



**Second
Evaluation
of
406 MHz
Location Protocol
Distress Beacons**

November 11, 2005

Author and Publisher

Principal Author: Douglas S. Ritter

Publisher: Equipped To Survive Foundation, Inc.
313 W. Temple Court
Gilbert, AZ 85233

Web Site: <http://www.equipped.org>

Chairman and Executive Director: Douglas S. Ritter
Board of Directors: Erik P. Bernstein
Steve White
David Pulver
Barry Schiff
Steven Callahan
Brent Blue, M.D.
R. Scott Weide, Esq.
Allen Wolpert

Equipped To Survive Foundation, Inc. is a 501(c)(3) tax-exempt non-profit corporation dedicated to saving lives by:

- 1. Raising awareness of potential survival emergencies**
- 2. Promoting preparedness as the key to surviving life-threatening circumstances**
- 3. Performing research and offering objective information to allow intelligent selection of effective survival equipment and supplies**
- 4. Providing education in practical survival techniques and procedures**
- 5. Encouraging development of new and improved survival equipment, supplies and techniques**

Copyright Notice

This entire report is copyright 2005 by Equipped To Survive Foundation, Inc. and is registered with the Register of Copyrights, U.S. Copyright Office, Library of Congress. All rights reserved. No portion of the text or photographs in this report may be modified, copied, distributed, disseminated electronically or otherwise, transmitted, displayed, performed, reproduced, published, licensed, derivative works created from, transferred, or sold except: (1) in accordance with the grant of license herein or (2) by the express written permission of the Equipped To Survive Foundation. In addition, for those portions of the text or photographs for which permission is granted for dissemination the information contained may not be taken out of context or presented in an unfair, misleading or discriminatory manner. For permissions, contact Doug Ritter, Executive Director of Equipped To Survive Foundation via email at: dritter@equipped.org.

Disclaimer and Certification

The publisher and authors have undertaken their best efforts to ensure that all information presented in this report is true and correct. Some of the information in the report has been obtained from or is derived from third parties, including U.S. government sources. While these third party sources of information are believed reliable, the publisher and authors cannot

guarantee the accuracy and correctness of that information or any further information or conclusions derived from use of that information. In addition, this report may inadvertently include technical inaccuracies or typographical errors.

The information in this report is provided on an "as is" basis. No warranties, express or implied, are made regarding the accuracy, adequacy, completeness, reliability or usefulness of the information in this report. ALL EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE AND NON-INFRINGEMENT ARE DISCLAIMED. This disclaimer extends to all information in the report, whether in whole or in part. In no event shall the publisher and/or authors be liable for improper or incorrect use of the information or the report or for any loss, injury or damage, including special, indirect, consequential or any damages whatsoever resulting from the information in this report, including the dissemination or use thereof.

Trademarks

Terrafix, Aquafix and Aerofix, are trademarks of ACR Electronics, Fastfind Plus is a trademark of McMurdo Ltd.; eTrex and GPSMap are trademarks of Garmin Ltd. Other trademarks may be used in this report and are the property of their respective companies and owners.

Dedication

To Sue, without whose support and sacrifice this evaluation and all the good works of the Equipped To Survive Foundation would not be possible.

Table Of Contents

Introduction	1
Sponsors & Participants.....	1
Evaluation Limitations and Considerations	4
Disclosures	5
Executive Summary	6
Background to the Evaluation	9
Beacon Test Anomalies	13
Beacon Descriptions	18
Field Tests	27
Evaluation Development, Conduct, and Methodology.....	27
Field Tests Schedule and Sequence.....	34
Field Tests Attendee List.....	35
Field Test Results	35
Baseline Scenarios.....	36
Inland Scenarios.....	39
Maritime Scenarios.....	48
Conclusions	55
Recommendations	58
Appendices	62
Appendix 1 - Original Test Protocols	63
Appendix 2 - Original Field Test Schedule	68
Appendix 3 - McMurdo Anomalies Report.....	73
Appendix 4 - Beacon Operating Schemes	87
Appendix 5 - Knott Report	91
Appendix 6 - McMurdo Battery Installation Instructions.....	94
Appendix 7 - McMurdo Review of Draft Report & ETS Foundation Response	97
Appendix 8 - ACR Review of Draft Report & ETS Foundation Response	104

Introduction

This evaluation is follow-on to the first evaluation conducted in 2004 by the Equipped To Survive Foundation in which deficits in self-locating performance in some beacons were identified. By and large, the beacons tested in this second evaluation provided an acceptable level of performance with regards GPS self-locating performance. All beacons appeared to provide the minimum acceptable level of distress alerting and Doppler locating performance expected from conventional, non-location protocol 406 MHz emergency beacons.

Sponsors & Participants

The conduct of this evaluation required considerable financial and equipment resources beyond that normally available to the Equipped To Survive Foundation. Sponsorship for the evaluation was solicited, both of financial assistance and of gifts in kind.

While we again received considerable financial support from the two organizations listed below, it was not nearly sufficient to conduct this evaluation. If the evaluation was to be conducted, then it was necessary to find other funding sources. After a frustrating and unproductive search and with no other viable alternatives, it was decided to solicit the manufacturers participating in the evaluation for additional funding necessary to conduct the evaluation. It was our determination in consultation with the other financial sponsors and stakeholders that the value of the testing for the consumer outweighed any issues of direct financial involvement by the manufacturers. They had already participated financially in the initial evaluation and would have done so in this second evaluation by underwriting the substantial cost of the beacons being tested and their participation at the evaluation. ACR Electronics and McMurdo Ltd. contributed \$12,600 each to the Equipped To Survive Foundation with the funds to be used to underwrite a portion of the cost of the evaluation. Without this financial support, this evaluation could not have been conducted. Neither company received any additional or special consideration in return for their equal cash contribution.

The two independent financial sponsors besides the Equipped To Survive Foundation's own funds were:

West Marine (Watsonville, California, USA – <http://www.westmarine.com>), a major U.S. headquartered, publicly traded marine chandlery chain and purveyor of marine safety equipment, both wholesale and retail. In addition, West Marine hosted the testing logistics out of their headquarters building, provided test beacons from their warehouse and store shelves, provided added logistical support, provided boats and equipment necessary for the marine testing, and assigned a number of employees to assist for the duration of the testing, as well as additional support both prior to and after the actual field testing.

BoatU.S. Foundation for Boating Safety & Clean Water (Alexandria, Virginia, USA – <https://www.boatus.com/foundation/>), a non-profit 501(c)(3) organization that creates

education and outreach campaigns, researches issues and products, and helps boaters and user groups learn specific actions they can take to be safer and better stewards of the environment while boating.

Additional assistance was provided by:

Landfall Navigation (Stamford, Connecticut, USA – <http://www.landfallnavigation.com>) provided McMurdo test beacons from their warehouse and store shelves and sent an independent observer to the evaluation.

Mr. Carl Ruhne (Santa Cruz, California, USA) donated the use of Willow, a Cal 2-46 ketch, as the “mother ship” for the maritime testing, with Carl captaining the Willow for our time onboard.

Mr. Chuck Hawley (Santa Cruz, California, USA) donated the use of his 21 ft. RIB

Mr. Bob Simpkins (Santa Cruz, California, USA) donated the use of his 22 ft. RIB

Mr. Peter Forey of Sartech Engineering Ltd (Surrey, United Kingdom – <http://www.sartech.com>) provided the use of two TSR406 406 MHz beacon receivers and attended the evaluation as the guest of Equipped To Survive Foundation, assisting in the conduct of the evaluation.

Mr. George Lariviere of Whiffletree Corporation (Marshfield, Massachusetts, USA – <http://www.whiffletreecorp.com>) donated the use of two WS Technologies BT100A 406 Beacon Testers (<http://www.wst-inc.ca>), and attended the evaluation as a guest of Equipped To Survive Foundation to operate the test sets.

Mr. Robert Dubner of Dubner International, Inc. (Westwood, New Jersey, USA – <http://www.dubner.com>) wrote and donated a computer program to seamlessly translate and capture the data received by the Sartech TSR406 receivers and GPS receivers and also provided donated database engineering and analysis services for the data generated by the field testing.

EMS Technologies Emergency Management Products Group (Ottawa, Ontario, Canada - <http://www.emssatcom.com>) provided near real-time access to the COSPAS-SARSAT satellite downlink.

Mr. David Shuler of David J. Shuler Yacht Photography (San Diego, California, USA - yachtphotography@hotmail.com) donated his professional photography services to document the evaluation.

Mr. Rick Lindstrom (Hayward, California, USA) donated his professional videography services to document the evaluation.

The Protection and Survival Laboratory FAA Civil Aerospace Medical Institute (Oklahoma City, Oklahoma, USA - <http://www.cami.jccbi.gov>) monitored these activities in furtherance of their mission to enhance safety and survival for transport aviation.

Iridium Satellite, LLC (Arlington, Virginia, USA – <http://www.iridium.com>) donated the use of an Iridium satellite phone and free airtime so that communications could be maintained when out of range of cellular phone service.

Roadrunner Fire & Safety Equipment (Glendale, Arizona, USA – <http://www.roadrunnerfire.com>) donated fittings and fire nozzle for use with our water pump to generate simulated rainfall.

Stearns, Inc. (Sauk Rapids, Minnesota, USA – <http://www.stearnsinc.com>) donated insulated waterproof waders for use in wading down a creek to place beacons in an otherwise inaccessible gorge.

Equipped To Survive Foundation volunteers donated their time and considerable efforts:

Mr. Dave Foster
Mr. Russ Tatro
Mr. Steve White
Mr. Dave Pulver

The Equipped To Survive Foundation also appreciates the cooperation and assistance provided by:

National Oceanic & Atmospheric Administration (NOAA) (<http://www.sarsat.noaa.gov>)
U.S. Air Force Rescue Coordination Center (<http://www2.acc.af.mil/afrcc>)

Evaluation Limitations and Considerations

As with many evaluations of lifesaving equipment, this one has been subject to limitations imposed by financial constraints, time and practical safety considerations.

Ideally, it would be desirable to test multiple distress beacons of each model in each scenario. The larger sample size would serve to mitigate the effects of a random failure that might not be typical. The high cost of the distress beacons made this approach prohibitive.

By the same token, it is generally accepted that lifesaving equipment must be exceptionally reliable. Because failure can be fatal, consumers have a reasonable expectation that lifesaving equipment will work the first time, every time. Lifesaving equipment failure is not considered an option by the consumer. As such, any beacon failure must be considered unacceptable and this mitigates the potential adverse effects of testing only a single distress beacon of each model in each scenario.

The time necessary to conduct the testing also limited the number of beacons that could be tested, as well as the number and scope of the scenarios to be evaluated. Additional time also translates to additional financial costs, not only for the evaluators, but also for the support personnel and organizations and the manufacturers who participated. The full week spent testing was the practical limit, and even then some participants had to cut their attendance short.

Ideally, it would be desirable to test the GPS-enabled distress beacons under controlled conditions in a GPS simulator to assess the GPS performance of the beacons under a variety of identical adverse conditions; however the cost of doing so was beyond the resources available to the Equipped To Survive Foundation.

Real world testing introduces numerous variables beyond the control of the evaluator. In the case of this evaluation, significant potential variables included weather, sea conditions, and GPS satellite visibility. All the manufacturers of the beacons tested signed on as participants, implicitly acknowledging that these variables were within accepted norms, and would not adversely impact the results if the evaluation were to be conducted in substantial accordance with the draft test protocols provided to them.

These distress beacons are meant to be used *in extremis*, often under the least favorable conditions of weather and, in the case of marine use, extreme sea conditions, often the cause for their necessary use by survivors. This evaluation was, for both practical and safety reasons, limited as to what tested environmental conditions could be experienced. Weather conditions were mild. Rainfall or exposure to drenching amounts of water in a marine environment was simulated for some scenarios, but was moderate, at worst, compared to what might conceivably be experienced under real life-threatening circumstances. Sea conditions varied from moderate, but unchallenging, at their worst to virtually dead flat seas at

times, as noted in the scenario reports. Any failures must be viewed in this light, but the ultimate value of success in these tests must also be tempered by these limitations.

The results presented here are for tests of particular beacons. Readers of this report are cautioned that it can be potentially erroneous to extend the self-location results for any particular beacon to any beacons not tested unless the combination of GPS chip, software, GPS antenna and relationship between the GPS antenna, and transmitting antenna are substantially the same due to the complex interactions involved.

Disclosures

Doug Ritter, Executive Director of Equipped To Survive Foundation, organizer and director of this evaluation and principal author of the report has had an ongoing professional and journalistic relationship with most 406 MHz beacon manufacturers for some time, with manufacturers providing “dummy” beacons for display and photographic purposes. At various industry events, beacon manufacturers’ representatives have treated Mr. Ritter to meals. Both ACR Electronics and McMurdo Ltd. have provided PLBs for Mr. Ritter to give away as door prizes during non-paid survival equipment presentations promoting 406 MHz PLB usage to various consumer groups. Mr. Ritter has, from time to time, recommended beacons from all the tested manufacturers to consulting clients and at times the beacons have been purchased via his contacts with the manufacturers or a manufacturer’s distributor.

The Equipped To Survive Foundation has in the past received 10% of sales of both ACR and McMurdo PLBs made on the GetRescued.net retail web site operated by Pulver Technologies, Inc., which also hosts the Equipped To Survive web site.

BoatU.S. Foundation, which made a financial contribution towards the conduct of this evaluation, has received price consideration from ACR for beacons purchased for their EPIRB rental program.

West Marine, which made a financial contribution towards the conduct of this evaluation, provided personnel and resources for the evaluation, and which provided some of the off-the-shelf beacons for evaluation, has sold both ACR and McMurdo beacons and other products produced by these companies. West Marine is an authorized service center for ACR.

Landfall Navigation, which provided some of the off-the-shelf beacons for evaluation and sent an observer to the evaluation, has sold both ACR and McMurdo beacons and other products produced by these companies.

Both ACR Electronics and McMurdo made an equal financial contribution towards the conduct of this evaluation as well as providing replacements for the test beacons. Equipped To Survive Foundation was not obligated to either respond or to edit the report, but agreed to publish any such response in the report.

Executive Summary

This evaluation of 406 MHz Location Protocol Emergency Beacons was limited in scope to the following two beacon manufacturers; ACR Electronics (Ft. Lauderdale, Florida, USA – a subsidiary of Cobham PLC, United Kingdom – <http://www.acrelectronics.com>) and McMurdo Ltd. (Portsmouth, United Kingdom – a subsidiary of Chemring Group PLC, United Kingdom – <http://www.mcmurdo.co.uk>) who produce beacons approved for the U.S. market and which are also sold worldwide. This evaluation was primarily concerned with the self-locating performance of these beacons in real-world conditions and not the beacons' performance vis-à-vis COSPAS-SARSAT or other regulatory standards, per se, nor for the most part any other specific performance parameters of the beacons except those few others specifically included. Beacons were divided into types; EPIRB (Emergency Position Indicating Radio Beacon, a marine distress beacon) or PLB (Personal Locator Beacon for personal use on land or in the maritime environment) and by whether they were off-the-shelf consumer beacons or a prototype design. All beacons tested in this second evaluation use an internal GPS source for self-location (the ACR PLBs offer the option of interfacing with an external GPS receiver, but we did not test that capability). While no beacon tested performed flawlessly, all the beacons appear to provide a reasonable level of self-locating performance, a substantial improvement over the first evaluation. **All the beacons tested appear to provide the minimum acceptable level of distress alerting performance expected from conventional, non-location protocol 406 MHz emergency beacons.**



Location Protocol 406 MHz Emergency Beacons tested: (clockwise from 12:00) McMurdo Precision EPIRB, ACR AquaFix PLB-200, ACR Prototype PLB, McMurdo Fastfind Plus PLB

The following beacons were tested:

- ACR Electronics “AquaFix 406 GPS I/O Personal EPIRB” with Integral GPS and option external GPS interface, Model PLB-200 (see Note 1 below)
- ACR Electronics “Prototype based on Model PLB-200 GPS I/O” PLB with Integral GPS and option external GPS interface (see Note 2 below)
- McMurdo Ltd. “Precision 406 MHz GPS EPIRB” (internal GPS), also sold as the “G4 406 MHz GPS EPIRB”
- McMurdo Ltd. “Fastfind Plus 406 MHz Personal Location Beacon” or “Fastfind Plus 406 MHz PLB” (internal GPS)

NOTE 1: The ACR “AquaFix 406 GPS I/O Personal EPIRB” is identical with regards construction, operation and coding with the ACR TerraFix GPS I/O PLB and AeroFix GPS I/O Personal ELT (all of which have the same model number) and the results herein also encompass those models as well.

NOTE 2: The ACR “Prototype based on Model PLB-200 GPS I/O” PLB incorporated hardware, software and mechanical differences from the current PLB-200 that ACR reports may be incorporated into future production beacons once appropriate approvals are obtained. Externally, the beacons appeared identical to the production AquaFix beacons tested and were identified with a "P" handwritten in indelible ink on the cover.

The production ACR beacons were literally off-the-shelf beacons from West Marine stock, taken from their warehouse and store shelves. The prototype ACR beacons were shipped direct from ACR.

The McMurdo beacons came from a variety of sources. Some beacons were literally off-the-shelf beacons from West Marine and Landfall Navigation stock, taken from their warehouses and store shelves. In addition, owners of beacons that had been upgraded by McMurdo as part of the upgrade campaign resulting from the first evaluation were solicited to provide their beacons for the evaluation. These beacons had to have been upgraded prior to the participation agreement being signed by McMurdo. This solicitation was made via a number of online boating and aviation forums and those participating received a new McMurdo replacement beacon of the same type as was provided. Equipped To Survive Foundation and West Marine covered all shipping expenses. It should be noted that McMurdo was opposed to the inclusion of these field upgraded consumer beacons in the evaluation, and requested that if we did include them they wanted us to also include ACR beacons from the field as well. McMurdo stated that its concerns over the inclusion of consumer owned beacons were due to the fact that there could not be any confidence as to the condition of such beacons due to possible rough handling, poor storage etc., and it represented a disparity between our trials beacons and those from other manufacturers.

The Equipped To Survive Foundations position was that these field upgraded beacons represented a uniquely modified and assembled beacon that should be tested. Had we the resources to do so, we would have tested a complete set of field upgraded beacons as well as off-the-shelf beacons, but that was not possible. Instead, we used some of each. Each beacon comes with a frangible seal that indicates if it has been switched on and as long as the seal was intact, we could reasonably assume that the beacon had not be used or tampered with. We saw no reason to solicit ACR beacons from the field as they were not uniquely modified.

It should be noted that in the course of conducting our solicitation for the McMurdo beacons it became apparent that not all McMurdo beacon owners were aware of the upgrade campaign, despite considerable efforts on McMurdo's part to get the word out. Upgraded beacons can be identified by the blue collar with "GPS" printed on it for the Precision 406 GPS EPIRB and the text "GPS ANTENNA" and warning on the body of the Fastfind Plus PLB (see images to

right). We encourage anyone with a Precision GPS EPIRB or McMurdo Fastfind Plus PLB that has not yet been upgraded to contact McMurdo:

North and South America

Toll Free Telephone: 1-800-576-2605

Telephone: 561-819 2600

Email: sales@mcmpw.com

McMurdo Pains Wessex Inc.

200 Congress Park Drive

Suite 102

Delray Beach

Florida 33445

USA

Rest of the World

Telephone: +44 (0)23 9262 3808

Email: customerservice@mcmurdo.co.uk

McMurdo Ltd

Silver Point

Airport Service Road

Portsmouth PO3 5PB

UK



Upgraded McMurdo Location Protocol
Beacons: Precision 406 GPS EPIRB (left),
Fastfind Plus GPS PLB (right)

The evaluation was divided into three distinct phases: Baseline, Maritime, and Inland, with the results summarized in the tables that follow:

(Please note that the terms “success” and “fail” in these tables refers to the acquisition of a GPS-derived location and is not indicative of the alerting performance of the beacons.)

