Safety At Sea Studies - Harness and Tether Study

The Sailing Foundation Harness and Tether Study
1999

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Safety At Sea Studies - Harness and Tether Study Summary

Executive Summary

The Safety at Sea Committee of the Sailing Foundation in Seattle, Washington, undertook a study of commonly used sailing harnesses and tethers in 1998. Major funding for the study was provided by the Bonnell Cove Foundation .

The study was comprised of an in the water test to determine towing characteristics, a static test to determine comfort and ease of use, and a dynamic load test to ascertain compliance with ORC regulations. Harnesses were also evaluated for desirable features such as reflective tape, stitching, quick release capability, and general quality. For comparison, rock climbing and industrial harnesses were also examined.

When used while being towed through the water, most of the harnesses were fairly comfortable. The exception occurred when a Type III PFD was worn underneath a harness. The PFD kept the support straps from riding up under the armpits, which placed the load heavily on the lower back and causing quite a bit of discomfort. The sailing harnesses did a good job of keeping the wearer's head above water, while the rock climbing and industrial harnesses did not show this tendency.

The test results indicated the harnesses had varying levels of comfort while worn without any load. When under a heavy load they varied from mildly uncomfortable to painful, depending on where the straps wrapped around the ribs. Testing by the Tacoma Women's Sailing Association showed that even those harnesses marketed toward women could be extremely uncomfortable under load, depending on the wearer's physique.

The dynamic testing yielded the most noteworthy results. **8% of the harnesses failed the test** (one a prototype), while **fully 47% of the tethers failed the test**.

None of the harnesses met the committee's criteria of an "ideal" harness, although several came close. Likewise we did not find the "ideal" tether, although there are several on the market which come close.

Study Objective

In 1998, The Safety at Sea Committee embarked on a program to evaluate common safety harnesses and tethers used in sailing. We also wanted to examine the area of commercial and rock climbing harnesses to see if there was anything to be learned or applied from them.

There are no standards in the US for recreational yacht harnesses. There is a UL/U.S. Coast Guard standard for inflatable life vests but it does not include a provision for testing the efficacy of a built in harness (other than a statement that the harness must be adequate for its intended use).

The Offshore Racing Council has specifications for yachting harnesses, tethers, and jacklines. These are substantially derived from the old British Standard 4224. US Sailing, the governing body for racing sailors in the U.S., subscribes to these rules and prescriptions. While these rules are aimed at racing sailors, they are equally relevant for cruising sailors. It should also be noted that US Sailing does have separate safety recommendations for cruising sailors, and the requirements

for harnesses and tethers are identical between the two.

Most testing for this study was based on the ORC regulations. We tested to the 1996-1997 version of the regulations. In 1998, the ORC changed their requirements and now reference ISO Standard 12401. However, since the ISO standard was not even available to the public or the manufacturers at the time we started the test, we opted to use the older rules.

Our testing consisted of both subjective and objective criteria. The subjective criteria was mostly an evaluation of comfort and ease of use and adjustment, and how well the harnesses worked while the wearer was being dragged through the water. The objective criteria consisted of metrics such as weight, magnetic properties, and a dynamic load test where the harness or tether is attached to a 220 pound weighted dummy and dropped 6.6 feet.

Products Tested

We broke down the harnesses into three different groups. First are the inflatable life vests with built in harnesses. These could be either the manual inflation type (which are approved by UL and the US Coast Guard), or the automatic inflation. We tested only the manual versions, as there is little difference between the two types. Second are the "standard" harnesses, which are simply nylon webbing with a D-ring attachment point on the front for a tether. Last, we tested both commercial OSHA safety harnesses and tethers, and rock climbing harnesses which some foredeck crew use while racing. For tethers, we chose as many manufacturers as we could find, and tried to find a variety of end fittings among those products.

The inflatable harnesses tested include Captain Al's (same as Stearns), Mustang, SOSpenders, Stearns, Stormy Seas, Survival Technologies, and West Marine.

The standard harnesses included Captain Al's (same as Holland Yacht Equipment), Gill (made by Crewsaver), Forespar Passagemaker, Holland Yacht Equipment Model 1278T, Jim Buoy, Lirakis Newport, Musto, Raudaschl, Stormy Seas (Australia) Jacket and Vest, Survival Technologies Deck Pro and Pelican 2, and West Marine Basic, Securite', and Ultimate Harnesses. The Crewsaver harness was tested while in the Gill Southern Cross jacket. In the water testing was also done with a Henri-Lloyd jacket with built in harness. Commercial harnesses were Miller Industrial Model E650, and DBI/Sala Model L2000. The rock climbing harnesses were made by Black Diamond and Arcteryx, along with a chest harness made by Recreational Equipment, Inc.

Tethers tested were Captain Al's Single and 3-point, Forespar Passagemaker, Holland Yacht Equipment, Helly-Hansen 3-point, Jim Buoy, Lirakis, Raudaschl, SOSpenders 3-point, Survival Technologies Single and Shock Arrest, West Marine (four different models), Wichard (two different models), along with Miller Industrial tether models 913RSS and 216M.

All these products were purchased either from floor stock or over the phone. None of the manufacturers were told what the fate of their products would be. See Appendix I for details on each product, as well as the summary in Appendix III.

Safety At Sea Studies - Harness and Tether Test Methodology

Test Methodology

In the Water Testing

Our first phase was an in the water test, to determine the characteristics of safety harnesses in actual use in a crew overboard situation. We evaluated the attitude of the Crew OverBoard (COB) as they were towed through the water, the relative comfort for the wearer, whether the harness slipped under load, ease of breathing under load, and ease of reboarding the vessel. We also tested a quick release tether shackle under load to see if it would release. When being towed, each harness was evaluated using both a three foot and six foot tether.

Harnesses tested included a manual inflatable lifejacket with harness, harnesses built into foul weather gear, two "normal" sailor safety harnesses, a rock climber's harness (both with and without a chest harness), and an industrial safety harness.

The second phase of static testing consisted of examining the harnesses for workmanship, as well as evaluating the comfort and ease of adjustment. We also measured the width of the load bearing straps, tested the metal components for magnetic properties, and weighed the harness.

Static Hoist Test

Each harness was donned both with and without foul weather gear, to simulate both cold and warm weather sailing conditions. The harnesses were donned; the time to do so was measured, as well as any comments about the ease or difficulty of doing so recorded. The harnesses were subjectively evaluated for things such as whether they felt heavy, how easy they were to adjust, whether the harnesses had pinch points or features that might cause discomfort (such as a shoulder strap rubbing against the neck), did it interfere with the use of a life jacket, etc.

We then went to a dinghy hoist and hauled ourselves off the ground wearing each harness. The harnesses were evaluated for comfort, ease of breathing, and pinch points. We also tested whether there was any tendency to fall out of the harness particularly with arms raised, as a COB might do when trying to crawl back aboard.

The dinghy hoist test was repeated by members of the Tacoma Women's Sailing Association, to evaluate both unisex harnesses and harnesses marketed specifically toward women.

Harness ready to be dropped in the Dynamic Load Test Fixture.

For the last phase, we rented a test facility to do a dynamic load test. For this test, the harness was attached with a tether to a 220 pound dummy and dropped 6.6 feet. For each harness a brand new tether was used, to eliminate the tether as a variable. When testing the tethers, we used the same type of harness to eliminate it as a variable. Each harness and tether was soaked in water before the test, per the *International Sailing Federation Special regulations Governing Offshore and Oceanic Racing for 2002-2003 including US SAILING Prescriptions*. It should be noted that this improves the shock absorbing qualities of nylon webbing. Failure criteria include "flaws, defects, or deterioration after testing that would jeopardize the safety of the wearer". It can be debated whether this means any deterioration at all. There were some harnesses and tethers that either had bent or slightly deformed hardware and one instance where the webbing was shredded, but the equipment still held.

Safety At Sea Studies - Harness and Tether In-Water Test

Test Summary
In the Water Test

Test Setup

A six-foot and a three-foot safety harness were attached to a genoa track slide located on the deck edge of the vessel. The COB would don the safety harness, and then enter the water. The COB would attempt several positions in the water, including face down, face up, and totally relaxed (as an unconscious COB would be). Weather conditions were air temperature 65-70 F, wind 8-10 knots, seas 1 foot, water temperature 60 F.

Test Results

For all harnesses, the leeward side will be easier to drag from, because the hull sets up a lee that knocks down the waves somewhat. On the windward side, there are many small waves that bounce off the hull and into the COB's face making breathing somewhat difficult. In all COB situations, it will be imperative to stop the progress of the boat. For all harnesses, the 3' tether put more strain on the ribs, because more of the wearer's weight was supported by the harness and less by the water. However, with the 3 foot tether more of the COB's body is out of the water, delaying the onset of hypothermia.

Static Test showing how the attachment point on the Forespar Passagemaker Harness comes close to the face. This also manifested itself during the in the water testing.

The standard harnesses were rated comfortable while being towed, and the ability to breathe was deemed adequate. The West Marine Securite' harness seemed to do a better job at keeping the wearer's head above water than the Forespar Passagemaker. The attachment point on the Forespar harness moved up into the wearer's face, causing him to declare this harness the most uncomfortable of the harnesses he tested. The West Marine Securite' harness is marketed towards women as being more comfortable for them. The male wearer of the harness declared it the most comfortable of the harnesses he wore that day.

