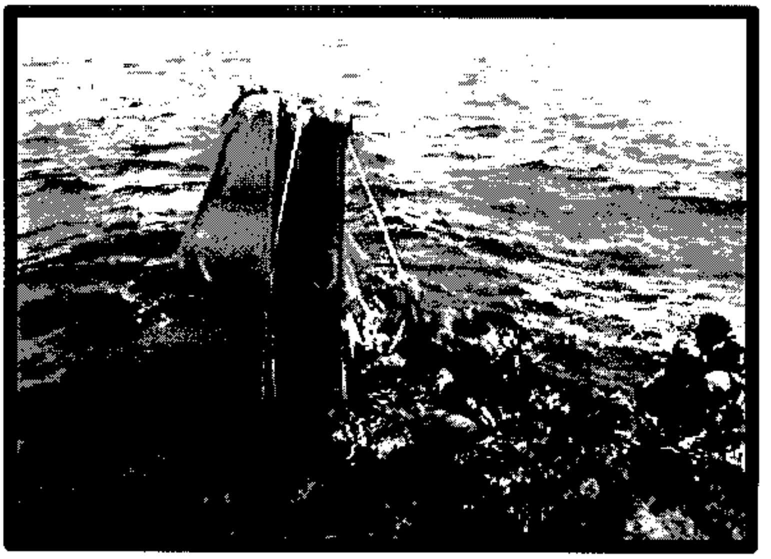
Issues Relating to Liferaft Operation

Report to N.S.W. Police for Sydney Hobart Yacht Race Coroner's Inquiry



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1. Terms of Reference

The brief for this report was provided by DSC Stewart Gray, and David Upston of the N.S.W. Police Service. The N.S.W. Police requested an assessment of the following aspects of liferaft operation relating to the 1998 Sydney Hobart yacht race:

1. Correct procedure on stowage and storage of liferafts.
2. Procedure for deployment from deck and from water.
3. Righting the liferaft in calm and sea conditions (one person righting, with people inside).
4. Entering a liferaft.
5. Cutting of the floor of the raft.
6. Test rigidity of raft after cutting floor.
7. Possible reasons for failure to inflate.
8. Liferaft equipment.

1.1 Methodology

A number of strategies were implemented in order to obtain the information contained in this report. These included:

- Reviewing *The 1998 Sydney Hobart Race Review* (1999 SHRR).
- Reviewing of legislation, rules and recommendations relating to liferafts.
- Reviewing manufacturers' advertising material and operating instructions.
- Inspection of Pro Saver liferaft, fittings and equipment.
- Interviews and consultation with competent persons.
- Survey questionnaires.
- Written and practical assessment of volunteer members of the Tasmanian yachting community.
- Practical trials involving a number of liferafts and volunteer persons in calm water and at sea.

1.2 List of Persons Consulted or Interviewed

- Richard Phillips, Lecturer, Faculty of Bio medical Science, University of Tasmania, 30th July 1999.
- David Lawson, Safety Officer Cruising Yacht Club of Australia, 10th August 1999.
- Graham Bear, 1993 SHYR crew member on yacht *Adjustor*, 10th August 1999.
- Zane Boucher, Peter Johnston Ship Chandlers, Hobart. 30th August 1999.
- Richard Hooper Tamar Marine 16th September 1999.
- John Frearson, Australian Maritime College (AMC) Survival Centre Technical Officer.
- John Ferris RFD N.S.W. 19th - 21st September 1999.
- Steven Walker, Crew member *Business Post Naiad* 5th November 1999

1.3 Disclaimer

Any opinions expressed in this report are those of the author or of persons interviewed in the course of preparing this report and are not those of the Australian Maritime College.

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2. Standards for Liferaft Construction Fittings and Equipment

The damage sustained by a number of liferafts deployed during the 1998 Sydney Hobart Yacht Race, including the loss of the floor and canopy of the *Winston Churchill's* Pro Saver liferaft has raised questions relating to the suitability of light weight liferafts for Category 1 races. The 1998 SHRR found that there is currently no Australian Standard for the construction of liferafts for offshore racing or cruising yachts (P.141). However there are a number of regulations and rules that relate to liferafts for small commercial, as well as larger commercial vessels. This section compares current CYCA rules/guidelines pertaining to liferaft construction, equipment packs and fittings with those contained in the *Uniform Shipping Laws (USL) Code*, Chapter III of the *SOLAS Convention* and in Australian *Marine Orders Part 25.*

2.1 Current Sources of Liferaft Standards

2.1.1 AYF Rules

Standards adopted by CYCA are those published in the Australian Yachting Federation *Racing Rules of Sailing* for 1997-2000. These standards are based on those determined by the Offshore Racing Council (ORC), with the exception that the liferaft equipment packs are required to be packed within the liferaft on Australian vessels.

The general requirements for liferafts with respect to capabilities, stowage, recovery time, certification, canopy and floor requirements are contained in Rule 4.19 of Addendum A.1 (p.178) and Appendix II which contains the AYF and Offshore Racing Council minimum specifications for yachtsmen's liferafts.

2.1.2 Coastal Standards

Standards for construction, fittings and equipment for inflatable liferafts carried on board some classes of state registered commercial vessels are contained in Appendix J

'Coastal Liferafts (Inflatable)' of Section 10 of the *Uniform Shipping Laws (USL) Code*.

2.1.3 SOLAS Standards

Regulations 38 and 39 of Chapter III of the *Safety of Life at Sea Convention* and Chapter IV of the *International Life-Saving Appliance Code* (LSA Code) contain the standards for construction, fittings and equipment carried on Australian registered and state registered commercial vessels. The application of these regulations to Australian vessels occurs through *Marine Orders Part 25* and Appendix H of Section 10 of the *USL Code*.

2.2 Comparison of AYF and USL Code Coastal liferafts

A review of the AYF *Racing Rules of Sailing*, the USL Code and the *RFD Product Catalogue* highlighted two areas where the Pro Saver liferaft and USL Code Coastal liferafts vary.

1. Weight of construction materials.
2. Requirement for withstanding exposure to the elements.

2.2.1 Withstanding Exposure to the Elements

Appendix J (1.12) of the USL Code requires that:
"The liferaft shall be of suitable material and construction, and shall be so constructed as to be capable of withstanding exposure for 30 days afloat in all sea conditions."

This requirement also applies to SOLAS liferafts. There is no such requirement in the AYF and ORC Minimum Specifications for Yachtsmen's Liferafts. This raises the question of why this standard was omitted when the AYF rules were developed and leads to speculation as to the suitability of the AYF construction standards for Category 1 races.

When asked to comment on the current AYF liferaft rules, David Lawson (CYCA Safety Officer) indicated that racing yachts are getting lighter, resulting in a demand for lighter liferafts. It was also stated that in some instances the designer of the vessels determines the weight and stowage position of the liferafts, resulting in a large demand for light weight rafts, which manufacturers currently are meeting. Table 2.1 shows the typical weights and approximate price of a range of 6-person liferafts based on the *RFD Product Catalogue.*

Raft Type	Packed weight (AYF)	Retail Price (Tamar Marine)
6-person Pro-Saver	28 kg	$2,527
6-person Pacific*	44 kg	$2,500
6-person Seasava Plus*	46 kg	$3,584
6-person Surviva*	74 kg (SOLAS Pack has additional 6 kg of water rations as well as additional equipment)	$6,471

Table 2.1

*Approved as a USL Coastal Standard Raft

A comparison between the AYF approved Pro Saver and Coastal Pacific liferafts (with AYF equipment packs) shows a 16kg weight difference in construction materials, but very little difference in price.

2.2.2 Manufacturer's Recommendations for Suitability for Category 1 Races

The *RFD Product Catalogue* describes the Pro Saver liferaft as follows:
"Application: Racing Yachts and recreational boating. A super lightweight liferaft that combines quality fabrics with the latest manufacturing techniques. The Pro Saver features outstanding strength and durability at a fraction of the weight of other liferafts without compromising any of the necessary safety features eg. 2 independent buoyancy chambers, ballast pockets, boarding ladder, observation port etc. At seriously competitive prices, this is the answer for the racing yachtie or for smaller craft, power or sail."

Additional documentation relating to Pro Saver liferafts, originating from the German manufacturer 'Nautiv' was provided by John Gibson (*Winston Churchill* survivor). This is located in Appendix 1 to this report. There are two references to the use of this raft in these documents:

1) "*the Pro Saver is an inexpensive safety factor in waters near to the coast.*"
2) German text which interprets to: "*for coastal waters, lakes and rivers*"

John Ferris of RFD supplied a similar brochure (also in Appendix 1) which states that:

" *the Pro Saver life raft will meet all regulatory requirements for coastal, offshore and ocean voyages*"

These brochures have been included to provide background information only. Although there appears to be discrepancies relating to the usage of the raft, the Pro Saver liferaft has been approved as meeting AYF requirements documented in the *Racing Rules of Sailing.* The N.S.W Police provided a Pro Saver liferaft for the purpose of conducting a series of practical trials at the Australian Maritime College relating to liferaft operation. The raft was manufactured in December 1997, and had been in service on a vessel for about 14 months. These trials provided an opportunity to observe the liferaft in operation, and to report on its durability.

2.3 Operation Trials of a Light Weight Liferaft (Pro Saver)

During the trials, the RFD Pro Saver liferaft was inflated and used for practical liferaft operation in still water on the 19th and 20th of September, and at sea on the 21st of September 1999. During the course of these trials Pro Saver liferaft was subjected to the following activities:

- Boarding from the water by 28 subjects.
- Capsizing with one subject inside the raft 28 times.
- Underwater escape by one subject 28 times.
- Boarding when inverted by 5 subjects 5 times.
- Underwater escape when inverted by 5 subjects 5 times.
- Righting with 1, 2, 3, 4 and 5 subjects inside the raft.

During the conduct of trials the buoyancy and canopy support tubes remained intact and at full working pressure. Damage sustained to the raft during these activities consisted of:

- Damaged stitching adjacent to the canopy entrance hold back ties for a distance of 3-5 cm either side of each tie (see Figure 2.1).
- Separated stitching for a distance of about 4 cm at the lookout port point of attachment to the canopy.
- Righting strap attachment point on the corner to the left-hand side of the canopy entrance (Figure 2.2) separated from the liferaft. This occurred during righting trials with more than the recommended number of persons remaining inside the raft. No such problem was experienced with the Petrel or SOLAS 6-person rafts during similar trials.
- The left hand boarding ladder attachment point (Figure 2.1) separated from the liferaft. This resulted from righting activities after the main righting attachment point parted, placing the righting line load on the boarding ladder strong point.
- The canopy become detached from the canopy support arch.

All damage was repaired prior to the conduct of the 'at sea' trials.

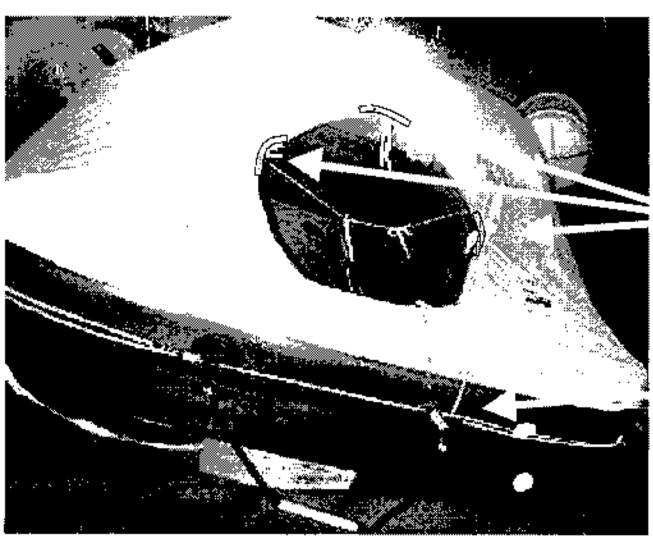
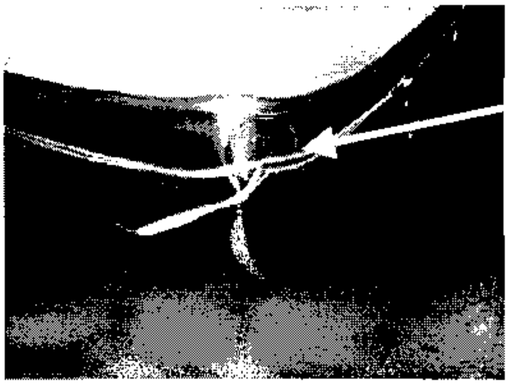


Figure 2.1
Areas of canopy and ladder damage



Righting line attachment point pulled free from raft (shown here undamaged).

Figure 2.2
Strong point damage

During conduct of the sea trials it was observed that the Pro Saver liferaft floor and canopy were much less resistant to damage than those of a 6-person Petrel liferaft. These observations are fully described in Section 4 of this report.

2.4 Fittings and Equipment

A review of the fittings required for AYF and USL Coastal liferafts found that there is no requirement for canopy lights on AYF rafts. This differs from the Coastal raft which requires that:

"*the top and inside of the cover shall be fitted with a lamp which derives its power from a sea-activated cell.*" (Appendix J 1.3).

A review of the equipment packs found that the AYF pack is superior to the USL pack in the requirements for:

- Pyrotechnics (an additional 2 red rocket parachute, 2 red hand and 1 orange smoke flare).
- Sunscreen (2 tubes).
- Water marker (1 recommended for long Category 1 races).
- Plastic bags (1 per person).

The Coastal pack is superior to the AYF pack in the requirements for:

- Water rations (an additional 0.5 litres per person).
- Fishing line and six hooks (1).
- Chemiluminescent lights (6).
- Paddles (2).

There is no formal requirement for paddles in an AYF raft. However, these are provided as standard equipment by the manufacturer. The paddles provided for the Pro Saver liferaft were provided in the form of mits that were placed over the hands of the raft occupants who are required to paddle. These are shown in figure 2.3.

Figure 2.3
Pro Saver light weight mit paddles

According to John Ferris (RFD) mit paddles are provided to meet customer demand to keep the weight of the raft as low as possible. These were packed inside the equipment bag. The nature and method of stowage of the mit paddles raises concerns relating to accessibility, identification and effectiveness:

- The unconventional shape may result in problems with the identification, and means of operation of the paddles.

