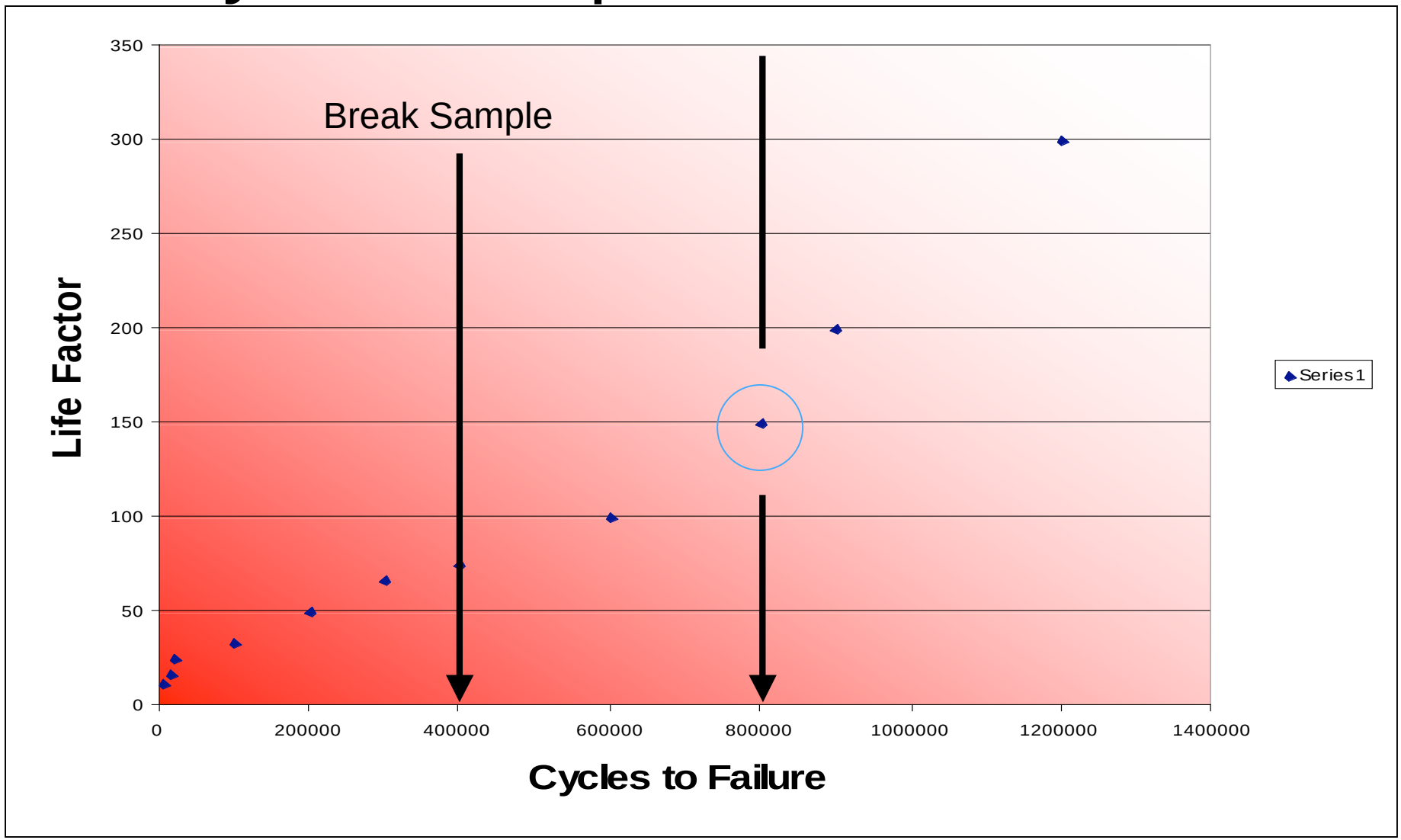
3x19 Wire Rope					
9/16" Diameter					
	Sheave	Rope			
	Pitch	Tension	Rope		
	Diameter	% of Breaking	Tension	Safety	Life
D/d	[inches]	Strength	[pounds]	Factor	Factor
10	5.625	20	6,500	5.00	50
10	5.625	30	9,750	3.33	33
10	5.625	40	13,000	2.50	25
10	5.625	60	19,500	1.67	17
20	11.250	10	3,250	10.00	200
20	11.250	20	6,500	5.00	100
20	11.250	30	9,750	3.33	67
20	11.250	40	13,000	2.50	50
30	16.875	10	3,250	10.00	300
30	16.875	20	6,500	5.00	150
30	16.875	30	9,750	3.33	100
30	16.875	40	13,000	2.50	75