Summary of Baseline Testing

Baseline Scenario Description	Satellites in view and locked on per Garmin Etrex Legend GPS Success or Failure to acquire a GPS location within 35 minutes Time to acquisition if location was acquired in minutes:seconds			
	McMurdo Precision EPIRB	ACR AquaFix PLB-200 PLB	McMurdo Fastfind Plus PLB	ACR Prototype PLB
On jetty with expansive sky view and horizon	6 Success 2:50	6 Success 1:41	6 Success 2:49	6 Success 1:40
Relocation to beach with expansive sky view and horizon ¹	6 Success NA	6 Success NA	6 Success NA	6 Success NA
On jetty with expansive sky view and horizon, sprayed with water to simulate moderate rain. ²	6 Success 2:49	6 Success 3:22	6 Success 8:42	7 Success 4:13

¹ For the relocation scenario, the beacons were hand-carried to a new location 400 yards distant to determine if the new location was acquired and transmitted at the 20-minute location update cycle.
² For PLBs this test served as Baseline Test for Maritime testing as well as actual testing for Inland testing

Summary of Maritime Testing

Maritime Scenario Description	Conditions Seas, Skies	Satellites in view and locked on per Garmin Etrex Legend GPS located on boat Success or Failure to acquire a GPS location within 35 minutes Time to acquisition if location was acquired in minutes:seconds			
		McMurdo Precision EPIRB	ACR AquaFix PLB-200 PLB	McMurdo Fastfind Plus PLB	ACR Prototype PLB
On aft deck of vessel, under mizzen boom	3-4 ft. swells with waves, clear	6 Success 2:37	7 Success 15:58	8 Success 10:05	6 Success 2:33
In water tethered to Rigid Inflatable Boat	4-6 ft. swells with waves, clear	6 Success 6:37	----	----	----
In water with simulated rain/spray	2-3 ft. swells with waves, overcast	6 Success 15:16	----	----	----
Secured on simulated swimmer's vest in water	4-6 ft. swells with waves, clear	----	6 Success 2:10	6 Success 2:50	6 Success 1:52
Secured on simulated swimmer's vest in water with simulated rain/spray	4-6 ft. swells with waves, clear	----	6 Success 1:54	6 Success 10:21	6 Success 3:11
In 6-person life raft, canopy open	3-4 ft. swells, overcast	6 Success 2:49	6 Success 3:22	8 Success 13:02	6 Success 10:56
In 6-person life raft canopy closed	3-4 ft. swells, overcast	6 Success 2:50	6 Success 7:36	6 Success 2:50	6 Success 4:10
In 6-person life raft canopy closed, simulated rain	2-3 ft. swells, overcast	6 Success 2:50	6 Fail NA	6 Success 11:12	6 Success 1:41

Summary of Inland Testing

Inland Scenario Description	Satellites in view and locked on per Garmin Etrex Legend GPS Success or Failure to acquire a GPS location within 35 minutes Time to acquisition if location was acquired in minutes:seconds		
	ACR AquaFix PLB-200 PLB	McMurdo Fastfind Plus PLB	ACR Prototype PLB
Small clearing, solid tree line	6 Success 3:23	6 Success 2:50	6 Success 1:42
On jetty with expansive sky view and horizon, sprayed with water to simulate moderate rain.	6 Success 3:22	6 Success 8:42	7 Success 4:13
Clearing – 3 satellites only in view	3 Success 5:01	3 Success 7:52	NOT TESTED ³
Under forest canopy 2-3 satellites in view	2-3 INVALID TEST ¹ NA	2-3 INCONCLUSIVE ² NA	2-3 Success 12:42
Hidden from GPS satellite for initial start-up period, cover removed to allow GPS acquisition at 20 minute update	7 Success	6 Success	6 Success
¹ Incorrect Beacon Tested – No GPS in the beacon – see "Beacon Test Anomalies" ² Due to GPS satellite availability a fair comparison between this beacon's performance and that of the others in the same test could not be made. Readers are directed to the full report, Inland Scenario Charlie, page 41, for full details. ³ Beacon not tested due to difficulty establishing 3 GPS satellites consistently, decision by ACR representative with concurrence of test principals that since production PLB-200 had acquired, no significant data lost by not testing this prototype in this scenario. Readers are directed to the full report, Inland Scenario Bravo, page 41, for full details.			

Background to the Evaluation

Readers are referred to the Background to the first evaluation for considerable history about these sometimes controversial evaluations and detail about the beacons, how they function and the COSPAS-SARSAT system which can be found at http://www.equipped.org/406_beacon_test_summary.htm#Background.

After the publication of the results of the first evaluation (see http://www.equipped.org/406_beacon_test_toc.htm), McMurdo Ltd. (Portsmouth, United Kingdom – a subsidiary of Chemring Group PLC, United Kingdom – <http://www.mcmurdo.co.uk>) introduced an upgrade campaign that encouraged owners of their GPS-equipped beacons to receive a free upgrade to an improved specification. This program was initially offered only in the U.S. McMurdo footed the entire cost of this upgrade. McMurdo conducted tests of their upgraded beacons; declaring "McMurdo Precision EPIRB and Fastfind Plus PLB Perform 'Faultlessly' In New Tests" (see http://www.equipped.org/mcmurdo_test_results_pr.pdf). McMurdo subsequently released their report on these tests (see http://www.equipped.org/406_beacon_test_mcmurdo.htm#mcmurdotrialsreport).

In the meantime, ACR Electronics (Ft. Lauderdale, Florida, USA – a subsidiary of Cobham PLC, United Kingdom – <http://www.acrelectronics.com>) introduced a new PLB, their first with integrated GPS, the Model PLB-200.

Equipped To Survive Foundation remained convinced that only truly independent testing could serve consumers' interests by determining if the upgraded McMurdo beacons did, indeed, address the shortcomings that were evident in the first evaluation. Moreover, it was felt that the consumer would equally benefit from independent testing of the new ACR PLB. Together, these two companies comprise nearly all of the consumer market for GPS-equipped 406 MHz beacons in the U.S. and a significant majority of consumer GPS-equipped 406 MHz beacons in the world. Equipped To Survive Foundation commenced on a fund-raising campaign to raise the money to conduct such testing, while also soliciting the cooperation of the manufacturers. It soon became obvious that the Equipped To Survive Foundation would not be able to independently raise the funds necessary for conducting an evaluation, approximately \$40,000. Many potential sponsors indicated that they felt that the biggest bang for the buck had already been provided by the first evaluation and were not prepared to further support this work within their limited budgets for such activities or would do so only at a reduced level. Moreover, internal Equipped To Survive Foundation funds were also quite limited compared to the previous year.



Location Protocol 406 MHz Emergency Beacons tested: (clockwise from 12:00) McMurdo Precision EPIRB, ACR, AquaFix PLB-200, ACR Prototype PLB, McMurdo Fastfind Plus PLB

After consultation with the primary sponsors, legal and non-profit experts, and others it was determined that the only way to proceed was to offer the participating manufactures the opportunity to contribute to the partial funding of the evaluation on an equitable basis. Failing that, no evaluation could be conducted.

After review of the budget and existing funding, a contribution of \$6300 per beacon model tested was set and an invitation was sent to all beacon manufacturers. Had sufficient interest from at least the two major manufacturers not been forthcoming, the evaluation would not have been conducted. While initial interest came from a number of manufacturers, after months of negotiations only ACR and McMurdo agreed to participate and signed agreements outlining requirements and responsibilities of the parties. Both companies would have two beacon models tested, ensuring that they each contributed an equal amount to the evaluation, an ideal balance.

The following beacons were tested:

- ACR Electronics “AquaFix 406 GPS I/O Personal EPIRB” with Integral GPS and option external GPS interface, Model PLB-200 (see Note 1 below)
- ACR Electronics “Prototype based on Model PLB-200 GPS I/O” PLB with Integral GPS and option external GPS interface (see Note 2 below)
- McMurdo Ltd. “Precision 406 MHz GPS EPIRB” (internal GPS), also sold as the “G4 406 MHz GPS EPIRB”
- McMurdo Ltd. “Fastfind Plus 406 MHz Personal Location Beacon” or “Fastfind Plus 406 MHz PLB” (internal GPS)

NOTE 1: The ACR “AquaFix 406 GPS I/O Personal EPIRB” is identical with regards construction, operation and coding with the ACR TerraFix GPS I/O PLB and AeroFix GPS I/O Personal ELT (all of which have the same model number) and the results herein also encompass those models as well.

NOTE 2: The ACR “Prototype based on Model PLB-200 GPS I/O” PLB incorporated hardware, software and mechanical differences from the current PLB-200 that ACR reports may be incorporated into future production beacons once appropriate approvals are obtained. Externally, the beacons appeared identical to the production AquaFix beacons tested and were identified with a "P" handwritten in indelible ink on the cover.

The McMurdo beacons came from a variety of sources. Some beacons were literally off-the-shelf beacons from West Marine and Landfall Navigation stock, taken from their warehouses and store shelves. In addition, owners of beacons that had been upgraded by McMurdo as part of the upgrade campaign resulting from their poor GPS location performance in the first evaluation were solicited to provide their beacons for the evaluation. These beacons had to have been upgraded prior to the participation agreement being signed by McMurdo. This solicitation was made via a number of online boating and aviation forums and those participating received a new McMurdo replacement beacon of the same type as was provided. Equipped To Survive Foundation and West Marine covered all shipping expenses. It should be noted that McMurdo was opposed to the inclusion of these field upgraded consumer beacons in the evaluation, and if we did include them they wanted us to also include ACR beacons from the field as well. In the end they agreed to participate knowing that it was our intention to do so and to not solicit ACR beacons from consumers.

The Equipped To Survive Foundations position was that these field upgraded beacons represented a uniquely modified and assembled beacon that should be tested. Had we the resources to do so, we would have tested a complete set of field upgraded beacons as well as off-the-shelf beacons, but that was not possible. Instead, we used some of each. Each beacon comes with a frangible seal that indicates if it has been switched on and as long as the seal was intact, we could reasonably assume that the beacon had not be used or tampered with. We saw no reason to solicit ACR beacons from the field as they were not modified in any respect.

The manufacturers agreed to provide beacons to replace beacons already obtained from West Marine, Landfall Navigation and McMurdo customers and sequestered by the Foundation, the case with ACR and McMurdo production beacons, or in the case of the ACR Prototypes beacons, to provide them for the testing. Nine EPIRBs and 15 PLBs of each model to be tested were required. After the evaluation, the tested beacons would be returned to the manufacturers.

Those manufacturers who elected to participate were offered the opportunity to have up to three representatives observe the testing, subject to signing a confidentiality agreement and a personal waiver of liability. ACR sent two representatives and McMurdo sent three representatives.

Pursuant to the agreements with the manufacturers, just as with the first evaluation and report, the manufacturers have received a preview of the draft report and were invited to offer a response including comments and corrections, if desired. Equipped To Survive Foundation was not obligated to either respond or to edit the report as a result of any comments or corrections, but agreed to publish any such response in the report. McMurdo's comments and the Equipped To Survive Foundation's response can be found in [Appendix 7](#). ACR's comments and the Equipped To Survive Foundation's response can be found in [Appendix 8](#).

Invitations were also sent out to numerous Search and Rescue-related organizations and industry.

The U.S. Coast Guard Office of Aviation Engineering authorized the Aviation Life Support Equipment Manager and an assistant to participate.

Captain Eric Knott, Director of Training / Commercial and Agency Sales at Landfall Navigation, joined us as an independent observer. Landfall Navigation is a dealer for both ACR and McMurdo beacons and other products. His independent report is included as [Appendix 5](#).

The Equipped To Survive Foundation invited a number of interested parties to observe and participate as guests of the Equipped To Survive Foundation.

Mr. Peter Forey of Sartech Engineering Ltd (Surrey, United Kingdom) provided the use of two TSR406 406 MHz beacon receivers at both the initial and this second evaluation and also served as an "independent observer" to McMurdo's self-test of their beacons. Forey is a dealer for ACR, McMurdo and other beacon manufacturers, as well as a manufacturer of beacon replacement batteries and beacon test equipment that are sold to the entire industry.

Mr. George Lariviere of Whiffletree Corporation (Marshfield, Massachusetts, USA), the U.S. distributor for WS Technologies, donated the use of two WS Technologies BT100A 406 Beacon Testers when the manufacturer was unable to participate again this year due to prior commitments and was invited to attend to operate the testers. Lariviere has previously

worked for a sister company beacon manufacturer to ACR, currently consults for a sister company beacon manufacturers to ACR and is a distributor in the U.S. of McMurdo's non-survival related marine electronic products.

Beacon Test Anomalies

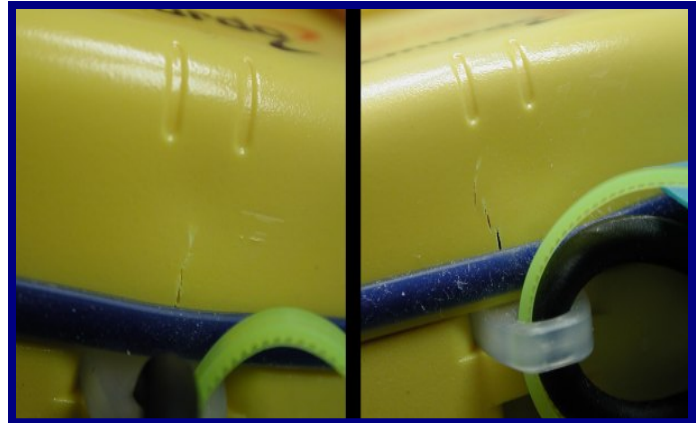
We experienced a number of anomalies in conducting the second evaluation:

1. One ACR AquaFix / PLB, Model PLB201, the model without an integral GPS, was included in the test beacons received from West Marine. Both the box for the beacon and the beacon itself was correctly marked, though this marking is only a checkmark in a box on a side panel and a small sticker on the end panel. Otherwise the box is identical for both beacons. We have been unable to ascertain how this beacon came to be sent for the testing from the store involved or why it was not identified as incorrect at the time of receipt, but on the sheet provided by West Marine of the test beacons received it was incorrectly identified as a Model 200. Subsequently, at no time during the test protocol assignment by Equipped To Survive Foundation personnel, recoding by the ACR engineering representative or during activation or re-activation of the beacon was it identified as being the incorrect beacon. The question was raised in one instance during this beacon's testing as to why this beacon had a different, light colored face (compared to the other ACR beacons), but the ACR representatives' response was that the color of the face was not an indication of anything in particular and may have been a production variance. In fact, it is the most visible difference between a PLB-200 and PLB 201, however the face is hidden when the cover is closed and the difference is not apparent from outward appearances. Nor was this difference in color in these new beacons recognized by Equipped To Survive Foundation attendees. The model number is indicated on the data plate on the underside of the beacon. The cover was not opened during the assignment phase, but was opened during recoding and activation. The end result, as noted in the test results, was an invalid test result for the test in which this beacon was used. After the evaluation, ACR took this AquaFix PLB back for analysis of its failure to acquire and to report on what they found. Identification of the beacon as a Model PLB 201 was made only after the beacon was returned to ACR for investigation of its failure to acquire a position. It appears that the error was initiated with the shipment of the incorrect beacon from a West Marine retail store, but ultimately the failure to catch this error rests solely with those conducting the evaluation.



ACR Model PLB201 without GPS showing light colored faceplate

2. During the test protocol assignment process, it was observed that three McMurdo Fastfind Plus PLBs appeared to have cracks in the case where the battery retention screw is located. It was determined at that time to avoid assigning these beacons to those few maritime tests where the beacon would be subject to immersion and the crack may have allowed water penetration, resulting in a failure. We had no way of determining if it would or wouldn't at the time. Since the primary purpose of the evaluation was to test the GPS function, this was determined to have been



Cracked cases of two McMurdo Fastfind Plus PLBs

inconsequential in the conduct of the tests. The issue of the cracking would be dealt with separately from the primary issues of the evaluation. Subsequent inspection with a magnifying glass revealed that one of the apparent cracks, the smallest, was only a mark on the case, so that **only two cases were actually cracked**. After the evaluation, McMurdo took one of these cracked Fastfind Plus PLBs back for analysis and to report on what they found. [Appendix 6](#) includes copies of the instructions provided by McMurdo (as referenced below) for installation of the battery to prevent over tightening. Both PLBs with cracked cases were from field upgraded beacons sent by customers. Our investigation revealed no known instances of abuse of these two beacons, but that necessarily cannot be a definitive finding.

McMurdo reported:

During the inspection of the beacons prior to the trials commencing two Fastfind Plus PLBs were observed to have small cracks in the upper part of the case near the lanyard retention / battery retaining point.

McMurdo have been unable to replicate the failure mode exhibited by the 2 Fastfind Plus PLBs from the ETSF trials and at this time do not have an explanation for them. Subsequent examination of a total of 373 PLBs showed no further units with this problem. It has been demonstrated that the battery retention screw can be over tightened by a factor of 2 or 3 times and no damage occurs to the PLB. McMurdo provides guidance on tightening this screw both to consumers and internally within its production processes. McMurdo's conclusion is thus that the design of the PLB is fit for purpose and even if the screw is over tightened well beyond McMurdo's recommended torque settings this does not lead to a crack appearing in the outer case of the PLB. At this time we are unable to explain how the cracks came about in the 2 ETSF PLBs and we would recommend that it is worthwhile trying to back track the history of these PLBs to see if there is anything unusual about them, particularly in terms of any rough handling, dropping or adverse storage conditions. McMurdo has

instigated an extra inspection process to check for any future evidence of this problem and if further faulty units are found further investigations will be carried out.

A copy of McMurdo's full evaluation report is included in [Appendix 3](#).

While there is no indication that this is an inherent problem, because McMurdo has been unable to determine a cause for the cracked cases we found on Fastfind Plus PLBs and because these were field upgraded units, prudence dictates that customers with field upgraded beacons should probably inspect their beacon(s) for cracking before further use. Since some customers may have purchased their beacons from dealers who had their stock upgraded, all owners of Fastfind Plus PLBs with a serial number of 500-530-2524 and lower should examine their beacons. McMurdo reports that a few units with serial numbers higher than this may also have been field upgraded, so a look by all owners is probably in order. McMurdo retains a record of each beacon produced and its history, so if there are any questions, you can contact McMurdo.

3. During the recoding process, one of the McMurdo Fastfind Plus PLBs was found to fail the self-test and was determined to have a dead battery. McMurdo supplied a replacement battery from a spare PLB they had brought, so that the test could be conducted. Since the primary purpose of the evaluation was to test the GPS function, this was determined to have been inconsequential in the conduct of the tests. McMurdo retained the failed battery for analysis and to report on what they found. They subsequently asked for and received the Fastfind Plus PLB to which that battery was originally fitted to further their investigation.

McMurdo reported:

One Fastfind Plus PLB was found to have a flat battery during the initial beacon recoding exercise before the trials began.

Investigations have shown that there was nothing wrong with the PLB or the Battery Pack that would explain why the battery was discharged (flat). McMurdo has checked its records and can find no evidence of this problem ever having occurred previously. The cells within the battery have been returned to the manufacturer for investigation, however a report back is not expected for sometime and it is considered unlikely at this time that this will reveal any additional facts or information. It is suggested that we try and track the history of this beacon to see if this might provide any indication of how the battery could have got into this condition. Self testing the beacon prior to going on a trip would have shown up this problem and allowed the user to obtain a replacement unit.



Chris Hoffman (McMurdo Director of Engineering) checks dead PLB battery during recoding session

A copy of McMurdo's full evaluation report is included in [Appendix 3](#).

4. During the recoding process, one of the McMurdo Fastfind Plus PLBs would not accept its recoding. This beacon was replaced in its assigned test with one of our spare beacons. After the evaluation, McMurdo took this Fastfind Plus PLBs back for analysis and to report on what they found.

McMurdo reported:

One Fastfind Plus PLB would not program during the initial beacon recoding exercise before the trials began.

Investigations indicated that this was due to a dry joint on pin 3 of the membrane which is the Anode connection for the IR programming LED. McMurdo believes that this was a one off isolated incident due to human error during the upgrade process. This problem would not have resulted in failure of the beacon to transmit a distress alert in an emergency. McMurdo has modified its internal process instructions and inspection procedures as a result of this finding to increase awareness of this problem and take extra care in this process in future. It has also advised its partner in the USA upgrading the beacons to implement the same tightened controls. All beacons are tested prior to leaving the facility to ensure they contain a valid distress message.

A copy of McMurdo's full evaluation report is included in [Appendix 3](#).

5. As noted in the test results, one McMurdo Precision 406 EPIRB behaved in an unexpected manner during its test, with the strobe light not functioning for some time after activation and only providing a location after an unexpectedly and anomalously long period of time, though it did eventually generate and transmit a location within the COSPAS-SARSAT allotted time. McMurdo retained this EPIRB for analysis and to report on what they found.

McMurdo reported:

During the sea trials one Precision EPIRB took longer than expected to start transmitting once it was placed in the sea.

Investigation of this EPIRB could not find any fault with the unit. The sea water contacts on the EPIRB and the battery inside the EPIRB both operated normally and no problems were found with the EPIRB. It can only be surmised that somehow a low level of contamination (a very fine film of grease maybe) got onto one or both of the sea water switch contacts of this EPIRB before the trial and this caused the delayed activation seen during the trial. The sea water switch contacts on the EPIRB were examined when the unit was first received back at the factory but no obvious signs of contamination were evident. It is further surmised that the intermittent activation seen during the first 10 minutes was due to this film and that movement of the EPIRB in the sea was then sufficient to break through this barrier after 10 minutes which thus then

activated the EPIRB. Although there was a slight delay the beacon did work as intended and would have sent a distress alert in a real emergency.