- Stowing the paddles in the equipment pack may result in them being overlooked or in a delay in them being located. This may prove significant, as paddles can be an important means of moving clear of damaged rigging or from a sinking or burning vessel.
- The small surface area and lack of a shaft appears to result in a less efficient design. This concern was addressed by conducting a comparative trial in the AMC Survival Centre pool using a 10-person liferaft. The liferaft was fully loaded and propelled over a distance of 9 metres using conventional and the light weight paddles as shown in figures 2.4 and 2.5. The results of this trial are summarised in Table 2.2.

Figure 2.4
Mit paddles in use

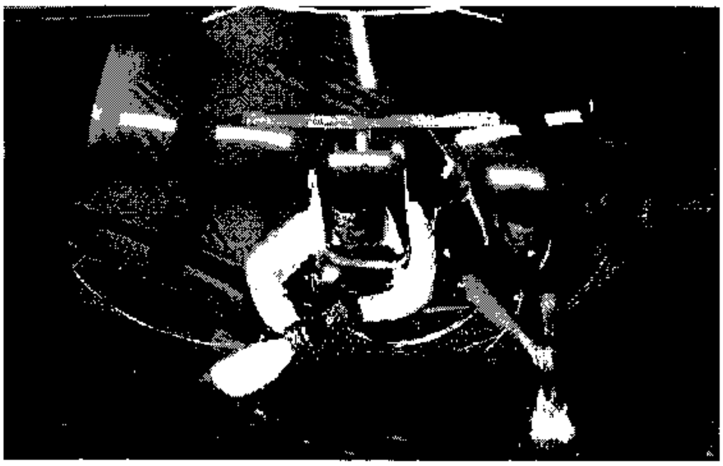


Figure 2.5
Conventional paddles in use

9 metres using light weight mit design	1 minute 21 seconds
9 metres using conventional design Note: this trial was conducted immediately after the mit paddle trial using the same subjects.	38 seconds

Table 2.2
Results of Paddle Comparison Trial

These results indicate that the mit design paddles are less efficient than conventional paddles.

2.5 Location of Liferaft Equipment

A comparison between liferafts of different makes will usually show there is variation in the stowed position of equipment items. In liferafts such as the Pro Saver, all equipment items except the knife and rescue quoit and line are packed inside an equipment bag. This is lashed in a secure manner inside the raft as is shown in Figure 2.6.

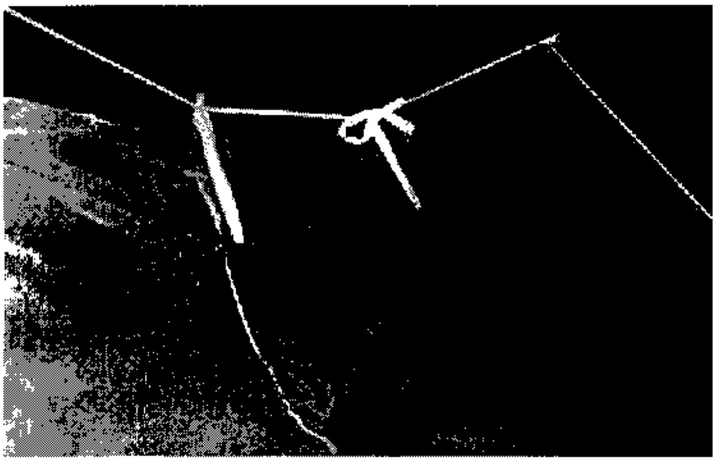


Figure 2.6
Pro Saver equipment pack

To access the equipment items, the contents must be removed from the pack (generally onto the liferaft floor) after the securing lashings have been removed. Once this has occurred, there is a risk of losing equipment through any open canopy entrances in the event of a capsize. Equipment was reported lost in this manner by survivors from both of the *Winston Churchill* liferafts as was reported in the *Sydney Hobart Race Report* (pp. 88-90).

2.6 Conclusions Relating to Liferaft Standards

- The difference in the requirement for 'withstanding exposure to the elements' between AYF and USL Coastal liferafts appears to indicate that 'leisure' or 'sport' liferafts are not expected to be exposed to sea conditions as bad as those that a small commercial vessel might have to face. The 1993 and 1998 Sydney Hobart Yacht Races clearly indicate that AYF approved rafts will be required to perform in adverse sea conditions.
- There appears to be a strong desire for light weight liferafts for use on racing yachts. The reason for this demand seems to be related to the advantage that can be gained by keeping the deadweight of the yacht as low as possible during a race.
- The AYF rules for lighting and some equipment items differ significantly from those that apply to small commercial vessels.
- Current methods of securing liferaft equipment packs have the potential for equipment to be easily lost overboard in the event of a capsize.

2.7 Recommendations Relating to Liferaft Standards

1. Consideration should be given to making the following additions to the AYF *Racing Rules of Sailing* for liferafts used on Category 1 races:
    - All liferafts must meet the requirement for withstanding 30 days exposure to the elements as is the case with USL Coastal and SOLAS standard liferafts.
    - All new rafts should be fitted with external and internal canopy lights. Existing rafts should to be supplied with a chemical light suspended from canopy, ready for immediate operation. This should be packed in a manner that will protect it from accidental activation during the liferaft packing process.
    - 6 chemical lights should be carried as per USL coastal liferaft requirements.

- 2 conventional paddles should be carried, stowed in a position where they can be immediately accessed.

2. Equipment items which will be required early in an abandonment and may be required immediately on boarding a liferaft such as;

   - paddles,
   - torch,
   - emergency leak stopping plugs, and
   - sea sickness preventative medication

   should be stowed separately from the equipment pack, inside the liferaft, secured via a lanyard to prevent accidental loss.

3. The equipment pack should be attached to the liferaft via a permanent lanyard which will reduce the likely-hood of it being lost overboard once the initial securing lines have been removed to allow access. These lines should be capable of easy operation by persons with cold hands.

4. An easy to open and reseal arrangement such as velcro or plastic zipper should be used to seal the equipment bag. This should be easily operated by people with cold hands.

3. Liferaft Stowage and Access

If abandonment becomes necessary from a racing yacht, there are three factors that become critical to the process:

- the location of the liferaft,
- the degree of accessibility to the raft, and
- the securing and release system.

Information relating to these issues was obtained using the following methods:

- Review of manufacturer's recommendations and instructions.
- Review of CYCA race rules pertaining to liferaft carriage and stowage rules/guidelines.
- Review of AYF rules/guidelines/recommendations.
- Survey of SHYR participants relating to liferaft stowage, accessibility and crew training.
- Inspection of stowage systems actually in use on a range of offshore racing yachts which was facilitated by a visit to Sydney to inspect and record methods used as well as crews' justifications for their choice of stowage methods.
- Assessment of 15 trained and 14 untrained volunteer subjects' knowledge of liferaft launching procedures.

3.1 AYF Requirements for Liferaft Stowage and Access

Rule 4.19 (a) of the AYF *Racing Rules of Sailing* (p.178) allows for 'on deck' or 'below deck' stowage provided that rafts stowed below deck do not exceed 40 kg and are "*securely*" stowed adjacent to the companionway.

Part (b) of this rule requires that:

"Each raft shall be capable of being got to the lifelines within 15 seconds."

There are no rules relating to any particular method of securing liferaft to a vessel contained in the *Racing Rules of Sailing*. However, Rule 1.2 (p.143) states that owners:

"must ensure that all safety equipment is properly maintained and stowed and that the crew know where it is kept and how it is to be used".

This leaves the stowage location and securing method up to the vessel's owner.

3.2 Survey of SHYR Participants Relating to Liferaft Stowage and Accessibility

In order to obtain information on stowage positions and securing methods typically used on racing yachts, a questionnaire survey was distributed to the owner of each of the yachts that participated in the 1998 SHYR (see Appendix 2). These were distributed in July 1999 and 61 responses were received, representing a response rate of 53%. Information was received relating to 85 inflatable liferafts carried on 61 vessels. This was followed up by an inspection of a number of racing yachts at the CYCA marina in August 1999.

3.3 Survey Results

The results of the survey items relating to liferaft stowage and accessibility issues are summarised in tables 3.1 –3.7.

3.3.1 Preferred capacity

Table 3.1 summarises the responses to survey item 1 which relates to the types of liferaft carried on board racing yachts.

Raft Capacity	Number	Percentage
4	8	9.4%
5	1	1.2%
6	39	45.9%
8	26	30.6%
10	10	11.8%
12	1	1.2%
Totals	85	100%

Table 3.1
Liferaft capacities

From the responses received, it appears that 6 and 8 person liferafts are the preferred size. These account for 76.5% of the liferafts covered by the survey.

3.3.2 Liferaft Weights

Tables 3.2 and 3.3 summarise the responses to the questionnaire item relating to liferaft weights.

	Number	Percentage
Weight Reported	39	45.9%
No Weight Reported	46	54.1%
Totals	85	100%

Table 3.2

Over half of the respondents failed to state the weight of the liferafts carried on their vessel. This raises the issue of whether yacht owners or crew are actually aware of the weight of the liferafts on their vessels. If they are not, there is potential for problems encountered when allocating personnel to move the rafts. This would be especially significant where liferafts are stowed below deck, after a roll over in dark conditions.

Weight Break Down	Number	Percentage
23-30 kg	11	28.2%
31-50 kg	17	43.6%
> 50 kg	11	28.2%
Totals	39	100%

Table 3.3
Liferaft weight distribution

Almost 72% of liferafts carried by respondents are 50 kg or less in weight. 66.7% of the rafts surveyed were 40 kg or less.

3.3.3 Liferaft Containers

Table 3.4 summaries the responses to the survey relating to the type of container liferafts were packed in.

Type of Container	Number	Percentage
Soft Valise	43	50.6%
Rigid Container	42	49.4%
Totals	85	100%

Table 3.4
Choice of liferaft stowage container

3.3.4 Stowed Positions

Table 3.5 summarises the responses to the survey relating to the position where liferafts are stowed on each vessel.

Stowed Position	Number	Percentage
On Deck	45	52.9%
Below Deck (in cabin)	40	47.1%
Totals	85	100%

Table 3.5
Liferaft stowage location

Note: Seven of the rafts included in the on deck category are stowed in a compartment in the cockpit deck and are accessed via a hatch as shown in Figure 3.1.

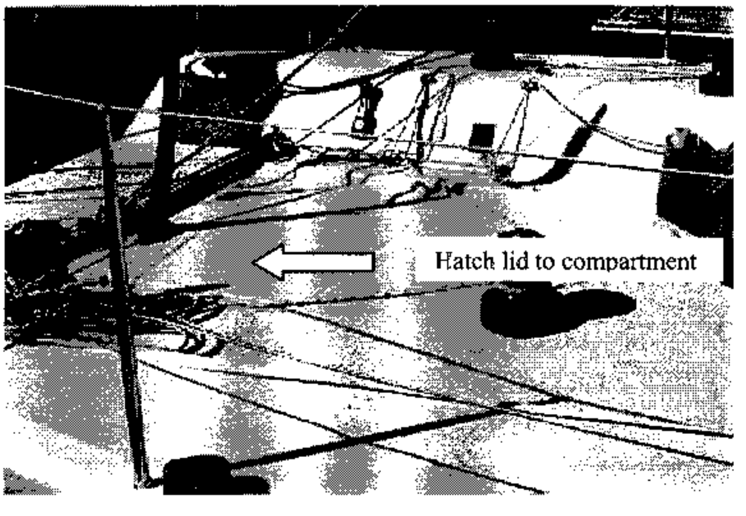


Figure 3.1
Purpose built liferaft stowage compartment

Table 3.6 summarises the reasons behind the choice of stowage locations that were provided by the survey respondents. The reasons given were grouped into the broad categories of justifications shown in the left column.

Justification for Choice of Stowed Position	On Deck Stowage	Below Deck Stowage (in cabin)
Safe from being washed overboard	4	12
Original vessel design	7	4
Enhances stability	2	6
Assists vessel trim and balance	2	4
Out of the crews way	10	7
Easy to access	21	14
Easy to launch	11	0
No lifting required	6	0
Best option available	9	2

Table 3.6
Justifications for choice of stowed position

Table 3.7 shows the frequency of use of purpose built brackets for liferaft stowage.

	Number	Percentage
Bracket used for stowage	31	50.8%
No bracket used	12	29.5%
Not applicable	12	19.7%
Totals	61	100%

Table 3.7

3.4 Discussion

The survey results show an almost even distribution between on deck and below deck stowage for liferafts. The reasons provided for choice of position indicate that some owners have strong views, particularly relating to below deck stowage.

3.4.1 Below Deck Stowage

Figures 3.2 and 3.3 show examples of below deck liferaft stowage positions observed by the author in August 1999 at the CYCA. The survey indicated that 47% of liferafts were stowed below deck (Table 3.5), which is permissible under the AYF rules. The justifications provided for this method of stowage (Table 3.6) show that the below deck position does have some disadvantages in the areas of 'ease of launch' and the need to be 'lifted to a launching position'.

The survey also received 8 responses reporting that the liferafts stowed below deck were not stowed in a position adjacent to the companionway in accordance with the *Racing Rules of Sailing*. Figures 3.2 and 3.3 show examples of this situation.

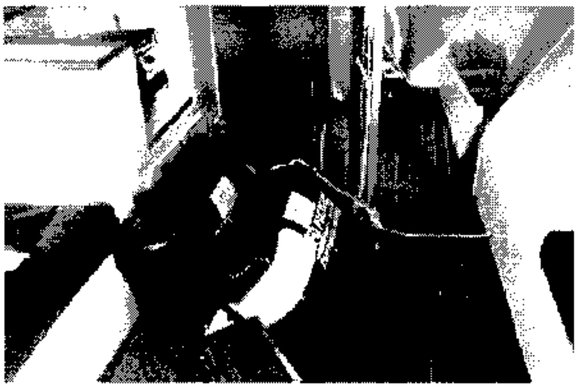


Figure 3.2
Liferafts stowed several metres from companionway

Normal liferaft stowage position as indicated by yacht crew

Figure 3.3
Liferaft stowage position several metres from companionway

Figure 3.4 shows the usual below deck liferaft stowage position on a vessel, adjacent to the companionway.