We tested two models of foul weather coat with built in harness. One was a new Gill Southern Cross with Crewsaver harness, and the other was an older model Henri-Lloyd. We used the shoulder straps on the Gill/Crewsaver model, rather than using the chest strap only. The shoulder straps made it a little more difficult to put the coat on, because the straps had a tendency to fall down into the sleeves. A keeper would be a good idea to retrofit to the liner, or it may be best to leave the shoulder straps off. Leg straps were an option for the harness but were not fitted. This particular harness could be used as a stand-alone item, but installation into the jacket took approximately 20 minutes and required disassembly of the harness. It should be considered a permanent installation for that reason. The Henri-Lloyd model had only a single strap around the chest.

Henri-Lloyd jacket with integral harness being tested in the water.

The Gill/Crewsaver jacket/harness combination was comfortable and breathing was adequate. Both the Gill/Crewsaver and Henri-Lloyd would not keep the wearer's head out of the water, however. One item of note is that with a load on the jacket, it had a tendency to constrict around the neck as long as the zipper was zipped tight. When testing the Henri-Lloyd jacket, the wearer wore a type III PFD under the jacket. Normally, when under load the harness would slide up under the armpits. However, with the PFD underneath, the harness would not ride up. The wearer was in considerable pain because the pressure was being absorbed low on the rib cage and lower back. It appears that wearing a PFD under the jacket is not recommended.

The inflatable vest tested was comfortable under load and uninflated. Breathing was adequate, but the wearer's face is closer to the water with this type than with a good standard harness. When inflated, the bladder causes constriction around the neck, although breathing is still quite possible. Also, when inflated it had a tendency to funnel water up between the inflation tubes and into the wearer's face. When the COB was on his back the tether went across the front of the bladders. With a shorter tether this had a tendency to cause the head to take a "bow down" attitude, making it to go down towards the water and causing the wearer to strain his neck to keep his head above water.

Many foredeck crew wear a rock climbers harness. The foredeck ape who tried this harness without the chest harness didn't feel it was acceptable for being towed at speed, because it is difficult to control your attitude in the water. It is possible to get crosswise to the current and strain your back. It was an improvement to include the chest harness, as this prevented the wearer from getting crosswise to the flow. These harnesses are comfortable and don't interfere with breathing. There was some discomfort in the groin area from the leg straps when the wearer jumped in the water. Ostensibly that is only a problem for males.

Miller Industrial Harness

The Miller industrial harness had a tether attachment point between the shoulder blades. This has become the most common location for industrial harnesses. The disadvantage of such a position is that if the wearer went face down in the water, they would have to take active measures to get face up again. When facing backwards, this harness should allow the most comfortable breathing while being towed at speed. The cross chest strap constricted the neck slightly, although that may have been due to faulty adjustment by the user.

The 6-foot safety tether used had a quick release shackle, similar to the shackles used by smaller boats for spinnaker and jib halyards. It released easily under load at approximately 4 knots.

See Appendix II for details.

Safety At Sea Studies - Harness and Tether Study Summary

Test Summary
Static Testing

Test Setup

Each harness was donned both with and without foul weather gear. The time to don was recorded, as was the ease of donning. The normal wearing comfort and apparent weight of the harness, and whether a Type III PFD interfered with the harness was evaluated. We donned each harness and hoisted ourselves on a dinghy lift, and evaluated the harness for comfort, pinch points, breathing.

Test Results

General Comments on the inflatable harnesses:
All the harnesses appeared well built, and were fairly easy to don because the straps don't easily tangle. They all rated in the middle for perceived weight, because they have the added burden of the inflation mechanism and bladder. They all passed the magnetic test (none were able to affect the compass, even when placed right next to it). The workmanship was excellent for models examined. They were all uncomfortable under load, some being slightly better or worse than others were. The average time to don an inflatable was approximately 5-8 seconds.

General Comments on the standard harnesses:
The standard harnesses varied more in their makeup than the inflatables. The harnesses that included some sort of a vest in the harness were easiest to put on (Raudaschl and Survival Technologies Deck Pro), and the harness that didn't have a rib strap (Lirakis) was easier to put on than those that did. Time to don the harnesses ranged from about 5 seconds to 45 seconds (when wearing foul weather gear and also putting it on backwards). Standard harnesses were perceived as lighter weight than the inflatable harnesses, because they didn't have the added weight of the inflation bladder. We found that most of the harnesses were uncomfortable under load, the exception being the Raudaschl harness and the industrial and rock climbing harnesses. A crotch strap helps take the load off your ribs and increases the comfort level. Because of the location of the attachment rings at approximately mid-sternum, wearing a PFD over the harness will mean that the tether will have to snake out over the PFD, and it will not allow easy access to the attachment shackle. The main shortcoming of almost all products were instructions for use and care, the exceptions being the inflatable harnesses which must meet UL and Coast Guard requirements, and the Crewsaver and Holland Yacht Equipment harnesses. We did find that the Jim Buoy harness was slightly magnetic, which could cause compass problems.

Comments specific to the comfort of the harnesses for women:
It is very difficult to make general comments on the comfort for women. Some harnesses marketed specifically toward women were found uncomfortable under load, notably the Survival Technologies Deck Pro. Also, some women preferred having the rib strap lower on the back, while others liked it at armpit level. Some liked the shoulder straps close to the neck (like the West Marine Securite), while others liked them farther out (like a standard unisex harness). Our recommendation would be to try the harness on at a chandlery and put a substantial load on the harness, parallel to the spine, to see if there might be any discomfort. The two most comfortable harnesses were the Raudaschl, and a rock climbing harness worn in combination with a chest

harness.

See Appendix III for a table summary of harness details.

Safety At Sea Studies - Harness and Tether Study Summary

Test Summary
Dynamic Testing - Harnesses

Test Setup

In this test, each harness was placed on a 220 pound dummy. A new tether was attached to the harness, and the dummy was raised up to a quick release shackle such that when the shackle was released, the dummy would free fall 6.6 feet. Failure criteria include "flaws, defects, or deterioration after testing that would jeopardize the safety of the wearer".

Dynamic Load Test in Progress

Test Results

Of the standard harnesses only the Jim Buoy failed outright, while there were three that had some visible damage but didn't allow the dummy to come free. On the Jim Buoy, the rib strap parted completely, possibly due to sharp edges on the metal adjustment fitting. There was also some damage to the Jim Buoy D-ring where it gets welded together. It is probable that the poor weld of the D-ring would have failed if the webbing hadn't failed first. Harnesses which showed some damage but not outright failure were the West Marine Securite' and Basic harnesses, and a prototype of the Stormy Seas harness/jacket combination. Both West Marine harnesses had single D-rings that deformed under load. There was no visible evidence of cracking in the D-rings. Note that in our tether testing we used a West Marine Ultimate harness, which has double D-rings. This harness was dropped nine times without failure of the D-rings. The webbing on a prototype version of the Stormy Seas jacket/harness shredded due to sharp edges on the adjustment hardware, although a production version did pass the test without failure. All the other sailing harnesses tested passed the dynamic load test without failure.

We did not test the climbing harnesses. It was felt that the dummy could have damaged the test fixture, because the harness positioned the dummy in a more reclined position. The industrial harnesses passed with no failures. They also appeared to arrest the fall more smoothly than the sailing harnesses.

See Appendix III for details.

Safety At Sea Studies - Harness and Tether Study Summary

Test Summary
Dynamic Testing - Tethers

Test Setup
In this test, a harness was placed on a 220 pound dummy. Each tether to be tested was attached to the harness and the dummy was raised up to a quick release shackle such that when the shackle was released, the dummy would free fall 6.6 feet. Failure criteria include "flaws, defects, or deterioration after testing that would jeopardize the safety of the wearer".

Test Results

General Comments on the Tethers:
We were somewhat surprised that there were so many tether failures. 47% of the tethers failed in such a way as to endanger the wearer. Failures were both in the hardware, stitching, or sometimes both. Build quality of the tethers varied considerably from company to company.

We generally consider a tether with a quick release shackle at the inboard end to be an important feature; however, we tried to test as broad a spectrum of hardware as possible to see if there might be any lessons learned. We did come to this conclusion: quick release snap shackles are robust, as are the locking, gated snap hooks (the Wichard and Gibb hooks). Snap hooks without a gate, even the well-respected Wichard forged models, and most of the other non-locking hardware have too high a failure rate to trust your life to them. Also, snap hooks have been known to pick up a lazy jib sheet while walking along the deck, and can come undone if twisted on a padeye in a not uncommon manner.

As with the harnesses, we will leave it to the reader to determine whether they consider something like a quick release shackle with a bent pin to be a failure, even though the shackle didn't open and let the dummy free. However we do consider it a failure when a gated snap hook fails in such a way that the gate remains open. It appears that the weak link in the whole system generally comes down to the tether.

The following products failed in a way that could have caused the wearer to lose contact with the boat:

- Captain Al's single tether
- Captain Al's 3-point tether
- Forespar Passagemaker tether
- Holland Yacht Equipment tether
- Helly-Hansen 3-point tether
- Raudaschl tether
- Wichard Model 7001 tether.

The Captain Al's, Holland Yacht Equipment, and Helly-Hansen products all had failures of the stitching. All the other failures were due to hardware bending or breaking.

