# SPECIAL REPORT : SR99/007

## Tensile testing of a Yachting Line

**Roads and Traffic Authority**
www.rta.nsw.gov.au

**Crashlab**
56 Rothschild Avenue
Rosebery NSW 2018
PO Box K198
Haymarket 1238
Telephone (02) 9662 5277
Facsimile (02) 9662 5990

**Client :** NSW Police Service
NSW Water Police Branch,
Wharf 25
Harris Street
PYRMONT NSW 2009.

**Client's Reference :** Fax dated 23rd November 1999.

**Test Specifications :** Australian Standard AS 2227:1992,
Yachting Harnesses and Lines- Conventional lines.

Australian Standard AS 1753:1990,
Webbing for Restraining Devices for Occupants of Motor Vehicles.

**Test Items :** Two (2) Replica yachting lines.

**Date of Tests :** 1st December 1999

**Report prepared by :** _____ Date: 18 Feb 2000
Derek Wainohu (Cert. Mech. Eng)
Test Laboratory Manager.

**Issued by :** _____ Date: 18 Feb 2000
Ross Dal Nevo (BE Mech)
Manager, Crashlab.

## CONTENTS

Page

## 1. INTRODUCTION

The NSW Water Police Branch had requested testing of a yachting line, as part of a Coronial Inquest into the 1998 Sydney to Hobart Yacht Race. A webbing safety line allegedly failed on the 'Sword of Orion' resulting in the helmsman being washed overboard. This report examines the performance of a newly manufactured 'replica' safety line to determine whether the stitch pattern is adequate for its application.

In March 1999 RTA Crashlab conducted dynamic drop tests on yachting harness samples supplied by NSW Water Police Branch and in July 1999 conducted tensile tests on yachting line also supplied by NSW Water Police Branch. The results of that testing are contained in Crashlab - Special Report SR99/004 and SR99/006 respectively. The failure of the safety lines reported in both Special Report SR99/004 and SR99/006 resulted from total failure of the stitching with no significant damage to the webbing.

NSW Water Police Branch consulted Workcover NSW and RTA Crashlab to determine what would be required for the next phase of testing. It was recommended that tensile testing of a newly manufactured 'replica' yachting line would be conducted. Workcover NSW organised a Industrial Harness manufacturer to produce six (6) safety lines similar in construction and specification to the safety lines from the 'Sword of Orion' and as used in the testing reported in Crashlab Special Report SR99/004 and SR99/006. The results of the tensile testing of the 'replica' safety line would then be compared with the results recorded in Crashlab Special Report SR99/006. This comparison would give an indication as to the ability of an 'as new' safety line from the 'Sword of Orion' to meet the strength requirements of AS2227

Essentially all revisions of AS2227 have required the hooks and other "non-deteriorating" components, i.e. load bearing stitch pattern, to meet a tensile force of 12 kN and webbing to meet a dry breaking strength tensile force of 22 kN.

The harnesses and safety lines originally obtained from the 'Sword of Orion' were supplied to Crashlab as assemblies. However, only the harnesses bore the identification labels of Tuff Marine Australia. The only identification on the safety lines were the hand written words 'Sword of Orion'. For the purpose of this report the safety lines supplied from the 'Sword of Orion' are identified as such rather than assuming the identification of Tuff Marine Australia.

## 2. AIM

- To determine whether or not a 'replica' safety line would demonstrate compliance with the strength requirements of AS2227.
- To assess whether or not an 'as new' safety line, as used on the 'Sword of Orion' yacht, would meet with the strength requirements of AS2227.

## 3. DESCRIPTION

The 'replica yachting lines were assigned with Crashlab test specimen numbers TS18749 and TS18750. Refer to Appendix A

The 'replica' yachting line consisted of a length of blue webbing with hooks attached at both ends. The hooks were retained by the webbing being folded through an eye in the hook and then stitched in place. The stitch pattern consisted of three stitched 'bar tacks' and a large rectangular stitch pattern with diagonals. The three stitched 'bar tacks' were slightly longer in length than the 'bar tacks' used on the safety lines from the 'Sword of Orion'. Refer to Photograph 3 in Appendix B.

## 4. TENSILE TEST

### 4.1 Test Equipment

Crashlab is NATA registered for tensile testing of webbing to Australian Standard AS 1753. The test methodology and procedures used for testing webbing to AS2227 are the same as those used for the tensile testing as specified in Appendix A of Australian Standard AS1753:1990 Webbing for Restraining Devices for Occupants of Motor Vehicles.

Testing was conducted on an Avery Tensile Tester, Type No. 7108 DCN, Machine No. E70421, identified by Crashlab equipment number of TCL 474. Refer to Photograph 1 in Appendix B.