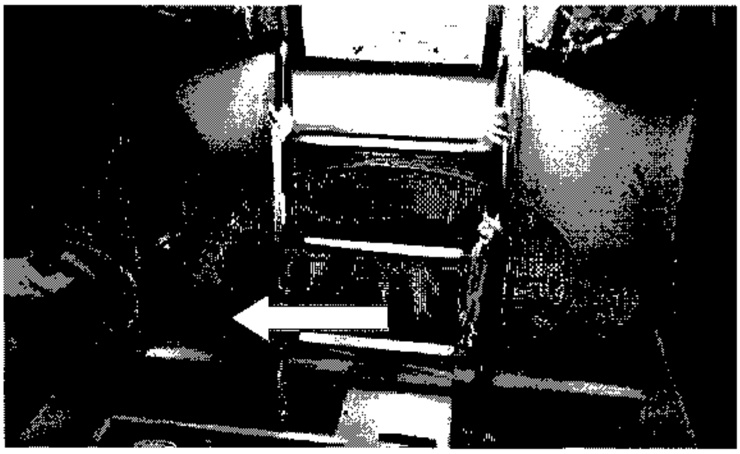


Figure 3.4
Liferaft stowage position adjacent to companionway

3.4.1.1 Problems Associated with Below Deck Stowage

Mr. Steve Walker, a crew member of *Business Post Naiad* was interviewed by the author on November 5th 1999 about difficulties experienced with liferafts stowed below deck. During the interview, Mr. Walker stated that 'great difficulty' was experienced by the crew of the vessel in attempting to lift the rafts from below deck through the companionway to the cockpit area. The reasons cited for the difficulties encountered included:

- A significant weight of water that had found it's way into the valise due to flooding below deck in the vessel, and a slightly loose fitting liferaft valise.
- Dark, wet and greasy conditions below deck, due to the presence of diesel fuel and oil in the water below deck.

The situation experienced on *Business Post Naiad* supports the SHYR Report finding that:

"*Crews found it difficult to recover soft-pack liferafts from below deck in the prevailing conditions; it is doubtful that the rafts stowed adjacent to the* *companionway below deck could be deployed to the lifelines within 15 seconds as per the requirements in the RRS, Addendum A 4.19."*

3.4.1.2 Use of Liferafts to Enhance Trim and Balance

The admission by 4 survey respondents that the below deck stowage of liferafts assists with trim and balance during a race may require further attention. It is apparently common practice on some yachts to move the liferafts about below deck to suit the situation once a race has commenced. This practice could make locating the liferafts quite difficult after an event such as a rollover as a result of them being thrown about and possibly covered and obstructed by items such as sails and bedding materials.

3.4.2 On Deck Stowage

The practice of locating liferafts on deck appears to be slightly more common than below deck with 53% of the liferafts covered by the survey reported stowed on deck (Table 3.5). Figures 3.5, 3.6 and 3.7 show typical examples of on deck liferaft stowage positions observed by the author in August 1999 at the CYCA.

Figure 3.5
Cockpit stowage under tiller

Figure 3.6
Cockpit stowage

Figure 3.7
Transom stowage

The justifications provided for this method of stowage (Table 3.6) show that the on deck position is seen to have the advantages of the raft being easy to launch and not needing to be lifted to a launching position. However, on deck stowage has the potential for:

- Rafts being damaged by rigging in the event of a knock down or rollover event.
- Rafts being washed overboard by large waves. Particularly if stowed in exposed positions and not securely latched in position.

Liferafts were reported lost overboard from deck stowed positions from two vessels during the 1998 SHYR; *Inkeeper* and *Gundy Grey*. The *SHYR Report* (pp.84-85) describes the loss of a deck stowed liferaft from *Gundy Grey* after the vessel was struck by a large wave (p.84). After examination of the securing strap by the author, it appears that the raft was able to break free due to the parting of a small diameter line used between the webbing strap and the deck. Figure 3.8 shows the line used to secure the raft to the vessel.

Figure 3.8
Webbing strap and securing line from *Gundy Grey*

A more recent incident involving the loss of a liferaft from a deck stowage position occurred on August 6th 1999 from the yacht *Wahwoo*. The lashing systems used by *Wahwoo* and *Inkeeper* when the liferafts were lost are not known to the author.

Although the potential for loss of rafts overboard was identified by survey respondents, the issues of 'ease of access' and 'ease of launching' appear to outweigh the risk of the raft being accidentally washed overboard. This problem appears to be addressed by advocates of on deck stowage through the choice on deck location, and by using a secure method of securing the raft container to the deck. The securing methods used by vessels surveyed included rope and/or webbing lashings.

3.4.3 Securing and Release Arrangements

Lashing a liferaft securely into position should ensure that it is not accidentally lost overboard, and will remain in the position it is meant to be so that it can be located quickly in the event of an abandonment. The means of securing and releasing liferafts stowed on and below deck reported in the survey are summarised below:

- 52% of vessels surveyed used a direct lashing that must be untied or cut with a sharp knife to release the liferaft (Figure 3.5).
- 34% of vessels surveyed used a lashing secured via a quick release mechanism such as a senhouse slip (Figure 3.6).
- 3 % of vessels used webbing lashing straps that are manually slipped off the raft to release it.
- 3 % of vessels relied on the hatch securing mechanism associated with on deck stowage in a purpose built compartment (Figure 3.1).
- The remaining vessels reported either wedging the raft into position below deck (2 vessels) or leaving the rafts loose below deck (2 vessels).

Each of the securing and release systems reported in use are appropriate for offshore racing vessels. However, it is important that where a knife is required to cut a lashing, it should be kept sharp and lashed to the raft. It is also vital that all crew members know of its existence.

3.5 Conclusions Relating to Liferaft Stowage and Access

- The optimum position for stowing a liferaft on a yacht will vary depending on the design of the vessel.
- There is a strong indication that some yacht crews use liferafts stowed below deck as 'moveable ballast'.
- In some instances, liferafts stowed on deck do not appear to be properly secured.
- In some instances, liferafts stowed below deck do not appear to be properly secured.

- The use of a knife to release liferaft lashings on racing yachts for liferafts stowed on deck seems appropriate for the racing environment.

3.6 Recommendations Relating to Liferaft Stowage and Access

1. Where liferafts are stowed below deck Rule 4.19 (a) iii of the *Racing Rules of Sailing* should be enforced with respect to location adjacent to the companionway and security of stowage.
2. Liferafts stowed below deck should be securely lashed into position.
3. Liferafts stowed on deck should use a lashing system that is robust. Lines used for lashings should be inspected for deterioration on a regular basis.
4. Yacht crews should receive on board familiarisation training relating to the lashing and release system and used for each raft carried on a vessel.
5. On board training for crew members at accessing and moving a liferaft stowed below deck to a launching position should be encouraged.

4. Liferaft Operation

This section reports on investigations made into the following areas of liferaft operation:

- Launching.
- Boarding.
- Operation of canopy closures.
- Evacuating a capsized liferaft.
- Righting a capsized liferaft.

These areas were investigated through practical trials conducted by the Australian Maritime College in September 1999. The aims of the trials included:

- Identifying problems associated with locating and interpreting liferaft launching and post launching survival instructions.
- Identifying difficulties likely to be experienced in evacuating a capsized liferaft.
- Determining the feasibility of righting a small liferaft with most crew remaining inside.

Liferaft operation trials were conducted in a controlled still water environment at the AMC Survival Centre on the 19th and 20th of September 1999. Trials were also conducted at sea in Bass Straight on the 21st of September 1999 in a position about 2 nautical miles north of Low Head light house, off the entrance to the Tamar River. The sea trials were included in order to determine the effect that a seaway would have on liferaft operations. The Tasmanian Police vessel *Van Dieman* was used as the support platform for the experiments. The sea conditions prevailing during the conduct of the sea trials are summarised in Table 4.1.

Element	State
Wind	Northerly @ 8-10 knots (moderating)
Swell	Northerly @ 1-1.5 metres
Wind Waves	Up to 0.3 meters

Table 4.1
Wind and sea state for liferaft trials

The liferaft operation trials were conducted in the presence of the following observers:

- John Stanley (Survivor *Winston Churchill* Pro Saver liferaft).
- John Gibson (Survivor *Winston Churchill* Pro Saver Liferaft).
- John Ferris RFD N.S.W.
- Teki Dalton representing CYCA.*
- Inspector Hank Timmerman Tasmanian Police Marine Search and Rescue.**

* Did not attend trials conducted on September 19th.

* * Present for sea trials only.

4.1 Liferaft Operating Instructions

The location, readability and clarity of operating instructions for an inflatable liferaft are all factors that may contribute to the successful launch and subsequent operation of a liferaft, its fittings and equipment. The operating instructions associated with a 6-person Pro Saver liferaft were reviewed as a part of the liferaft operation trials.

4.1.1 Instructions on the Liferaft Container

The launching instructions for launching an inflatable liferaft were located on the outside of the stowage container in the form of pictorial instructions as shown in Figure 4.1 These were presented in a clear and understandable format on the Pro Saver valise.

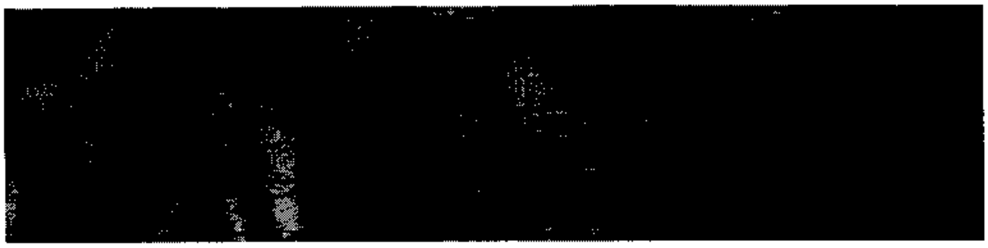


Figure 4.1
Pro Saver launching instructions

4.1.2 Internal Operating Instructions

There appears to be considerable variation in AYF liferafts when it comes to the format and location of instructions for 'immediate action' and instructions on 'how to survive within a liferaft'. This can most likely be attributed to the lack of a formal requirement for operation and survival instructions in the AYF and USL Coastal liferaft standards such as those contained in 4.1.5.22 and 4.1.5.23 of the *LSA Code*.

Typical locations and formats for these instructions include:

- Written instructions stencilled on the liferaft floor. These may be overlooked if sat upon.
- Written instructions suspended from the canopy support arch, as is common in SOLAS liferafts.
- Written instructions stowed in the liferaft equipment pack. These may be overlooked until equipment pack is opened.

The 'immediate actions for survival' instructions contained in the Pro Saver Liferaft were found to be located inside the equipment pack. These were printed on waterproof plastic sheets located in a plastic sheath and identified by the heading "Important Documents". Extracts from these instructions are shown in Figure 4.2.

5. IMMEDIATE ACTIONS
Cut operating line with knife (to be found inside beside entrance).
Stear away from sinking vessel with paddles.
Bail out sea-water using bailer and sponge.

Close entrance in heavy weather.

6. SUBSEQUENT ACTIONS
Nomination of a commander.
Keep calm, save energy
Top-up buoyancy chambers if necessary.
Assign duties such as keep look-out, managing emergency equipment and hold distress signals ready.
Never drink sea-water.

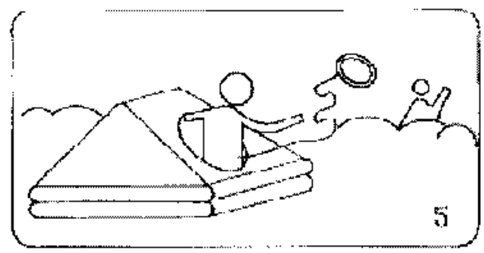


Figure 4.2
Immediate action instructions from Pro Saver liferaft

Figure 4.3 shows the 'immediate action' instructions that were located on the floor of the ME Petrel 6-person liferaft used in the 'at sea' trials.

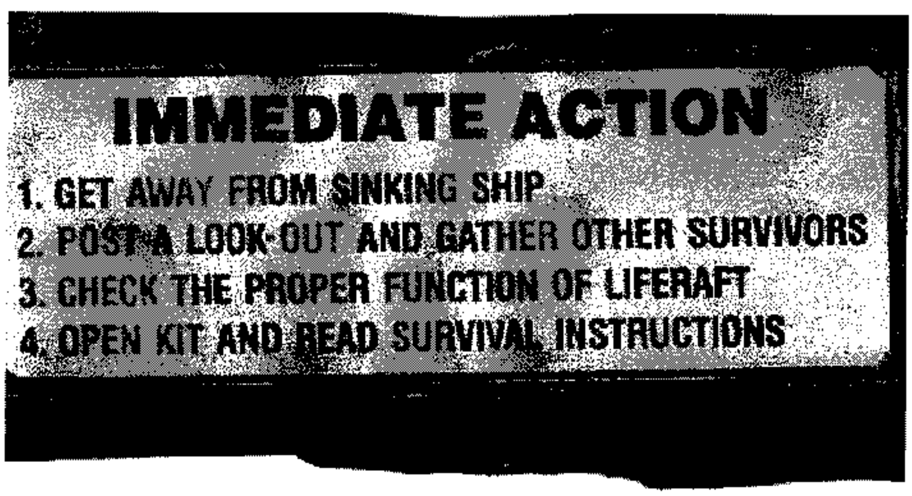


Figure 4.3
Immediate action instructions from ME Petrel liferaft

The SOLAS requirement for these instructions refers to *International Maritime Organisation Resolution A.657 (16)* Annex 1 Parts A and B relating to the format and content of "Instructions for Immediate Action in a Liferaft" and "Instructions on How to Survive in a Liferaft". These ensure that a common standard is used in the content and display of these instructions.

4.1.3 Instructions Relating to Liferaft Fittings

Liferaft fittings such as a knife and rescue quoit and line are normally located inside a liferaft, attached by a lanyard which prevents accidentally loss. These items are sometimes identified by the use of pictorial signs so that they are less likely to be overlooked by the raft occupants during the first critical moments after boarding. The Pro Saver liferaft was found to contain pictorial instructions for operation of inflation points stencilled to the inside of the buoyancy tubes, but did not use any means of identifying the knife or quoit and line, apart from the instructions for immediate action contained in the liferaft manual (Figure 4.2). However, as Figure 4.4 shows, the location of these fittings would make them difficult to overlook, provided the occupants knew to look for them.