The following tethers had some damage to them that did not endanger the wearer:

- Survival Technologies single point tether
- West Marine 6' tether with dual snap shackles

In both instances, the damage was a slightly bent pin on the quick release shackle. In both cases the shackle remained closed, and could be opened by tugging on the release lanyard.

The following tethers passed the dynamic test without failures:

- Jim Buoy
- Lirakis
- SOSpenders
- Survival Technologies Shock Arrest
- West Marine 6' tether with snap shackle
- West Marine 6' basic tether
- West Marine 6' tether with snap shackle and Gibb Hook
- Wichard Model 7015 Tether

It should be noted that the Jim Buoy tether passed the dynamic test, however the opening in the snap shackle is too small according to ORC regulations (it must be greater than 1/2").

We tested only one industrial tether, the Miller 216M. It passed the dynamic test, but its most interesting feature was a small flag sewn into the tether material. When the tether is stressed beyond a certain point the stitching holding the flag breaks, allowing the flag to unfurl and giving you an indication that the tether has been overstressed.

Safety At Sea - Harness and Tether Study Conclusions

Test Summary
Conclusions

Our Ideal Harness

Our ideal harness would be easy to adjust and lightweight. It would be easy to don, and not be too hot. It should have reflective tape on the shoulders and a place for extra gear, such as a whistle, strobe light, and a flare. We prefer two attachment rings for redundancy. The stitching would be a contrasting color from the webbing for easy inspection, and the material would be supple for comfort on bare skin. None of the harnesses we tested fit all these wishes, although a couple came close, notably the Raudaschl, Survival Technologies Deck Pro and Pelican 2, and the West Marine Ultimate.

We also are very much in favor of harnesses with built in inflation. All the inflatables we tested are good products, although the Stearns seemed to have trouble (in one version) with not having enough Velcro to hold it closed, and the Survival Technologies seemed stiff compared to the others. We were unable to fully test the Stormy Seas gear, but they seem to have some nice features for cool weather sailors with their flotation, harness, and warmth and protection from the elements. There are advantages and disadvantages to having automatic inflation. Obviously the automatic inflation will give you a better chance if you get knocked unconscious while going overboard, but the manual unit shouldn't inflate from getting doused on the foredeck (although the current generation of auto-inflating products is improved over the previous). Recently, USCG and UL approval has been secured by some models of automatic inflation units, so the issue of having an inflatable that is not CG approved is now moot.

Our Ideal Tether

Our ideal tether would have a quick release snap shackle at the inboard end, and both a three-foot and six-foot leg. The six-foot leg may have some shock cord built into it to help keep it from getting in the way while working the deck. One skipper in the '98 Sydney-Hobart race thought it ridiculous that his crew had to unhook from a windward padeye, and drop knee deep into water on the leeward side before finding a padeye and then easing a sheet. A dual tether would have solved that problem. The boat end of the tether would have either the new Wichard patented locking snap hook or the Gibb snap hook with locking gate, which is preferable to a snap shackle that may take two hands to attach. The stitching would be at a minimum two or three inches long, and a contrasting color to the webbing for easy inspection. The snap shackle would have a very substantial cotter ring, and the release line would have an easy to grip feature such as plastic balls to help in giving it a good pull. None of the tethers we tested have all these features.

Safety At Sea - Harness and Tether Study - Appendix I Part 1

Appendix I
Summary of Product Data
Inflatable Harnesses

Captain Al's' Model 1143

This harness appears identical to the Stearns unit, with the exception of having enough Velcro on the bladder to keep it from coming unraveled. In fact, Captain Al uses the same model number as the Stearns and sends it in a Stearns box with Stearns labeling.

Recommendation: This is a better model than the Stearns 1143 due to the additional Velcro. Otherwise the same comments apply.

Mustang Air Force Model MD 3012

This harness was rated high for ease of donning and comfort while worn. It was easy to adjust. It weighed 41 ounces. It rated terrible for comfort under load, mostly due to the rib strap being too low on the back. The bladder had strips of reflective tape on both sides of the chest area as well as the area behind the head. It has toggles for attaching to your foul weather jacket, an attached whistle and a lifting strap. The lifting strap appears to be a good idea, however its execution could cause problems. When the strap is used it looks like it might tear open the bladder, and also the most convenient position for lifting will pull the COB over the rail face first, where the inflation mechanism might get hung up and tear the bladder. The handle loop is also too small for a normal sized man's hand to fit through. It comes with a well written owner's manual, which warns you not to wear the automatic inflation unit inflated because it may cause over-pressurization when the CO2 cartridge fires.

Recommendation: This harness appears to be well made and includes some unique safety features. The lifting strap idea could be improved to be more functional.

SOSpenders Model 38MHAR-P-1

This harness was rated high for ease of donning and comfort while not under load. It was easy to adjust. It weighed 38 ounces. It rated as uncomfortable under load. The bladder had reflective tape only near the ears. It had an attached whistle. The rearming instructions are conveniently attached to the inflation mechanism in water-resistant ink. The manual is well written. This model is Coast Guard approved.

Recommendation: This is a well-constructed harness, easy to wear and comfortable.

Stearns Model 1143

This harness was rated high for ease of donning and comfort while worn. It was easy to adjust. It weighed 37 ounces. It rated as uncomfortable under load. The bladder had reflective tape on only the left chest area. It had an attached whistle. The Velcro used to hold the bladders in the closed position wasn't sufficient to keep the bladder from unrolling after donning the harness only twice.

It has a well-written manual. The rearming instructions are conveniently attached to the inflation mechanism in a water-resistant ink, as well as being in the manual. It has a clear red/green indicator telling you whether the cartridge has been fired or not. This model is Coast Guard approved.

Recommendation: This is a well-constructed harness, with the exception of a shortage of Velcro to keep it closed while being worn. More reflective tape would also improve the product.

Stormy Seas Inflatable Vest, Model Offshore Vest 40

This harness was rated high for ease of donning and comfort while worn. It is more difficult to adjust, because the adjustment hasps end up inside the vest. It weighed 42 ounces. It rated as more comfortable under load than most others due to the rib strap running under the armpits and not around the ribs. The vest had reflective tape on both shoulders, and a lifting strap attached at the left shoulder for helping overboard crew back into the boat. It had an attached whistle. The vest has some insulation value, and a couple of handwarming pockets. It also has a couple of clever Velcro pockets for holding the harness portion out of the way when you aren't using the vest for sailing. This vest was not dynamic load tested. It has a clear red/green indicator telling you whether the cartridge has been fired or not.

Recommendation: This is a well-constructed harness/vest. We were unable to dynamically test this product.

Stormy Seas Inflatable Jacket, Model Offshore 39

This is an interesting model of harness, in that it also is a jacket as well as having an inflatable bladder with 35 pounds of buoyancy built in (it's a manually triggered bladder). This is an easy harness to don, and has only a single strap around the ribs (no shoulder straps). This harness can't be used as a stand alone item. It is comfortable to wear since it is inside the jacket and out of the way. In our testing of a prototype version, it was rated as uncomfortable to very uncomfortable to wear under load, because the harness was either too low or in the wrong place, particularly for women. It has a clear red/green indicator telling you whether the cartridge has been fired or not. It also includes a whistle. In our testing, a prototype version failed the dynamic load test, while the full production version passed.

Recommendation: This is a well built coat/life vest/harness combination. Combining all these functions into one unit makes good sense, although you may still need an additional harness to wear in warm weather.

Survival Technologies Model B01330

This harness was rated high for ease of donning, but some testers thought it was uncomfortable on the back of the neck while worn. The material used on the outside of the bladder was very stiff, which seems to be the cause of the problem. It was not easy to adjust because it used a velcro strip as the adjustment and keeper. While this allows for a large range of adjustment, it means you must reach well around your back to secure the webbing in place, and it is not self-aligning. It weighed 41 ounces. It rated as uncomfortable under load. The bladder had reflective tape only near the ears. There is a red/green indicator telling you whether the CO_2 cartridge has been fired. It had an attached whistle. There are no rearming instructions on the harness, nor detailed instructions on how to do

this in the manual. The manual is well illustrated but is not nearly as technical as the others. This model is not Coast Guard approved.

Recommendation: This harness is well built, but it is really too stiff to wear for long periods of time.

West Marine Model 38MHAR-P

This harness was rated high for ease of donning and comfort while worn. It was easy to adjust. It weighed 34 ounces. It rated as not very comfortable under load. The bladder had reflective tape only near the ears. It had an attached whistle. The rearming instructions are conveniently attached to the inflation mechanism in water-resistant ink. This model is Coast Guard approved.

Recommendation: This is a well-constructed harness, easy to wear and comfortable. It differs from the SOSpenders slightly in the way the bladder folds, and we were told it is no longer manufactured this way.

Safety At Sea - Harness and Tether Study - Appendix I Part 2

Appendix I
Summary of Product Data
Standard Harnesses

Captain Al's Harness

This harness is identical to the Holland Yacht Equipment harness. See comments under that product.

Gill (Crewsaver) Model 594 Harness

This harness was bought through Gill for one of their foul weather jackets, but it had a Crewsaver label on it. It was one of two that had a crotch strap. It was rated easy to don while in the jacket, but needs some sort of keeper for the shoulder straps as they had a tendency to slide down into the armholes. This harness could be used as a stand alone item, however it takes about 20 minutes to get it installed in the jacket correctly, pretty much precluding a single harness being used both with the coat and without. It is easy to adjust, although once in the jacket the adjustments are hidden, making that difficult. There is no whistle or reflective tape. While the crotch strap should take some of the load off the ribs, in practice the jacket somewhat prevents the harness from riding up under the armpits, and puts more of a strain on the back. Without the crotch strap it is just as uncomfortable as the rest. It weighed 14 ounces. There was no apparent damage to the harness after dynamic testing. There was no apparent damage to the coat after testing.