A copy of McMurdo's full evaluation report is included in [Appendix 3](#).

5. During the Inland Scenario Golf testing of the ACR AquaFix PLB, two invalid tests were experienced before a valid and successful test was conducted. On the first invalid test, the beacon was incorrectly turned off approximately 1.5 minutes earlier than it should have been. On the next attempt, a spare beacon was uncovered prematurely due to incorrect GPS receiver timing information provided by the ACR engineering representative. Subsequently, the correct timing sequence was determined and as a result of canceling one of the tests, allowing the availability of another test beacon, this Inland Scenario Golf test was run again and the beacon received a position as reported in the test results.

6. ACR requested they receive the AquaFix PLB that failed to acquire a position during the Maritime Scenario Foxtrot test (in a retest on the Baseline Scenario Alpha jetty location it acquired a location in 1:42) for analysis and to report on what they found and it was shipped to them.

ACR reported:

We've analyzed unit #61 that did not acquire inside a life raft while the raft was subjected to water spray. Our findings are as follows:

The unit, SN #61, manufactured March 2005, programmed test protocol, with HEX ID: 2DDC64807AFFBFF has a GPS receiver with sensitivity measured at 4dB worse than normal. This reduced sensitivity could easily explain why it would struggle under certain adverse conditions to acquire a GPS position lock.

Doug, the potential for using receivers with marginal sensitivity is something we observed last year, (I believe you and I have talked about this previously, perhaps at RTCM?). What we've learned is that in every production lot the sensitivity of the receivers follows a traditional Bell curve with the majority of units clustering near the nominal and with a few units performing at the fringes. This is unavoidable without an effective screening mechanism. It would appear that of all the (ACR) GPS enabled EPIRBs and PLBs you've obtained on the market in your first test and now in this second test that this is the first marginal receiver you've come across.

Having discovered this issue, we have addressed it by buying a GPS simulator in April 2005 in order to have the ability to measure GPS receiver performance. We require that our GPS receiver suppliers provide us with units that meet our performance specification. With our GPS simulator we can test/measure/screen units to insure that they meet our performance specs. We can say with confidence that the units we've built since late-April/early-May time frame fall within a much tighter performance specification than what GPS vendors typically provide to their customers. To our

knowledge we are the only 406 Beacon manufacturer supplying units to the recreational market that has invested in GPS simulator technology and that has the ability to screen receivers to insure their performance capability.

A further comment: we are working with GPS receiver manufacturers, providing them with our test data and unique performance requirements, to upgrade the quality of GPS receivers that we purchase. We now have prototype receivers that are better than any we've found in the general market. These prototype GPS receivers were used in the prototype beacons in your recent test. I'm sure we'll be commenting more on their performance once we receive your report.

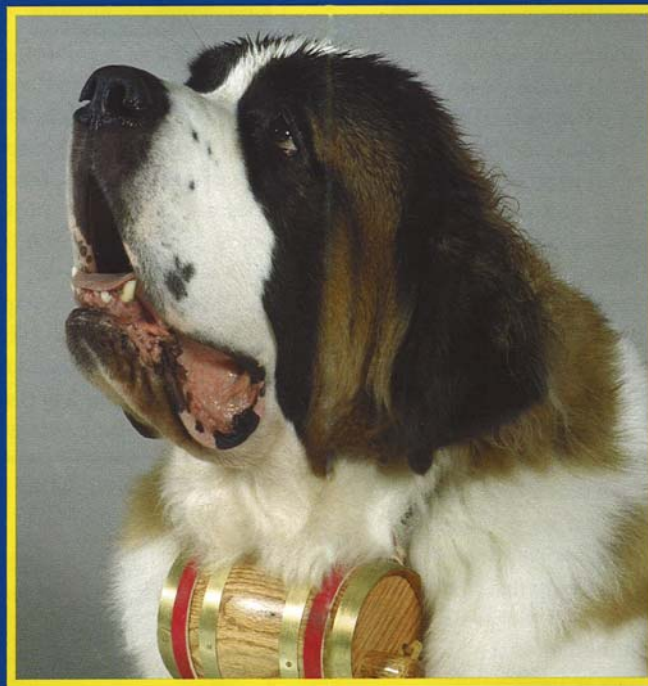
Bottom line: The issue of GPS performance is one we take very seriously at ACR and have since day one. It is not something we take for granted nor have we accepted the status quo. We continue to lead the industry by identifying issues and solving them before they become known to others.

*Paul Hardin
ACR Electronics*

Beacon Descriptions

The following pages include copies of the manufacturers' sales materials for the beacons tested:

The AquaFix™ 406 GPS Personal EPIRB takes the “search” out of Search and Rescue.



Same idea, minus the slobbering.

 AquaFix 406



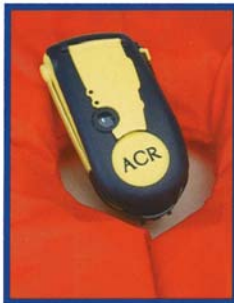


There's also a place in every mariner's ditch kit for the AquaFix™ 406 P-EPIRB. Even though boaters have used

Emergency Position Indicating Radio Beacons (EPIRB) for years, new regulations will disallow the use of the smaller, more affordable 121.5/243.0 MHz (Class A and B) EPIRBs in 2009. Mariners using emergency beacons will need to switch to those operating at 406 MHz, which traditionally have been expensive and out-of-reach for many boaters pursuing recreation on the water. But now, there's the AquaFix™ 406 P-EPIRB.



Weighing a mere 12 ounces, it's easy to pack and easy to carry. The lanyard secures the P-EPIRB to your wrist, when holding it in your hand. If you drop the AquaFix™ 406 P-EPIRB, don't worry. The rugged yellow case protects the sophisticated electronics inside. It even floats and is totally waterproof.



So the next time you venture into the great outdoors, make room for the AquaFix™ 406 P-EPIRB. You'll never make a wiser decision.

Your first choice as a last resort.

You can count on the AquaFix™ 406 P-EPIRB for rapid rescue. Simply push the activation buttons simultaneously to transmit your emergency distress signal, leaving it on in an area with the clearest view of the sky possible. A global satellite system will quickly pick up the signal and relay your location to the nearest Search and Rescue team. Interface a GPS receiver or choose an integral AquaFix™ model, and an even more precise location is sent immediately.

Rescuers review the mandatory registration database and make contact with the emergency phone numbers you supplied. Upon confirmation of an emergency, rescue forces are dispatched. The AquaFix™ 406 P-EPIRB dramatically reduces the time it takes to locate you, so all that remains is the rescue.

P-EPIRBs must only be used in situations of grave and imminent danger where conventional communications are unavailable and all other means of self-rescue are exhausted. A cell or satellite phone should always be considered first because rescuers can be better prepared to handle your emergency when you can tell them the nature of the assistance you need.

Make sure all members of your party are familiar with the AquaFix™ 406 P-EPIRB and its proper use. U.S. law stipulates penalties for deliberate false activations including incarceration, fines and reimbursement of costs associated with a false alert.





Each year, thousands of extreme outdoor enthusiasts trek into America's wildest, most remote regions. White water rafters ride challenging, remote courses. Hunters pack into the most remote high-country. Snowmobilers cut virgin tracks through the hinterlands. And every day, hikers escape into the nation's most desolate, brutal wilderness, carrying little more than a backpack.

At best, these rugged environments are unforgiving. At worst, in an emergency, they can turn so savage, so suddenly, survival becomes the only thing on your mind, especially if you're out there alone.

You could rely on traditional means to alert a rescue team, but they all have flaws. Cell phones



don't work in remote areas and are dead when you need them. Two-way radios are limited in range. Plus, they're useless unless someone's listening on the channel. So what's the answer?

Go to the ends of the earth, without going out on a limb.

© Lomale Dyppe/Greenland Expedition



Now that the Federal Communications Commission has approved 406 MHz transmitters for use on land throughout the United States, it will be easier than ever to find and rescue people in danger in out-of-the-way areas. These high-tech, 406 Personal EPIRBs (P-EPIRB) utilize the exact same satellite technology that the military, marine, and aviation industries have trusted for nearly 20 years. At last count, more than 15,000 lives have been saved with 406 MHz beacons.

With the much-anticipated introduction of ACR's AquaFix™ 406 P-EPIRB, outdoor enthusiasts can finally explore America's most remote regions with complete peace of mind, knowing that if an emergency arises, with alert rescue forces,



they can quickly be found. Think of our 406 P-EPIRB as a state-of-the-art safety net.

AquaFix™ 406 GPS Personal EPIRB
Product No. 2797.4/2797.2
**406 MHz Personal EPIRB with On Board
and/or GPS Interface**

- Transmits on 406.028 MHz with a 5 w digitally coded distress signal, also 50 mw homing signal on 121.5 MHz has audible tone and Morse Code "P" identifier
- P/N 2797.4: Internal GPS acquires LAT/LON when the unit is activated if externally obtained GPS coordinates are not present, providing rescue agencies with your exact position to within 100 meters
- Recessed, waterproof GPS interface (NMEA 0183) allows you to download your GPS coordinates from a hand-held GPS receiver into your P-EPIRB; when activated, your LAT/LON transmits instantaneously saving valuable time for your distress message to reach local rescue centers
- Patented proprietary electronics provide greater frequency stability for most accurate position through the LEOSAR satellites
- Smallest, most functional personal P-EPIRB can be easily carried in a pack or pocket; ideal for mariners, skiers, hikers, hunters, kayakers, climbers, pilots or any outdoor enthusiast
- Simple, simultaneous two-button activation; red LED flashing indicates the P-EPIRB is transmitting 406 MHz to the LEOSAR satellite system, green LED flashing indicates GPS coordinates are present and being transmitted to the GEOSAR stationary satellites
- Multiple TEST options allow testing of battery power, GPS data confirmation, internal circuitry; battery power indicator alerts user that less than 24 hours of operating life remains
- Style and protection for your P-EPIRB allows for multiple mounting options on life vests, foul weather gear and safety harnesses
- Powder-coated, flat, stainless steel antenna wraps compactly around product for easy stowage and is easy to extend when needed or for testing
- Upright, floating pouch for GPS and beacon storage available as an option

SIZE: 1.74 x 5.71 x 3.03 in (4.4 x 14.5 x 7.7 cm)

WEIGHT: 12 oz (338 g)



YOUR ULTIMATE WAY OUT

ACR Electronics, Inc.

5757 Ravenswood Road, Fort Lauderdale, FL 33312, U.S.A.

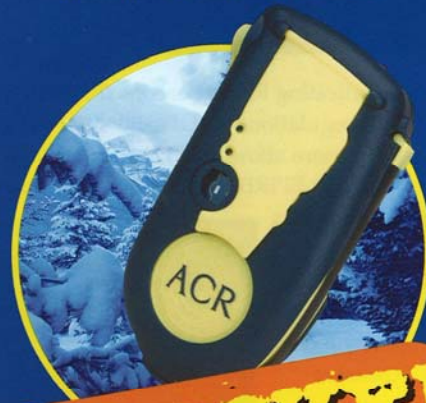
Tel Worldwide: +1 (954) 981-3333 • Fax: +1 (954) 983-5087

e-mail: plbinfo@acrelectronics.com • www.acrplb.com



©2004 by ACR Electronics, Inc. All rights reserved. Reproduction in whole or part is permitted only with permission of ACR Electronics, Inc. E3-01-0142 Rev. B

Personal EPIRB



APPROVED

**for sale
in the U.S.**



ACR Electronics, Inc.

www.acrplb.com

A Chelton Group Company

406 MHz **GPS** EPIRB PRECISION

The Precision 406 GPS EPIRB has been specifically designed to meet the needs of leisure boaters and commercial ship operators alike. The Precision features an internal 12 channel parallel GPS receiver within a compact 406 EPIRB.

When activated, the Precision 406 GPS EPIRB provides a 406 MHz alert signal via the COSPAS-SARSAT satellite system. There is a visual indication of GPS acquisition. Precision also transmits on the International Aircraft Emergency Frequency of 121.5 MHz providing a homing signal for the Search And Rescue (SAR) services. A built-in self-test facility includes testing of the 406 MHz and 121.5 MHz signal (where permitted) and GPS power up.



- **GMDSS compliant**
- **Built-in state-of-the-art 12 channel parallel GPS engine**
- **Visual indication of GPS acquisition**
- **Internal GPS allows position updates**
- **Position up-date throughout beacon operating life (>48 hours at -4°F)**
- **5 year battery replacement interval**
- **Global alert via COSPAS-SARSAT satellites**
- **121.5 MHz homing frequency**
- **5 year limited warranty**

Using the latest COSPAS-SARSAT geo-stationary constellation, the 406 GPS EPIRB has the ability to provide the Search And Rescue (SAR) services with location details including latitude and longitude.



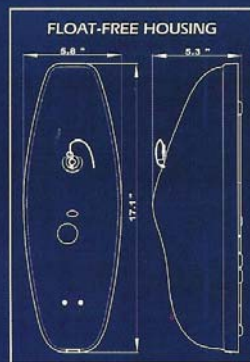
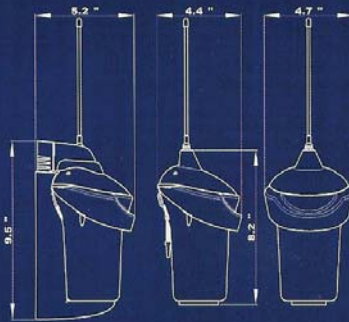
Wainwright Approved





technical specifications

406 MHz GPS EPIRB PRECISION



General

Message formats

Programming
Temperature

Battery life
Operating life
Sealing depth
Weight
Auto case & EPIRB

406 MHz transmitter

Frequency
Output power
Modulation

121.5 MHz transmitter

Frequency
Output power
Modulation

Visual location

Intensity
Flash rate

Approvals

Complies with IMO resolutions A662(16), A694(17), AB10(19)
IEC 1097-2
COSPAS-SARSAT C.S.T.001 and T.007
European ETS-300-066
USA, RIGM, FCC Approved,
EU MED (Ship's Wheel) Approved
See www.mcmurdo.co.uk for all other approvals

This document is McMurdo Limited copyright and contains proprietary owned intellectual property rights and confidential data. All rights are strictly reserved. McMurdo policy is one of continuous research and development and the right is reserved to alter specification without prior notice.

08/04

EPIRB National, Standard and User Location Protocol as applicable, plus EPIRB user protocols. Serialised, MMSI and radio call sign.

Via RS232, light pen and windows based PC Beacon: Manual deployment
Operating: -4 °F to +131 °F (Class 2)
Storage: -22 °F to +158 °F (Class 2)
Float free mechanism:
Operating: -22 °F to +158 °F (Class 2)
Storage: -22 °F to +158 °F (Class 2)
6 years storage from date of manufacture
48 hours minimum

Waterproof to 30 feet
730 g (1.6 lb)
2.2 kg (4.9 lb)

406.028 MHz +/-1 kHz
5 Watts +/- 2 dB
Biphase L 1,1 +/- 0.1 radians

121.5 MHz +/-3 kHz
50 mW ERP
AM, up or down swept tone

0.75 Cd Xenon discharge light
23 flashes per minute



MEMBERS OF CEMBRING GROUP PLC

Emergency Position Indicating Radio Beacon (EPIRB)

The award winning design of the Precision 406 GPS EPIRB is a result of extensive research and development.

The Precision 406 GPS EPIRB features an built-in 12 channel parallel GPS receiver within a compact 406 EPIRB. The benefit of the Precision's internal GPS is that position can be updated throughout the operating life of the beacon and has the ability to provide a position when the EPIRB has been activated and is drifting at sea.

When activated, the Precision transmits radio signals into space which are detected by the COSPAS-SARSAT satellites. Ground stations track these satellites and process the distress signals. Emergency alerts received by the satellites are relayed to the closest automated ground station, known as Local User Terminals (LUTs). The processed information is then forwarded to the MCC (Maritime Co-ordination Centre) where the digital message is decoded. The distress details and registration information is then passed to the appropriate rescue co-ordination centre who co-ordinate the relevant SAR [Search And Rescue] authorities.

The Precision 406 GPS EPIRB is fully compliant with international legislation and meets worldwide approval standards.

- High intensity xenon strobe light
- Global coverage with COSPAS-SARSAT polar orbiting satellites
- Geostationary coverage >70°N - 70°S
- Minimum battery life 48 hours at -4 °F
- Supports all EPIRB location protocols
- 121.5 MHz homing transmitter indicator
- 406 MHz transmit indicator
- Visual indication of GPS acquisition
- Built-in 12 channel parallel GPS receiver
- Internal GPS allows position updates

PLEASE NOTE: GPS reception requires a clear view of the sky.

Ordering information

Model	Category	Class	Deployment / Description	Part No.
Precision GPS EPIRB	2	2	Manual / c/w Bulkhead Bracket	82-514A
Precision GPS EPIRB	2	2	Manual / c/w Protective Housing	82-524A
Precision GPS EPIRB	1	2	Auto / c/w Float-Free Housing	82-504A
Protective Housing	-	-	Manual / w/o HRU	82-534A
Float-Free Housing	-	2	Auto / c/w HRU	82-544A
Bulkhead Bracket	-	-	Manual	82-276B

To comply with UN regulations for transportation, as of January 2003 any products containing lithium batteries will be classified as UN Hazardous Class 9

Other equipment in the McMurdo range includes PLBs, SARTs, AIS, VHF radios, DSC VHF radios, survivor location lights, ICS NAVTEX equipment and Pains Wessex pyrotechnics.

AUTHORIZED DEALER

McMurdo Pains Wessex Inc.
200 Congress Park Drive, Suite 102
Delray Beach, Florida 33445
Tel: +1 561 819 2600
Fax: +1 561 819 2650
sales@mcpw.com
www.mcpw.com

406 MHz GPS PERSONAL LOCATOR BEACON FASTFIND Plus



The Fastfind Plus is a revolutionary hand-held Personal Locator Beacon that features a built-in GPS (Global Positioning System) receiver combined with a 406 MHz transmitter and 121.5 MHz homing signal. It is ideal for alerting the rescue services of an emergency during maritime, light aircraft and outdoor activities. (Where licensing allows).

When activated, the Fastfind Plus with integral GPS provides a 406 MHz alert signal via the COSPAS-SARSAT satellite system. There is a visual indication of GPS acquisition. Fastfind Plus also transmits on the International Aircraft Emergency Frequency of 121.5 MHz providing a homing signal for the Search And Rescue (SAR) services. A built-in self-test facility includes testing of the 406 MHz and 121.5 MHz signal (where permitted) and GPS power up.



- Built-in 12 parallel channel GPS receiver
- Visual indication of GPS acquisition
- Internal GPS allows position updates
- Global alert via COSPAS-SARSAT satellites
- 121.5 MHz homing frequency
- Built in self test on 406 MHz and 121.5 MHz
- Complete with carry case and Kevlar lanyard
- Simple three stage manual activation
- User replaceable battery packs (-4 °F or -40 °F)
- Compact and lightweight
- Accepts serialised or MMSI protocols
- 5 year limited warranty

The standard Fastfind 406 MHz Personal Location Beacon has all the features of the Fastfind Plus but without GPS. The 406 MHz frequency provides an alert signal to the rescue services within 90 minutes, depending on satellite passes and gives a positional accuracy to within 3 nm. Once in the vicinity the 121.5 MHz transmitter provides a signal for the rescue services to home-in on. This information is more than sufficient to enable rescue services to find a vessel or individual in distress particularly if equipped with flares and a lifejacket light.