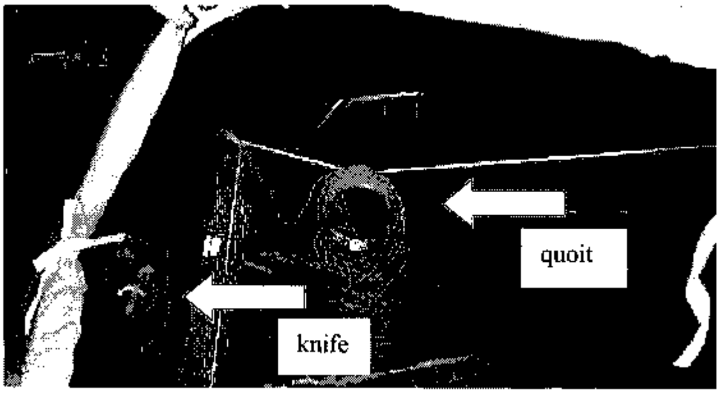


Figure 4.4
Location of some internal fittings in the Pro Saver

4.2 Boarding arrangements

The difficulties often associated with boarding liferafts from the water are summed up by comments made by John Gibson with respect to boarding a Pro Saver liferaft when abandoning the *Winston Churchill*.

"...I recall that I wasn't able to scramble in by myself, no matter how hard I tried, and I had to be assisted in...."
"The problem with getting into the raft was that the sides of the raft were quite high physically for me to get into and I was impeded by the life jacket which had a large area on the chest...."

There are two boarding systems currently used on inflatable liferafts; boarding ladder as shown in Figures 4.6, and a boarding step or semi-rigid ramp as shown in figure 4.7.

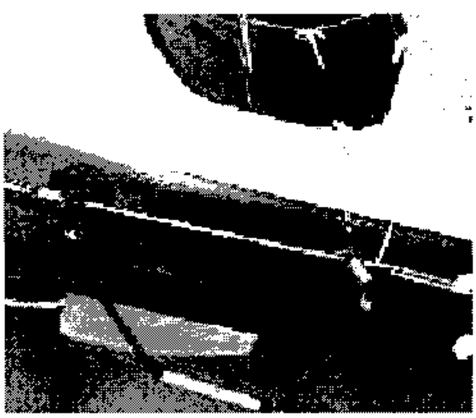


Figure 4.6
Boarding ladder

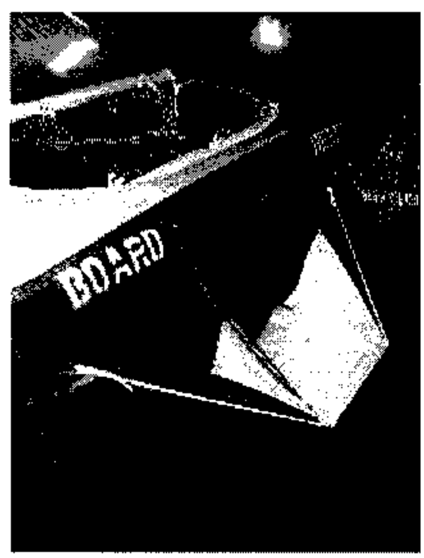


Figure 4.7
Boarding ramp

The semi-rigid ramps may be inflatable or non-inflatable units. At present, semi-rigid boarding ramps are mandatory for SOLAS liferafts under 4.2.4.2 of the *LSA Code*. There is no requirement for these arrangements for Coastal or AYF standard liferafts, although semi-rigid boarding ramps are offered as an option by some liferaft manufacturers.

During the still water liferaft trials conducted on September 19th both the trained and the untrained subject groups were required to board a liferaft fitted with a boarding step as well as the Pro Saver liferaft via a boarding ladder. Both groups were observed to experience greater difficulty boarding the Pro Saver liferaft than the Beaufort liferaft via a boarding ramp. The mean scores attained by each group (out of a possible maximum of 5) during the practical boarding assessment are summarised in Table 4.2.

Subject Group	Boarding Ramp Fitted	Boarding Ladder
Trained	4.2	3.7
Untrained	3.8	3.2

Table 4.2
Means scores attained by trained and untrained subjects when boarding liferafts

These results show a higher score was achieved by each group when able to board via a boarding ramp. This observation is supported by the results obtained from the response to a post trial questionnaire completed by each subject (see Appendix 3). These are summarised in Table 4.3 and Chart 4.1.

Raft fitted with boarding step was easier to board.	Raft fitted with ladder was easier to board.	Same degree of difficulty in boarding both types.
78.6% (22 of 28)	10.7% (3 of 28)	10.7% (3 of 28)

Table 4.3
Summary of raft trial subjects' views on the relative ease of boarding liferafts

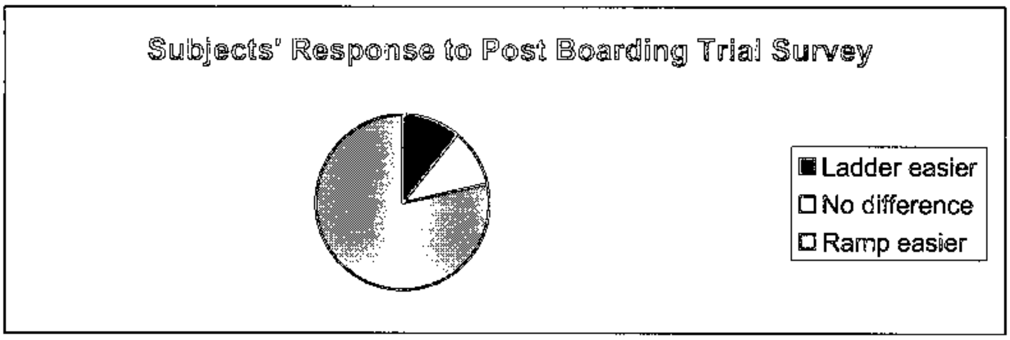


Chart 4.1
Summary of raft trial subjects' views on the relative ease of boarding liferafts

Other observations made relating to difficulties experienced by subjects boarding liferafts included:

- Two trained subjects and one untrained subject had to remove their lifejackets in order to board the Pro Saver.
- One subject from the untrained group was unable to board the Pro Saver liferaft via a ladder.

These observations tend to support the need for a liferaft boarding ramp.

4.3 Conclusions Relating to Liferaft Boarding Arrangements

- Difficulties are experienced by some people when attempting to board a liferaft from the water using a standard boarding ladder. These difficulties arise from factors such as physical fatigue, the bulk of a flotation device and the added weight of water trapped within wet weather gear.
- A semi-rigid boarding ramp reduces the difficulties encountered in boarding a liferaft from the water.

4.4 Recommendations Relating to Liferaft Boarding Arrangements

1. AYF rules should be amended to require a semi-rigid boarding ramp be fitted to at least one entrance to a liferaft for all new liferafts. This would need to be implemented over a sufficient period to allow manufacturers to develop suitable modifications to AYF liferaft designs.
2. Practical training in boarding a liferaft from the water should be a requirement of any sea survival training course required for SHYR participants.

4.5 Liferaft Egress Arrangements

In the event of a liferaft capsizing, at least one occupant will need to leave the liferaft so that the raft can be righted. The degree of difficulty that will be experienced by a person attempting to escape from an inverted raft will depend on the following factors:

- The method used to initially close and secure the canopy.

- The design of the canopy entrance.
- The method adopted for passing through the entrance and under the raft buoyancy tubes.

During the liferaft trials conducted on September 21st all subjects were successful in exiting both inverted liferafts. However, the subjects reported that the Petrel liferaft proved much easier to egress than the Pro Saver. This was attributed to:

- the larger canopy entrance with no tunnel, and
- a reduced number of canopy closure lines hanging in the way of an escaping occupant.

(Refer to underwater video footage of liferaft egress from the Pro Saver and a 6-person RFD SOLAS life raft with a similar canopy entrance to the Petrel).

During the still water egress assessment trials conducted on September 19th using trained and untrained subjects the following difficulties were observed:

- Three subjects reported they experienced difficulties in untying canopy securing lines prior to escaping. Mr. Winning from the *Winston Churchill* #1 raft reported experiencing the same problem in a ME Petrel liferaft. (p.88 *The 1998 Sydney Hobart Race Review*).
- Thirteen subjects reported experiencing difficulty due to becoming fouled by canopy closure or other liferaft lines.
- Four untrained subjects became trapped during the escape and needed assistance from a rescue diver.

These observations tend to confirm the need for practical training in liferaft egress. Although liferaft canopy closure designs will continue to differ, occupants who have been trained in a feet first escape technique (as was the case in the training provided for the trials) appear to be less likely to become trapped under the liferaft when escaping.

4.6 Conclusions Relating to Liferaft Egress Arrangements

- Difficulties in manipulating canopy closure and opening mechanisms are encountered with systems based on ropes, chords or ties. This is most prevalent when the operator's hands and fingers are wet and cold and in low light conditions.
- Canopy closure lines have the potential to foul a person attempting to egress a capsized liferaft.
- Persons who attempt to exit a capsized liferaft in a 'duck diving head first' manner are very likely to experience difficulties in exiting the raft.

4.7 Recommendations Relating to Liferaft Egress Arrangements

1. Manufacturers should be encouraged to begin incorporating shock cord, velcro or heavy duty plastic zips into canopy closure mechanisms to avoid the difficulties encountered in manipulating small diameter lines. This is already common practice on SOLAS lifejackets.

2. Any sea survival course should include a learning outcome and assessment criteria that requires course participants to physically escape from an inverted liferaft.

4.8 Liferaft Righting Arrangements

Although liferafts are designed with water stabilising pockets, evidence from a number of abandonment situations suggests that they are prone to capsizing in adverse wind and sea conditions. Liferafts are constructed in a way that allows them to be righted by one person in the event of a capsize incident as stated in Appendix II 1.0 (f) of the *Racing Rules of Sailing.* However, the righting fittings supplied tend to vary between liferaft models.

The righting arrangements on liferafts generally consist of either;

- a righting line or strap (Figure 4.8) which runs across the outside of the floor of the liferaft, or

- one or more grab handles (Figure 4.9) located on the outside of the floor of the liferaft.

The Pro Saver liferaft used for trials was fitted with a webbing righting strap which runs diagonally across the outside of the liferaft floor as shown in Figure 4.8. Instructions for righting the Pro Saver liferaft were found located in the instructions for survival located inside the equipment pack. These included pictorial instructions as shown in figures 4.10.

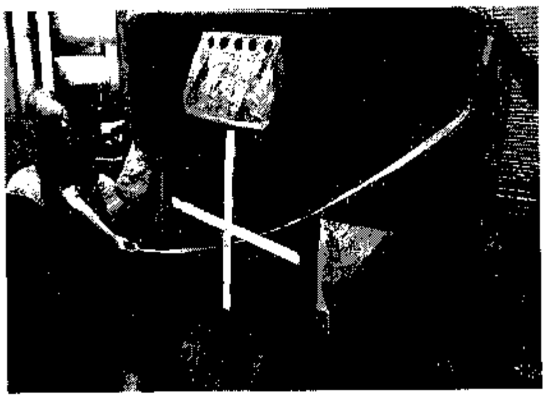


Figure 4.8
Righting strap

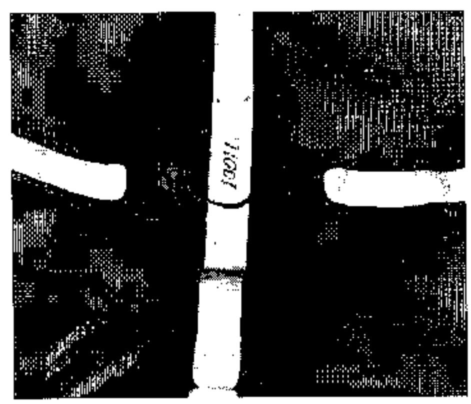
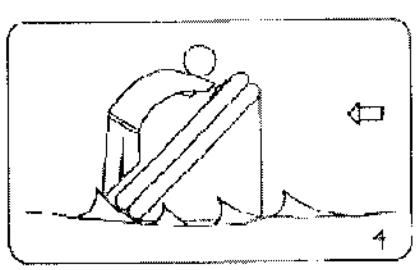


Figure 4.9
Righting handle



Extract from liferaft operating instructions located inside raft equipment pack.

Figure 4.10
Interior righting instructions

In addition to the internal righting instructions, a pictorial set was stencilled on the outside of two sides of the buoyancy tubes as shown in figure 4.11.

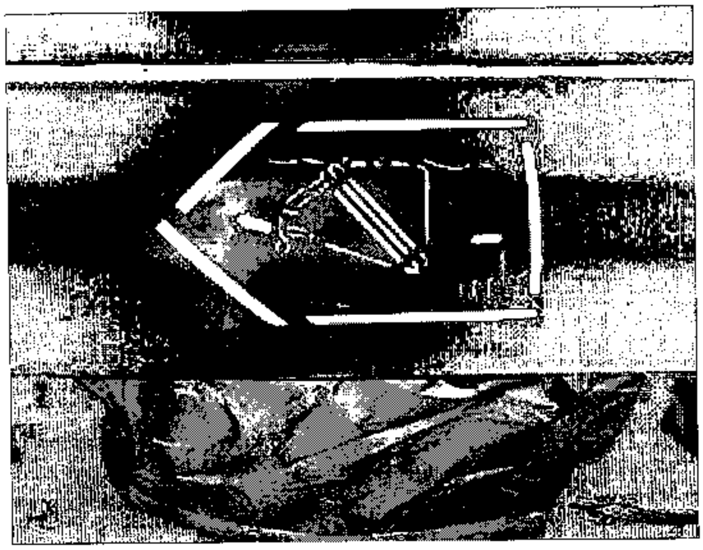


Figure 4.11
External righting instructions

4.9 Liferaft Righting Procedures

During police interviews[1] relating to the abandonment of the *Winston Churchill*, John Gibson and John Stanley expressed the view that the prevailing conditions were such that to go outside the liferaft would prove to be extremely life threatening. Comments made by John Gibson also indicate that the occupants of the liferaft were unaware of the nature of any righting fittings or method for righting the liferaft.