Recommendation: This is a well-constructed harness, and one of the few remaining jackets on the market that can be used integrally with a harness.

Forespar Passagemaker

This harness was rated for moderate comfort while worn, and fair for ease of donning. It weighed 16 ounces. It was rated as uncomfortable under load, and of special note was the metal plate that routed all the harness straps in front would be at about tooth level when under load. There was no reflective tape or whistle. The shoulder did have an adjustment. There was no apparent damage to the harness after the dynamic load test.

Recommendation: This is a well-constructed, moderately comfortable basic harness. When under load, the metal plate in front is cause to worry about your teeth. The tether that came with the harness failed the dynamic load test.

Holland Yacht Equipment Model 1278T

This harness was rated for moderate comfort while worn, mostly due to its weight of 25 ounces. This harness was one of the more difficult to don, with straps getting twisted either while wearing foul weather gear or not, and in one instance it took someone 37 seconds to put on. Hopefully practice would reduce that number. Having the shoulder straps being red (left) and green (right) is helpful to remember the correct colors for running lights. It had adjustments both for the rib

strap as well as the shoulder straps, so it should allow a good range of sizes. It rated as fair comfort under load. There is reflective tape on each shoulder strap. It did not have an attached whistle. There was no apparent damage to the harness after the dynamic load test.

Recommendation: This is a well-constructed, moderately comfortable basic harness.

Jim Buoy Model 922

Failed webbing on the Jim Buoy harness

This is an economy model harness that includes a tether. The rib webbing is wide, but is somewhat stiff. It is fairly easy to don, but the stiff webbing could become uncomfortable after a time. It is quite lightweight at 7 ounces, and was just as comfortable (or uncomfortable) as the others when under load. There is no reflective tape or a whistle. This was the only harness to fail the magnetic test (if close to a compass it may cause deviation). We noted before the dynamic test that there were burrs on some of the metal components that might cause premature failure of the straps. This rang true during the dynamic testing, as this was the only harness to fail completely. We noted also that the D-ring weld was cold, and the weld joint had started to open.

The D-ring most likely would have failed had not the webbing given way first.

Recommendation: We cannot recommend this harness.

Lirakis Newport Harness

This harness comes packaged with a tether. It has no rib strap, instead relying on straps that cross like an X across the back. The D-rings are held together by a loop in the tether, and there is no shackle at the inboard end. It was rated moderately easy to don, taking about 15-20 seconds when you include having to weave the tether through the D-rings with each use. There is no adjustment, nor is there a whistle or reflective tape. It was uncomfortable under load. It weighed 15 ounces. There was no apparent damage to the harness after dynamic testing.

Recommendation: This is a well-constructed harness, which would be improved with the inclusion of some reflective tape. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves.

Musto Model 6652 Harness

This harness was one of two that had a crotch strap. It was rated not easy to don, taking about 20 – 40 seconds when you include the crotch strap. Some wearers thought it might be easier to don if there was some contrasting color in some of the webbing. As it is now, the unit is a high visibility yellow, which made it confusing to figure out which straps were for the ribs or shoulders. It is easy to adjust, but there is no whistle or reflective tape. It is among the most comfortable under load when the crotch strap is in place. Without the crotch strap it is just as uncomfortable as the rest. It weighed 19 ounces. There was no apparent damage to the harness

after dynamic testing. The crotch strap came undone during the dynamic test, but this may have been because the strap was too tight (they're supposed to be worn somewhat loose).

Recommendation: This is a well-constructed harness, which would be improved with the inclusion of some reflective tape.

Raudaschl Harness

This harness is manufactured by a sailmaker in Canada, and is an interesting design. The harness is sewn inside a canvas vest making it much easier to put on than a more normal harness without a vest. The harness does not include a clasp for closing the harness. Instead it relies on the tether shackle to hold the D-rings together. There is a large chest pocket for holding extra gear like a strobe light, and a small loop that would work nicely to hold a whistle. This harness is also among the most comfortable under load; there is just more surface area to the vest to distribute the load. Most of the women who tested this harness found it to be the most comfortable, especially under load. It is a little heavier than the other standard harnesses at 24 ounces. The canvas is an orange material, which should help make the crew more visible. The main drawback to the design is the canvas may make it too hot for tropical cruising. During the dynamic load test the harness rode up over the dummy's shoulder, but this may have been due to the fact that we had a size XL harness on a size medium dummy. Note that the harness still held the dummy. Average time to don the harness was approximately 5 seconds.

Recommendation: This is a well built, easy to wear harness. The only improvement would be to add some reflective SOLAS tape to the shoulders.

Survival Technologies Deck Pro

This harness, primarily marketed to women, is similar in design to the Raudaschl harness in that it incorporates a vest with the harness. Unlike the Raudaschl harness it was uncomfortable under load when worn by women. It is a little heavier than the other standard harnesses at 22 ounces. The vest is a padded dark blue material, which would not help locate a crew that has fallen overboard. The harness is easy to put on and take off, and includes a zippered front to keep the vest closed. Average time to don the harness was approximately 5-8 seconds.

Recommendation: This is a well built, easy to wear harness. Despite being marketed toward women, it was found to be uncomfortable for them under load. Adding some reflective SOLAS tape to the shoulders would improve the product.

Survival Technologies Pelican 2 Harness

This harness was rated low to moderate for comfort. The stiffer material makes is somewhat easier to don, but the price is chafing of the skin. It did rate relatively well for donning, and does have SOLAS reflective tape built in.

Recommendation: This is a well-built harness that is a little stiff for long-term wear.

West Marine Basic Harness

This harness was rated for high comfort while worn. This was a fairly easy harness to don due to its simplicity, and it took approximately 20 seconds. It was easy to adjust. It weighed 10 ounces. It rated as not very comfortable under load. There is reflective tape on each shoulder strap. The single metal D-ring was deformed during the dynamic load test, although it did not break. One wearer commented that it was as good as the West Marine "Ultimate" harness, although it should be noted that the ultimate harness double D-rings did not deform under load.

Recommendation: This is a well-constructed harness, easy to wear and comfortable. While this harness passed the dynamic load test, we feel the D-rings should be strengthened.

West Marine Securite' Harness

Photo showing the deformed D-rings on the West Marine Basic and Securite' Harnesses

This harness is marketed toward women, although one male tester found it to be the most comfortable harness while being towed through the water. The design is somewhat different in that the shoulder straps, instead of coming down vertically from the shoulder, come together near the solar plexus in kind of an Y configuration. This may be an advantage for people with narrow shoulders. This harness was rated for high comfort while worn. Like most standard harnesses it can be difficult to don once the webbing gets tangled in the wet locker, and it took approximately 30 seconds to don the harness. It was easy to adjust. It weighed 20 ounces. It rated as not very comfortable under load, even for women. There is no reflective tape. The single metal D-ring was deformed during the dynamic load test, although it did not break. We noted during our metrics testing that the rib webbing had a tendency to come loose from the keeper, and indeed when doing our static load test the rib strap came loose and slipped. This was due to the lazy end of the webbing coming out of the keeper. We have been informed that a new design of keeper is being used for this harness now. The old keeper had a "finger" of plastic to hold the webbing in place, while the new design makes you thread the webbing through a closed slot.

Recommendation: This is a well-constructed harness, easy to wear and comfortable. It could stand some reflective SOLAS tape on the shoulders, and it is advisable to get the newer design with the improved keeper. While this harness passed the dynamic load test, we feel the D-rings should be strengthened.

West Marine Ultimate Harness

This harness was rated for high comfort while worn. This was not a terribly easy harness to don, and it took approximately 30-40 seconds. It was easy to adjust. It weighed 19 ounces. It rated as not very comfortable under load. There is reflective tape on each shoulder strap. It had an attached whistle. There was no apparent damage to the harness from the dynamic testing. In fact, one of these harnesses was subjected to ***nine drops without failure*** during the tether dynamic

testing.

Recommendation: This is a well-constructed harness, easy to wear and comfortable. This was one of the harnesses that came closest to our ideal harness.

Safety At Sea - Harness and Tether Study - Appendix I Part 3

Appendix I
Summary of Product Data
Tethers

General Comments on the tethers:

The build quality of the tethers varied considerably from company to company. Some tethers failed in the sewing, and some failed at the hardware. We generally consider a tether with a quick release shackle at the inboard end to be an important feature; however, we tried to test as broad a spectrum of hardware as possible, to see if there might be any lessons to be learned. As with the harnesses, we will leave it to the reader to determine whether they consider something like a quick release shackle with a bent pin to be a failure, even though the shackle didn't open and let the dummy free. However we do consider it a failure when a gated snap hook fails in such a way that the gate remains open. We were somewhat surprised that there were as many tether failures as we found. It appears that the weak link in the whole system generally comes down to the tether.