Bollards were used to grip the webbing and prevent slippage and damage of the test specimen as per Australian Standard AS E35/BWG. Refer to Photograph 2 in Appendix B.

### 4.2 Test Description

Australian Standard AS2227 requires the hooks and other "non-deteriorating" components, i.e. load bearing stitch patterns, to meet a tensile force of 12 kN. As the requirements for testing yachting harnesses and lines requires the specimen to be wet, it was decided to conduct a series of 'wet' and 'dry' tensile tests.

The following tests were conducted;

1. Test one end of the yachting line including hook and stitch pattern to 12 kN in a Dry condition
2. Test the other end of the yachting line including hook and stitch pattern to 12 kN in a Dry condition
3. Test one end of the yachting line including hook and stitch pattern to 12 kN in a Wet condition
4. Test the other end of the yachting line including hook and stitch pattern to 12 kN in a Wet condition

The load range of the Avery Tensile Tester was set at 50,000 N full scale. The Avery was paced to ensure the specified time taken to obtain the required load, for this test program the following setting was used:

| Full Scale | Test Load | Pacer Reading |
|---|---|---|
| 50 kN | 12 kN | 24% of full scale load in 60 seconds |

The yachting line was unable to be threaded through the Bollard grips with a hook attached to both ends of the line. To enable the yachting line to be attached to the Avery Tensile Tester via the Bollard grips, a hook was removed from one end of the line, the design of the hook

enabled removal without interfering with the stitch pattern.

## 5. RESULTS

### Test G90099

The hook from end '5B' was attached to a fixture at the top head of the Avery and the webbing end was threaded through the Bollard grips at the bottom head. Refer to Photograph 2 in Appendix B.

This test was conducted with the specimen in the 'dry' condition. A maximum load of 9.85 kN was achieved prior to failure of the stitch pattern.

**Assessment: Fail**

### Test G90100

The hook from end '5A' was attached to a fixture at the top head of the Avery and the webbing end was threaded through the Bollard grips at the bottom head. Refer to Photograph 2 in Appendix B.

This test was conducted with the specimen in the 'dry' condition. A maximum load of 9.6 kN was achieved prior to failure of the stitch pattern. It was observed that the load fluctuated as the stitch pattern commenced to fracture and a new portion of the stitch pattern was loaded until complete fracture, this load fluctuation was recorded as being 9.2 - 9.6 kN.

Specimen TS18749 was used in both tests G90099 and G90100. Refer to Photograph 4 in Appendix B.

**Assessment: Fail**

### Test G90101

The hook from end '6B' was attached to a fixture at the top head of the Avery and the webbing end was threaded through the Bollard grips at the bottom head. Refer to Photograph 2 in Appendix B.

This test was conducted with the specimen in the 'wet' condition, the specimen was saturated in a bucket of water prior to testing. A maximum load of 9.0 kN was achieved prior to failure of the stitch pattern.

**Assessment: Fail**

### Test G90102

The hook from end '6A' was attached to a fixture at the top head of the Avery and the webbing end was threaded through the Bollard grips at the bottom head. Refer to Photograph 2 in Appendix B.

This test was conducted with the specimen in the 'wet' condition, the specimen was saturated in a bucket of water prior to testing. A maximum load of 8.9 kN was achieved prior to failure of the stitch pattern. It was observed that the load fluctuated as the stitch pattern commenced to fracture and a new portion of the stitch pattern was loaded until complete fracture, this load

fluctuation was recorded as being 7.2 - 8.9 kN.

Specimen TS18750 was used in both tests G90101 and G90102. Refer to Photograph 5 in Appendix B

**Assessment: Fail**

## 6. COMMENTS

The tensile failure loads of the 'replica' safety lines were as follows:

- The 'Dry' stitch patterns sustained an average tensile load of 9.73 kN
- The 'Wet' stitch patterns sustained an average tensile load of 8.95 kN

The tensile failure loads of the safety line, from the 'Sword of Orion' yacht and reported in Crashlab Special Report SR99/006 were as follows:

- The stitch patterns sustained an average tensile load of 6.2 kN

The stitch pattern used on the 'replica' yachting line consisted of three stitched 'bar tacks' and a large rectangular stitch pattern with diagonals. The three stitched 'bar tacks' were slightly longer than the 'bar tacks' used on the original safety lines from the 'Sword of Orion'. It was expected that the replica safety lines would give slightly higher tensile loads as a result of more thread being used in the three longer stitched 'bar tacks' and the test results confirmed this expectation.
The 'replica' safety lines were produced to be similar in construction and specification to the Tuff Marine Australia safety lines, as used in the testing reported in Crashlab Special Report SR99/004 and SR99/006. The 'replica' safety lines were produced and tested in an attempt to determine whether or not an 'as new' safety line, as used on the 'Sword of Orion' yacht, would meet the strength requirements of AS2227.
Even with the three longer stitched 'bar tacks' giving slightly higher tensile loads, the average tensile loads, sustained by the 'replica' safety lines, were below the strength requirements of AS2227. Essentially all revisions of AS2227 have required the hooks and other "non-deteriorating" components, i.e. load bearing stitch pattern, to meet a tensile force of 12 kN. It would be unlikely that an 'as new' safety line as used on the 'Sword of Orion' would demonstrate compliance with the strength requirements of AS2227.