This is not an uncommon situation. During an interview conducted with Mr. Graham Bear on August 10th 1999, Mr. Bear related his experience as a crew member on the 1993 SHYR yacht *Adjustor* with 8 crew onboard. In this incident the yacht was abandoned in wind speed of 50-60 knots and wave heights estimated 8 metres. The 8 crew took to an eight-person liferaft raft. Following a capsize, all occupants exited the raft safely, but were unable to right the raft and gave up trying to do so. Some crew members climbed on top of the capsized rafts and others were required to remain in the water, holding on the liferaft lifelines until they were rescued by fellow competitors.

[1] 7312 – 98/0096, SYD -22307.me and 7312- 99/2225, SYD-22749ar

In a more recent incident, Mr. Thierry Dubois, a competitor in the 1996-97 Vedee Glode Single Handed Yacht race, recalled experiencing difficulties in righting a 10 person RFD liferaft that had been dropped to him from an aircraft. During his debrief (at which the author was present) Mr. Dubois reported almost being struck on the head by the liferaft gas cylinder during the righting process.

In both these events none of the raft occupants had undertaken any form of liferaft training. Additional cases of people experiencing difficulties righting a liferaft were encountered during the AMC liferaft trials conducted on September 19th 1999. During these trials 4 of 14 untrained subjects were unable to right a liferaft.

Comments made by the volunteer subjects who participated in liferaft righting trials conducted on September 19th 1999 are summarised in Chart 4.2.

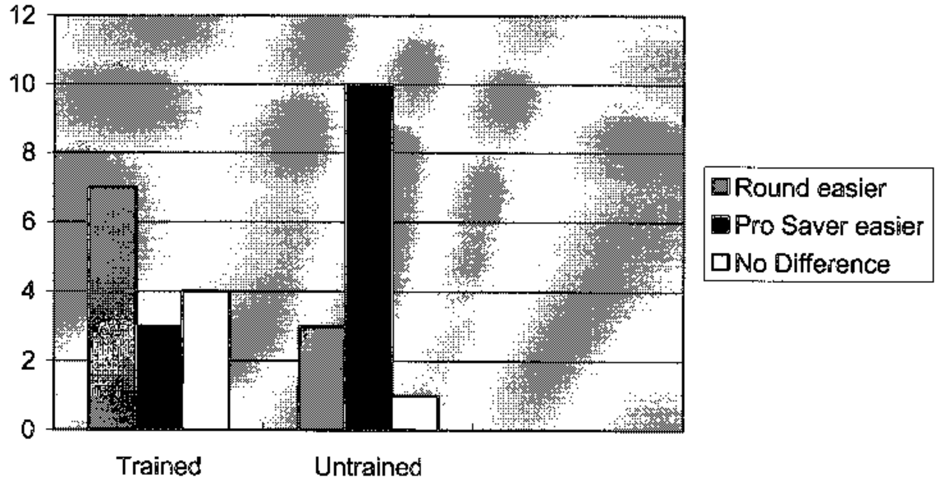


Chart 4.2
Subjects comments relating to ease of righting of liferafts

The round raft was a 10 person SOLAS raft fitted with a righting line. This raft was significantly larger in size than the 6-person Pro Saver liferaft as can be seen in the video footage of the righting trials. The comments and observations associated with this raft appear to indicate that training in righting technique does improve a persons ability to right a liferaft.

4.9.1 Righting Liferafts with Crew Remaining Inside

The trials conducted at the AMC initially involved righting empty liferafts in accordance with manufacturers' recommendations. The rafts were also righted with most occupants remaining inside the raft. These trials were conducted at sea as well as in still water at the request of the N.S.W. Police and were recorded on videotape. It was found that it is possible for a 6-person liferaft to be righted with up to 5 occupants remaining in the raft by an experienced person. This proved less difficult with a circular shaped liferaft than with a square raft. In the case of the Pro Saver, the righting strap parted from the raft with more than three persons remaining inside the raft. Another problem encountered with this righting method was that the occupants sometimes were rolled over, coming to rest on top of one another. This has the potential for one or more occupants becoming pinned for a short time with their face under any water in the liferaft.

While this method of righting is not recommended by liferaft manufacturers, it was noted that Mr. Winning (an occupant of the *Winston Churchill* #1 liferaft) righted the raft with the other occupants remaining inside (P.88 SHRR). This seems to have been a sound decision, based on the sea conditions being experienced at the time.

4.10 Effect of Placing Incision in a Liferaft Floor

One of the findings of *The 1998 Sydney Hobart Race Review* relating to liferafts (9.6.1) has determined that:

"*The destructive damage to WC's #2 liferaft was most probably instigated by the crew cutting an air hole in the floor. Additional forces of body weight, wave action and tumbling of the raft then compounded the damage.*"

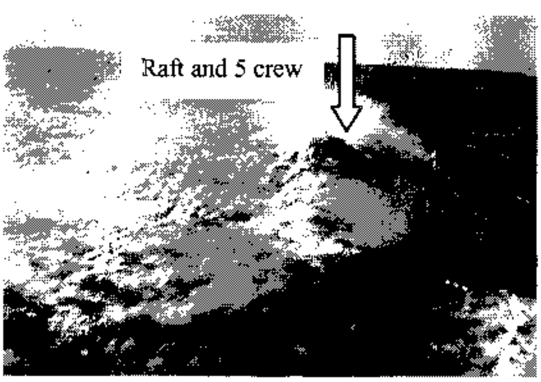
One of the aims of the liferaft trials was to determine the effect of placing an incision in the floor of a Pro Saver 6-Person liferaft. To achieve this, an experiment was conducted by the AMC and Tasmanian Water Police, which involved reproducing the incision size and location in a Pro Saver liferaft, in a seaway, with a crew of five. This experiment was conducted on September 21st 1999. John Stanley and John Gibson (*Winston Churchill* #2 liferaft survivors) were present for this experiment and provided advice on the exact location, size and direction of the incision. A similar incision was also made in a RFD Petrel 6-person liferaft so that the effects of this action could be compared with those observed on the Pro Saver liferaft (refer to video footage).

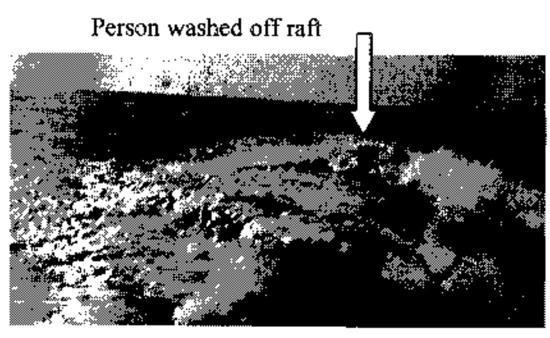
The incision in the Pro saver was made with the raft in an inverted position with 5 crew inside. The raft was then righted by one person with 4 occupants remaining inside. Upon becoming upright, the raft began to flood via the hole. The incision did not initially increase in size. However, after about 1 minute of standing and stamping on the floor the incision suddenly enlarged in a direction perpendicular to the direction of the incision. This tear extended across the entire width of the raft floor within about 30 seconds. From this point, the weight of the occupants appeared to cause the floor to separate from the base of the buoyancy tubes leaving small sections of floor attached to the buoyancy tubes as shown in Figure 4.12.

The raft was then exited by all occupants and turned over to facilitate video footage of the damaged floor. Following this, the raft was boarded in the inverted position to determine the effect of 5 occupant's body weight on the integrity of the canopy. The canopy began to tear at the lookout port and extended across the raft in less than 1 minute. The raft was then righted to facilitate video footage of the damaged canopy.

Figure 4.12
Effect of incision on Pro Saver floor

In order to establish the effect of breaking waves on the shape of the liferaft buoyancy tubes the *Van Diemen* made several close runs past the liferaft and five 'occupants' at about 30 knots. Each run had the effect of producing a breaking stern wave estimated to be 2 metres from trough to crest as shown in Figures 4.13 and 4.14. Also refer to video footage). The Pro Saver liferaft is constructed in a manner that bends the buoyancy tubes in a series of right angles to achieve a rectangular shape. This method relies heavily on the floor and canopy to maintain the original shape. The waves had the combined effects of causing the square shape of the Pro Saver raft to be lost as it folded into a 'diamond shape' (Figure 4.15), as well as throwing between 1 and all 5 occupants off the raft and into the water as it tumbled in each wave.





Figures 4.13 and 4.14
Wave hitting a liferaft

Figure 4.15
Shape of Pro Saver raft with floor and canopy removed

The experiment was then repeated using an RFD 6-person Petrel liferaft which had been condemned 3 days prior to the trial. In this case the floor was observed to be more resistant to tearing from the incision. It took considerably more stamping to initiate spreading, but once started extended across the raft at about the same rate as that in the Pro Saver. However, the final extent of floor damage was much less than that experienced with the Pro Saver. In this instance, half of the floor remained intact as is shown in Figure 4.16. The raft then was inverted to facilitate video footage and then re-boarded in this position.

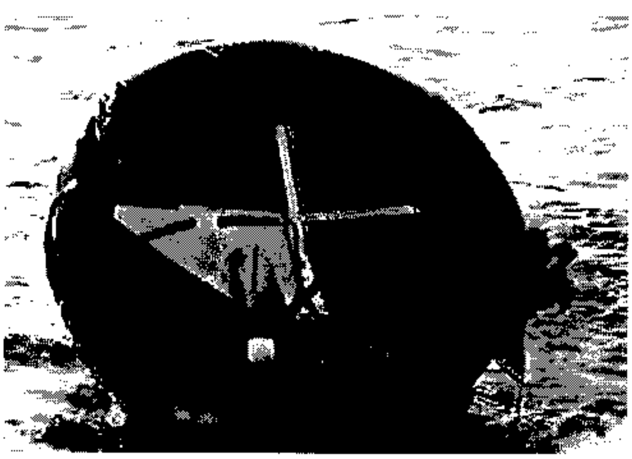


Figure 4.16
Effect of an incision in the Petrel liferaft floor

The Petrel liferaft canopy was observed to display a significantly higher resistance to damage than the Pro Saver liferaft. The raft occupants were unsuccessful in initiating a deliberate tear in the canopy by stamping and jumping in the inverted raft. The canopy and remainder of the floor were subsequently cut away using a knife. *Van Diemen* then made three close passes at 30 knots to determine the effect of a breaking wave on the shape of the raft. The raft remained its original circular shape but the occupants were easily washed from the raft on two occasions as it tumbled in the wave.

4.11 Other Incidents Involving Liferaft Destruction by Waves

There has been at least one incident involving the total destruction of a liferaft by a wave that has occurred in recent times. During the 1997 Southern Ocean rescues of Vendee Globe 1996-1997 Single-Handed Yacht Race competitors, a RFD 10 U Mk 8 10-person aviation liferaft was totally destroyed by a large breaking wave soon after being boarded by Thierry Dubois. A report in the Daily Telegraph (p.7 Friday January 10th 1997) quotes Dubois:

"*After about 10 minutes there was a big wave that hit the life raft and it exploded.*"

At the time of this occurrence winds were reported as exceeding 60 knots with seas of up to 10 metres. This report is consistent with the story related by Mr. Dubois during his debriefing. The liferaft concerned was constructed of light weight materials and had not been damaged by the occupant.

4.12 Survival Time in a Capsized Liferaft

An important issue that has been raised by the *Winston Churchill* # 2 liferaft incident, is that of survivability in a capsized liferaft environment. In order to determine the predicted survival time in a capsized liferaft, a review of the literature relating to oxygen consumption and carbon dioxide production rates, was made by Richard Phillips, Lecturer, School of Applied Biomedical Science of the University of Tasmania. Mr. Phillips also reviewed the literature relating to the effects of low oxygen levels and elevated carbon dioxide levels on human subjects. The internal volume of the Pro Saver raft was calculated and used to determine predicted survivability for the occupants in an inverted liferaft assuming nil gas exchange. Calculations were made relating to oxygen depletion and carbon dioxide build up with the liferaft. The results were compared with empirical data obtained for occupational health and safety purposes during the still water liferaft trials conducted on September 20th, 1999. This information is contained in Annex 1 to this report.

4.13 Conclusions Relating to Liferaft Righting and Incising a Liferaft Floor

1. A liferaft is not designed to safely protect its occupants in the inverted position. There is minimal gas exchange, resulting in risks associated with carbon dioxide build up and oxygen depletion.
2. The failure to right the *Winston Churchill* Pro Saver liferaft would have contributed to the destruction of the liferaft canopy due to the weight of the occupants acting on it.
3. The act of incising the floor of the Pro Saver liferaft provided a weak point in he structure that allowed the floor to tear, separate from the bottom of the buoyancy tubes and contributed to the raft's loss of structure and integrity.
4. The shape adopted by the buoyancy tubes of a liferaft once the floor and canopy were removed did not prove to be a contributing factor to the ease of maintaining contact with the raft during practical trials. Liferaft occupants observed that it was extremely difficult to maintain contact with the Petrel and the Pro Saver liferafts when they were hit by a breaking wave. This is supported by the video footage recorded during the liferaft sea trials.
5. The floor and canopy materials of the Pro Saver liferaft were observed to be much less resistant to tearing than those of the Petrel liferaft which was constructed from heavier materials.
6. It is possible to right a 6-person liferaft with up to 5 persons remaining inside the raft.
7. A person who has received practical training in liferaft righting should experience less difficulty in righting a liferaft than an untrained person.

4.14 Recommendations Relating to Liferaft Righting and Incising a Liferaft Floor

1. Liferaft manufacturers should be encouraged to use liferaft floor materials which display strong resistance to tearing in the event of the floor becoming accidentally cut, chaffed or torn.

2. Race participants should be made aware of the dangers associated with remaining inside an inverted liferaft for too long:

    - Prolonged immersion in cold water resulting in possible hypothermia.
    - Problems associated with oxygen depletion and the rapid build up of carbon dioxide within the limited volume of the air space in the inverted raft.
    - High probability of the occupants' weight damaging the canopy, particularly in rafts constructed from light weight materials.

In addition, the dangers associated with cutting a hole in the floor of an inverted liferaft should also be explained.

3. All sea survival training courses required for SHYR participants should include practical training in liferaft righting techniques.

5. Factors Affecting Liferaft Launching and Inflation

During the SHYR there were two incidents reported relating to problems associated with liferaft inflation. These were:

- The premature inflation of a liferaft on board *Business Post Naiad*, and
- The failure of a liferaft to inflate when deployed into the water from *VC Offshore Stand Aside*.