Life Factor
350
300
250
200
150
100
50
0
0
200000
400000
600000
800000
1000000
1200000
1400000
Cycles to Failure
Series1

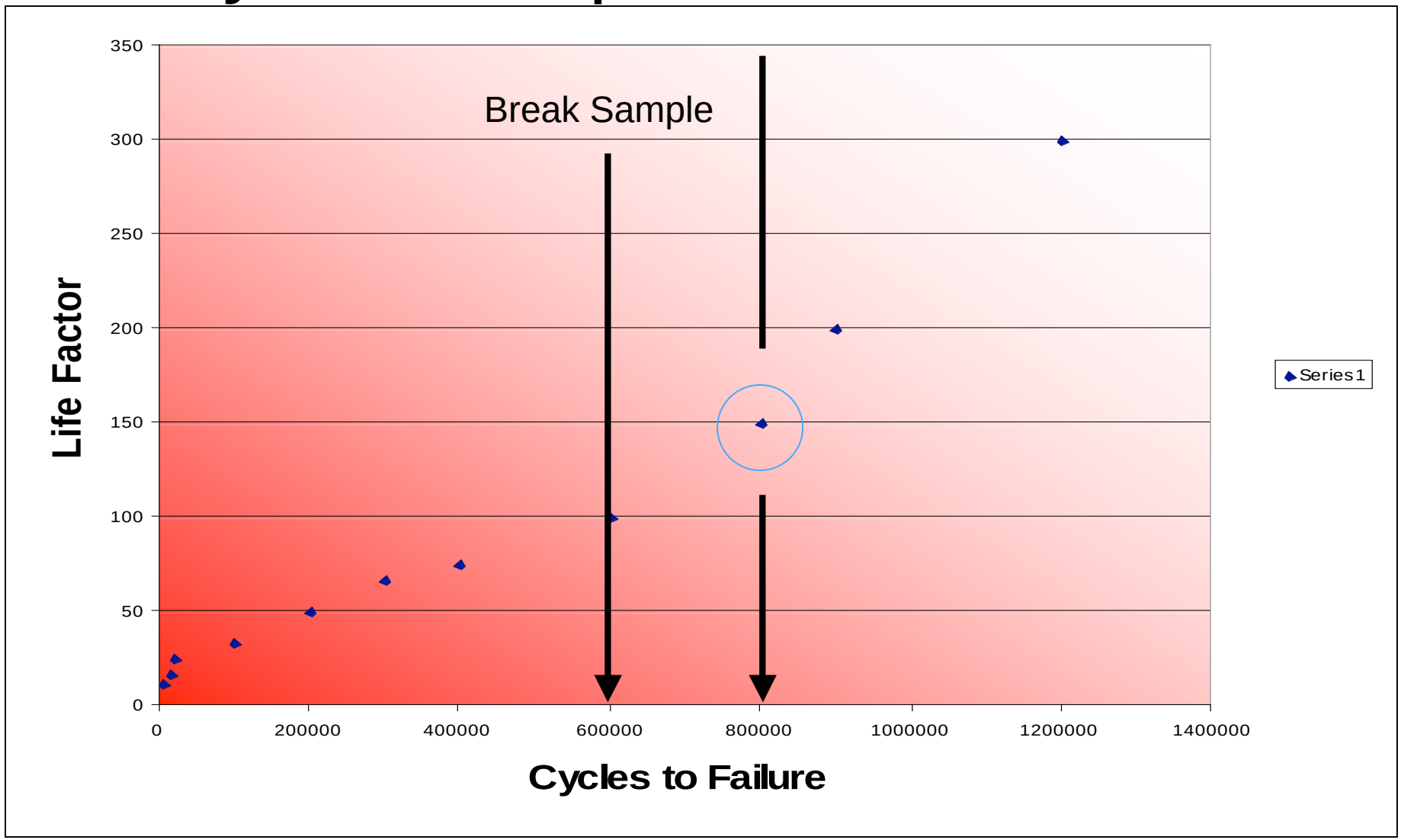
- Repeat the previous tests but stop after reaching half the bend cycles and break the sample. Provides residual strength at the half way point.
- Repeat again but stop after 3/4 of the ropes life and break the sample.
- Yield information about how rope strength diminishes with increasing bend cycles.