## 7. CONCLUSION

- The 'replica' safety lines were unable to meet with the strength requirements of AS2227 in both the wet and dry conditions.
- It is unlikely that a 'new' safety line, of the design used on the 'Sword of Orion', would meet the strength requirements of AS2227.

# APPENDIX A

## TEST SPECIMEN DETAILS

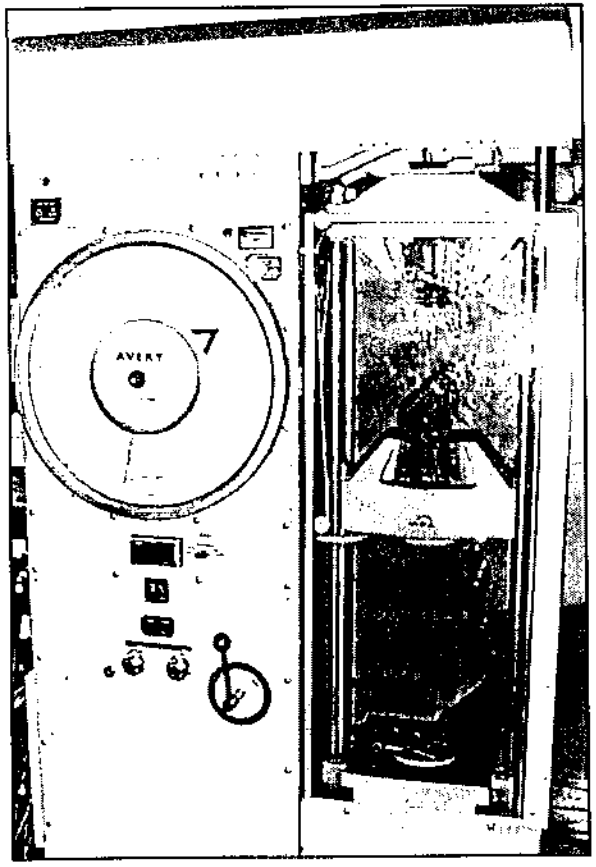
| Specimen Number | Description | Identification Text Markings | Model | Serial Number | Date of Manufacture |
|---|---|---|---|---|---|
| TS18749 | Replica Yachting line Sample 5 | 5A 5B | Unknown | Unknown | Unknown |
| TS18750 | Replica Yachting line Sample 6 | 6A 6B | Unknown | Unknown | Unknown |

## TEST RESULT DETAILS

| Test Number | Test Date | Specimen Numbers | Line End Marked | Pacer Recording | Peak Load *(kN)* | Load Criteria *(kN)* | Location of failure | Pass/Fail |
|---|---|---|---|---|---|---|---|---|
| G90099 | 1/12/99 | TS18749 | 5B | 24% | 9.85 | 12.0 | Stitch pattern | **Fail** |
| G90100 | 1/12/99 | TS18749 | 5A | 24% | 9.6 | 12.0 | Stitch pattern | **Fail** |
| G90101 | 1/12/99 | TS18750 | 6B | 24% | 9.0 | 12.0 | Stitch pattern | **Fail** |
| G90102 | 1/12/99 | TS18750 | 6A | 24% | 8.9 | 12.0 | Stitch pattern | **Fail** |