5.1 Possible Causes of Premature inflation

5.1.1 Accidental Exposure and Pulling of Painter

In order to obtain first hand information relating to the *Business Post Naiad* incident, Mr. Steve Walker was interviewed by telephone by the author on November 5th 1999. Mr. Walker witnessed the pre-mature inflation of a 6-person RFD Seasava liferaft. Mr. Walker recalled that the liferaft was in the process of being relocated from the cockpit area to its original position below deck when the accidental inflation occurred. The raft began to inflate in the companionway entrance as a result of the painter being pulled tight when one of the crew members carrying the raft slipped. Once it was evident that the liferaft was inflating it was quickly pulled clear of the companionway entrance and placed over the side of the vessel.

Mr. Walker stated that the painter had "become slack" and had worked its way out of the soft valise. The valise had begun to open due to a large volume of water that had accumulated inside. This occurred when the raft became submerged in water below deck, which had accumulated when the vessel was knocked down and rolled.

When asked to comment on the situation described above, Mr. Richard Hooper of Tamar Marine indicated that the design of liferafts stowed in a soft valise, can allow a bight of painter close to the gas cylinder to protrude if the velcro holding the valise closed works open.

5.1.2 Inappropriate Painter Fastening Position

During an inspection of liferaft stowage arrangements conducted by the author on the 10th of August 1999, it become apparent that the stowage method used on some vessels may have the potential for pre-mature inflation of liferafts. If a liferaft painter is secured to a strong point that is below deck, several metres from the companionway entrance or the launch position, the raft has the potential to be accidentally inflated. Figure 5.1 shows two liferafts stowed below deck on a racing yacht. In this case the painter lines have been secured to the mast base. It is the opinion of the author that this arrangement has the potential for premature inflation in the event of the painter line being pulled tight due to;

- not having sufficient length to allow the raft to reach a suitable launching position,
- the painter line becoming fouled during the moving process, or
- the liferaft breaking free and moving about the cabin in the event of a severe knock down or rollover.

Figure 5.1
Painters secured below deck several metres from companionway

5.2 Possible Causes for Non-inflation

As the liferaft concerned (*VC Offshore Stand Aside)* was lost, one can only speculate as to the reason for non-inflation. The non-inflation may have resulted from any of the following reasons:

5.2.1 Departure from Manufacturer's Standard Packing Procedures

Whenever a liferaft is packed in a manner contrary to manufacturer's standard procedures, there is potential for possible non-inflation. The liferaft involved in the non-inflation incident on *VC Offshore Stand Aside* was a new 6-person RFD Pacific liferaft, manufactured in 1998. This raft was originally supplied packed in a soft valise. However, prior to being placed on board the vessel for the race the raft was repacked into a rigid canister. The canister used was a "Roaring Forties" design (not RFD). When asked whether it was common practice to mix different manufacturer's components, Mr. John Frearson, Mr. Zane Boucher and Mr. Hooper were of the opinion that a licensed liferaft packing station should never depart from the packing instructions and parts specified for any given brand of liferaft. This was view confirmed by Mr. John Ferris N.S.W. Manager of RFD Australia. It is possible that the direction of pull of the painter resulted in excessive friction, preventing the painter from fully exiting the canister. Confirmation of this theory is not possible, as the raft was not recovered.

5.2.2 An Empty Gas Cylinder

This is probably the most likely cause for a non-inflation incident. Mr. Hooper has been packing liferafts since 1990 for Tamar Marine, Launceston. On average he packs 120 liferafts per year. In this time Mr. Hooper recalls coming into contact with liferafts with empty cylinders on five occasions, and liferafts with partially empty cylinders on one occasion.

In three incidents the leak was attributed to a cracked cylinder neck in alloy cylinders. All had been hydrostatically tested the year before the survey that detected the defect. The cracks may have been due to the cylinder valve being screwed too far into the neck. The other incident involved a faulty head valve.

An additional incident occurred around 1997-8. A new Zodiac liferaft was undergoing its first annual inspection when it was noted that the cylinder was down to approximately one third of it's normal capacity. The cylinder was inspected and the leak was found to be due to a very small hole in the almost rusted out base of the cylinder. The cylinder had been manufactured in 1967, and was a converted CO_2 fire extinguisher. Mr. Hooper recalled only one occasion where he has encountered a liferaft that he suspected was packed with an empty cylinder.

Zane Boucher has 18 years experience packing liferafts and has packed an average of 200 rafts per year over the last 7 years in Hobart. During this time Mr. Boucher has come across empty gas cylinders on 6-8 occasions. Mr. Boucher is of the opinion that the cylinders lost gas through a slow leak or were empty when fitted to the liferaft as a result of poor packing procedures.

The Australian Maritime College has also experienced problems due to empty cylinders. There have been several occasions where an empty or partially full cylinder has been in accidentally fitted to training liferafts used at the AMC Survival Centre. These incidents occurred due to the non-implementation of the rigorous re-packing procedure that applies to commercially packed liferafts. The training raft cylinders were not routinely check weighed as the rafts were only for demonstration with the result of empty cylinders becoming confused with the full cylinders.

Under normal circumstances, it is unlikely that an empty cylinder would be fitted to a liferaft during an annual survey. However, if the liferaft servicing station departed from standard commercial packing procedures there is a possibility that an empty cylinder could be fitted to a liferaft.

5.2.2.1 Leak Testing Procedures

Mr. Boucher and Mr. Hooper have stated that liferaft packing procedures require that any cylinder that has been refilled is checked for slow leaks. This is done by using soapy water or a sodium carbonate pH change technique. This check is aimed at detecting any slow leak that has developed due to any malfunction of the valve seating mechanism.

5.2.3 Loose High Pressure Hose or Fittings

A liferaft may fail to inflate fully if any of the connections between the cylinder and the raft are loose or not sealed correctly. This situation was observed during the deployment of the RFD Pro-Saver 6-person liferaft during the performance trials conducted at the AMC on the 19th of September 1999. This incident was captured on videotape, and should be viewed by the reader. A significant volume of gas escaped from the 'T' fitting shown in Figure 5.2. during the inflation process resulting in a partially inflated raft as shown in figure 5.3.

Figure 5.2
"T" piece showing frozen CO_2 deposited as a result of escaping gas

Figure 5.3
Partially inflated Pro Saver

The location of the leak was confirmed using a soapy water test (see video footage). This leak appeared to be the result of incorrectly tensioned securing bolts. This incident was unexpected and creates concern about the state of the "T" piece assembly on other Pro Saver liferafts.

5.2.4 Cylinder Head not Attached to the Painter Line

Although this would result in non-inflation incident, it is unlikely that the attachment of the cylinder head wire or line would be overlooked by a competent liferaft packer.

5.2.5 Cylinder Head Malfunction

The cylinder head fitted to the *VC Offshore Stand Aside* liferaft was a Kiddy Mk1 type. It is the opinion of the three Tasmanian liferaft packers that this unit is robust, simple in operation and very reliable. None reported having heard of the unit failing to operate. The AMC has used this head extensively since 1983 for training rafts. These are inflated on a regular basis (approximately 100 inflations a year since 1991) and no problems have been encountered with this type of cylinder head valve. It is unlikely that a cylinder head valve malfunction was the cause of the inflation failure of the liferaft.

5.3 Conclusions Relating to Liferaft Inflation Issues

- The premature inflation of the *Business Post Naiad* liferaft was caused by the accidental pulling of a section of painter which had worked free from the valise closure mechanism due to the build up of water in the valise.
- The inflation failure incident of *VC Offshore Stand Aside* can be most likely be attributed to either; an empty gas cylinder, or the use of a non approved rigid container.
- It is possible for empty gas cylinders to be fitted to a liferaft if a well organised system for checking cylinder weights is not in place or adhered to.

5.4 Recommendations Relating to Liferaft Inflation Issues

1. The potential problems associated with soft valises and the potential for painters to work free of the valise should be passed on to competitors during survival at sea training courses.

2. Yacht owners should be required to stow their liferafts adjacent to the companionway as required by Rule 4.19 of the *Racing Rules of Sailing*. If the painter is secured to a position close to the companionway there will be less chance of accidental inflation, particularly below deck.

3. Liferaft servicing stations should be discouraged from using non approved parts when packing liferafts without the authority of the liferaft manufacturer.

4. Liferaft servicing stations should review current procedures for identifying and storing charged and empty cylinders in liferaft packing areas.

5. Action should be taken to determine whether the leaking 'T' piece incident observed on the RFD Pro Saver liferaft at the AMC was an isolated incident or is likely to affect other liferafts.

6. Sea Survival Training

Following the 1998 SHYR, the topic of sea survival training has become an important issue for the race organisers and the AYF. Finding 9.9 (p. 148) of *The 1998 Sydney Hobart Race Review* states that:

"*Many crews, despite having high levels of ocean racing experience were poorly informed on many aspects of safety equipment and SAR. These include:*

- *the inability to deploy flares, particularly parachute flares,*
- *the lack of awareness of SAR retrieval techniques, such as what would happen when a helicopter arrived, how to get into a sling etc., and*
- *the deployment and efficient/effective use of liferafts, including righting and use of raft's equipment……"*

There appears to be a need for some form of training to be completed by some proportion of race participants. This section has been included in this report in order to assist in the resolution of the sea survival training issue.

With respect to racing yachts, sea survival training can be divided into two types;

- formal training courses including safety seminars and sea survival courses which result in a certificate of attendance or attainment, and
- practice exercises and informal training which is conducted on board a vessel.

6.1 Current Training

6.1.1 Pre Incident

Prior to the publication of *The 1998 Sydney Hobart Race Review*, there was no requirement for formal training to be undertaken by any crew members participating in the event, except for on-board training conducted in accordance with Rule 1.2 (Owner's Responsibility) of the AYF *Racing Rules of Sailing* (p.143). As a result, the practice of informal on-board training is being regularly practiced by a number of participating vessels in accordance with Rule 1.2. An indication of the extent of this practice was obtained from items 9 and 10 of the liferaft survey questionnaire. These are summarised in Tables 6.1 and 6.2.

Type of on Board Training Conducted	Yes	No	Totals
Access and moving to a launch position	27	34	61
	44.3%	55.7%	100%
Launching and abandonment	19	42	61
procedures	31.1%	68.9%	100%

Table 6.1
Training conducted on board racing yachts

Frequency of on Board Training	Number	Percentage
Pre race	16	59.3%
Twice a year	4	14.8%
Once a year	2	7.4%
Infrequently	1	3.7%
As required by training vessel operations	2	7.4%
At liferaft servicing	1	3.7%
Not stated	1	3.7%
Totals	27	100%

Table 6.2
Frequency of training conducted on racing yachts

Discussions with Mr. David Lawson, CYCA Safety Officer, indicated that compliance with this rule is difficult to enforce under existing pre-race inspection procedures, which are mainly focused on the safety equipment items carried by participating vessels. The recent introduction of safety seminars by the CYCA and other yacht clubs was partly aimed at overcoming this concern. Mr. Lawson indicated that one method currently under consideration for overcoming this problem is a modification of the existing pre-race safety inspection. Under the proposed system, the inspector will have the authority to require crew members to demonstrate, or explain the operation of a lifesaving appliance selected at random during the course of an inspection.

6.1.2 Post Incident – CYCA recommendations

The *Notice of Race* for the 1999 SHYR was reviewed to determine which recommendations relating to training have been implemented for the next event. Under provision 6.2.1 of the Notice of Race for Telstra Sydney Hobart Yacht Race:

"At least 30 percent of the crew on a yacht must have completed a CYCA Safety Seminar or AYF Yacht Safety and Survival Course or a CYCA approved equivalent."

This requirement is consistent with the compulsory requirement for 30% of crew members undertaking such training as described in recommendation B2 (p.155) of The *1998 Sydney Hobart Race Review*. However, the recommendations for 100% of crew members to attend a safety seminar (p.156) and for 50% of the crew to have undertaken;

"a 'Survival at Sea', 'Marine Survival Course', or similar course, which includes abandoning ship, life raft survival skills and a SAR recovery section." (p. 158),

have not been implemented for the 1999 race.

6.2 Impact of Sea Survival Training on Survival Skills

In order to determine whether there would be any observable difference between racing yacht crew members who had been trained in sea survival to those who have not received such training, a small pilot study was developed and conducted at the AMC in September 1999.

6.3 Study Rationale and Aims

This pilot study was conducted in order to address the issue of whether or not sea survival training should become mandatory for crew members participating in long Category 1 yacht races. The study was opportunistic in nature, taking advantage of the presence of volunteer crew racing yacht crew members as subjects for liferaft trials.

Aims of the study included:

1. determining whether sea survival training has significant effects on survival knowledge and skills, and
2. identification of any physical difficulties experienced by subjects in operating liferafts and a helicopter rescue strop.

6.4 Methodology

Trials were initially conducted in still water at the AMC Survival Centre pool. 29 volunteers from the Northern Tasmanian yachting community were used as samples from the racing yacht crew population. These subjects were observed in order to make an assessment on the possible impact of training on individuals' general knowledge of survival skills and practical ability to operate a liferaft and helicopter-lifting strop.

This was achieved by providing a one day sea survival course based on learning outcome 2 of the Australian National Training Authority Module ABF 511 Occupational Health and Safety at Sea, with additional emphasis placed on AYF life saving appliances and equipment. Appendix 4 contains an outline of the training conducted for half of the study subjects two weeks before the comparative trial was conducted. On the day of the comparative still water trial, the 15 trained and 14 untrained subjects were asked to complete a short written test paper relating to survival at sea knowledge (Appendix 5). The subjects had no prior warning that this test would be administered as a part of the study. The subjects were then observed and recorded on video tape as they individually performed the following sequence of practical tasks in low light conditions:

1. Swim two laps of the pool (50m in total) wearing yachting foul weather gear and a coastal Personal Flotation Device Type 1.
2. Board a 10-person Beaufort SOLAS liferaft via an inflatable boarding ramp.
3. Retrieve and pull on board a simulated unconscious casualty using a police diver as an assistant for lifting.

4. Swim to, and board a 6-person RFD AYF standard Pro Saver liferaft.
5. Secure the canopy entrance.
6. Remain inside the raft during a capsize.
7. Exit the raft after capsize.
8. Right the 6-person RFD AYF standard Pro Saver liferaft.
9. Right the 10-person Beaufort SOLAS liferaft.
10. Don a helicopter lifting strop and signal when ready for hoisting.