Captain Al's Single Point Tether

Captain Al's Three-point (left) and Single (right) tethers

This is a 6 foot tether with two locking aluminum carabiners, rated at 2000 kgs (4400 pounds) on the ends. This tether has a very short amount (less than one inch long) of stitching holding the carabiners in place. Also, the stitching is black on a dark blue webbing, making it hard to inspect without very good lighting. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, the stitching parted, allowing the test dummy to come free.

Recommendation: We cannot recommend this tether.

Captain Al's Three Point Tether

Photo showing the failed stitching of Captain Al's Single and Three-point tethers

This is a three-point tether with one leg of approximately three feet and one leg approximately six. The outboard ends are anchored by two of the same locking aluminum carabiners that are used on the single point tether, while the inboard end has a quick release shackle. Again, this unit had very short, black stitching holding the hardware in place. When subjected to the dynamic load test, the stitching parted, allowing the test dummy to come free.

Recommendation: We cannot recommend this tether.

Forespar Passagemaker Tether

Photo showing the failed snap hook on the Forespar Passagemaker tether. The shape before the dynamic load test can be seen in the photo of the Passagemaker Harness.

This is an approximately five and a half foot tether with a small locking hook on the outboard end, and a snap ring on the inboard end. There is a small button on the locking hook used to unlock the gate, which is an improvement over the standard snap ring without a locking gate. We found the button to be somewhat difficult to actuate, because it was small. The stitching is done in yellow on yellow webbing, making the inspection of stitching very difficult even in good light. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, the inboard snap ring bent straight, allowing the test dummy to come free.

Recommendation: We cannot recommend this tether.

Holland Yacht Equipment Single Tether

This is a 6 foot tether with two locking stainless steel snap hooks, rated at 2200 kgs (4800 pounds) on the ends. This tether has a very short amount (about 1-3/8 inch long) of stitching holding the snap hooks in place. Also, the stitching is black on dark blue webbing, making it hard to inspect without very good lighting. Due to an ordering error we had two tethers. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, on the first tether the stitching parted, allowing the test dummy to come free. When the second tether was tested the stitching at both ends gave way, allowing the test dummy to come free.

Recommendation: We cannot recommend this tether.

Helly Hansen Three Point Tether Model K-947

This is a 6 foot, three point tether of somewhat unusual design. Instead of having one leg of three feet sewn into another leg of six feet (which is fairly common in the industry), this tether has a loop sewn into its middle to attach the second snap hook. There are three identical snap hooks. The stitching is yellow on yellow webbing, making it hard to inspect without very good lighting. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, the stitching parted where the intermediate (3 foot) snap hook was attached, although the webbing kept its integrity and the test dummy didn't come free. However, one of the snap hook gates bent open, which might allow the tether to come unhooked. We consider this type of defect to be a failure.

Photo showing failed snap hook and torn webbing of the Helly-Hansen tether

Recommendation: We cannot recommend this tether.

Jim Buoy 922 Tether

This is a six foot rope tether with a single gated snap hook on one end and spliced loop at the other. This tether comes as a package with the Jim Buoy harness. It is attached to the harness by snaking the hook end through the D-rings and the loop at the end of the tether, making a "permanent" attachment at the inboard end. The locking gate used for this product was the only one to fail the ORC requirement of being able to pass a 0.500" dowel through its opening. The splice is apparently well done and the white whipping on a gold and white rope sheath is not too bad for inspection. When subjected to the dynamic load test, this tether had no failures.

Recommendation: This tether will work, although we think the harness that comes with it could be potentially life threatening. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves.

Lirakis Newport Tether

This is a six-foot tether with a single forged Wichard snap hook on one end and loop in the webbing at the other. This tether comes as a package with the Newport harness. It is attached to the harness by snaking the hook end through the D-rings and the loop at the end of the tether, making a "permanent" attachment at the inboard end. The stitching is white on red webbing for good contrast, however the stitching is spaced somewhat far apart making inspection a little tougher than it could be. When subjected to the dynamic load test, this tether had no failures.

Recommendation: This is a good basic tether. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves.

Raudaschl Tether

Photo of hardware failure in the Raudaschl Tether. Top photo - before the test, bottom photo - after the test.

This is a six foot tether with what appear to be cast snap rings on the ends. The stitching is a black or dark blue on a medium blue webbing, making inspection difficult. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, the snap ring deformed from a "D" shape to a straight "I" shape, allowing the test dummy to come free.

Recommendation: We cannot recommend this tether.

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SOSpenders Three Point tether with Snap Shackle

This is a three point tether with one leg of approximately three feet and one leg approximately six. The outboard ends are anchored by two of the same type of gated snap hook, while the inboard end has a quick release shackle. The stitching is white on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, this tether had no failures.

Recommendation: This is a good tether, which allows crew the freedom of either a long or short tether length. We would prefer to see either the Wichard or Gibb locking gated snap hook on the outboard ends.

Survival Technologies 6' Tether with snap shackle

Survival Technologies Single tether (left) and Shock Arrest tether (right).

This is a six foot tether with a gated hook/carabiner on one end and a snap shackle on the other. The locking gate is easy to actuate with one hand. The stitching is red on black webbing, making inspection relatively easy. When subjected to the dynamic load test the pin on the snap shackle bent slightly, although if the release cord was tugged, the shackle would release. The test dummy did not come free even with the bent pin.

Recommendation: This is a good basic tether.

Survival Technologies Shock Arrest Tether

This is a six foot tether of unusual design. Instead of using webbing, it uses a spliced braided line. Woven into or around one end of the line is a piece of shock cord to help absorb the load of a fall. One end has a snap shackle and the other a snap hook. The splicing appears good, but the whipping is black on a black sheath so inspection requires good eyes and good light. When subjected to the dynamic load test there were no failures.

Recommendation: This is a good tether of interesting design to help absorb shock loads.

West Marine 6′ Tether with snap shackle

This is a six foot tether with a gated hook/carabiner on one end and a snap shackle on the other. The locking gate is easy to actuate with one hand. The stitching is white on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, this tether had no failures.

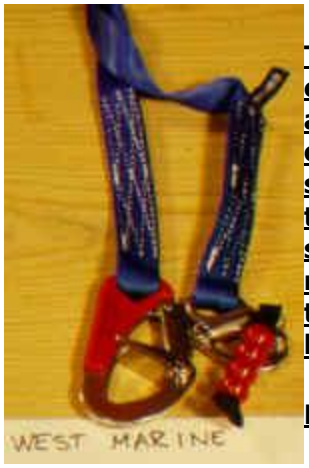
Recommendation: This is a good basic tether.

West Marine 6′ Basic Tether

This is a six foot tether with a snap hook on each end. The locking gate is easy to actuate with one hand. The stitching is white on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, this tether had no failures.

Recommendation: This is a good basic tether. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves.

West Marine 6′ Tether with snap shackle and Gibb Hook



This is a six foot tether with a locking Gibb snap hook on one end and a snap shackle on the other. The locking gate is easy to actuate with one hand, and doesn't suffer from the ability to open when twisted around a padeye (the single wire sprung snap hooks will open when twisted around a padeye in a not too unusual manner, causing them to open inadvertently). The stitching is white on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, this tether had no failures. We used 25 of this model for our harness testing, and none of them failed.

Recommendation: This is a good basic tether.

West Marine 6' Tether with dual snap shackles

This is a six foot tether with a snap shackle on both ends. The stitching is white on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, one of the pins on the snap shackle bent slightly, although if the release cord was tugged, the shackle would release. The test dummy did not come free even with the bent pin.

Recommendation: There is a good basic tether. However since it is sometimes necessary to use two hands to secure the snap shackle, we don't recommend the use of snap shackles on the boat end of the tether.

Wichard 7015 Tether

This is a six foot tether with a patented locking gate hook on the ends. The locking gate is easy to actuate with one hand. The stitching is multicolored on medium blue webbing, making inspection relatively easy. When subjected to the dynamic load test, this tether had no failures.

Recommendation: This is a good tether, although it does not have a quick release shackle on the end. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves.

Wichard 7001 Tether

This is a six foot tether with forged snap rings on the ends. The stitching is multicolored on medium blue webbing, making inspection relatively easy. When wearing a tether without a quick release, the crew should always have a knife within easy reach in case they get trapped and need to release themselves. When subjected to the dynamic load test, one of the gates on a snap ring came unsprung. While the test dummy did not come free, we consider this type of defect to be a failure.

Recommendation: We do not recommend this tether.

Safety At Sea - Harness and Tether Study - Appendix II

Appendix II
In The Water Test

Purpose of Test:
The purpose of the test was to determine the characteristics of safety harnesses in actual use in a man overboard situation. We evaluated the attitude of the Crew OverBoard (COB) as they were towed through the water, the relative comfort for the wearer, whether the harness slipped under load, ease of breathing under load, and ease of reboarding the vessel. We also tested a quick release tether shackle under load to see if it would release. Harnesses tested included a manual inflatable lifejacket with harness, harnesses built into foul weather gear, a "normal" sailor safety harness, a rock climber's harness (both with and without a chest harness), and an industrial safety harness.

Test Equipment:
Miller Industrial Safety harness
West Marine Securite' harness
Forespar Passagemaker harness
Henri-Lloyd foul weather jacket with built in harness (older model)
Gill Southern Cross foul weather jacket with Gill 594 harness
West Marine manual inflatable life vest with harness
Arcteryx rock climbing harness
REI rock climbing chest harness
Pearson 365 ketch
Wetsuit
Video recorder
35mm camera with slides
Digital camera

Test Setup:
A six-foot and a three-foot safety harness were attached to a genoa track slide located on the deck edge of the vessel. The COB would don the safety harness, and then enter the water. The COB would attempt several positions in the water, including face down, face up, and totally relaxed (as an unconscious COB would be). Weather conditions were air temperature 65-70 F, wind 8-10 knots, seas 1 foot, water temperature 60 F. Test Date Saturday, 26 September 1998.