*Checked by:* _____ *Date:* 18-2-2000

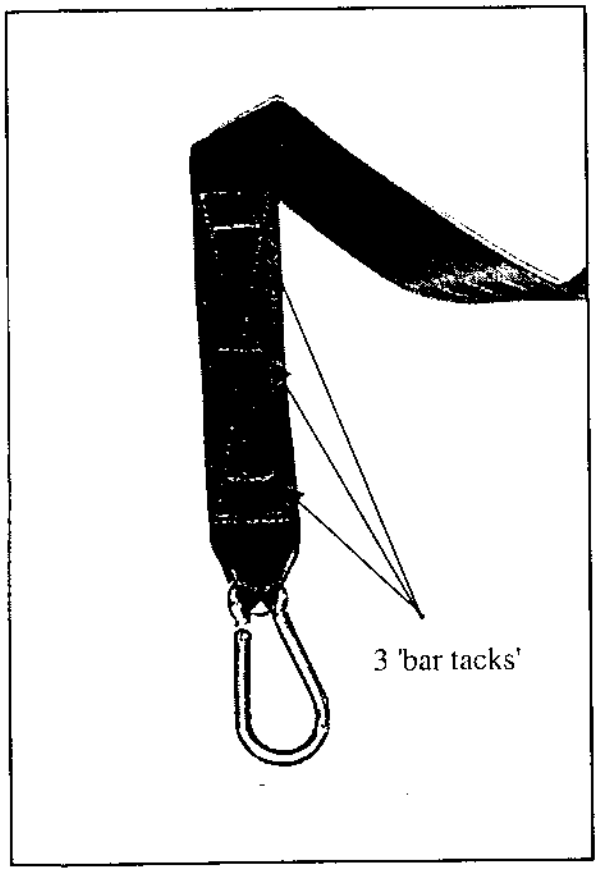
# APPENDIX B



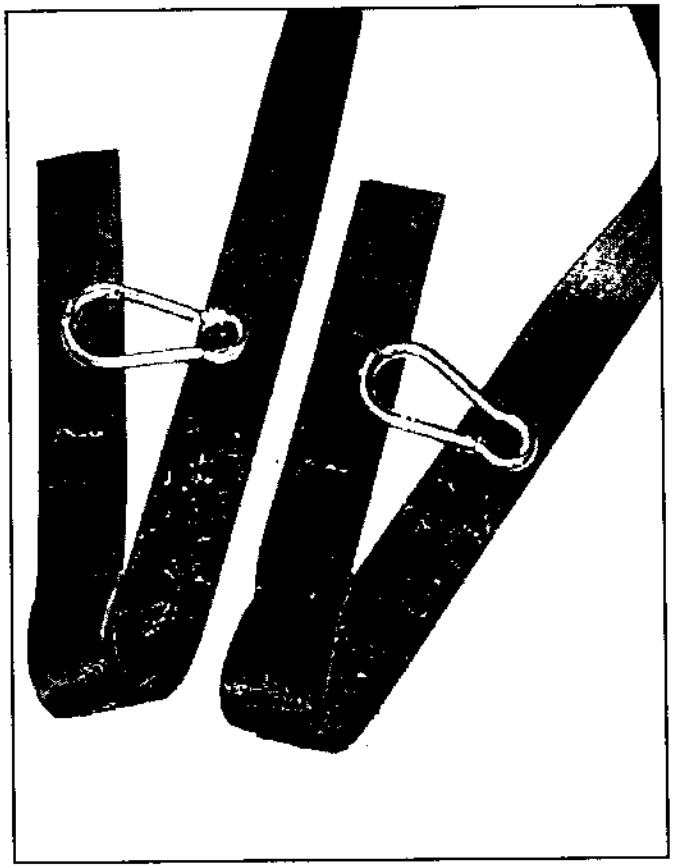

Photograph 1.

Photograph 2.

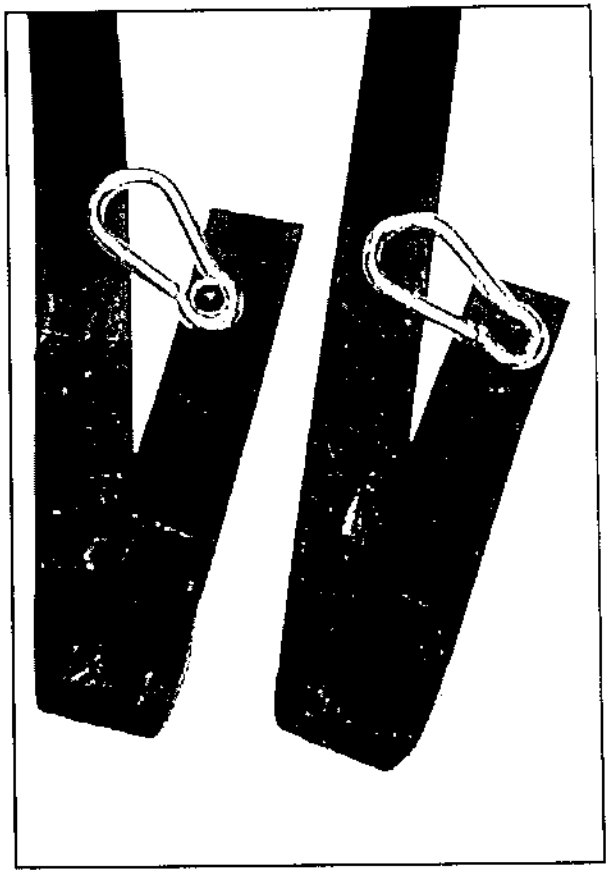
Checked by: _____ Date: 18-2-2000




**Photograph 3.**



**Photograph 4.**



**Photograph 5.**

*Checked by:* _____ *Date:* 18-2-2000