Subjects had no prior knowledge of the nature or sequence of practical tasks, and were not permitted to observe the conduct of these tasks until they had completed their turn.

The practical skills demonstrated by each subject were observed and scored by Hugh Hurst, AMC lecturer in survival and emergency response. Scores were allocated according to the following descriptive rating scale:

0 1 2 3 4 5

0	Failure to complete task
1	Very poor technique
2	Poor technique (task completed but required assistance from safety diver)
3	Satisfactory technique
4	Good technique
5	Technique totally correct

The subjects were also asked to complete a questionnaire (Appendix 3) relating to their experiences and any difficulties encountered during the trial as soon as they had showered and changed.

6.5 Data Analysis

6.5.1 Test Scores

A descriptive statistical analysis of the scores obtained (Appendix 6) showed the distribution of test scores is not normal, making a two-tailed 't' test inappropriate to test the null hypothesis (that there would be no significant difference between the mean scores obtained by each group of subjects). It is believed the skewed nature of the distributions can be attributed to the low sample population used for this study. The test for significance used to test to a 95% probability level was a "mean error bar test" (based on standard errors).

6.5.2 Practical Performance

Although a descriptive rating scale was used to allocate scores for each subject there is a possibility of bias due to the small sample size available for this study. The data obtained can not credibly be tested for significance using traditional statistical tools. Any conclusions drawn are based solely on direct comparison of each group of subjects' practical performance, and cannot be proven to be statistically significant to a 95% probability level.

6.6 Findings

6.6.1 General Survival Knowledge Test

The test scores obtained by each subject group are summarised in Chart 6.1. The mean error bar test disproved the null hypothesis and showed that there was a significant difference in test scores between each group of subjects. Based on general educational experience, a second (data dependent) hypothesis was developed. This hypothesised that the trained subjects would obtain a higher test score than the untrained subjects. Although the test scores were not normal, a single tailed 't' test provided a strong indication that the trained subjects scored significantly higher than the untrained subjects.

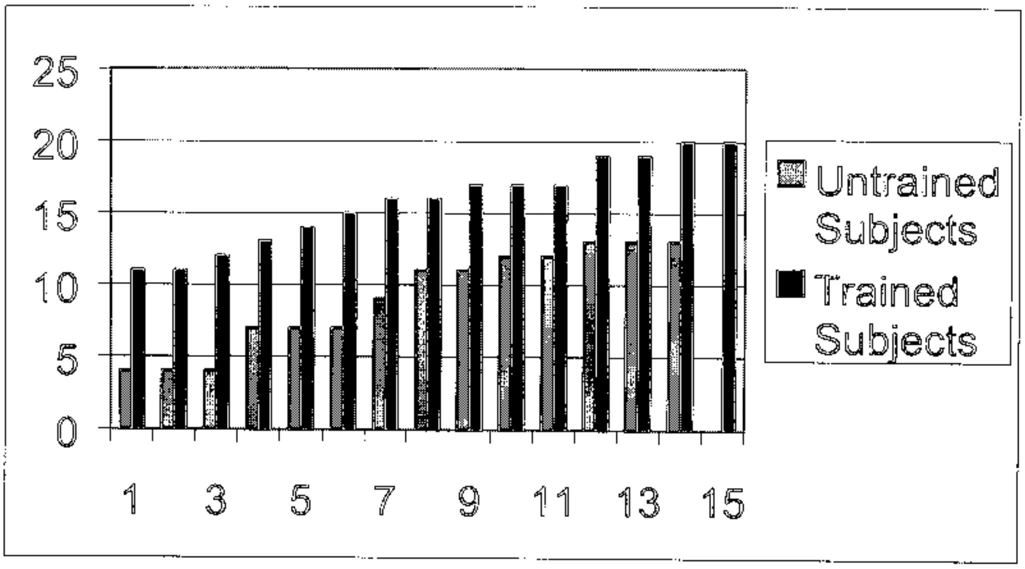


Chart 6.1
Comparison of test scores

The mean score achieved by each group summarised in Table 6.3.

Subject Group	Mean Score
Untrained	45.3%
Trained	77.5%

Table 6.3
Mean scores achieved

6.6.2 Practical Skills Assessment

The author's hypothesis relating to practical survival skill was that there would be a difference between the practical performance of the trained subjects and the untrained subjects. An indication of relative performance of each group may be obtained from the percentage break down of scores awarded to each group for each practical task as summarised in Table 6.4. Each figure shown represents the percentage of that group which achieved the indicated score. Note that a score of less than 3 represents unsatisfactory performance.

Score *Practical Task and Rating*		*0* %	*1* %	*2* %	*3* %	*4* %	*5* %	*Mean Score*
Boarding Pro Saver (rope boarding step)	T	0	0	7.1	21.4	64.3	7.1	3.7
	UT	7.1	7.1	0	35.7	50	0	3.2
Boarding Beaufort (boarding platform)	T	0	0	0	0	78.6	21.4	4.2
	UT	0	0	0	21.4	78.6	0	3.8
Escape Inverted Raft	T	0	0	21.4	28.6	42.9	7.1	3.4
	UT	0	21.4	35.7	21.4	21.4	0	2.4
Donning Helicopter Strop	T	7.1	0	14.3	42.9	28.6	7.1	3.1
	UT	64.3	7.1	14.3	7.1	0	0	0.9
Righting Pro Saver Raft	T	0	0	21.4	28.6	42.9	7.1	3.4
	UT	0	7.1	28.6	42.9	7.1	14.3	2.9
Righting Beaufort Raft	T	0	0	0	14.3	57.1	28.6	4.1
	UT	21.4	0	7.1	42.9	28.6	0	2.6
Unconscious Casualty Retrieve	T	0	0	7.1	28.6	50	14.3	3.7
	UT	0	0	64.3	7.1	28.6	0	2.6
Unconscious Casualty Lift into Raft	T	0	0	21.4	35.7	35.7	7.1	3.3
	UT	0	0	21.4	50	28.6	0	3.1

Table 6.4
Breakdown of trial subject practical assessment scores

In addition to the generally distribution of higher scores attained by the trained subjects, further evidence that training may be valuable for a survival situation can be derived from the following observations made during he trials:

- 1 untrained subject failed to board the Pro Saver liferaft.
- 3 untrained subjects failed to right the 10-person Beaufort liferaft.
- 4 untrained subjects became entangled in lines or in the canopy hatch during the underwater escape and required assistance from the safety diver to get free.
- 9 untrained subjects failed to don the helicopter strop in a manner that would not result in injury or falling from the strop compared to 1 trained subject.
- 9 untrained subjects failed to maintain contact with the liferaft via the rescue quoit and line.

6.7 Conclusions Relating to Sea Survival Training

- Sea survival training makes a significant difference to the general survival skill knowledge of a racing yacht crew member.
- Trained racing yacht crew members were observed to be generally better able to perform practical survival tasks than untrained racing yacht crew members.

6.8 Recommendations Relating to Sea Survival Training

1. The recommendation for 50% of a yacht crew to undertake a 'Survival at Sea', 'Marine Survival Course' should be implemented as a minimum requirement. Such a course should be independent of general safety and seamanship courses. This would allow it to be delivered in 1 day as is currently the case with mandatory survival courses conducted for the small commercial craft industry such as the survival component of ANTA Module ABF 511 (Learning outcome 2). This approach would ensure that race participants would have a large choice of training institutions to choose from. There is at least one training provider accredited to deliver this training in each state.

2. Any sea survival course considered should include assessment criteria that require all participants to:

    - board a liferaft,
    - locate and use a rescue quoit ,
    - bring a simulated unconscious casualty on board a liferaft,
    - escape from a capsized liferaft,
    - right a capsized liferaft, and
    - don and be lifted in a helicopter rescue strop.

3. Yacht owners should be encouraged to organise for the racing crew to inspect the vessel's liferaft, fittings and equipment during its annual survey. The familiarisation gained would provide valuable knowledge for any crew member who is subsequently required to use the raft in an abandonment in dark and adverse weather conditions.

APPENDIX 1

PRO SAVER BROCHURES

Appendix 1: Pro Saver Brochures

PRO SAVER

Händlerpreisliste 1999
Gültig ab 15.11.98

PRO SAVER Rettungsinseln

Für küstennahe Gewässer, Seen und Flüsse mit selbstaufrichtender Dachkonstruktion

Interpreted – "Close to the coast"

	Ident-Nr.	Einkaufspreis DM exkl. MwSt	Empf. Verkaufsp DM inkl. MwSt
PRO SAVER für 4 Personen in Tasche 65 x 36 x 31 cm, ca. 18 kg	9880016	[redacted]	2983,00
PRO SAVER für 4 Personen in Container 65 x 48 x 23 cm, ca. 20 kg	9880023	[redacted]	3173,00
PRO SAVER für 6 Personen in Tasche 66 x 36 x 31 cm, ca. 22 kg	9880039	[redacted]	3215,00
PRO SAVER für 6 Personen in Container 65 x 48 x 23 cm, ca. 24 kg	9880046	[redacted]	3404,00
PRO SAVER für 8 Personen in Tasche 78 x 40 x 35 cm, ca. 25 kg	9880053	[redacted]	3662,00
PRO SAVER für 8 Personen in Container 76,5 x 51,5 x 29 cm, ca. 28 kg	9880069	[redacted]	3905,00

PRO SAVER Rettungswesten

Vollautomatisch nach EN-Norm mit CE-Zeichen

AMCsearch LTD
WAY AHEAD !

Inflata

The PRO SAVER inflatable life raft provides basic safety for a 4, 6 or 8 man crew .

It is a must on board, as container or valise. The high-standard fabrication, excellent material and its extreme tear resistance are elements which you can trust in the case of an emergency. Two buoyancy tubes with independent chambers and a self-erecting roof are, of course, included, as are capsizing protection bags, access aid and handline. With its wide range of equipment, the PRO SAVER is an inexpensive safety factor in waters near to the coast.

The PRO SAVER should be regularly serviced to ensure your safety. Make use of our world-wide service from authorised specialist companies.

- inexpensive self inflating life raft
- in valise or container
- 2 buoyancy tubes with independent chambers
- capsizing protection bags, access aid, all-around handline, closable entrance, additional lookout
- reflective strips
- sea anchor, paddle, quoit with line, baiter, sponge, pump, repair set

PRO SAVER

Technical dat

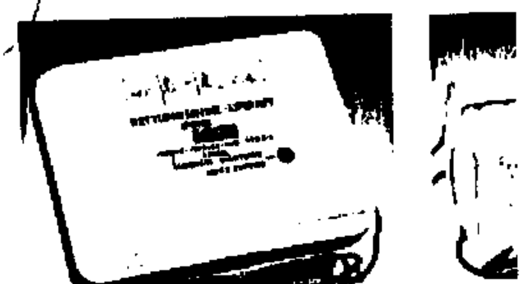
PRO SAVER 4 n

PRO SA

The PRO SAVER life raft offers the latest in life raft design and technology at a cost attractive to all boat owners. Space age materials and manufacturing techniques provide a light weight, tear resistant life raft with features seen only on the most expensive alternatives. The self righting PRO SAVER life raft features standard dual tube and self inflating canopy, system design, and can be equipped according to each boat owners intended use. Correctly equipped, the PRO SAVER life raft will meet all regulatory requirements for coastal, off shore, and ocean voyages (please refer to the PRO SAVER technical data sheet for equipment kit contents).

For your own safety, the PRO SAVER should be serviced at regular intervals. Authorised service stations are to be found worldwide.

PRO SAVER LIFERAFT
for 4, 6, or 8 persons



APPENDIX 2

LIFERAFT STOWAGE & ACCESSIBILITY

QUESTIONNAIRE

Appendix 2: Liferaft Stowage & Accessibility Questionnaire

Liferaft Stowage & Accessibility Questionnaire

Dear Respondent,

Thank you for taking the time to complete this questionnaire. This information is being collected in order to obtain a cross section of current practices with respect to liferaft stowage and accessibility on board offshore racing vessels.

There is no need for you to identify your vessel. Information provided by respondents will be collated and will be submitted to the N.S.W Police to assist with the Coroner's Inquest into the 1998 Sydney Hobart Yacht Race.

Once complete, please place the questionnaire in the reply paid envelope provided.

I will be in Sydney attending the CYC on August 10th 1999 if you would like to speak with me relating to any issues raised by this questionnaire. I can also be contacted via email at T.Boyle@mte.amc.edu.au or by telephone on 0363 354758 during business hours.

Tony Boyle
Consultant to N.S.W Police
AMC SEARCH LTD

Item 1

Please complete the following details relating to the liferaft/s carried on board your vessel during offshore racing activities.

Manufacturer	
Model	
Standard (AYF/Coastal/SOLAS)	
Capacity	
Packed weight	

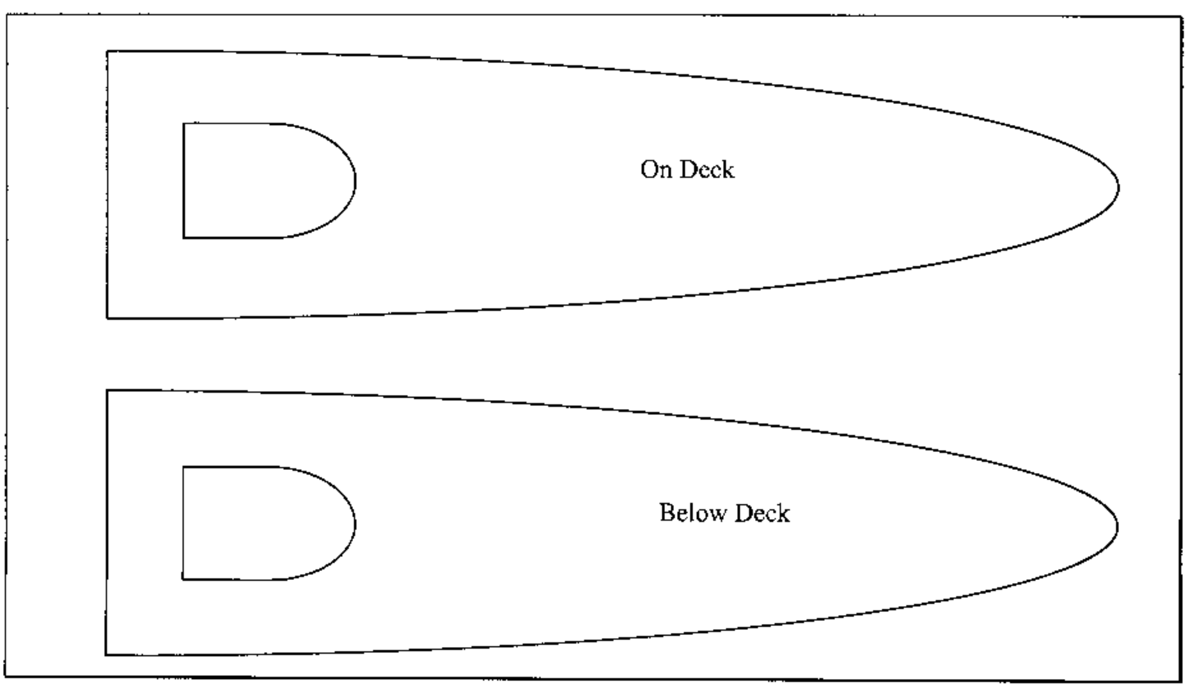
Item 2

Please indicate whether your liferaft is stowed in a soft or rigid valise. (Please circle your response)

Rigid (i.e. fiberglass case)	**Soft valise (bag)**

Item 3

Please indicate on the plan views below where your liferaft/s is/are normally stowed during offshore races. (Indicate approximate distances if possible)



Item 4

Please state the reasons for your choice of stowage location as the relate specifically to your vessel and its racing operations.