Life Factor
350
300
250
200
150
100
50
0
0
200000
400000
600000
800000
1000000
1200000
1400000
Cycles to Failure
Series1

Break the sample after ½ the cycles that produced failure



Break the sample after ¾ of the cycles that produced failure



- Would tests of this type on 9/16” trawl wire be useful to the R/V community?

Wire Inventory

Wire Inventory

UNOLS OCEANOGRAPHIC CABLE POOL									
Inventory as of 9 Mar 2007									
TYPE	ID	SIZE	LENGTH	DESIGN	MANUF	WEIGHT	REEL #	LOCATION	GRANT
COAX	95-CX06	0.68"	8,565	01241	Rochester	22,060	Q3200-C1	W.C.P.	
COAX	**99-CX10**	**0.68"**	**30,150**	**01241**	**Rochester**	**24,000**	**Q3648-C1-1**	**E.C.P.**	
COAX	**99-CX09**	**0.68"**	**30,000**	**01241**	**Rochester**	**22,790**	**Q3645-C1**	**E.C.P.**	
COAX	**99-Cx11**	**0.68"**	**30,000**	**1241**	**Rochester**	**22,000**	**no reel #**	**W.C.P.**	
EM	03-C122	.322"	13,320	A301592	Rochester	2,500	Q4392-C4	E.C.P.	
EM	**04-C127**	**.322"**	**33,000**	**A301592**	**Rochester**	**5,775**	**Q4512-C3**	**W.C.P.**	
EM	**07-C138**	**.322"**	**33,000**	**A301592**	**Rochester**	**6,586**	**Q6062-C1**	**ECP**	
EM	07-C139		33,000					ECP	
EM	07-C140		33,000					WCP	
EM	07-C141		33,000					WCP	
Hydro	**20-H25**	**1/4"**	**29,923**	**3X19, AA**	**MacWhyte**	**4,000**	**BB00998-04**	**E.C.P.**	
Hydro	**02-H26**	**1/4"**	**33,996**	**3X19,AA**	**MacWhyte**	**5,461**	**BBS0085-01**	**E.C.P.**	
Hydro	**02-H27**	**1/4"**	**26,994**	**3X19AA**	**MacWhyte**	**3,175**	**WHOI reel**	**E.C.P.**	
Hydro	**05-H28**	**1/4"**	**30,000**	**3x19**	**WRCA**	**3,499**	**SJB2230-01**	**W.C.P.**	
Trawl	05-T30	7/16"	2,203	3x19	LOOS	700	1029942/1	E.C.P.	
Trawl	02-T27	1/2"	16,299	3 X 19 AA	MacWhyte	13,100	BB01007	E.C.P.	
Trawl	**02-T28**	**1/2"**	**29,922**	**3X19AA**	**MacWhyte**	**12,846**	**BBS0086-01**	**E.C.P.**	
Trawl	**95-T23**	**1/2"**	**33,000**	**3X19,AA**	**MacWhyte**	**14,000**	**no reel #**	**W.C.P.**	
Trawl	05-T31	1/2"	2,079	3x19	LOOS	850	1029940/1	E.C.P.	
Trawl	05-T32	9/16"	1,764	3x19	LOOS	900	1029942/1	E.C.P.	
Trawl	07-T35	9/16"	45,000	3x19	WRCA		BBS0984-01	WCP	
Trawl	07-T36	9/16"	30,000	3x19	WRCA		BBS0985-01	ECP	
Fiber	01-FO1A	0.681	24,232	A302351	Rochester	18,208	Q4473-C!	E.C.P.	
Fiber	01-FO1B	0.681	8,566	A302351	Rochester	6,645	Q3970-C1	W.C.P	
Fiber	02-F02	0.681	34,189	A302351	Rochester	28,009	Q4255-C1	W.C.P.	

Fiber Optic Cable

- West Coast
  - 8566 ft (2612 m)
  - Approx. 9840 ft. (3000 m)
  - Approx. 19680 ft. (6000 m)
- East Coast
  - 24,380 ft (7433 m)