Test Data:

Harness	Vmax	Towing Attitude	Comfort Under Load	Slippage
Miller Industrial	4.0 kts windward side	Good face up If you go face down you could stay that way	Excellent	Chest strap moved up to neck (sewing in place might solve)
West Marine	6.0 kts	Face close to	OK without	None

Manual Inflatable	windward side	waves Water in face	inflation (inflation constricted neck)	
Henri Lloyd Foul Weather jacket	4.1 kts windward side	Head under water at 4.0 kts	Uncomfortable (compresses ribs)*	None
Forespar Passagemaker	4.4 kts windward side	Head under water	Comfortable except (see next column)	Attachment point moved up toward neck **
Gill Southern Cross jacket with harness	4.7 kts windward side	Head under water	More comfortable than Henri-Lloyd	Jacket moved toward throat (release zipper)
West Marine Securite' Harness	4.5 kts leeward side	Head out of water	Comfortable	Shoulder straps did no work under load
Arcteryx Rock Climbing (waist only)	4.2 kts leeward side	Variable - head under when relaxed (not acceptable)	Very comfortable	None
Arcteryx w/REI chest harness	1.9 kts leeward side	Improvement - doesn't let wearer go face down	Discomfort on landing due to leg straps***	None

* Wearer had life jacket underneath the coat. This caused the harness to stay in position on the lower part of the back. Wearer thinks if he wasn't wearing the life jacket, the harness would have run up closer under the armpits and been more comfortable with less pressure on the ribs.
** On this harness, the attachment point moved up toward the wearer's face obstructing his vision. Wearer found this distracting. This trait was the worst of all the harnesses tested.
*** This could also happen without the chest harness.

Harness	Breathing Under Load	Reboarding	Tether
Miller Industrial	No problem Chest strap could move up toward neck and constrict	Impossible without aid	3' and 6' No difference
West Marine Manual Inflatable	Constricts at higher speed when inflated****	Impossible without aid	6' tether better 3' tether pulled head down while on back
Henri Lloyd Foul Weather jacket	Adequate*****	Impossible without aid	3' put more pressure on ribs***

Forespar Passagemaker	Adequate	Impossible without aid	3' more load on ribs but head farther out of water
Gill Southern Cross jacket with harness	Adequate*****	Impossible without aid	
West Marine Securite' Harness	Adequate	Impossible without aid	3' put more pressure on ribs
Arcteryx Rock Climbing (waist only)	Okay	Impossible without aid	Some discomfort with 3' tether There is a load on the crotch strap
Arcteryx w/REI chest harness	Okay	Impossible without aid	Tested with 6' tether only

**** The inflated life vest allows a smooth ramp for water to run up to the face. It may be better to slightly deflate so water runs between the deflated sides.
***** Jacket or clothing can add to pressure around neck, causing breathing to be more work. One solution is to unzip the jacket slightly.

Safety At Sea - Harness and Tether Study - Appendix III Part 1

Appendix III
Static Testing Tables

Inflatable Harnesses

Harness Make/ Model	Weight oz [gm]	Adjust-able	Price Retail/ Street	Time to don (sec)	Strap width Inch [mm]	Crotch Strap	SOLAS Tape	Magnetic	Pass/ Fail
Captain Al's Model #1143 Inflatable	37 [1051]	Yes	110.00	9	1.99 [51]	No	Yes	No	Pass
Mustang MD3012 Inflatable	41 [1165]	Yes	288.00 189.00	7	2.03 [51.4]	No	Yes	No	Pass
SOSpenders 38MHAR-P Inflatable	38 [1079]	Yes	175.00 116	8	2.04 [52]	No	Yes	No	Pass
Stearns Model #1143 Inflatable	37 [1051]	Yes	149.00 95.00	9	1.99 [51]	No	Yes	No	Pass
Stormy Seas Jacket	59 [1678]	Yes	N/A	<5	1.78 [45.2]	No	Yes	No	Pass*
Stormy Seas Vest	42 [1194]	Yes	N/A	<5	1.78 [45.2]	No	Yes	No	Not tested
Survival Technologies #BO1330 Inflatable	41 [1165]	Yes	149.00 149.00	7	1.51 [38.5]	No	Yes	No	Pass
West Marine Manual Inflatable	34 [966]	Yes	155.00	8	2.00 [51]	No	Yes	No	Pass

*A prototype version failed due to shredded webbing, while a production version passed

Safety At Sea - Harness and Tether Study - Appendix III Part 2

Appendix III
Static Testing Tables

Standard Harnesses

Harness Make/ Model	Weight oz [gm]	Adjust-able	Price Retail/ Street	Time to don (sec)	Strap width Inch [mm]	Crotch Strap	SOLAS Tape	Magnetic	Pass/ Fail
Captain Al's 1278T	25 [710]	Yes	32.00	37	1.69 [43]	No	Yes	No	Pass
Forespar Passagemaker	16 [455]	Yes	114.00 103.00	15	2.00 [51]	No	No	No	Pass
Gill (Crewsaver)	14 [398]	Yes	83.33 75.00	<5 (used w/coat)	1.88 [48]	Yes	No	No	Pass
Holland 1278T	25 [710]	Yes	69.00 59.00	37	1.69 [43]	No	Yes	No	Pass
Jim Buoy	7 [199]	Yes	52.00 44.00	13	2.50 [63.5]	No	No	Yes	Fail
Lirakis Newport	15 [426]	No	160.00 148.50	18	2.00 [51]	No	No	No	Pass
Musto Model 6652	19 [540]	Yes	123.65 79.02	22	2.02 [51]	Yes	No	No	Pass
Raudaschl	24 [682]	No	96.00 Can.	8	1.80 [45.7]	No	No	No	Pass
Survival Tech Deck Pro	22 [626]	Yes	126.00	8	1.78 [45.2]	No	No	No	Pass
Survival Tech Pelican 2		Yes		18	1.75	No	Yes	No	Pass

					[44.5]				
West Marine Basic	13 [370]	Yes	39.00	20	2.00 [51]	No	Yes	No	Pass *
West Marine Securite’	18 [512]	Yes	39.00	33	2.00 [51]	No	No	No	Pass *
West Marine Ultimate	18 [512]	Yes	53.50	40	2.00 [51]	No	Yes	No	Pass
Miller Indust. E650	51 [1449]	Yes	87.10	30 (with practice)	1.80 [45.7]	Leg Straps	No	No	Pass
DBI/Sala L2000	54 [1534]	Yes	72.70	95	1.78 [45.2]	Leg Straps	No	Yes	Pass
Black Diamond	19 [540]	Yes	50.00	Not tested	2.55 [64.8]	Leg Straps	No	No	
Arcteryx Verro	17 [483]	Yes	75.00	30		Leg Straps	No	No	

Safety At Sea - Harness and Tether Study - Appendix III Part 3

Appendix III
Static Testing Tables

Tethers

Tether Make/ Model	End Fitting Harness End	End Fitting(s) Deck End	Cost Retail/ Street	Pass/ Fail	Failure Mode
Captain Als' Single Point	Locking Aluminum Carabiner	Locking Aluminum Carabiner	40.00	Fail	Stitching
Captain Al's Three Point	Locking Aluminum Carabiner	Locking Aluminum Carabiner	80.00	Fail	Stitching
Forespar Passagemaker	Snap Hook	Locking Snap Hook	Incl. w/ harness	Fail	Harness Snap Hook Bent
Holland Yacht Equipment 1284T	Snap Hook	Snap Hook	27.50	Fail	Stitching
Helly-Hansen K-947 Three Point	Snap Hook	Snap Hook	59.50	Fail	Snap Hook Deformed
Jim Buoy 922	Splice	Snap Hook	33.77	Fail	Snap Hook opening too small
Lirakis Newport	Loop	Snap Hook	Incl. w/ harness	Pass	
Raudaschl	Snap Hook	Snap Hook	52.00 Canadian	Fail	Snap Hook Bent
SOSpenders Three Point	Snap Shackle	Locking Snap Hook	97.68 66.05	Pass	
Survival Technologies 6' with snap shackle	Snap Shackle	Snap Hook	44.50	Pass*	
Survival Technologies Shock Arrest Tether	Snap Shackle	Snap Hook	76.50	Pass	
West Marine 6' with Snap Shackle	Snap Shackle	Snap Hook	44.00	Pass	
West Marine 6' Basic	Snap Hook	Snap Hook	34.00	Pass	
West Marine 6' with Snap Shackle and Gibb Hook	Snap Shackle	Gated Gibb Snap Hook	84.00	Pass	

West Marine 6’ with Dual Snap Shackles	Snap Shackle	Snap Shackle	53.00	Pass*	
Wichard 7001	Snap Hook	Snap Hook	104.00 88.40	Fail	Snap Hook bail failed open
Wichard 7015	Gated Snap Hook	Gated Snap Hook	115.00 98.00	Pass	

*Slightly bent pin on snap shackle

Safety At Sea - Harness and Tether Study - Appendix IV

Appendix IV
Contributors, Participants, and Test Locations

Contributors:
Members of the Sailing Foundation Safety at Sea Committee: Jim Arbogast, Gail Borling, Doug Engle, Doug Fryer, Fred Hayes, Keith Johnson, Jack Lidral, Frank Shriver.