Fastfind



Carry case and lanyard



Three stage activation



2



3

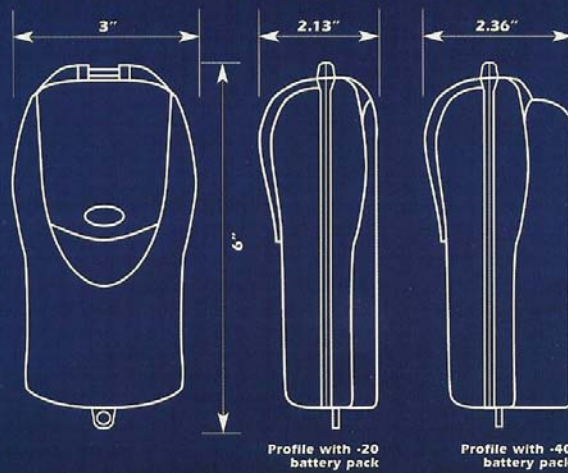


Transmitting



technical specifications

Fastfind and Fastfind Plus



General

Message formats PLB National, Standard, and User Location Protocol as applicable, plus serial user (non-GPS version)

Programming Via RS232 light pen and windows based PC

Temperature Storage: -67 °F to +158 °F (Class 1)
Operating: -40 °F to +131 °F (Class 1)
With class 1 battery pack

Storage: -22 °F to +158 °F (Class 2)
Operating: -4 °F to +131 °F (Class 2)
With class 2 battery pack

Battery life 5 years storage from date of manufacture
Operating life 24 hours minimum

Sealing BSEN 60945 temporary immersion
MIL-STD-810F method 500.4
15,000 feet altitude

Weight Approx. 0.4 kg (13 oz) with -40 °F battery pack
Approx. 0.3 kg (10 oz) with -4 °F battery pack

406 MHz transmitter

Frequency 406.028 MHz +/- 1 kHz
Output power 5 Watts +/- 2 dB
Modulation Biphasic L 1.1 +/- 0.1 radians

121.5 MHz transmitter

Frequency 121.5 MHz +/- 3 kHz
Output power 50mW ERP
Modulation AM, up or down swept tone

Approvals

COSPAS-SARSAT Approved
R&TTE Approved
FCC Approved
See www.mcmurdo.co.uk for all other approvals

Accessories



Dive Canister



Direction Finder



Emergency Receiver

This document is McMurdo Limited copyright and contains proprietary owned intellectual property rights and confidential data. All rights are strictly reserved. McMurdo policy is one of continuous research and development and the right is reserved to alter specification without prior notice.



Fastfind and Fastfind Plus Personal Locator Beacons

The Fastfind and Fastfind Plus Personal Locator Beacons feature the same advanced technology as found in the award winning Rescue EPIRB and Precision 406 GPS EPIRB. Designed using miniaturised components to fit into an ergonomically styled compact casing both versions employ a simple three-stage manual operation and feature user replaceable battery packs, which are available for use in temperatures of -4 °F and -40 °F.

Carrying the Fastfind could not be simpler, both versions are supplied with a lanyard and carry case to enable the user to keep the PLB safely attached at all times.

These latest advanced products from McMurdo have been designed to provide recreational boaters, professional and semi-professional crew, delivery yachtsmen and fishermen with the very best chance of being found without delay at sea in an emergency.

Intended for use within the maritime mobile service and where permitted by national administrations within the land mobile service.

- Global coverage with COSPAS-SARSAT polar orbiting satellites
- Geostationary coverage >70°N - 70°S
- Comprehensive indication of operation
 - 121.5 MHz transmission
 - 406 MHz transmission
 - GPS acquisition and fix status
- Integral 12 channel parallel GPS receiver
- Internal GPS allows position updates

PLEASE NOTE: GPS reception requires a clear view of the sky.

Ordering information

Model	Class	Description	Part No.
Fastfind 406 PLB (-4°F battery)	2	C/w bag, lanyard & user manual	85-826-004A
Fastfind 406 PLB (-40°F battery)	1	C/w bag, lanyard & user manual	85-846-004A
Fastfind Plus 406 GPS PLB (-4°F battery)	2	C/w bag, lanyard & user manual	85-825-004A
Fastfind Plus 406 GPS PLB (-40°F battery)	1	C/w bag, lanyard & user manual	85-845-004A
Battery Replacement Kit (-4°F battery)	2		85-763-020
Battery Replacement Kit (-40°F battery)	1		85-763-040
Fastfind Dive Canister		Tested to a depth of 150m	85-754A
Carry Case			85-736-004
Lanyard			88-769
Emergency Receiver		121.5 MHz MOB alerting unit	88-704A
Direction Finder		121.5 MHz MOB alerting & direction finding unit	88-804A

To comply with UN regulations for transportation, as of January 2003 any products containing lithium batteries will be classified as UN Hazardous Class 9

Other equipment in the McMurdo range includes EPIRBs, PLBs, SARTs, AIS, VHF radios, DSC VHF radios, survivor location lights, ICS NAVTEX equipment and Pains Wessex pyrotechnics.

AUTHORIZED DEALER

McMurdo Pains Wessex Inc
200 Congress Park Drive, Suite 102
Delray Beach, Florida 33445
Tel: +1 561 819 2600
Fax: +1 561 819 2650
sales@mcpw.com
www.mcpw.com

Field Tests

Evaluation Development, Conduct, and Methodology

Beacons for the test were shipped to West Marine's Chuck Hawley and logged in by an assistant. Each beacon was given a unique tracking ID number that was imprinted on an adhesive label and adhered to the beacon. The source of the beacon was recorded and the beacons sequestered in a secure area. For field-upgraded McMurdo beacons secured from customers, a replacement beacon was sent upon confirmation that the beacon was correct and that the witness seal was intact.

On the Saturday prior to the field tests, Ritter, West Marine representatives and Equipped To Survive volunteers met at West Marine. Beacons were unpacked, randomly selected, and assigned to a particular test scenario, except that field-upgraded McMurdo beacons were not assigned to any baseline tests to ensure that the limited supply would be used for the "real world" testing. The Beacon I.D. of every beacon to be used in the testing was recorded from the label on the beacon. Each beacon was then labeled with its assigned scenario for quick identification at the test site. EPIRBs were labeled using waterproof tape applied to the body of the beacon. PLBs were labeled using a waterproof plastic tag secured to the beacon with a plastic cable tie. Each Beacon I.D., manufacturer, model, and assigned scenario was recorded on Data Sheets that would be used to manually record data during each scenario, as well as on a master list.

All Data Sheets were laser printed on Rite-In-The-Rain brand waterproof paper and were filled out with indelible ink due to the wet conditions that might be experienced during the testing. After this, each beacon was placed into a lockable bin secured with two padlocks. The only keys to the padlocks were retained by Ritter and the primary Equipped To Survive Foundation volunteer. Within each bin, beacons were segregated by test scenario with dividers. The bins of beacons were themselves labeled with the scenarios for the beacons they contained. At the end of the day, the bins were loaded into the rented delivery cargo van along with the rest of the equipment and supplies for the testing, and the door was padlocked with the only keys retained by Ritter and the primary Equipped To Survive Foundation volunteer. Bins were unlocked for removal of beacons for particular scenarios, then locked up again for security or were in full view of the participants and witnesses if unlocked for any longer period of time.

On Sunday prior to the field test, a full test was conducted of the data gathering equipment. In order to ensure commonality of all the data recorded, all Equipped To Survive recorded time data was recorded as UTC (Universal Coordinated Time, still commonly referred to as GMT, Greenwich Mean Time) with time synchronized using the time supplied from the GPS receivers.

Multiple sources for receiving and recording locally the 406 MHz beacon transmissions were used in order to ensure back-up capability.

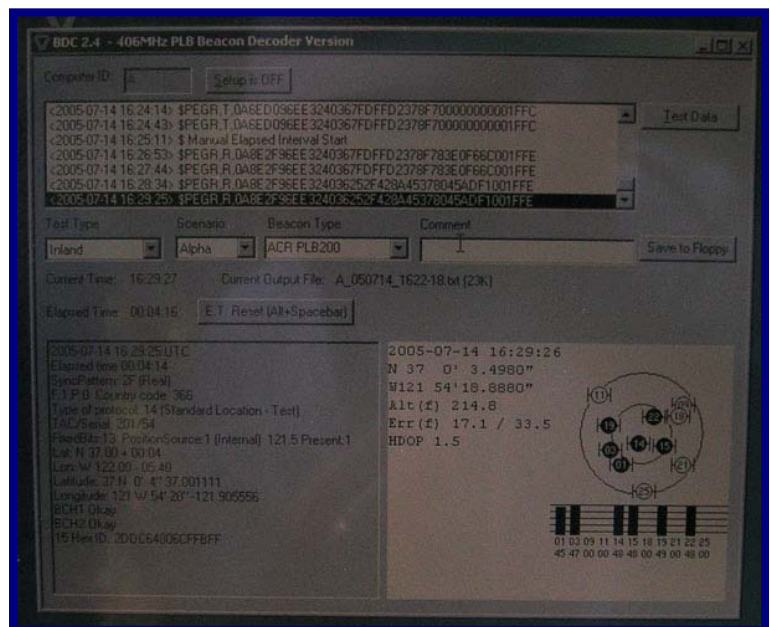
Sartech Engineering Ltd (UK) provided two model TSR406 406 MHz receivers. These each included an antenna with attached coaxial lead and connectors to make up a 12-volt power cord and a serial cable to connect to a computer. While recording software was provided, it did not meet our needs. The receivers output via a serial cable the 30-character hexadecimal code the beacon is transmitting. Three Panasonic CF-28 Toughbook computers were acquired via Ebay for the field testing, one for each tester and one held in reserve. The Sartech receivers were hooked up to these Toughbooks.



Sartech TSR406 receivers hooked up to Toughbook computers. Doug Ritter, left, with ETS Foundation volunteer Russ Tatro.

Bob Dubner of Dubner International wrote an update to his original data acquisition program from the first evaluation (BDC) that took the serial output from the receiver and translated it into plain English so that the Beacon ID and any GPS-derived location information transmitted could be read. This was displayed in real time on the computer display upon receipt of each data burst from a beacon, and was saved to diskette and to the hard drive. Also saved with this information was a date and time stamp from the computer, operator-inputted scenario information and any added comments inputted into the comment field.

In addition, each computer was also connected to the serial NMEA output from a GPS receiver (Garmin GPSMAP 296 with remote active antenna and GPSMAP 76) using a 50 foot serial cable and serial to USB adapter. Dubner's BDC program converted this data to a real time graphic display showing the relative location of the GPS satellites in view, their approximate power levels and the actual GPS location duplicating the format found on the Garmin receivers as well as the HDOP (horizontal dilution of precision) of the GPS constellation. This information was recorded every 5 seconds during data acquisition.



Dubner's Beacon Decoder Program with GPS interface

Also incorporated into the BDC program was a timer that was manually activated upon initial activation of the beacon and which would then record elapsed time for each data burst from the beacon, providing the total elapsed time from start until a GPS derived location was transmitted. Finally, on each reset, the computer automatically reset the clock to UTC time based on the data input from the attached GPS receiver, no human intervention was required to set the time, ensuring that each computer clock was identical.

During the Maritime phase of the testing, the assigned operator's bout of seasickness resulted in some operator inputted scenario information to be in error, but accurate time stamps allowed the data to be properly integrated.

Because the computers' batteries would not last for an entire day of testing, a man-portable Honda EU1000i Generator/Inverter was used. This provided both 120-volt power for the computers and to charge camera batteries. 12-volt power for the Sartech receivers was provided by a West Marine portable battery pack that was recharged each night.

For the terrestrial testing, the antennas were attached to a telescoping aluminum pole that provided adequate elevation, approximately 7-8 feet, for good reception under all testing conditions. For the maritime testing the antennas were secured to the mizzenmast. In testing prior to the evaluation we were able to receive a 406 MHz signal from over $\frac{1}{4}$ mile away.

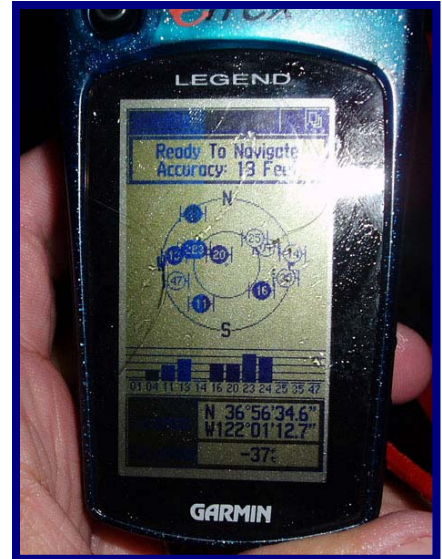
Wiffletree Corporation provided two WS Technologies Inc. (Canada) Model BT100A 406 Beacon Testers. These provided essentially all the functionality, as well as added data parameters, of the aforementioned Sartech receivers and computers together, integrated into a handheld Dell Personal Digital Assistant. The built-in antenna had a range of 10 meters. Unlike last year, we were not able to secure a remote antenna which would have provided a range of approximately 50 meters, so we had to improvise to ensure that the tester could be in close proximity to the beacon in the water for the marine testing. A second RIB was enlisted to carry these testers. These units recorded data on Secure Digital memory cards and this data was then later transferred to a computer. Each data burst resulted in an HTML page of formatted data, saved with its date and time stamp. File names were coded to provide scenario, manufacturer, and model of the beacon and receiver I.D.

Dubner wrote a program that extracted the data from the thousands of HTML files and combined it with the date and time stamp and the decoded file name to output to a results database with fields equivalent to the other data recorded. Due to operator and software issues, time stamps were not reliably consistent with UTC time recorded by the other data collection methods, however this data did generally provide accurate elapsed time and beacon ID information that allowed for effective back-up for our other data collection methods.

The Equipped To Survive Foundation provided the GPS receiver that served as the standard reference beacon. This was a Garmin model eTrex Legend (WAAS enabled) which was selected because 1) it is a WASS-enabled mid-range member of the most popular moderate-

priced portable handheld GPS line sold in the U.S.; 2) it is the model GPS used as reference for the Key West Test

As a back-up to the data recorded by the BDC program, we manually recorded the number of satellites being received by the GPS and their signal strength using a water-resistant Olympus Stylus 300 digital camera to photograph the GPS display. The water-resistant camera could be safely taken on board the life raft during those maritime scenarios, without risk of damage. The camera also saved in the individual image metadata files the date and time the image was taken. While the camera has the capability to display the date and time stamp in the image itself, it was decided not to display this data due to the possibility that it might obscure critical data in the image. A back-up Canon PowerShot SD300 Digital Elph camera in a waterproof enclosure was available as back-up to the Olympus, if needed.



Reference Garmin Etrex Legend GPS showing typical image recorded showing GPS satellites, signal strength, lock-on and location.

For data reduction purposes, these images could be printed out with this included metadata date and time stamp as a caption using the “contact sheet” production capability of ACDsystems’ ACDSee software to produce a reference that could be manually integrated into the results database.

A candid digital photographic and digital video record of all beacon tests by the Equipped To Survive Foundation professional photographer and videographer, including preparations involving the beacons, was made for documentary purposes. In addition, a number of participants and observers also took their own digital video and photographs and these were made available to Equipped To Survive Foundation by prior agreement. Images in this report have been taken from these photographs.

On the morning of July 11, the off-the-shelf and field-upgraded beacons were recoded to test protocol coding by their respective manufacturers’ representatives in the Sea Cliff Hotel Sea View room, while being witnessed by all observers and participants. The beacons were recoded to IDs from a list previously supplied by the manufacturers, which had been sent to NOAA 60 days prior pursuant to their rules. This allowed NOAA to ensure that no actual alerts would be issued



ACR representatives recoding their beacons.

and that their software would record the data received from these test protocol coded beacons, which would otherwise be ignored by the system. The prototype beacons from ACR were already test protocol coded and did not have to be recoded.

After all the beacons were recoded they were locked up again in their respective totes for transport to the test sites.

Multiple beacons were required of each model to ensure that each test beacon started on equal terms, from what is known as a “cold start.” This is based on the assumption that the beacon will likely not have been activated prior to use and thus will have no GPS information, ephemeris data or the almanac in memory, which could possibly shorten the time to acquiring a location. Before the GPS can derive a location, it must download from the satellite certain data. This takes a period of time and can theoretically significantly impact time to acquisition and even if acquisition is successfully accomplished in the time available. If that data has already been downloaded and held in a memory, it is likely that the GPS will acquire a location faster or acquire when it might not otherwise. Manufacturers claim that their beacons do not retain this data after being shut off, but as there is no practical way for us to independently confirm this, and there are technically ways in which it could be accomplished even with no power, the only way to ensure a cold start is to use a fresh, un-activated beacon for each test.

Because ephemeris data is location- and time-dependent, we ensured that the test location was thousands of miles away from the factory or importer of the beacons to ensure that even if the beacons acquired and maintained in memory the ephemeris or almanac data from an original functional test, it would not be current and would need to be reacquired upon activation. Again, this was not expected to be an issue for a variety of practical reasons, including the extended time interval between when the manufacturer had possession of the beacons and the test, but this was an matter raised at the original Key West Test where the location was close enough to one manufacturer’s facility that it theoretically could have influenced the results.

The field testing was conducted in and around Santa Cruz, California, USA. The same sites were used as were used in the first evaluation to retain commonality and provide some degree of comparability.

The draft field test protocols for this evaluation were initially based on those used in the Key West Test. They were then refined and additional tests added based on input from a variety of industry and government sources and the results of the laboratory tests. Only minor revisions based on experience at the first evaluation were made to the test protocols for the second evaluation, none of these of a substantive nature. Some tests from the first evaluation were eliminated that weren't specifically GPS performance related.

For each scenario the following procedure was specified in the original test protocols ([see Appendix 1](#)). They were modified in the field as noted in accordance with the original

protocols, which also provided for “test protocols subject to revision with concurrence of sponsors.”

5. *Perform beacon self-test in accordance with manufacturer’s instructions, note any anomalies.*

Some beacons had their self-test activated 2 or 3 times prior to beacon activation to confirm that both sets of local receivers were properly receiving the beacon’s transmission. In almost all the tests, the GEO satellites also received this self-test transmission.

11. *Deactivate beacon once it is confirmed that GPS location has been transmitted and beacon has gone to “sleep” or after 35 minutes, whichever occurs first.*

The beacons were left on for approximately five minutes after a GPS location encoded transmission was initially transmitted as indicated on our test receivers. This allowed the Geosynchronous Satellite to receive at least five bursts of data with the location information, just in case there was an anomaly that prevented the first burst from being received. We did have numerous examples where the first transmission received had an anomaly and provided only the coarse location. If a beacon did not transmit a location, the plan was that it be left on for the maximum 35 minutes, based on the COSPAS-SARSAT requirement that the internal navigation device provide valid data within 30 minutes (COSPAS-SARSAT T.001 section 4.5.5.3), and allowing for some additional leeway to compensate for any timing or other issues. In some cases with approval of the manufacturer's representative a beacon was turned off prior to 35 minutes if it was agreed that the GPS receiver had gone to sleep and any further time on would be useless since the GPS receiver was not operating.

An attempt was made to utilize the services offered by EMS Technologies Emergency Management Products Group (<http://www.emssatcom.com>) to monitor in near real time the receipt of the beacon transmissions to the satellites and back down to the Local User Terminal (LUT) ground stations using their independent GEOLUT. This would theoretically be equivalent to having access to NOAA's downlink data immediately. Due to short notice, however, it was not possible for them to attend with their remote satellite terminal, so we had to work via cell phone and Iridium satellite phone link through a company intermediary, himself communicating with their Canadian satellite communications facility. This communications link was at times troublesome such that this capability proved to be not quite as useful as it might have



Doug Ritter on Iridium Satellite phone, communicating with EMS Technologies

otherwise been. The missed beacon transmissions in Inland Scenario Delta might have been able to be troubleshot at the time if we had their satellite terminal on site or had not the communications issues and delays inherent in the chain of communications. As noted in the Recommendations, once missed, this data is irrecoverable and valuable information on both beacons and the system can be lost.

To maintain consistency, accuracy and ensure independent recording of manually recorded data, all of the hand-written data recording was accomplished by a single West Marine representative. All data was recorded using a pen with waterproof indelible ink. The data sheets were stored in the integral storage space within the provided clipboard maintained in the possession of the recorder, and kept overnight in secure storage.

Test results recorded locally during the test were supplemented by beacon message data provided by NOAA. This supplementary GEOLUT data was primarily used to provide confirmation of locally recorded data, and to confirm acquisition of the data by the satellite. LEOLUT data was used for determining performance of beacons in those scenarios where integrated system performance relying upon Doppler location in unconventional operating conditions was the primary purpose of the test. Dubner decoded the GEOLUT and LEOLUT data received from NOAA and incorporated it into the results database.

During the at sea tests, interference from some local unidentified RF source produced large quantities of false data via the SARTECH receivers. Attempts at filtering out this interference the second day at sea were only partially effective. For some of the at sea tests the manually recorded back-up timing data or WS Technologies receiver data was relied upon for the results presented here.

Beacons that failed to acquire a location during a test, were retested on the last day in the Baseline Scenario Alpha jetty location with a full view of the sky. All the functional beacons so tested acquired a location at the earliest possible opportunity, indicating that their GPS receiver was functioning.