Item 5

Please indicate the method used to secure your liferaft/s on your vessel. (Tick the appropriate box)

- ❑ Via direct lashing with no manual quick release such as a senhouse slip.
- ❑ Via a hydrostatic release/ and manual quick release such as a senhouse slip.
- ❑ Via a manual quick release device such a senhouse slip.
- ❑ Other means (Please describe)

Please explain why you have chosen this method of securing.

Do you use a custom made mounting bracket for stowing your liferaft/s. (Please circle your response)

YES	NO	NOT APPLICABLE

Item 6

Please list any advantages that you feel are to be gained from your current method of liferaft stowage and securing in an abandonment situation.

Item 7

Please list any problems that you believe may be encountered as a result of your current method of liferaft stowage and securing in an abandonment situation.

Item 8

Do you have any ideas that you believe may reduce the time and effort required for deployment of the liferaft/s on your vessel?

Item 9

Do you conduct practice exercises relating to accessing and moving liferafts to a launching position? (Please circle your response)

YES	NO

If you answered yes, please indicate how frequently is this exercise is conducted.

Item 10

Do the exercises described in item 9 include instruction on liferaft launching and abandonment procedures? (Please circle your response)

YES	NO

Summary

Please indicate your view about the following statements by circling the number which best fits your feelings **based on the usual manner of stowing and securing the liferafts on my vessel:**

The liferafts can be quickly accessed during light or darkness in a seaway.

Strongly Disagree					Strongly Agree
0	1	2	3	4	5

The securing lashings on the liferafts can be easily released during light or darkness in a seaway.

Strongly Disagree					Strongly Agree
0	1	2	3	4	5

The liferaft/s can be easily moved to a suitable launching position during light or darkness in a seaway.

Strongly Disagree					Strongly Agree
0	1	2	3	4	5

Thank you.

Once complete; please place the questionnaire in the reply paid envelope provided.

APPENDIX 3

POST TRIAL SURVEY

Appendix 3: Post Trial Survey

Item 1

Please mark the box adjacent to the statement that is closest to your experience during the trial.

- ❑ The round raft was easier to board.
- ❑ The rectangular raft was easier to board.
- ❑ The degree of difficulty in boarding was the same for both liferafts.

Item 2

Did you experience any difficulties when boarding either of the liferafts?

- ❑ Yes
- ❑ No

If you answered yes please identify the liferaft concerned (round or rectangular) and describe the problems you encountered.

____

____

____

____

Item 3

Please describe any problems you encountered when escaping from the capsised liferaft.

____

____

____

____

Item 4

Please mark the box adjacent to the statement that is closest to your experience during the trial.

- ❑ The round raft was easier to right.
- ❑ The rectangular raft was easier to right.
- ❑ The degree of difficulty for righting was the same for both rafts.

Item 5

Did you experience any difficulties when righting either of the rafts

- ❑ Yes
- ❑ No

If you answered yes please identify the liferaft concerned (round or rectangular) and describe the problem/s you encountered.

____
____
____
____

Thank you for your assistance with this study.

Tony Boyle

APPENDIX 4

SURVIVAL TRAINING OUTLINE

Appendix 4: Survival Training Outline

One Day Sea Survival Course Outline

0900-1000	**Threats to survival**		
		Survival defined	
		Major threats	-cold water shock
			-drowning
			-hypothermia
			-hyperthermia
			-dehydration
A/V SOLAS Ch 3 pt 4			-loss of will to live
			-fear
1000-1010	**Break**		
1010-1100	**Liferafts**		
		Types	-SOLAS
			-Coastal
			-AYF
		Construction features	-support
			-protection
			-detection
			-life support
		Fittings	
		Equipment	
		Securing	
		Launching	-manual
			-float free
		Initial actions	-on boarding
			-for survival
1100-1110	**Break**		
1110-1200	**Lifesaving appliances**		
		Lifejackets	-SOLAS
			-Coastal
			-lights
			-whistles
			-retro tape
		Lifebuoys	-types
			-markings
			-lines
			-self igniting lights
			-MOB light/smoke float
		TPA's	
		Immersion suits	
		Pyrotechnics	-red hand flare
			-orange hand smoke
			-orange smoke flare

			-rocket parachute flare
		Strobe lights	
1200-1300	**Lunch**		
1300-1330	**Search & Rescue**		
		State Police	
		AusSar	-powers/resources
		fixed wing aircraft -types	
			-range of operation
			-MSC drops
			-PADs
		Helicopters	-types
A/V MSC Drop			-range of operation
A/V Heli rescue			-types of lift
			-precautions with helo's
		Ships	-likely rescue procedures
1330-1350	**EPIRBS & SARTs**		
		121.5/243Mhz- description	
			-operation
			-testing
			-aircraft detection range
			-COSPAS/SARSAT detection
		406 Mhz EPIRBS	-description
			-COSPAS/SARSAT detection
A/V Alive via Satellite.			-aircraft detection
1350-1400	**Change**		
1400-1630	**Wet drill**		-see 'conduct of wet drills'

CONDUCT OF WET DRILLS

Practical:	Launching a davit launched liferaft. Trainees change and meet at northern end of pool. Introduce life guard[1]. Medical check. Non-swimmer identification[2].
Brief:	PFD donning. Helicopter strop donning. Jumping from a height. Preparation for thermal shock.
Practical:	Don immersion suit and jump into pool, swim and climb a ladder/rescue net. Jump into water from north end of pool. Maintain airway protection. (Instructor to use hose to demonstrate need for airway protection). Swim to south end of pool (any method).
Brief:	Swimming in PFD - on back, legs together, using arms only.
Practical:	Swim to north end of pool as briefed. Exit pool unaided (use of ladder not permitted)
Brief:	Heat Escape Lessening Posture. Use of towing strop.
Practical:	Enter water, adopt HELP. Pair off, towing exercise to south end of pool. Change over at half way mark.
Brief:	Crocodile towing technique.
Practical:	Towing exercise to north end of pool.
Brief:	Group huddle.
Practical:	Group huddle.
Brief: *& Demo*	PFD features (face up in 5 seconds). Swimming under oil. Donning PFD in the water.
Practical:	PFD features (face up in 5 seconds). Swimming under oil[3]. Donning PFD in the water.

[1] The life guard must be aware of the oxy- viva location and familiar with its operation.
[2] Non-swimmers are to enter pool one at a time under close supervision after remainder of trainees.
[3] Non-swimmers are exempt from this exercise.

Brief:	Climbing ladder. Climbing a boarding net.
Safety:	Trainees must keep at least 3 metres from base of ladder or net whilst waiting their turn.
Brief:	Jumping from a height wearing a PFD. Boarding a liferaft via a boarding step (unassisted).
Safety:	Ensure all PFD's are securely donned.
Practical:	Jump from 3 metres. Swim to liferaft. Board raft. Exit raft from other entrance. Swim to net or ladder and climb.
Brief:	Assisting injured/exhausted personnel into a liferaft. Dangers of rough handling.
Practical:	Rescue quoit use. Two persons in raft, as each trainee is pulled on board. They take a puller's position. If needed two trainees can enter the water to push victim from below.
Brief: *& Demo*	Liferaft righting.
Practical:	Each trainee to right an inverted liferaft.
Safety:	Lifeguard **must** be in the water for this exercise.
Practical:	Trainee to proceed to helicopter strop for lift from pool.
Safety:	Technical assistant is to ensure strop is correctly donned prior to hoisting regardless of trainee's hand signals.
Brief: *& Demo*	Escape from an inverted liferaft.
Practical:	Escape from inverted liferaft.
Safety:	Lifeguard **must** be in the water for this exercise.

ABANDONMENT EXERCISE

Briefing:

Trainees are to be split into two groups.
Each group is to nominate a leader.
Each group is to be allocated a survival craft.
'Emergency stop' whistles are to be issued and use of explained.
Torches to be issued.
Emergency muster and abandon ship signals reviewed.
Both groups instructed to observe inflation of 10 person liferaft before abandoning vessel.
Review initial actions after abandonment.

Practical:
Safety: Five (5) short blasts on emergency whistle, repeated as required will stop the exercise.

Debriefing:

Each leader/group asked to comment on:
Communications.
Tasks performed.
Tasks omitted/forgotten.
Mistakes made.
Recovery of personnel/equipment form water.
Post rescue treatment of rescued personnel.
Aspects handled well.
Aspects that might be handled differently next time.

APPENDIX 5

SURVIVAL KNOWLEDGE WRITTEN TEST

Appendix 5: Survival Knowledge Written Test

Question 1

Describe briefly the procedure required for launching an inflatable liferaft.

Question 2

List four signs that would indicate that a person was suffering from hypothermia.

Question 3

The H.E.L.P. or Heat Escape Lessening Position will increase your survival time by up to:

(a) 25%

(b) 35%

(c) 50%

(d) 75%

Question 4

Six survivors swim to and board an inflatable liferaft in the Tasman Sea. List five actions that they could carry out to prevent the onset of hypothermia.

Question 5

The battery of an EPIRB is required to operate the device for at least:

(a) 24 Hours

(b) 48 Hours

(c) 72 Hours

(d) 96 Hours

Question 6

State two advantages that a 406 Mhz EPIRB has over a 121.5/243Mhz EPIRB.

Question 7

During helicopter winching rescue which crew -member should be first to be winched to safety:

(a) One who is uninjured and alert.

(b) One who is suffering from moderate hypothermia.

(c) One who is unconscious, with no visible physical injuries.

(d) One who has life-threatening physical injuries.

APPENDIX 6

DESCRIPTIVE STATISTICS FOR WRITTEN ASSESSMENT

Appendix 6: Descriptive Statistics for Written Assessment

Count	Untrained Scores	Trained Scores
1	4	11
2	4	11
3	4	12
4	7	13
5	7	14
6	7	15
7	9	16
8	11	16
9	11	17
10	12	17
11	12	17
12	13	19
13	13	19
14	13	20

Untrained Subjects	
Mean	9.071429
Standard Error	0.940331
Median	10
Mode	4
Standard Deviation	3.518397
Sample Variance	12.37912
Kurtosis	-1.50179
Skewness	-0.35335
Range	9
Minimum	4
Maximum	13
Sum	127
Count	14

Trained Subjects	
Mean	15.50000
Standard Error	0.5060078
Median	16
Mode	17
Standard Deviation	2.95479
Sample Variance	8.73077
Kurtosis	-1.04763
Skewness	-0.19829
Range	9
Minimum	11
Maximum	20

Sum	217
Count	14

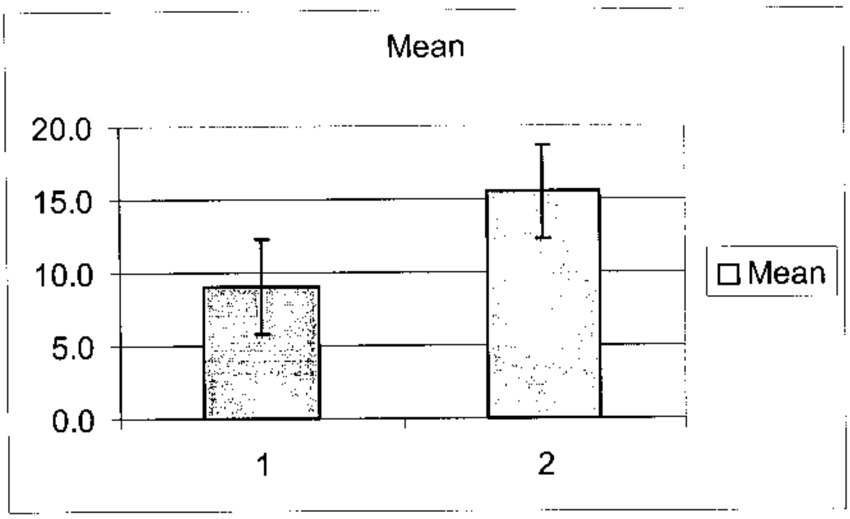


Chart showing the result of the error bar test based on standard errors.

t-Test: Two-Sample Assuming Equal Variances

	Variable 1	*Variable 2*
Mean	9.071429	15.5
Variance	12.37912	8.730769
Observations	14	14
Pooled Variance	10.55495	
Hypothesized Mean Difference	0	
df	26	
t Stat	-5.23523	
P(T<=t) one-tail	9.04E-06	
t Critical one-tail	1.705616	
P(T<=t) two-tail	1.81E-05	
t Critical two-tail	2.055531	

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	Variable 2
Mean	9.071428571	15.5
Variance	12.37912088	8.730769
Observations	14	14
Hypothesized Mean Difference	0	
df	25	
t Stat	-5.235226854	
P(T<=t) one-tail	1.0151E-05	
t Critical one-tail	1.708140189	
P(T<=t) two-tail	2.0302E-05	
t Critical two-tail	2.05953711	

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