Participants:
Members of the Tacoma Women's Sailing Association: Judy Arbogast, Karen Atten, Gail Borling, Joanne Dennis, Phyllis Hayes, Evonne Howard. Also Mike Arbogast.

Test Locations:
In the Water Test: Lake Washington, Seattle, Washington

Static Testing: Seattle Yacht Club, Seattle, Washington

Dynamic Load Testing: Fruitland, Idaho

Safety At Sea - Harness and Tether Study - Appendix V

Appendix V
Manufacturer Contact Information

Cal-June (Jim Buoy)
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Captain Al's
P.O. Box 370153
West Hartford, CT 06137-0153
Phone: (860) 232-9065 (860) 232-9065
Email: captal@nai.net

Crewsaver, Ltd
Mumby Road, Gosport, PO12 1AQ
England
(01705) 528621

Forespar Products (Passagemaker)
22322 Gilberto
Rancho Santa Margarita, CA 92688
Phone: (714) 858-8820 (714) 858-8820
info@forespar.com
http://www.forespar.com/

Helly-Hansen (US) INC (K-947 Tether)
17275 N.E. 67 th. Court
Redmond WA 98052
P.O.Box 97031
Redmond, WA 98073-9731 USA
(425) 883-8823 (425) 883-8823
usa@helly.no
http://www.hellyhansen.com

Henri-Lloyd/Mariner Resource
86 Orchard Beach Blvd.
Port Washington, NY 11050
Phone: (516) 883-8450 (516) 883-8450 , Toll Free: (800)645-6516 (800)645-6516
http://www.henrilloyd.com/

Holland Yacht Equipment
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Lirakis Safety Harness

18 Sheffield Ave.
Newport, RI 02840
Phone: (401) 846-5356 (401) 846-5356 , Toll Free: (800) USA-SFTY (800) USA-SFTY

Mustang Survival
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Bellingham, WA 98226
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Musto
Box 30
Batesburg, SC 29006
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Navtec Norseman Gibb
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New Whitfield St.
Guilford, CT 06437-0388
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Raudaschl Sails
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Sporting Lives (SOSpenders)
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sospfd@primenet.com
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Stormy Seas
P.O. Box 1570
Poulsbo, WA 98370
Phone: (360) 779-4439 (360) 779-4439 , Toll Free: (800) 323-7327 (800) 323-7327

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http://shop.sailnet.com

West Marine
500 Westridge Dr.
P.O. Box 50050
Watsonville, CA 95077-5050

Toll Free: (800) 538-0775 (800) 538-0775
http://www.westmarine.com/

Wichard
507 Hopmeadow St.
Simsbury, CT 06070
Phone: (860) 658-2201 (860) 658-2201
http://www.wichard-usa.com/

Safety At Sea - Harness and Tether Study - Appendix VI

Appendix VI
US and International Standards

US Sailing Association
P.O. Box 1260
15 Maritime Drive
Portsmouth, RI 02871-6015
(401) 683-0800 (401) 683-0800 Voice
(401) 683-0840 Fax
email JohnKeavy@ussailing.org
http://home.ussailing.org/Home.htm

Offshore Racing Council (Merged with the International Sailing Federation in 2001)
Ariadne House
Town Quay
Southampton
SO14 2AQ, ENGLAND

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062
(847) 272-8800 (847) 272-8800
http://www.ul.com

International Standards Organization
International Organization for Standardization (ISO)
1, rue de Varembé
Case postale 56
CH-1211 Genève 20
Switzerland
http://www.iso.ch

In the US, the ISO contact is:
American National Standards Institute
11 West 42nd Street
New York, NY 10036
USA
http://www.ansi.org

Safety At Sea - Harness and Tether Study - Addendum

Manufacturer's Comments

11 April Letter from Captain Al's Products

14 May Letter from Captain Al's Products

14 May Test Report from Captain Al's Products

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13 April Letter from Musto Ltd.

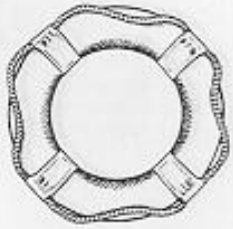
07 May Letter from SOSpenders

Letter from Stormy Seas

April 11

CAPT. AL'S PRODUCTS, INC.

P.O. BOX 370153
WEST HARTFORD, CONNECTICUT 06137-0153
860.232.9065 FAX 860.231.7647
TOLL FREE 800.266.2656
e.mail alan@captainals.com
visit us at www.captainals.com



11 Apr 1999

Matt Pederson
The Sailing Foundation
Safety at Sea Committee

Dear Matt,

Thank you to the Committee for an impartial and thorough test program.

We at Captain Al's Products, Inc. were especially interested to see how our products stacked up against the competition. Happily, several of those you tested performed as we know they would.

We were surprised at the performance of our Tethers, though. We put our Tethers through a static test loading of over 3000#. The results of your dynamic testing has caused us to rethink our fastenings, and we have instituted the use of a secondary fastening effective immediately. We are confident that the use of this secondary method will give our customers the security they need and deserve.

Thank you for bringing this to our attention. You can be sure that we consider the safety of our customers as paramount.

Very truly yours,

Alan Byer
President

May 14

CAPT. AL'S PRODUCTS, INC.

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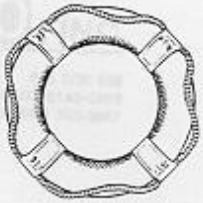

14 May 1999

Matt Pederson
The Sailing Foundation
PO Box 4213
Tumwater, WA 98501

Dear Matt,

This morning we tested 6 of our tethers using a dynamic model. We tested 4 of our combo elastic tethers (snap shackle at one end and locking -on handed- caribener at the other) and 2 of our 3-part tethers (snap shackle in the middle with a 3' leg and an elastic 6' leg).

We used the criteria defined in your report - ie: 220# dropped over 6' for full extension of the tethers.

Testing was done at a certified testing facility with 5 witnesses.

ALL of our tethers successfully passed the drop test with no stitch or hardware failure.

We have the signed certification of this test, along with the test items for verification should there be any question.

A copy of the certificate is included.

Please call me when you receive this letter.

Thank you,

Alan Byer
President

May 14

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ENFIELD (860) 749-7441
WINDSOR LOCKS (860) 623-9524

A.K.O.

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CHARGE TO

Capt. Al's Products, Inc.
PO Box 370153
West Hartford, CT 06137

SHIP TO

OUR LAB NO.	YOUR REFERENCE NO.	SHIPPED FROM	VIA	SHIPMENT	DATE
74310		Enfield, CT	truck	SCRAP ☐ PART ☐	05-14-99

QUANTITY	PART NO.	DESCRIPTION	
6		Tether	PARTS CONFORMING 6 PARTS NOT CONFORMING

METHOD USED: Parts were drop tested at 220 lbs certified weight at a distance of 6 feet per instructions of Alan Byer of Capt. Al's Products Inc.

RESULTS: Parts conform to specifications.

EQUIPMENT USED:

The above parts have been carefully tested in accordance with above methods. This inspection is limited to defects disclosed from above method only. OUR LIABILITY NOT TO EXCEED COST OF RE-INSPECTION OR RE-TEST.

Subscribed and sworn to before me
this ..... day of ..... 19 .....
(Seal)
..... Notary Public
My commission expires .....

RESPECTFULLY SUBMITTED,

Certification No. 104780
William T. Stamer
Inspector

51B (51B)

April 14

April 14, 1999

Matt Pedersen
7718 19th Ave NE
Seattle,Wa 98115

RE: The Sailing Foundation Harness and Tether Study

Dear Sir;

I think you report is essentially sound, I can find only small criticisms which do not change the central focus.

Concerning the Lirakis Harness as you determined it is virtually indestructible The fundamental premise was to build a harness that was strong simple wearable and easy to put on and lightweight.

Part of this process was also to put as little metal as possible on the harness, again I think we succeeded in our objective. This harness can be put on rightside up upside down, inside out and backwards. Naturally there is a right way to wear it however in a panic it will do it's job and the wearer can re-adjust it at a later and safer moment. The harness can be worn backwards if you are working on a winch or coffee grinders so the the "D " rings will not hit or catch the handles, and the tether will not catch either.

It was a conscious decision not to put a hook or a quick release shackle on the inboard end of the harness. Shackles are prone to open under shock load. everyone should carry a sheath knife for a number of reasons not the least of which

LIRAKIS
SAFETY HARNESS INC.
18 SHEFFIELD AVENUE • NEWPORT
RHODE ISLAND • 02840 • USA
TEL: (401) 846-5356

April 14

as you correctly determined is to cut your tether should you need to. It is also possible that you could become tangled in something other than your harness and need a knife to release yourself.

Having expressed this thinking behind the design of the harness; Lirakis does offer a variety of tethers and hooks including locking models.

We consulted a number of Thoracic Surgeons concerning the design during the original design process; all concluded that the "figure eight" shape was the most effective/ friendly way to restrain the human body; distributing the load in the most effective way.