As a standard practice, tested devices are retained until well after publication of the report of an evaluation to ensure they are available in case of a challenge to the published results, or if questions arise regarding the devices tested. As previously noted, a number of beacons were returned to their respective manufacturers for failure analysis. These beacons were selected for exceptional treatment in this regard because their failure was an anomaly, their performance inconsistent with the overall performance of that model beacon in the full evaluation. As such and because such performance anomalies are, in the experience of the authors, most often caused by production or assembly errors that can and should be corrected at the earliest opportunity, considering the life-threatening potential such failures can cause, an exception is made to standard practice. Poor performance on a consistent basis would not be considered an anomaly, and would be dealt with in the overall context of the evaluation. In this evaluation, this did not become a factor.

Field Tests Schedule and Sequence

The original filed test schedule can be found in [Appendix 2](#). The field tests and operations were conducted in the following sequence:

July 9

Unpack all equipment and test for function.
Unpack, record and label all beacons.

July 10

Install test sets and equipment on board SV Willow and test for function.
Install gasoline-powered water pump and lines in RIB and test for function.

July 11

Kick-off Meeting
Signing of confidentiality agreements and liability waivers
Recoding of beacons
Baseline Scenario Alpha
Baseline Scenario Bravo
Baseline Scenario Charlie
Inland Scenario Golf

July 12

Maritime Scenario Alpha
Maritime Scenario Bravo
Maritime Scenario Charlie
Maritime Scenario Golf
Maritime Scenario Hotel

July 13

Maritime Scenario Delta
Maritime Scenario Echo
Maritime Scenario Foxtrot
Retest of McMurdo EPIRB Maritime Scenario Bravo



Doug Ritter looks on as McMurdo representatives recode their beacons.

July 14

Inland Scenario Delta
Inland Scenario Charlie
Inland Scenario Bravo
Inland Scenario Foxtrot conducted concurrently.

July 15

Baseline “Zulu” (Baseline Alpha style test) of beacons that did not get a GPS position in the original testing
Retest of ACR PLB-200 Inland Scenario Golf.

Field Tests Attendee List

Doug Ritter – ETS Foundation
Anne Sell – West Marine
Chuck Hawley – West Marine
Denis Inman – West Marine
Phil Cowley – West Marine
Capt. Eric Knott – Landfall Navigation
George Lariviere, Wiffletree – Guest of ETS
Peter Forey, SARTECH – Guest of ETS
MCPO Joseph Flythe – U.S. Coast Guard
SCPO Erik Forsland – U.S. Coast Guard
David Shuler – ETS Foundation Photographer
Andy Lindstrom – ETS Foundation Volunteer
Rick Lindstrom – ETS Foundation Videographer
Dave Foster – ETS Foundation Volunteer
Russ Tatro – ETS Foundation Volunteer
Sue Ritter – ETS Foundation Volunteer
Carl Ruhne – SV Willow - ETS Foundation Volunteer-
Bob Simpkins – Protector RIB - ETS Foundation Volunteer
Bill Cox – ACR Electronics
Mike Griffen – ACR Electronics
Chris Hoffman – McMurdo
Neil Galbraith – McMurdo
Kevin Robertson – McMurdo

Field Test Results

What follows is a summary of the field test results. The field tests were separated into three fundamental types: Baseline, Inland, and Maritime. These were in line with the same basic types used in the Key West Test. The inland and maritime tests are considered the real-world

tests. These represented simulation of use of the beacons in the natural environment under conditions that survivors might likely use them.

We do not consider the baseline tests to be appropriate to be combined in any statistical manner with the real-world scenarios, with the possible exception of Baseline Scenario Charlie (see following section). They were done to provide a baseline of performance under virtually ideal conditions, establishing a norm from which variation could be measured. It was anticipated that because of the nearly ideal conditions the beacons would all perform to COSPAS-SARSAT standards or better for these baseline tests.

Baseline Scenarios

The original Baseline test protocols that served as the basis for the actual tests are included in italics. Any variances from the scenario outlined are reviewed in the individual scenario results.

Baseline Scenario Alpha

Individual Beacon Test (PLB and EPIRB). Cold Start. Activate one beacon of each model sequentially in an open area at the test site, ensuring a clear line-of-sight to GOES East / West and no less than 6 available GPS satellites.



Baseline Scenario Alpha – Doug Ritter preparing to activate ACR PLB-200, manual recording of GPS location and time, WS Technologies BT100A receiver operators on rocks below.

The location of the Baseline Scenarios Alpha and Charlie tests was selected for having a full sky view and a horizon that was for the most part uninterrupted over most of the circumference of the site. The location was a jetty at the Santa Cruz Harbor entrance. Fully 220 degrees (approximately) of the horizon were uninterrupted ocean (Monterey Bay). An additional 50 degrees (approximately) was Twin Lakes State Beach on both sides and 20 degrees (approximately) was the open harbor itself. The remaining horizon was about 300 yards at the closest point running back sharply from there, an approximately 15-20 ft high cliff with personal residences on top.

The location of the Baseline Bravo relocation point was approximately 400 yards East on the beach with similar sky view but somewhat more restricted horizon except somewhat closer to the cliff and without the open harbor. Satellite visibility was comparable to the Baseline Alpha location.

Baseline Alpha

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	20:50:22	N36°57'69.5" W122°00'09.8"	20:52:03	1:41	N36°57'48" W122°00'12"	Yes
ACR Prototype PLB	6	18:38:30	N36°57'69.5" W122°00'09.8"	18:40:10	1:40	N36°57'48" W122°00'12"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	19:32:33	N36°57'69.5" W122°00'09.8"	19:35:22	2:49	N36°57'48" W122°00'08"	Yes
McMurdo Precision 406 GPS EPIRB	6	21:27:10	N36°57'69.5" W122°00'09.8"	21:30:00	2:50	N36°57'40" W122°00'08"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

Baseline Scenario Bravo.

Updated Position Test (PLB and EPIRB). Beacons activated in Phase 1 will be transported while still active to an open area that is at least 300 meters from site in Phase 1, to check the "update" capability. The beacons will remain active until the updated position is observed to be transmitted, or 30 minutes has elapsed once the beacon is at the new site.



Baseline Bravo relocated McMurdo Fastfind Plus PLB looking back towards Baseline Alpha location on jetty

Baseline Bravo tested the beacon's ability to update its location when moved or relocated. In an actual survival situation this is most likely in a maritime environment where wind, waves and current can cause a significant movement over time. The integral GPS beacons are limited to updating their location every 20 minutes, so each beacon was moved to the new location immediately after they completed Baseline Alpha so that they were in place at the new location well before the 20-minute point was reached. Transit time was approximately 10 minutes with the beacon held with the antenna vertical while in transit.

Baseline Bravo

Beacon	Sats in View ¹	Revised Location Data Sent ²	Time Delta	GEOS Updated Location Received
ACR PLB-200 PLB	6	21:13:44	23:22	Yes
ACR Prototype PLB	6	19:02:01	23:31	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	19:54:37	22:04	Yes
McMurdo Precision 406 GPS EPIRB	6	21:51:45	24:35	Yes
¹ Reference Garmin Etrex GPS ² All times UTC				

Baseline Scenario Charlie.

While being sprayed with water to simulate heavy rainfall, activate one beacon (PLB and EPIRB) of each model sequentially in an open area at the test site, ensuring a clear line-of-sight to GOES East / West and no less than 6 available GPS satellites.

Scenario Baseline Charlie was to determine what effect rain or a similar drenching would have on acquisition of a location, a person trapped in a river under a waterfall where there is a constant drenching with water, for example. Because this scenario might be a real-world inland scenario with regards the PLBs, for purposes of statistical analysis we have included the Baseline Scenario Charlie tests of PLBs with the Inland results.



Baseline Scenario Charlie – Simulated rain on ACR Prototype PLB

The RIB with water pump and an attached fire hose was located in the harbor channel adjacent to the jetty and a rescue swimmer used the hose to maintain a stream of water over the beacons that were set up on the edge of the jetty.

The use of saltwater to simulate rain was determined to be valid for our purposes as the primary purpose was to assess the effect on reception of the GPS signals and there is not a significant difference in attenuation of this signal between fresh and salt water.

Baseline Charlie

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	22:25:56	N36°57'41.7" W122°00'09.8"	22:29:18	3:22	N36°57'44" W122°00'12"	Yes
ACR Prototype PLB	7	22:47:20	N36°57'41.7" W122°00'09.8"	22:51:33	4:13	N36°57'44" W122°00'12"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	23:03:30	N36°57'41.7" W122°00'09.8"	23:12:12	8:42	N36°57'44" W122°00'08"	Yes
McMurdo Precision 406 GPS EPIRB	6	22:10:47	N36°57'41.7" W122°00'09.8"	22:13:36	2:49	N36°57'44" W122°00'08"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

Inland Scenarios

The inland scenarios were designed to progressively increase the difficulty for the PLBs to obtain a GPS location by reduction in sky view and reduced horizon, thereby reducing the number of satellites visible to the beacons. This included scenarios where there were less than the three satellites, minimum, required for a 2-D GPS location showing on the Garmin eTrex, but where an adequate number of satellites were visible to the better-performing GPS receivers on hand, allowing a location to be acquired.

Time limits and difficulty obtaining fine differences in satellite visibility in the available natural conditions combined to reduce the evaluation's ability to define the point of demarcation between the likelihood that a particular beacon would acquire a location and when it would not based solely on satellite visibility under obscured overhead conditions. This does not adversely impact the overall conclusions, particularly when viewed in combination with the Baseline and Maritime testing results and in context of the Key West Test results, but does limit the conclusions that can be made vis-à-vis a particular beacon's susceptibility to marginal satellite visibility due to overhead obstructions, such as a forest canopy.

The original Inland test protocols that served as the basis for the actual tests are included in italics. Any variances from the scenario outlined are reviewed in the individual scenario results.

Inland Scenario Alpha

Activate each PLB model in an area with minimal obstructions (e.g., an open area with few trees and a surrounding tree line at least 25 meters away, but not more than 50 meters away to simulate operation in a typical moderate size forest clearing.), so that there is not a significant obstruction to the GPS satellites (at least 5 satellites visible as determined by handheld GPS).

Inland Scenario Delta

Activate each PLB model in an area with minimal overhead obstructions (e.g., an open area with few trees and a surrounding tree line at least 10 meters away, but not more than 15 meters away to simulate operation in a typical small forest clearing.), so that there is not a significant obstruction to the GPS satellites (at least 5 satellites visible as determined by handheld GPS).



Inland Scenario Delta small clearing location

Inland Scenarios Alpha and Delta represented use of the beacons in circumstances where it was felt that anyone familiar with typical GPS performance would normally expect the beacon to obtain and transmit a location, a clearing in a forest with a clear sky view overhead, but a restricted horizon due to the tree line.

Inland Scenario Alpha was canceled by mutual agreement of all parties after all beacons successfully obtained a GPS location in the more difficult Scenario Delta. Due to a miscommunication, scenario Delta was recorded as scenario Alpha and scenarios had to be reassigned when we prepared our database of results.

The ACR AquaFix PLB-200 was not received by the Geosynchronous (GEO) satellite, neither the unlocated alert nor the location data. The ACR Prototype PLB that immediately preceded it in the test sequence was received by the GEO satellite, but only the low precision, 15 second resolution was sent through to the GEOLUT, possibly indicating some sort of interference issue. Both of these beacons were clearly received by the GEO satellite(s) for extended periods from the bottom of the gorge in the Inland Scenario Foxtrot test (see below), indicating, we believe, **that both beacons were transmitting at a satisfactory power level and that the problem was elsewhere in the system.** NOAA has been unable to offer an explanation for this glitch.

Inland Delta

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	16:25:11	N37°00'03.5" W121.54'18.7"	16:28:34	3:23	N36°00'00" W121°54'16"	No ³
ACR Prototype PLB	6	16:16:07	N37°00'03.5" W121°54'18.8"	16:17:49	1:42	N36°00'04" W121°54'16"	Yes ⁴
McMurdo Fastfind Plus 406 GPS PLB	6	16:07:12	N37°00'03.5" W121°54'19.0"	16:10:02	2:50	N36°00'04" W121°54'16"	Yes

¹ Reference Garmin Etrex GPS
² All times UTC
³ This same beacon used in Scenario Inland Foxtrot at bottom of gorge was received by GOES 10
⁴ Low precision / 15 second location data only

Inland Scenario Bravo

Activate each PLB model in an area with moderate overhead obstruction (e.g., under a tree canopy) so that there is moderate obstruction to view of the GPS satellites Record with photographs the obscuration of the sky from the canopy.

Inland Scenario Charlie

Activate each PLB model in an area with significant overhead obstructions (e.g., under a heavy tree canopy) so that there is significant obstruction to the GPS satellites Record with photographs the obscuration of the sky from the canopy.

For Inland Scenarios Bravo and Charlie we had some difficulty in getting the same number of satellites visible for every beacon tested. This was critical to ensure an accurate comparison. In the end, we tested for Scenario Bravo in the location where we were expecting to test Scenario Charlie and vice-versa and the paperwork and assigned scenarios had to be reassigned when we prepared our database of results. The results presented reflect the actual results for the effective scenario tested. As



Inland Scenario Charlie – McMurdo Fastfind Plus PLB sky view and location

noted previously, the ACR PLB tested in Inland Scenario Charlie did not contain a GPS receiver, so no valid result was obtained for this test for that PLB.

For Inland Scenario Bravo we identified a location and tested the first beacon with positive results and a consistent three GPS satellites on the Garmin Etrex. For the second beacon in this scenario we activated it in the identical location with three GPS satellites in view, but then the satellites dropped to two, invalidating the test. We then sought another location where we had consistently three GPS satellites in view, no more, no less. This proved very difficult, though eventually we did. When the time came to test the last beacon, the ACR Prototype, we again had great difficulty obtaining three GPS satellites consistently. In the end, the ACR representative determined that there was no significant data lost from their perspective since the production PLB-200 had gained a location. With agreement among the principles, he chose to test this beacon for purposes of their gaining additional data on a most difficult scenario, similar to Inland Scenario Charlie, with only two to three satellites visible, at best. This was not considered part of the evaluation proper.

Inland Scenario Charlie was a very difficult challenge with two to three GPS satellites variously in view during each test. Since three satellites are necessary to obtain a fix, these results could have been adversely influenced by the amount of time that three satellites were in view for each test. Following the results table are plots of the satellites in view and HDOP as recorded by the BDC program for Inland Scenario Charlie. It would appear that the McMurdo FastFind Plus GPS receiver, which did not obtain a location, did not have an equal same opportunity to gain a fix as the successful ACR Prototype. This is the difficulty with real world GPS testing under marginal GPS reception conditions. **Based on these GPS plots, we conclude that the results from this test for this beacon are inconclusive.** This beacon was retested on the Baseline Scenario Alpha jetty and received a location in 2:51, indicating that the GPS was functioning.

Inland Bravo

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	3	20:48:05	N37°00'06.8" W121°54'31.2"	20:53:06	5:01	N37°00'00" W121°54'20"	Yes
ACR Prototype PLB	NOT TESTED ³						
McMurdo Fastfind Plus 406 GPS PLB	3	19:52:26	N37°00'42.0" W121°54'32.7"	20:00:18	7:52	N37°00'00" W121°54'16"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC ³ Beacon not tested due to difficulty establishing 3 GPS satellites consistently, see text for explanation							

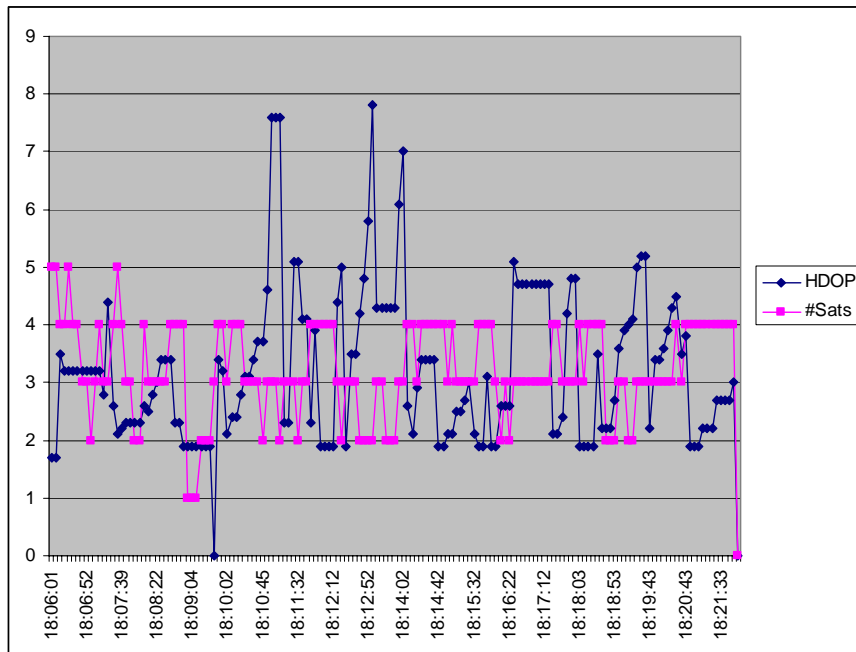
Inland Charlie

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	2-3	INVALID TEST ³					
ACR Prototype PLB	2-3	18:05:59	N37°00'06.2" W121°54'30.2"	18:18:40	12:42	N37°00'04" W121°54'16"	Yes
McMurdo Fastfind Plus 406 GPS PLB	INCONCLUSIVE RESULTS ⁴						
¹ Reference Garmin Etrex GPS ² All times UTC ³ PLB not equipped with a GPS – see "Beacon Test Anomalies" section ⁴ See text for explanation. Retested on Jetty: Location received 2:51							

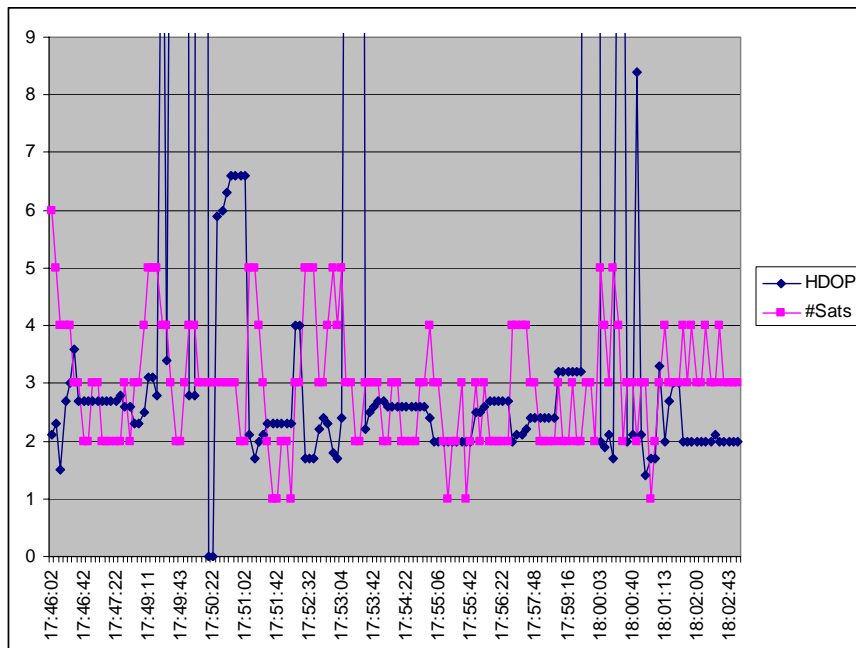
GPS Satellites Visible and HDOP – Computer B

NOTE: Connected to higher performance GPS, so likely more satellites seen than on the reference Garmin eTrex GPS, thus showing 3 satellites may indicate that only 2 were seen by reference GPS receiver.

Inland Scenario Charlie - July 14 18:06 – 18:22
ACR Prototype PLB - GPS location at 18:18:40



Inland Scenario Charlie - July 14 17:46 – 18:03
McMurdo Fastfind Plus PLB - No GPS location



Inland Scenario Foxtrot

Using the PLB beacons from a prior scenario, activate beacon at the bottom of a narrow forested canyon no less than 8 meters deep, plus any trees lining the canyon, without regard to GPS satellites visibility. Activate one beacon of each model sequentially such that each beacon transmits approximately every 10-15 seconds and they are separated by no less than 5 feet. Leave operating for multiple LEOSAT passes. Record scanner with audiotape and provide time stamps in audio to capture any inadvertent simultaneous transmissions. This is primarily a test of the 406 MHz distress signal, not the GPS location capability.

Inland Scenario Foxtrot was developed to assess the ability of the COSPAS-SARSAT system to receive an alert and derive a Doppler location in circumstances where the beacons had a very narrow and limited sky view, as when survivors are located in a narrow canyon. The location selected was within a narrow rock gorge through which flowed Aptos Creek. Estimated depth of the gorge where the beacons were placed was approximately 30-40 feet plus trees lining both sides. It was approximately 15-20 feet wide at the bottom and approximately 30-40 feet wide at the top at the point the PLBs were located. The beacons were placed on a rock shelf located to one side of the gorge.



Inland Scenario Foxtrot – Doug Ritter prepares to activate ACR PLB-200

The only access to the selected location was by traveling up the creek approximately 100 yards, which ran from wall to wall of the gorge in places. Ritter donned insulated waders and one of the Coast Guard Rescue Swimmers donned his dry suit and they waded up the creek, which was approximately 3 feet deep at its deepest, to place the beacons on the rock bar. The beacons were turned on sequentially with a 15-second interval and were left on for approximately 4 hours which allowed for 3 LEO satellite passes.

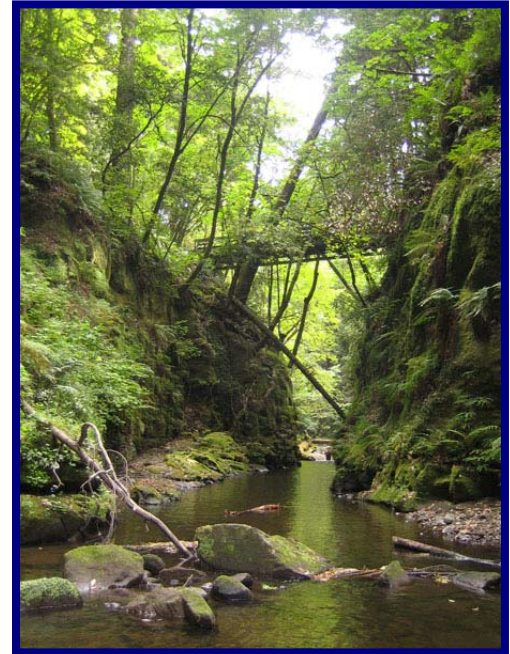
All three PLBs were picked up by the GOES 10 satellite, which would provide an "immediate" alert in an actual emergency. The ACR Prototype PLB was also picked up by GOES 12. It has been suggested by various experts that this may be the result of a lucky reflection off the rock wall of the gorge. ACR suggests, "the result is more a case of the beacon having a strong transmitter than it is a 'lucky shot'. Without ample power a reflected signal could never make it to the GOES 12 satellite."

All three PLBs were picked up by the Low Earth orbiting (LEO) satellites on their first pass, about 25 minutes into the test, which provided a Doppler location.

The McMurdo Fastfind Plus PLB did obtain a GPS fix from the bottom of the gorge, which was unexpected given that in most circumstances when we had a GPS receiver down in the gorge it was showing less than three satellites in view and there is a very narrow view of the sky. However this is not necessarily indicative of any comparative performance advantage; we simply cannot make such a judgment for a number of reasons.

In the first place, the PLBs were not placed in the identical location; they were spread out on the rock shelf at the bottom of the gorge, altering each particular beacon's view of the sky. Moreover, as we were unable to continually monitor the number of GPS satellites visible to each PLB in this test or compare that to when the beacons' GPS receiver was switched on, we cannot say that they had an equal opportunity at achieving a GPS location, other than in the very general sense.

Any results regarding GPS acquisition in the gorge may not be indicative of real world results in similar circumstances. Adequate satellite visibility in the narrow view of the sky available would have to coincide with the "on period" of each PLB's GPS receiver, which varies by manufacturer. As such, receipt of a GPS location dependent upon this would be almost entirely random, irrespective of the effectiveness of the GPS receiver in the PLB.



Inland Scenario Foxtrot location

As such we do not consider these results to be of any significance whatsoever in terms of comparative GPS performance of these beacons, but have provided them for the purpose of suggesting that even in such a narrow canyon, there is still the possibility of obtaining a GPS location if the GPS satellites align suitably for an adequate period of time that happens to also coincide with the on period for the GPS receiver.

McMurdo remarked on our conclusions with regards Inland Scenario Foxtrot (above) in their review of the draft report. In part they wrote:

"As all the beacons were operated concurrently we believe that they all had substantially the same opportunity to acquire. While we accept that it is unlikely that every beacon would acquire in these circumstances we believe that this demonstrates the improvements that McMurdo has made to its beacons recently..." (see [Appendix 7](#) for their full response and explanation for their position)

Inland Scenario Golf

Locate test site ensuring a clear line-of-sight to GOES East / West and no less than 4 available GPS satellites. Activate each PLB model while under metallic or other cover that ensures that no GPS satellites are visible to the beacon. After 20 minutes, remove cover and operate for another 20 minutes or until GPS coordinates are transmitted. This is a test of a circumstance where the beacon is initially activated by a survivor without due consideration of satellite visibility, under cover, and who subsequently moves to an area of better satellite visibility, either to be more visible for search aircraft or as a result of further consideration of the beacon operational limitations, taking the activated beacon with him/her. .

Inland Scenario Golf was developed to address a particular set of circumstances that might occur in a real-world survival scenario where the beacon is initially activated by a survivor without due consideration of satellite visibility and, not being able to receive the GPS satellite signal, does not acquire a location. The survivor later moves to an area of better satellite visibility, either to be more visible for search aircraft or as a result of further consideration of the beacon operational limitations, taking the activated beacon with them.

The test location was the beach next to the jetty used for the Baseline tests in order to ensure maximum GPS satellite visibility. The beacon was activated under a plastic “blanket” coated with an aluminum metalized film (commonly referred to as a “space blanket”) to prevent acquisition of the GPS signal. The blanket was supported by a folding stool to ensure it did not touch the beacon or antenna. It was confirmed using the local test sets that the 406 MHz signal was being transmitted and that no location was acquired.



Inland Scenario Golf – Doug Ritter activating ACR PLB-200 under cover to prevent initial GPS acquisition

The original protocol required that after 20 minutes the blanket was removed to see if the beacon acquired a location. This would ensure that the GPS receiver was hidden from GPS satellite for initial start-up period that heretofore was covered by the 20 minute time period. Once removed, then the beacon should get a GPS location at the 20 minute update. During the test we had difficulty with the ACR PLB-200 PLBs as the company had modified their operating scheme from the one we were familiar with and upon which the original 20 minute timeframe was set and there was confusion on the part of the ACR representatives as to what the correct operating scheme was. This resulted in two invalid tests, as previously noted. Once the actual operating scheme was determined after contact with the company, 30 minutes, and the test timing adjusted to cope with the new GPS receiver timing, with approval from both manufacturers, a subsequent test was conducted, which results have been included. (See [Appendix 4](#) for beacon operating schemes)

Inland Golf

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	7	17:29:12	N36°57'70.4" W122°00'17.9"	18:11:28 ³	N36°57'44" W122°00'12"	Yes
ACR Prototype PLB	6	01:03:10	N36°57'42.2" W122°00'10.9"	01:25:54 ⁴	N36°57'44" W122°00'08"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	00:17:52	N36°57'42.2" W122°00'10.9"	00:55:50 ⁴	N36°57'44" W122°00'08"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC ³ Shielded cover removed after 31 minutes ⁴ Shielded cover removed after 20 minutes						

Maritime Scenarios

The original maritime test protocols that served as the basis for the actual tests are included in italics. Any variances from the scenario outlined are reviewed in the individual scenario results.

For all the Maritime Scenarios the original protocols noted: *boat(s) will proceed offshore, to simulate conditions on open seas. As practical, effort will be made to seek out or simulate consistent non-stable conditions at sea.*

Three vessels were used for the maritime activities. The 46 ft. ketch "Willow" served as the "mother ship." The computers and long range test sets were on the Willow with receiving antennas on the mizzenmast. The Willow circled the test location clockwise with the receiver antennas facing the beacon in or on the water being tested, standing off approximately 50 yards.

A 21 ft. Zodiac RIB (Rigid Inflatable Boat) and a 22 ft. Protector RIB served as safety vessels and activities platform. These were also used to carry the WS Technologies testers and their operators as their internal antenna range was limited and it was necessary to stay within about 10 meters of the beacon to receive the transmission. The RIB used for beacon deployment and water spray was manned by the two U.S. Coast Guard rescue swimmers.

For the beacon tests conducted on board the life raft, West Marine provided a Switlik MD-2 Offshore life raft. This was not exactly the same configuration as the West Marine by Zodiac Offshore life raft used in the first evaluation, the latter being rectangular in configuration and the Switlik being hexagonal (essentially, round). Also, the Switlik had a single arch canopy support whereas the West Marine by Zodiac had dual canopy supports providing more clear space and head room. We configured the occupants inside the life raft as best we could to approximately the same as the first test, with three facing three.

Test conditions were as desired the first day of Maritime testing with moderate swells and waves estimated at 2-6 feet that created considerable motion on the Willow (and subsequent bouts of sea-sickness among some participants) and noticeable gyrations of the beacons when in the water. The second day of Maritime testing was much less challenging, seas were estimated 2 to 4-foot swells—very benign conditions. When reviewing the results, the reader is advised to take into account the prevalent environmental conditions.

Maritime Scenario Alpha

Activate each beacon model (PLB and EPIRB) in an upright position in the boat's cockpit.

The cockpit of the Willow was fitted with a full dodger (metal supported canvas and plastic covering) and it was feared that could potentially adversely influence the ability of the beacons to gain a location for Maritime Scenario Alpha. The test location was moved from the cockpit to the aft deck under the mizzen boom, approximating the structural interference experienced in a typical cockpit location with the mainsail boom overhead. This was the same location as used in the previous evaluation.



Maritime Scenario Alpha - McMurdo Fastfind Plus
PLB - aft deck of SV Willow

Two observers sat on both sides of the aft portion of the Willow and two at the aft end, approximating the effect of a cockpit with a modest number of occupants, but being further from the beacon than they would typically be in an actual cockpit were it located centrally. The beacons were placed in the middle of the deck and activated in turn. On the ocean, there was a complete 180 degrees above and 360 degrees around sky view with no less than 4 satellites were visible at all times despite the structural and personnel impediments.

Maritime Alpha

Beacon	Sats in View ¹	Start Time ²	Local GPS Location ³	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	7	18:47:10	N36°55'36.7" W122°01'26.7"	19:03:08	15:58	N36°56'00" W122°00'24"	Yes
ACR Prototype PLB	6	18:15:47	N36°54'45.7" W122°03'46.2"	18:18:20	2:33	N36°54'44" W122°03'56"	Yes
McMurdo Fastfind Plus 406 GPS PLB	8	17:55:15	N36°55'00.0" W122°03'07.3"	18:05:20	10:05	N36°54'48" W122°03'32"	Yes
McMurdo Precision 406 GPS EPIRB	6	18:30:42	N36°54'47.6" W122°03'27.1"	18:33:29	2:47	N36°54'56" W122°04'00"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC ³ At start of test							

Maritime Scenario Bravo

Each EPIRB model will be activated and set afloat, attached with its tether to a life raft, RIB or otherwise moored away from the mother vessel.

Maritime Scenario Charlie

While being sprayed with water to simulate heavy rainfall, each EPIRB model will be activated and set afloat, attached with its tether to a life raft or RIB.

The Maritime Bravo and Charlie scenarios were conducted with the EPIRB tethered to the RIB using its integral tether.

For Maritime Charlie scenario, the water pump and spray nozzle was used to simulate moderate rainfall or drenching spray/waves.

During the initial Maritime Charlie scenario test of the McMurdo Precision 406 GPS EPIRB, the RIB ran over the beacon during the test invalidating that test. Subsequently another test was conducted the following day using a spare EPIRB, which result is included.



Maritime Scenario Charlie – Simulated rainfall / spray drenching McMurdo Precision EPIRB

We also experienced a testing error while testing one McMurdo EPIRB that resulted in a retest with a spare beacon, as previously noted.

Maritime Bravo

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent ²	Time Delta	Location Data Sent	GEOS Location Received
McMurdo Precision 406 GPS EPIRB	6	19:25:05	N36°35'55.0" W122°00'49.5"	19:31:44	6:37	N36°55'56" W122°00'44"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

Maritime Charlie

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent ²	Time Delta	Location Data Sent	GEOS Location Received
McMurdo Precision 406 GPS EPIRB	6	16:47:03	N36°56'18.4" W122°00'52.6"	17:02:19	15:16	N36°56'20" W122°01'04"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

Maritime Scenario Delta

Each beacon (PLB and EPIRB) will be secured inside a life raft with the antenna vertical and activated with the canopy partially closed as initially erected providing partial sky obscuration. Record and photograph obscuration. As best as possible, ensure equal or nearly equal satellite visibility to all the beacons.



Maritime Scenario Echo

Each beacon (PLB and EPIRB) used will be secured inside a life raft with the antenna vertical and activated with the canopy fully closed to simulate activation in adverse weather conditions.

Maritime Scenario Foxtrot – Simulated rain on life raft canopy.

Maritime Scenario Foxtrot

Each beacon (PLB and EPIRB) used will be secured inside a life raft with the antenna vertical and activated with the canopy fully closed and while simulating heavy rain on the canopy to simulate activation in adverse weather conditions.

For Maritime Scenarios Delta, Echo and Foxtrot, the testing was conducted inside a six-person double tube Switlik MD-2 Offshore life raft. The raft was boarded by six individuals including 2 manufacturers' representatives, 2 sponsor representatives, a WS Technologies test set operator and Ritter. All occupants were wearing survival dry suits due to the cold water (approximately 50 degrees F) conditions. The included inflatable floor was manually inflated. Occupants arrayed themselves inside the life raft with three persons seated opposite each other as best as could be done considering the "round" nature of the life raft. This provided the maximum uninterrupted horizon around the raft with bodies squeezed into two sides and the major portion of the center section having unimpeded views of the horizon and sky though the canopy, entries, and inflated buoyancy tubes. This represents the optimum conditions in the life raft in terms of available horizon and sky view, providing the beacons the maximum opportunity to acquire a GPS location.



Maritime Scenario Delta - McMurdo Fastfind Plus PLB inside Switlik MD-2 life raft

For Maritime Scenario Delta through Foxtrot the beacons were activated in the center of the raft amongst the occupants' feet with the antenna vertical and the GPS antenna oriented towards the sky.

Maritime Delta

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	18:21:25	N36°56'21.8" W122°01'37.0"	18:24:47	3:22	N36°56'24" W122°01'40"	Yes
ACR Prototype PLB	6	17:28:39	N36°56'20.9" W122°01'20.2"	17:39:35	10:56	N36°56'20" W122°01'24"	Yes
McMurdo Fastfind Plus 406 GPS PLB	8	18:01:23	N36°56'22.0" W122°01'30.7"	18:14:25	13:02	N36°56'20" W122°01'36"	Yes
McMurdo Precision 406 GPS EPIRB	6	17:50:44	N36°56'21.9" W122°01'25.2"	17:53:33	2:49	N36°56'24" W122°01'28"	Yes

¹ Reference Garmin Etrex GPS
² All times UTC

For the next scenario, the canopy entries were closed up, as would be the case in poor weather or more extreme sea conditions.

Maritime Echo

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	19:37:21	N36°56'23.1" W122°00'57.3"	19:44:57	7:36	N36°56'24" W122°00'56"	Yes
ACR Prototype PLB	6	19:53:26	N36°56'26.4" W122°00'54.1"	19:57:36	4:10	N36°56'28" W122°00'52"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	19:27:14	N36°56'21.7" W122°00'57.7"	19:30:04	2:50	N36°56'20" W122°01'00"	Yes
McMurdo Precision 406 GPS EPIRB	8	19:15:57	N36°56'21.2" W122°00'57.8"	19:18:47	2:50	N36°56'20" W122°01'00"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

For the final test utilizing the life raft, the RIB pulled alongside and used the water pump to spray the canopy down with water to simulate moderate rainfall or spray on the canopy. Despite being closed up as tight as possible, the canopy leaked copious quantities of water and by the time the testing was completed there was approximately one foot of water in the life raft. No attempt was made to bail out the life raft as that might have interfered with the reception of the GPS signals by the beacon GPS receivers. The ACR PLB-200 that failed to acquire a location was retested on the Baseline Scenario Alpha jetty and received a location in 1:42, indicating that the GPS was functioning. ACR's report on their PLB-200's failure to acquire a position in Maritime Foxtrot is found in the Anomalies section above.

Maritime Foxtrot

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	20:52:51	N36°56'33.7" W122°01'12.4"	NO GPS ³	NA	NA	NA
ACR Prototype PLB	6	20:15:54	N36°56'30.2" W122°00'53.1"	20:17:35	1:41	N36°56'32" W122°00'56"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	20:26:22	N36°56'31.8" W122°00'58.3"	20:37:34	11:12	N36°56'32" W122°01'08"	Yes
McMurdo Precision 406 GPS EPIRB	8	20:43:02	N36°56'32.8" W122°01'09.3"	20:45:52	2:50	N36°56'32" W122°01'08"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC ³ Retested on Jetty: Location received 1:42. See Beacon Test Anomalies section for ACR's explanation for the failure of the PLB-2000 to acquire GPS location							

Maritime Scenario Golf

Using a person in PFD (and/or survival suit depending upon water temperature) or simulated person in PFD, activate each PLB, then dunk PLB in water and without draining any water from any cavities that might naturally retain water, attach with Velcro to PFD to simulate a typical man overboard situation in moderate to severe weather and sea conditions where the beacon is regularly drenched with water.



Maritime Scenario Hotel – ACR PLB-200

Maritime Scenario Hotel

Using a person in PFD (and/or survival suit depending upon water temperature) or simulated person in PFD, while being sprayed with water to simulate heavy rainfall, activate each PLB, attach with Velcro to PFD to simulate a typical man overboard situation in heavy rain conditions

For Maritime Scenario Golf and Hotel the PLB was mounted with Velcro on a PFD (Personal Flotation Device) that was fitted to a Man Overboard Exercise Dummy provided by the U.S. Coast Guard, often referred to as “Oscar”. The PLB was maintained off the surface of the water in its correct orientation with the GPS and transmitting antennas vertical. For Maritime Scenario Hotel the water pump and spray nozzle was used to simulate moderate rainfall or drenching spray/waves.

Maritime Golf

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	21:27:48	N36°56'17.7" W122°00'35.3"	21:29:58	2:10	N36°56'20" W122°00'36"	Yes
ACR Prototype PLB	6	20:48:44	N36°56'05.7" W122°00'29.0"	20:50:38	1:52	N36°56'08" W122°00'28"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	21:04:47	N36°56'11.1" W122°00'27.7"	21:07:37	2:50	N36°56'12" W122°00'28"	Yes

¹ Reference Garmin Etrex GPS
² All times UTC

Maritime Hotel

Beacon	Sats in View ¹	Start Time ²	Local GPS Location	Location Data Sent Time ²	Time Delta	Location Data Sent	GEOS Location Received
ACR PLB-200 PLB	6	21:51:26	N36°56'25.8" W122°00'28.1"	21:53:20	1:54	N36°56'28" W122°00'32"	Yes
ACR Prototype PLB	6	22:00:22	N36°56'24.8" W122°00'29.9"	22:02:14	1:52	N36°56'24" W122°00'28"	Yes
McMurdo Fastfind Plus 406 GPS PLB	6	22:10:42	N36°56'25.8" W122°00'23.3"	22:21:04	10:21	N36°56'24" W122°00'24"	Yes
¹ Reference Garmin Etrex GPS ² All times UTC							

Conclusions

The authors of this evaluation are of the opinion that the following conclusions can be drawn from the data and experience collected during this evaluation and the previous evaluation, and general observations of the use of these beacons during this evaluation and elsewhere:

1. The self-locating (GPS) performance of the beacons in this evaluation appears to be satisfactory for the most part under the circumstances that one would normally expect to receive a GPS location from a mid-level performance GPS handheld receiver without an amplified antenna. Under most moderate adverse environmental conditions a GPS-derived location will be reliably transmitted by these location protocol beacons.

2. The unsatisfactory self-locating (GPS) performance of the McMurdo beacons that was evident in the first evaluation appears to have been satisfactorily addressed by McMurdo's free upgrade program. Anyone who owns a McMurdo beacon that has not yet been upgraded should do so immediately.

3. In the opinion of the authors, the results of this test validate the functionality and desirability of a GPS-enabled beacon's added capability as a means of enhancing survivors' chances of rescue. While neither a panacea, nor without notable limitations, the current state



Maritime Scenario Alpha – ACR PLB-200 – WS Technologies BT-100A testers in waterproof case and pouch

of the art in Location Protocol 406 MHz Distress Beacons appears to be capable of improving the likelihood of a successful rescue by potentially shortening response times in many likely survival scenarios. The location information generally will allow for quicker dispatch of SAR resources and the more accurate location, compared to a Doppler-derived location, reduces the search area with resultant likelihood of quicker detection of survivors when SAR resources arrive on scene. Consumers seeking a survivability advantage would do well to consider self-locating beacons (those with GPS) as an option.