As far as reflective material is concerned; Lirakis offered a tether with reflective material bonded to it. The logic was that it made sense to be able to see at night if the tether was clear of any sheets or other lines. We could not sell this product. I might add that as far as the hooks are concerned: most people chose the standard hook which could be hooked with a flip of the wrist to some object over the locking model. It was a major change when for the last Whitbread race crews requested locking hooks.

In conclusion, I feel that your criticism is mostly fair it does not offer a complete picture. As example the time to don the harness ; there are two methods which are most effective; If you put your arms out in front of you with the harness draped over each arm (one arm through each loop) then if you lift your arms over your head the harness falls onto your shoulders then you only have to pass the tether one and one-half times through the "D" rings. Another method is to leave

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April 14

the tether looped through the "D" rings and slip out of the harness leaving it ready for when you return to it.

I will add that Lirakis does not subscribe to the elastic or retractable tether. A tether should always or should I say ideally be shortened as much as possible so that the length of "fall" is always as short as possible this is not easy when there is shock cord in the tether. The Lirakis harness a single hook tether can be shortened by passing the hook through something and hooking back to the "D" rings I also feel that a harness can be used to steady a person working on deck in rough weat this is accomplished by hooking at a distance from the position so that that the wearer must lean against the tether to work. This creates a three position stance which is quite stable. Again this is not as easy with a shock cord tether.

You were critical of the stitching on the tether of the Lirakis tether; We will match it against any on the market. You correctly observed the idea of contrasting color for the stitching.

As far as the crotch strap is concerned; I agree entirely; in fact a full body harness is better still, however, there is a decision to be made whether or not people will wear a full body harness or one with a crotch strap. Again, Lirakis offers all of these harnesses and options.

One question I have is why you included the bowman's harness in this study. It does not fit in the category of safety harnesses. It has a specific use. I will add a story again from the last Whitbread race where the bowman on one of the

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April 14

boats who wore has bowman's harness all the time while on deck (one made by Lirakis) with it he had a short tether which he kept attached to the jack lines at all times while on deck. As you may be aware the Whitbread 60's are a very wet boat. This system kept him from being swept off the deck almost constantly.

I have enclosed a copy of your catalogue so that you might see that we offer a broad selection which cover your concerns, I believe. What we do not do is to tell people how to enjoy their sailing.

Sincerely,

W. Stephen Lirakis

LIRAKIS
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April 13

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Mr Matt Pedersen
The Sailing Foundation
Safety at Sea Committee
PO Box 4213
Tumwater
WA 98501
USA

13 April 1999

Dear Matt

Many thanks for sending us a copy of your Foundation's study on Harness and Tethers.

Although we have dropped our of this area of the market we are still most interested in safety and therefore this report. It is really good to see such a professional study conducted. Congratulations.

Yours sincerely

Keith

Keith Musto

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E-MAIL ADDRESS: SOSPFD@SOSPENDER.COM

MAT PETERSEN DATE: 05-07-99

SAILING FOUNDATION

RE: DYNAMIC LOAD TESTING

It should be noted that Sporting Lives performs testing on the tethers and harnesses that we produce on a regular basis.

The snap shackles that had a slightly bent pin did not fail nor did they pose a risk to the user. The snap shackle was still useable i.e. would open or close easily. However we would agree with the Sailing Foundation's recommendation that this tether not be used and must be replaced after being subject to such and extreme load.

The Sailing Foundation has developed the concept of and "Ideal Tether". In the report it was mentioned that none of the tethers had all of the "Ideal Tether" features. However the West Marine 3 point tether and the SOSpenders 3 point tether have 4 of the five items mentioned for an "Ideal Tether". Those items are: snap shackle on the inboard end, at least 3 inches of

contrasting stitching for strength and ease of inspection, substantial cotter ring and plastic ball easy grip feature to assist the user in pulling the quick release.

Sporting Lives does make an “Ideal Tether”. The Sporting Lives TEH1013 is a three point tether with a snap shackle on the inboard end of a 3 foot and 6 foot tether equipped on the outboard end with the locking gate Gibb hook. The TEH1013 as well as all of the tethers that Sporting Lives manufactures incorporate at a minimum: 5 inches of cross stitch pattern using UL approved bonded white nylon high tenacity HB 207 thread for superior strength and ease of inspection and for those tethers with a snap shackle installed, the easy grip feature with a reinforced welded cotter ring. Sporting Lives also incorporates the new Wichard Hook with patented lock system into many of it’s manufactured tethers.

It was mentioned in the report that the West Marine Basic sailing harness was as comfortable as the West Marine Ultimate sailing harness. That is true and even though this harness and the Securite sailing harness had some deformation of the D-ring when subject to such an extreme load it still does not pose a risk to the user. The D-rings installed on all of the Harnesses manufactured by Sporting Lives have a minimum acceptable breaking strength of 5,000 lbf. well over the ORC requirements of 3300 lbf. We suspect the dynamic load test that this particular unit was subjected to can generate peak load values above 5,000 lbf. The hardware on this unit is designed to bend as appose to break under extreme loads. A D-ring made of a harder metal that resist deformation may have properties that make it more brittle and could pose a greater risk to a catastrophic failure.

The Securite sailing harness used in the dynamic load test was equipped with an old web keeper. All of Sporting Lives sailing harnesses are equipped with a new web keeper along with a new design that uses an “End Loop Retainer” The End Loop Retainer does not allow the loose webbing to come unsecured.

Sincerely,

R Mitch Mckinstry

Quality Assurance

The Stormy Seas Inflatable Jacket, Model Offshore 39 first used and tested in this study was a PROTOTYPE built for Karen Thorndike on her circumnavigation. Testing both in Australia and the U.S. indicated potential for the harness webbing to fray along the edge under dynamic load. The adjustment hardware was most likely the cause.

We immediately embarked upon further development of the product which included purpose machined harness buckles and heavy duty reinforced webbing.

The product modifications now have eliminated any potential for the harness webbing to fray. Subsequent dynamic load testing both in Australia and the U. S. have passed. Our full production products on both the jacket and the vest of course include these upgrades.

The harness has been purpose designed and manufactured as an integral component of the STORMY SEAS OFFSHORE RANGE, and is not available as an independent product and is not designed to be removed from the garment and used as a standalone item.

The harness is a single webbing strap that is fitted to the lining. The garment holds the webbing in place at chest level, and a correctly fitting garment, with the harness adjusted to suit, will eliminate any potential for the harness to slip and cause discomfort. It has been developed and tested to eliminate slippage deformity or failure.

The strap is adjusted to fit just once (or as needed), then quickly fastened each wearing by feeding a slim line bar through a larger buckle. A keeper is permanently attached to prevent the harness from slackening with body movement.

When not in use, the harness hardware is protected by a Velcro secured cover

The STORMY SEAS OFFSHORE JACKET and VEST have been approved by Standards Australia under AS 2227 (Yachting Harness) and AS 1512 PFD Type 1 (Lifejacket)

1998 Sydney to Hobart Race Review recommendations

The 1998 Sydney to Hobart Race Review Committee recommended an inflatable PFD Type 1 with integrated harness as a personal safety item, and that a buoyancy vest should be worn at all times.

The Race Review also revealed that:

Four harnesses slipped over the heads of crew as they were lifted from the water.

Incorporation of the harness in the Offshore Jacket and Vest will reduce that risk. The vest includes a

Lifting becket designed for securing the crew and lifting them back onto the boat.

It fulfills other recommendations of the Review Committee:

Compulsory:

- Personal strobe or high intensity lights

A water activated light and emergency strobe light are available as options

Recommended:

- Personal EPIRBS

A standard feature of the Offshore Range is a pocket for carrying a personal EPIRB

- Inflatable PFD Type 1 with integrated harness

A standard feature of the Offshore Range

- Extensive use of retro-reflective tape on personal clothing

The Offshore range includes SOLAS-A grade shoulder tapes that are visible from front and back

THE COMPLETE SAFETY PACKAGE AND FURTHER RACE RECOMMENDATIONS

It is important to note here that the STORMY SEAS OFFSHORE RANGE was developed as a complete personal safety package.

Features and Use

The inflatable chamber is capable of providing up to 35lbs lift. Pulling down on the specially designed inflation pocket activates the CO2 cylinder quickly and simply. The amount of buoyancy can be readily adjusted through the oral inflation tube.

In addition to the harness and inflatable harness, standard features of the Offshore Range include:

- CO2 inflation system
- Oral inflation tube
- Retro-reflective tape
- A signal whistle
- Pocket for personal EPIRB, strobe light or VHF radio
- Safety line with double action safety hooks

Options include:

- Water activated inflation system
- Water activated light
- Emergency strobe light

The Race Review also revealed that:

- Eight crew reported difficulty in undoing harness clips.

> *The clips on the Offshore Range safety line have been selected for their ease of use under pressure*

Karen Thorndike tested the jacket in the extreme conditions found in the Tasman Sea and the Southern Ocean. "When all heck is breaking loose on deck I cannot take the time to put on several safety items such as the harness over the jacket, an additional flotation unit, personal EPIRB… I needed to get out on deck immediately and the most important part. GET CLIPPED IN. Falling off the boat is simply not an option. Comfort and mobility are other key issues. The quicker and easier it is to move around and work on deck the quicker I can get back to the relative safety of the cabin below. I could put on a fashion show from my hanging locker with all the top foul weather clothing lines represented. But the equipment I will wear is STORMY SEAS."