4. Based on ACR's remarks regarding the inherent variability of GPS receiver sensitivity in commercially available GPS receivers, additional research with GPS receiver manufacturers and our own experience using handheld reference GPS receivers which provided inconsistent performance between identical units, some GPS receivers installed in some beacons may not perform as well as most other identical units unless efforts are made on the part of the beacon manufacturer to ensure a uniformly higher minimum level of performance. We have no practical way of determining the overall effect of this on performance in any particular survival circumstance.

5. The few anomalies experienced in this evaluation bear out the reality that even electrically operated emergency signaling devices manufactured and tested to very high quality standards may still be less than 100% reliable in the field and that it remains good practice that users should always self-test beacons prior to embarking upon any excursion or being involved in any situation where they may have to be relied upon in an emergency.

6. Consumer expectations regarding the performance of integral GPS beacons may be shaped by their personal experience with handheld GPS receivers or GPS installed in their automobile, which can prove to be an unreliable comparison. Users of the popular-priced Garmin eTrex class of GPS receivers can expect these beacons to perform comparably, meeting their experiential expectations. The beacons tested are not as likely to **reliably** acquire a location when a higher performance GPS receiver with an amplified antenna acquires a location with only 3 satellites in view and locked on. A consumer's experience using this class of handheld GPS is less likely to be indicative of a beacon's acquisition performance with the current internal GPS receivers and antennas used.



Baseline Scenario Charlie – McMurdo Precision EPIRB – RIB with fire pump and MCPO Flythe manning the hose creating simulated rain on the beacon.

7. Results from the gorge test suggest that Doppler location can be achieved even with a very limited sky view, though it may take multiple LEO satellite passes. While it may be possible to acquire a GPS location if there is a fortuitous confluence of sufficient GPS satellites visible during a period of time while the GPS receiver is operational, this cannot be counted upon in such circumstances.

8. Alert transmission time via COSPAS-SARSAT geostationary satellite appears to meet expectations of 3 minutes or less in most circumstances, but it extended to 5-10 minutes in some scenarios tested when the initial location transmitted was not adequately strong and thus only a “coarse” instead of “fine” location was received, which is of more limited value. It should be noted that claims that the “alert time is typically 3 minutes or less” may be misleading to many consumers who would not be knowledgeable enough to differentiate an alert from an alert with a fine location, nor does that take into account the added delay that can occur between the first transmission received and actual transmission of the alert to the Mission Coordination Center.

9. An integral GPS source offers advantages in weight, package size and ease of use over an external GPS source for PLBs that makes it a desirable option, particularly if the added cost is not too significant. In the opinion of the authors, a beacon that incorporates both internal and external GPS capabilities provides additional advantages under some limited circumstances, although the operator would have to have an advanced level of knowledge and have additional equipment, a high performance GPS receiver available and interface means, to take advantage of this capability. External GPS does have a place in some marine and aviation beacon installations where it receives a constantly refreshed location from an onboard GPS receiver and thereby the location is immediately available upon activation and not dependent upon an integral GPS acquiring a location.

10. All the beacons tested include a self-test of the GPS receiver. The ACR beacons provide the capability to confirm a successful location acquisition. Beacons that provide a means to test the GPS receiver including acquisition of a GPS-derived location provide added assurance that this capability will work when deployed in a survival situation. However, a beacon that allows comparison of the GPS derived location with a known location would provide an additional assurance that the GPS receiver is functioning correctly.



Maritime Scenario Bravo – McMurdo Precision EPIRB in the water.

11. Consumers cannot rely solely on regulatory means to ensure adequate performance and independent real world testing is essential to ensure that consumers are protected and have the information required to make

a knowledgeable purchase decision. Failure to enable this sort of consumer testing can unnecessarily imperil the lives of consumers relying upon these beacons.

Recommendations

The authors of this evaluation are of the opinion that the following recommendations are appropriate to make based on the data and experience collected during this evaluation and the previous evaluation, and general observations of the use of these beacons during this evaluation and elsewhere. Some of these recommendations are Location Protocol Beacon specific; some are more generic in nature and apply to any relevant beacons:

1. Considerable advances have been made in the past year towards improving the COSPAS-SARSAT standards governing these beacons to better ensure their adequate function in real world conditions. New COSPAS-SARSAT standards have been developed addressing a number of recommendations made in the previous report. COSPAS-SARSAT deserves recognition for their quick action. However, the revised standards approved by this international body do not adequately address some issues, particularly GPS minimum performance standards. Standards writing bodies such as RTCM should continue to work towards robust real-world related performance standards for integrated GPS receivers in these beacons with controlled conformity testing using a GPS simulator. Preferably, such standards will eventually be adopted by COSPAS-SARSAT providing all consumers worldwide with a higher standard.
2. COSPAS-SARSAT standards should be amended to require a fully functional self-test for GPS location acquisition of any included GPS receiver. The existing required beacon self-test fully functionally checks the transmitter circuitry, including sending a test burst. Ideally, an additional GPS self-test should also be provided for and should include transmission of the location so that with the proper equipment to receive and decode the self-test data burst, the accuracy of the GPS location can also be checked against a known position. A proposal to allow inclusion of such a capability was presented to COSPAS-SARSAT, but no action was taken this year.
3. COSPAS-SARSAT should revise or provide an alternative to the existing location protocol long message format to allow for transmission of location data resolution to at least 1 second. The current rounding of the location data deprives the search and rescue system of improved location resolution that already inherently exists within the GPS capability, but which cannot be taken advantage of due to the artificial limitations of the existing protocols. Improved resolution can only serve to improve chances for a successful rescue.

4. The beacon manufacturing industry or an appropriate independent standards setting body should develop voluntary objective performance standards and ratings for which cost-effective tests can be conducted which will accurately predict and represent the level of self-location performance consumers can expect from a particular beacon under particular defined real-world conditions of reduced GPS satellite reception on both land and in the marine environment.

5. ACR's implementation of improved processes to ensure consistent higher minimum GPS receiver performance seems to be a reasonable attempt to address an inherent variability in commercially available GPS receiver performance that could adversely affect some few users. Efforts to mitigate this variability and ensure a uniformly high level of GPS performance by manufacturers and appropriate independent standards setting bodies should be encouraged.

6. Users of emergency beacons, and any other electrically operated emergency signaling devices for that matter, should always self-test beacons, and ensure the functionality of other electrically operated emergency signaling devices, and also physically examine the devices for damage prior to embarking upon any excursion or being involved in any situation where they may have to be relied upon in an emergency as well as after any abuse, intentional or not, that the beacon may experience.

7. Care should be taken when purchasing a beacon with integral GPS that you have received the correct beacon. In the case of the ACR PLB packaging, it is nearly identical for a non-GPS equipped beacon and if we received an incorrect beacon and failed to identify it, so could a consumer. Retailers are urged to make an extra effort to ensure that the correct item is delivered to the consumer. Manufacturers are urged to clearly and explicitly mark their packaging to reduce the opportunity for confusion between non-GPS and GPS-equipped beacons. McMurdo's packaging clearly differentiates between GPS and non-GPS equipped beacons.

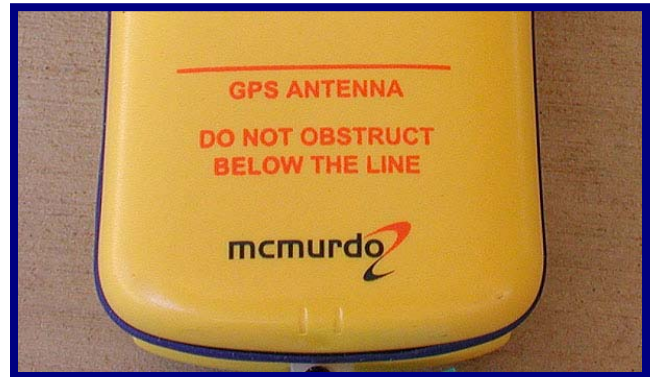
8. Operating instructions on or attached to the beacon should be improved. This is particularly critical in the case of the PLBs. In the opinion of the authors, operational instructions should be given the highest priority space on the beacon and should be as large and as distinct as possible. Marketing and cosmetic appearance considerations should not override the desirability of presenting essential operating instructions in the most effective manner possible when lifesaving is the aim.



Doug Ritter setting up SARTECH receivers and computers in Willow's cabin for maritime testing.

9. Manufacturers should provide better operating instructions on or attached to the beacon that would guide a user to more readily identify a failure to acquire a location, and which would guide the user in maximizing self-locating performance when such opportunities exist and would be prudent for the user.

10. Operating instructions on or attached to the beacon should emphasize the importance of GPS antenna orientation when this is an inherent design factor for optimum performance, the importance of not blocking the antenna with the body or body parts, and for marine operations, the importance of keeping the GPS antenna clear of the water if possible. The location and preferred orientation of the GPS antenna should be clearly marked. In instances where the GPS antenna might likely be covered by a survivor's hand(s) while being held in a foreseeable manner or by foreseeable means



McMurdo Fastfind Plus PLB GPS antenna identification and warning

of securing the beacon to a person or object under foreseeable survival circumstances, a warning against doing so should be clearly displayed. McMurdo has provided a practical and effective integration of some of these suggestions in their upgraded Fastfind Plus PLB.

11. Airborne search and rescue operators should be encouraged to accelerate the replacement of outdated direction-finding equipment limited to 121.5/243 MHz with direction finding equipment that will also operate on 406 MHz and that will automatically decode the data burst for direct reading by SAR resources on scene. Industry should be encouraged to develop inexpensive, compact handheld 406 MHz direction-finding and decoding equipment that can be fielded by volunteer search and rescue operators and local fire and rescue agencies with limited budgets.

12. In recognition that EPIRBs will be often be used inside an enclosed survival craft or occupied space, standards or regulations requiring a strobe light should provide for the optional termination of the strobe light by the operator.

13. Manufacturers are encouraged to develop a practical means by which the beacon can provide the owner an indication of the state of charge of a beacon's battery. ACR incorporates an "Electronic Witness Seal" on the PLB-200 that measures the current drawn while performing a self-test, GPS acquisition test, or any other operation of the beacon; and at a predetermined total indicates to the user that the battery should be replaced as, by their calculation, any further use might reduce battery capacity below that needed to meet the minimum operating specification of 24 hours at -20C. While not a direct indicator of the state of charge of the battery, this is a practical alternative.

14. Government agencies and regulatory bodies involved in operation and regulation of these beacons and the COSPAS-SARSAT system should establish an ongoing means to study the actual effects of alerts with self-location information on the outcome of distress situations with regular public reports that can be compared to alerts lacking self-location information.

15. NOAA and other government agencies involved in the operation of the COSPAS-SARSAT system should investigate the apparent anomalies experienced during these tests that could possibly be attributed to faults in the system.

16. There is an obvious and urgent need for government agencies involved in operation and regulation of these beacons and the COSPAS-SARSAT system to develop a more expedient means by which real world testing of these beacons can be conducted with a minimum of bureaucratic hurdles. It should be possible for any legitimate organization representing consumer interests to schedule a test of beacons on relatively short notice. For relatively small numbers of beacons, the use of operationally coded beacons should be facilitated, as the need to use test protocol-coded beacons is a very substantial impediment to the independent testing of these beacons.

17. Delay in receiving system performance data (satellite data) is detrimental to the expedient and effective testing of 406 MHz emergency beacons with the potential for devastating data loss and potential for invalidation of testing that, at best, is difficult and expensive to organize. This evaluation experienced just such a loss of irreplaceable data on one test. It should be a priority for the government agencies involved to enable testing organizations to receive immediate automated feedback, perhaps via the Internet, of the system performance during a test.



Maritime Scenario Golf – ACR
Prototype PLB attached to PFD on
Oscar with BT-100A test receivers in
RIB.

####

Appendices

1. Original Field Test Protocols
2. Original Field Test Schedule
3. McMurdo Anomalies Report
4. Beacon Operating Schemes
5. Knott Report
6. McMurdo Battery Installation Instructions
7. McMurdo Review of Draft Report & ETS Foundation Response
8. ACR Review of Draft Report & ETS Foundation Response

Appendix 1

Original Field Test Protocols

Beacon Test Protocols

Revised May 22, 2005

General

Prior to commencing the below tests, verify and record the ID of every beacon to be used in the testing; clearly label all beacons for quick ID at the test site. Secure and seal all beacons to ensure and maintain chain of custody. Beacons will be selected at random from the beacon pool of each model for any particular test scenario, except that field upgraded customer McMurdo beacons shall not be selected for low probability scenarios.

Input beacon IDs and other relevant data into field data recorder(s).

All field data will be recorded both digitally and on paper as back-up. Digital data will be recorded on CD or other non-volatile memory after each test sequence.

Two each of the following local test sets (a total of four) will be employed in order to provide back-up and cross-check:

Sartech Engineering Ltd TSR406
WS Technologies Inc. Model BT100A 406 Beacon Tester

A candid photographic and video record of all beacon tests, including preparations, will be made for documentary purposes. Back-up video and photographic equipment shall be available on site to ensure substantially continuous record.

West Marine will provide a West Marine by Zodiac Offshore life raft with a removable insulated floor. The floor will be removed as is contains aluminum-coated material that is not typical of most life rafts. If time and resources allow, additional test sequence may be conducted with the floor in place to determine what, if any, effect the metalized floor has on beacon performance in the life raft.

Test protocols subject to revision.

For reasons of safety and security, all on site participants and observers shall immediately comply with any reasonable request of the evaluation organizer. A liability waiver and confidentiality agreement provided by the organizer must be signed by all participants and observers. U.S. government employees are exempted from the liability waiver requirement.

Field Tests

The following procedures apply, unless alternate procedures are specified for a given phase:

1. Record GPS hand-held derived position of testing site (using at least two different model WASS enabled GPS units) for each beacon tested.
2. Record environmental conditions at test site (weather, temperature, sea conditions, etc.) and record any substantial changes that occur during each individual beacon test
3. Confirm each beacon ID prior to activation
4. Record total number and signal strength of GPS satellites “in-view” as indicated by GPS units (immediately prior to the each beacon activation and every 15 minutes until the beacon is deactivated). An attempt will be made to ensure similar satellite numbers, equivalent geometry and signal strengths for all beacons in each scenario, recognizing that there will be variability and that time for testing is limited. This determination shall be at the sole option of the test director.
5. Perform beacon self-test in accordance with manufacturer’s instructions, note any anomalies
6. All beacons will be placed in the same relative position for each particular test
7. Activate beacon in accordance with manufacturer’s instructions
8. Record time of beacon activation or scenario change (time synchronized from GPS units)
9. Use the local beacon test set to confirm beacon ID is transmitted, record digital data received, timestamp.
10. Use the local beacon test set to confirm when GPS information is transmitted, record digital data received, time stamp.
11. Deactivate beacon once it is confirmed that GPS location has been transmitted and beacon has gone to “sleep” or after 35 minutes, whichever occurs first.

Phase 1: Baseline Scenario Alpha. Individual Beacon Test (PLB and EPIRB). . Activate one beacon of each model sequentially in an open area at the test site, ensuring a clear line-of-sight to GOES East / West and no less than 6 available GPS satellites.

Phase 2: Baseline Scenario Bravo. Updated Position Test (PLB and EPIRB). Beacons activated in Phase 1 will be transported while still active to an open area that is at least 300 meters from site in Phase 1, to check the “update” capability. The beacons will remain active until the updated position is observed to be transmitted, or 30 minutes has elapsed once the beacon is at the new site. Beacons using external GPS will be cycled off and on at the new site.

Phase 3: Baseline Scenario Charlie. While being sprayed with water to simulate heavy rainfall, activate one beacon (PLB and EPIRB) of each model sequentially in an open area at the test site, ensuring a clear line-of-sight to GOES East / West and no less than 6 available GPS satellites. .

Phase 4: Inland Scenario Alpha. Activate each PLB model in an area with minimal obstructions (e.g., an open area with few trees and a surrounding tree line at least 25 meters away, but not more than 50 meters away to simulate operation in a typical moderate size forest clearing.), so that there is not a significant obstruction to the GPS satellites (at least 5 satellites visible as determined by handheld GPS). .

Phase 5: Inland Scenario Bravo. Activate each PLB model in an area with moderate overhead obstruction (e.g., under a tree canopy) so that there is moderate obstruction to view of the GPS satellites. Record with photographs the obscuration of the sky from the canopy.

Phase 6: Inland Scenario Charlie. Activate each PLB model in an area with significant overhead obstructions (e.g., under a heavy tree canopy) so that there is significant obstruction to the GPS satellites. Record with photographs the obscuration of the sky from the canopy.

Phase 7: Inland Scenario Delta. Activate each PLB model in an area with minimal overhead obstructions (e.g., an open area with few trees and a surrounding tree line at least 10 meters away, but not more than 15 meters away to simulate operation in a typical small forest clearing.), so that there is not a significant obstruction to the GPS satellites.

Optional - Phase 9: Inland Scenario Foxtrot. Using the PLB beacons from a prior scenario, activate beacon at the bottom of a narrow forested canyon no less than 8 meters deep, plus any trees lining the canyon, without regard to GPS satellites visibility. Activate one beacon of each model sequentially such that each beacon transmits approximately every 10-15 seconds and they are separated by no less than 5 feet. Leave operating for multiple LEOSAT passes. Record scanner with audiotape and provide time stamps in audio to capture any inadvertent simultaneous transmissions. This is primarily a test of the 406 MHz distress signal, not the GPS location capability and will be optional based on time available.

Phase 10: Inland Scenario Golf: Locate test site ensuring a clear line-of-sight to GOES East / West and no less than 4 available GPS satellites. Activate each PLB model while under metallic or other cover that ensures that no GPS satellites are visible to the beacon. After 20 minutes, remove cover and operate for another 20 minutes or until GPS coordinates are transmitted. This is a test of a circumstance where the beacon is initially activated by a survivor without due consideration of satellite visibility, under cover, and who subsequently moves to an area of better satellite visibility, either to be more visible for search aircraft or as a result of further consideration of the beacon operational limitations, taking the activated beacon with him/her.

Additional Inland Scenarios may be considered based on available resources.

For the Maritime Scenarios the boat(s) will proceed offshore, to simulate conditions on open seas. As practical, effort will be made to seek out or simulate consistent non-stable conditions at sea.

Phase 13: Maritime Scenario Alpha. Activate each beacon model (PLB and EPIRB) in an upright position in the boat's cockpit. .

Phase 14. Maritime Scenario Bravo. Each EPIRB model will be activated and set afloat, attached with its tether to a life raft, RIB or otherwise moored away from the mother vessel.

Phase 15. Maritime Scenario Charlie. While being sprayed with water to simulate heavy rainfall, each EPIRB model will be activated and set afloat, attached with its tether to a life raft or RIB.

Phase 16. Maritime Scenario Delta. Each beacon (PLB and EPIRB) will be secured inside a life raft with the antenna vertical and activated with the canopy partially closed as initially erected providing partial sky obscuration. Record and photograph obscuration. As best as possible, ensure equal or nearly equal satellite visibility to all the beacons.

Phase 17. Maritime Scenario Echo. Each beacon (PLB and EPIRB) used will be secured inside a life raft with the antenna vertical and activated with the canopy fully closed to simulate activation in adverse weather conditions. .

Phase 18. Maritime Scenario Foxtrot. Each beacon (PLB and EPIRB) used will be secured inside a life raft with the antenna vertical and activated with the canopy fully closed and while simulating heavy rain on the canopy to simulate activation in adverse weather conditions.

Phase 19: Maritime Scenario Golf. Using a person in PFD (and/or survival suit depending upon water temperature) or simulated person in PFD, activate each PLB, then dunk PLB in water and without draining any water from any cavities that might naturally retain water, attach with Velcro to PFD to simulate a typical man overboard situation in moderate to severe weather and sea conditions where the beacon is regularly drenched with water.

Phase 20: Maritime Scenario Hotel. Using a person in PFD (and/or survival suit depending upon water temperature) or simulated person in PFD, while being sprayed with water to simulate heavy rainfall, activate each PLB, attach with Velcro to PFD to simulate a typical man overboard situation in heavy rain conditions

Additional Maritime Scenarios may be considered based on available resources. If time and resources allow, additional test sequence may be conducted with the life raft insulated floor in place to determine what, if any, effect the metalized floor has on beacon performance (406 MHz only, not GPS) in the life raft.

####

Appendix 2

Original Field Test Schedule

Schedule

(Revised June 24, 2005)

Schedule will be adjusted as necessary depending on how testing progresses. Starting times are preliminary and may be changed according to circumstances.

Friday, July 8

Doug and Sue Ritter arrive Bay Area

Saturday, July 9

0800: DR and Sue pick up Panel Van from Ryder

1000: Meet West Marine Representative at West Marine, Watsonville

Unpack, assign and label all beacons for test phases

Test all shipped gear

Load all gear for transport

Doug and Sue Ritter

West Marine Representative (Phil Cowley)

ETS Volunteer (Dave Foster)

Other participants welcome

Run logistics errands as necessary

Test Fire Pump if time allows

Dinner on own

Sunday, July 10

0800: Meet at Santa Cruz Harbor and review logistics and installation of test sets and equipment into RIB and Test Boat(s), test all gear and installation as necessary (may require brief trip out of harbor)

Doug and Sue Ritter

Carl Ruhne (SV Willow)

ETS Volunteers (Russ Tatro, Dave Foster)

West Marine Representative(s) (Phil Cowley + TBA)

George Lariviere

Peter Forey

John Feitshans

Other participants welcome

Run logistics errands as necessary

After Harbor set-up completed, if time allows, drive to terrestrial test sites and review logistics for each.

1830: Kick-off Dinner – All participants welcome. No host.
Palapas Restaurant in Aptos

Monday, July 11

TBA before operations underway: WM rep picks up lunches

0730: General Meeting – Seacliff Inn meeting room
Introductions
Administrative details and handouts
Sign and witness Waivers and NDAs
Issue Harbor Parking Permits to car pool drivers
Witness re-coding of ACR and McMurdo beacons

0900: Logistics and RIB crew departs for Santa Cruz Lighthouse Jetty and unloads and sets up equipment (RIB crew to ready RIB and fire pump)

0930: Depart for Santa Cruz Lighthouse Jetty and harbor

10:00: Testing commences: Baseline tests

Dinner on own

Tuesday, July 12

TBA before operations underway: WM rep picks up lunches

0730: Logistics crew arrives boats and loads equipment

0800: Meet at Santa Cruz Harbor, Board Boat, Safety Brief

0830: Cast off lines; depart for test site offshore

0930: Arrive test site and commence maritime testing

1800: Depart test site for harbor

1900: Arrive Dock – Dinner on own

Wednesday, July 13

TBA before operations underway: WM rep picks up lunches

0730: Logistics crew arrives boats and loads equipment

0800: Meet at Santa Cruz Harbor

0830: Cast off lines; depart for test site offshore

0930: Arrive test site and commence maritime testing

1800: Depart test site for harbor

1900: Arrive Dock – Dinner on own

Thursday, July 14

TBA before operations underway: WM rep picks up lunches

0730: Logistics crew arrives Forest of Nisene Marks State Park test site and unloads and sets up equipment

0800: Meet at Forest of Nisene Marks State Park test site

0830: Testing commences

If sufficient time remains in the afternoon to conduct Inland Alpha, drive to site above campus and conduct testing.

Dinner on own

Friday, July 15

TBA before operations underway: WM rep picks up lunches

0730: Logistics crew arrives Forest of Nisene Marks State Park test site and unloads and sets up equipment

0800: Meet at Forest of Nisene Marks State Park test site

0830: Testing commences

If sufficient time remains in the afternoon to conduct Inland Alpha, drive to site above campus and conduct testing.

1900: Wrap-up Dinner – All participants welcome. No host.
Crows Nest Restaurant in Santa Cruz

Saturday, July 16

0800: Meet at West Marine, Watsonville
Unload van and pack all gear for shipping.
Doug and Sue Ritter
ETS volunteer (Dave Foster)
West Marine Representative (Phil Cowley)

1500: Doug and Sue Depart Watsonville

1700: Latest drop off of van at Ryder

TBA: Doug and Sue depart Bay Area

Appendix 3

McMurdo Anomalies Report

ETSF Trials 05 Beacon Investigations

Report 010-05

This document is McMurdo Limited copyright and contains proprietary owned Intellectual property rights and confidential data. All rights are strictly reserved. The information must not be used except for the agreed purpose, which is to provide an input into the ETSF 05 Trials Report. Unauthorised use, reproduction or issue to any third party is not permitted without written authority of McMurdo Limited. This document is to be returned to McMurdo when the agreed purpose is fulfilled.

McMurdo Limited
Silver Point
Airport Service Road
Portsmouth
Hampshire
PO3 5PB

ISSUE RECORD

DATE	29 September 2005				
ISSUE	1				

COMPILED BY

N Galbraith

APPROVED BY

C P Hoffman

Introduction

The Equipped To Survive Foundation (ETSF) Beacon Evaluation 2005 was conducted in the Santa Cruz area of California over a 5 day period between 11-15 July. The purpose of the trials was primarily to assess the GPS capability of 406 MHz beacons under adverse GPS reception conditions. During that time 24 McMurdo beacons (9 Precision EPIRBs and 15 Fastfind Plus PLBs) were tested. All of the beacons tested, operated and transmitted a distress alert, however a few incidental problems were discovered during the testing with a couple of beacons. These beacons were subsequently returned to McMurdo for investigation. This report summarizes the results of McMurdo's findings on these beacons.

Beacons Investigated

Four problems were found during the trials, these are listed below:

- 1) One Fastfind Plus PLB would not program during the initial beacon recoding exercise before the trials began.
- 2) One Fastfind Plus PLB was found to have a flat battery during the initial beacon recoding exercise before the trials began.
- 3) During the sea trials one Precision EPIRB took longer than expected to start transmitting once it was placed in the sea.
- 4) During the inspection of the beacons prior to the trials commencing two Fastfind plus PLBs were observed to have small cracks in the upper part of the case near the lanyard retention / battery retaining point.

Fastfind Plus PLB Programming Problem

Beacon Original Hex ID: 2DD6D8C1BF81FE0

Beacon Original Serial Number: 106883

Beacon Unit Number: 530-2733

Beacon Trials ID: 111614

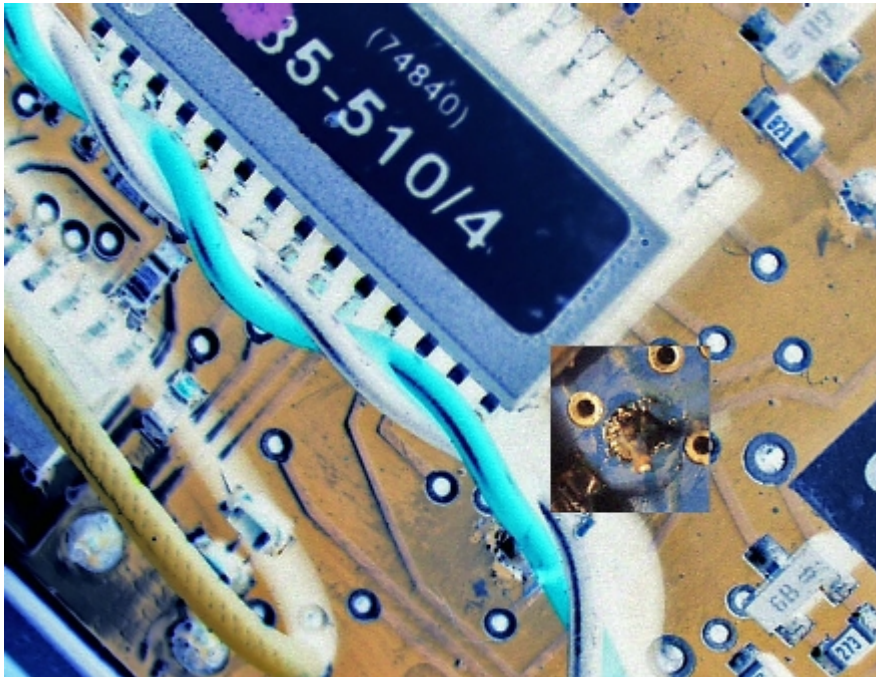
During the recoding exercise before the start of the trials it was discovered that this beacon could not be re-programmed. It was withdrawn from the trials and replaced with another beacon that was recoded correctly and this beacon was returned to McMurdo for fault investigation. Recoding of the beacons is necessary to ensure that they only transmit a "test" message rather than a "distress" message to the rescue authorities so that the trials beacons are not treated as real distress alerts.

This beacon was upgraded in the USA during 2004, as part of the upgrade process the beacon would have been reprogrammed over the infra-red (IR) link, thus we know that the link was working when the beacon was upgraded. This fact is evident as the beacon did

contain a valid Hex ID when read with a message reader during the recoding exercise. Thus the initial conclusion must be that something happened to the infra-red link circuitry after the upgrade.

It should be noted that this beacon was a fully functional PLB and if used in an emergency would have activated and transmitted a 406 MHz signal to the satellites.

The beacon was returned to McMurdo's Portsmouth UK facility and opened up for investigation to try and determine the cause of the programming problem. A close examination of the printed circuit board inside the PLB revealed a dry solder joint on one of the connections between the PCB and the membrane which connects to the LEDs and switches on the front face of the PLB. Further investigation indicated that this dry joint was in fact on pin 3 of the membrane which is the Anode connection for the IR LED. A photograph of the dry joint is shown below.



The joint was reflowed and the beacon programming function rechecked. The beacon then programmed successfully.

As part of the upgrade programme for the PLB it is necessary to remove the PCB from the PLB and in order to do this it is necessary to unsolder the membrane lead. Following the upgrade the membrane lead is re-soldered in place by hand and the beacon is reassembled and then tested including programming of the beacon over the IR link. It can be concluded that during this work this joint was poorly made. Obviously the connection was initially intact as the beacon was re-programmed, but at some later time, probably due to flexing of the

membrane during transportation, the joint became intermittent, thus resulting in the subsequent failure to programme.

McMurdo has subsequently checked its records and visually inspected a random sample of other upgraded beacons and has not discovered any other instances of poor soldering quality on the membrane pins.

Our conclusion therefore is that this is a one off isolated incident due to human error during the upgrade process. As previously stated this problem would not have resulted in failure of the beacon to transmit a distress alert in an emergency. McMurdo has modified its internal process instructions and inspection procedures as a result of this finding to increase awareness of this problem and take extra care in this process in future. It has also advised its partner in the USA upgrading the beacons to implement the same tightened controls.

Finally it should be noted that this was also one of the PLBs that was seen to have a small crack in the upper surface of the plastic. This problem has been investigated separately and details of this investigation can be found further on in this report.

Fastfind Plus PLB Flat Battery Issue

Beacon Original Hex ID: 2DD6D8823F81FE0
Beacon Original Serial Number: 110852
Beacon Unit Number: 530-3552
Beacon Trials ID: 111602
Beacon Trials Hex ID: 2DDED9F93F81FE0

During the recoding exercise before the start of the trials, when all of the beacons initially underwent a “self test” this beacon failed to provide any indication, either pass or fail. It was considered likely that this lack of any indication, not even a self test failure light was most probably due to some problem with the battery / power supply to the PLB.

Although obviously not desirable, a consumer following McMurdo’s operating instructions would have found this problem before taking the PLB into the field with them by carrying out a self test. Battery terminal voltage is one of the parameters measured as part of the internal self test routine within the PLB and a self test failure would be indicated well in advance of the battery getting into the apparently discharged state that this battery appears to be in.

It was decided to remove the battery pack from the PLB and to check the voltage on the terminals of the battery pack using a digital voltmeter. This indicated that there was no voltage present on the battery terminals. It was then decided to fit a spare battery pack (supplied by McMurdo) to the PLB in question to see if this fixed the problem. The beacon was again self tested and this time passed the self test. The beacon was subsequently re-programmed and tested again and as it still passed, it was decided to leave this beacon in

the trials. It should be noted that this beacon subsequently performed satisfactorily during the Inland Scenario Delta trial.

Finally it should be stated that there was no evidence that the PLB had previously been activated prior to the trials that might explain the flat battery.

The battery pack was then returned to McMurdo's facility in Portsmouth UK for investigation. Firstly, the open terminal voltage was measured using a DMM. This gave a reading of +7.03V, compared to an example fresh battery (+11.97V), which is very low. Secondly, a modest load of 36 Ohms was connected across the battery terminals in order that the on load voltage of the battery could be determined. This was designed to draw in the region of 200mA (normal current draw for a PLB when transmitting a 406 signal is in excess of 1.5A peak). However, the voltage collapsed to less than +0.02V, indicating a complete loss of charge in the battery.

Next the battery casing was opened to check the wiring and battery orientation, just in case a manufacturing error had caused infant mortality. The photograph below shows the top cover removed, revealing the date of manufacture and the replacement date for the battery pack.



The next photograph shows a close-up of the battery cells after the heatshrink wrapping had been removed. All of the cells appeared to be polarised correctly and all linkages and spot welds between the cells appeared to be sound.



Further examination of the internals of the pack indicated that all wires were in place and all joints were correctly made. There was no evidence of leakage from the battery or swelling of the cells in the battery or any other defect with the cells. Measurement of the individual cell voltages did not indicate that any one cell or a few cells were any more discharged than the rest of the cells.

The conclusion this leads one to make is that somehow the battery pack has been discharged during a previous period of use, storage, or inadvertent operation or that there is a fault within the battery pack or the PLB itself that caused the battery to self discharge.

Investigations then moved onto the PLB that had been supplied attached to this battery pack. The current consumption of the PLB was measured in both the “off” state and the “on” state. In the “off” state there was no discernable current drain, not even micro-amps. In the “on” state the PLB drew normal amounts of current. The PLB was then opened up to see if anything that could cause something like an intermittent short circuit within the PLB was present. No evidence of solder splashes, foreign debris or other contamination could be seen within the PLB.

It has thus been concluded that there was nothing wrong with the PLB that could have caused the battery to self discharge.

Not knowing the history of this beacon and its storage conditions and possible handling prior to the trial it is not possible to determine how the battery pack came to be flat. Has this battery pack always been fitted to this PLB or has it at some time in the past inadvertently been switched. Has the unit been stored for long periods at elevated temperatures, which greatly reduces battery capacity, is there an internal fault within one or more of the cells within the pack.

In conclusion then, there would not appear to be any obvious fault with either the PLB or the Battery Pack that would explain why the battery is discharged (flat). McMurdo has checked its records and can find no evidence of this problem ever having occurred previously. The cells within the battery have been returned to the manufacturer for investigation, however a report back is not expected for sometime and it is considered unlikely at this time that this will reveal any additional facts or information. It is suggested that we try and track the history of this beacon to see if this might provide any indication of how the battery could have got into this condition.

Precision EPIRB Slow Activation Problem

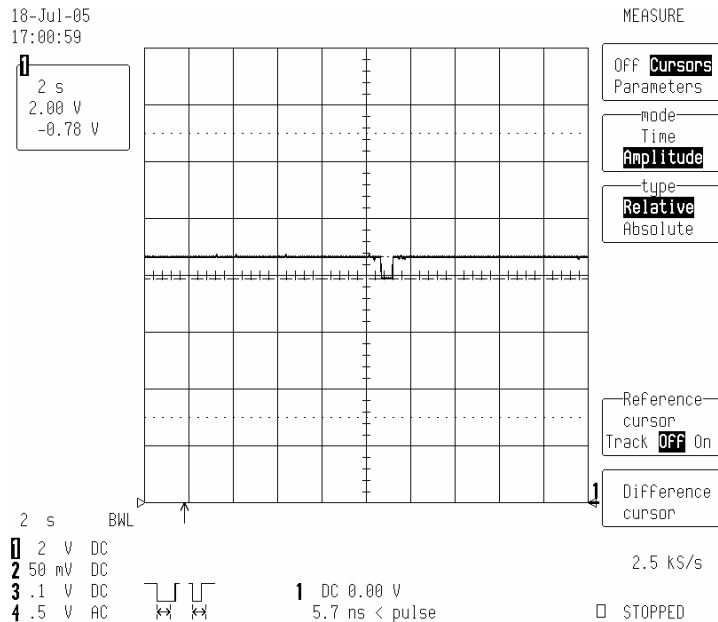
Beacon Original Hex ID: 2DD43979BF81FE0
Beacon Original Serial Number: 0029427
Beacon Unit Number: 33-2986
Beacon Trials ID: 0029607
Beacon Trials Hex ID: 2DDE39D3BF81FE0

This EPIRB was used in the Maritime Scenario Charlie tests at sea (EPIRB floating in sea sprayed with simulated rainfall). The EPIRB was self-tested successfully, prior to the commencement of the trial. It was then dropped into the Pacific Ocean off Santa Cruz. The EPIRB then seemed to fail to properly activate in the water, with the first 406 MHz burst not arriving until nearly 12 minutes after deployment. During this time the flashing strobe operated erratically, operating for say 20 seconds at a time. To the observer, it looked as if the beacon was constantly being reset. However, once the first burst had been successfully transmitted the EPIRB behaved normally.

This delay in the start up of the EPIRB transmissions is unusual, McMurdo's Precision EPIRBs normally start transmitting 2 minutes after the sea water contacts are immersed. **However the beacon did activate and send out a distress message and thus would have sent an alert had this been a real emergency.**

The EPIRB was returned to McMurdo's facilities in Portsmouth UK for further investigation. Initial suspicion centred on the battery, since some EPIRB batteries have been known to suffer passivation after prolonged storage periods. However, two facts count against this theory being the cause of the problem. Firstly the EPIRB in question was quite new and thus there had not been enough time to build up a large passivation layer. Secondly and perhaps more importantly is the fact that the battery chemistry used in the Precision EPIRB – Lithium Manganese-Dioxide (LMNO₂) - is not susceptible to passivation due to its lack of chromium. As LMNO₂ cells are heavier than other battery technologies that do exhibit passivation characteristics the weight of the battery pack was checked to determine that the correct battery was fitted. The battery weighed 360g approx., which indicates that it is the correct type. To make an assessment on the health of the battery, a measurement was made of the voltage drop at the battery terminals during a 406 MHz transmission. It was anticipated that a weak or passivated battery would show a large voltage drop as soon as any significant current was drawn from it due to the higher internal resistance of the battery.

The following oscilloscope screen shot shows that the drop was only about 0.8V, which is acceptable. The ambient temperature during this test was set to +8°C.



The EPIRB was then temperature cycled from ambient to +2°C, to -20°C, back to +2°C, then to +55°C, testing activation at each temperature point using both the manual switch and the sea contacts (using a low-resistance test lead). This cycle was repeated once more, but at no point did the EPIRB fail to activate.

The sea contacts were then tested at ambient using variable resistances in order to determine the resistance at which point the EPIRB would fail to activate. This test was then repeated on other Precision EPIRBs for comparison purposes. The ETSF EPIRB was found to operate at the same resistance as all the other EPIRBs. Thus no fault could be found with the operation of the sea switch or the battery.

The EPIRB was then floated in a tank of still salt water along with 3 other sample EPIRBs, all of the EPIRBs activated almost immediately. This test was repeated with the water being slightly agitated and all the EPIRBs activated instantly. The EPIRB was then held under a running tap of normal fresh drinking water and it again activated instantly. In all three tests when the EPIRBs were removed from the water they ceased activation as expected. Finally some contamination (in this case grease) was introduced onto the seawater switch contacts and again the EPIRB was placed in the tank of salt water, this time it failed to activate.

The sea water switch contacts on the EPIRB had previously been examined when the unit was first received back at the factory and no obvious signs of contamination were evident at that time. The sea water contacts on the EPIRB and the battery inside the EPIRB both appeared to operate normally and no problems were found with the EPIRB. It can only be surmised that somehow a low level of contamination (a very fine film of grease maybe) got

onto one or both of the sea water switch contacts of this EPIRB before the trial and this caused the delayed activation seen during the trial. It is further surmised that the intermittent activation seen during the first 10 minutes was due to this film creating a resistance between the sea water switch contacts close to the switching point of this circuit and that movement of the EPIRB in the sea was then sufficient to break through this barrier after 10 minutes which thus then activated the EPIRB.

Fastfind Plus PLB s with small Cracks in Upper Case

Beacon Original Hex ID: 2DD6D8C1BF81FE0
Beacon Original Serial Number: 106883
Beacon Unit Number: 530-2733
Beacon Trials ID: 111614

Beacon Original Hex ID: 2DD6D8E6BF81FE0
Beacon Original Serial Number: 111053
Beacon Unit Number: 530-2687
Beacon Trials ID: 111603
Beacon Trials Hex ID: 2DDED9F9BF81FE0

While examining the beacons for use on the trials ETSF discovered two of the 15 Fastfind Plus PLBs that they had showed evidence of a small crack in the upper surface of the plastic body near the lanyard retainer / battery retaining screw. One of these units (Trials ID 111614) was returned to McMurdo's facilities in Portsmouth UK for further investigation.

The small very fine crack is in the upper surface of the PLB body above the boss in the plastic that is used to retain the battery pack, between the two fine indentations in the upper surface of the plastic, see photograph below.



The following photograph shows the internal features of the boss.



It is not clear how the plastic came to be cracked on these two units in this area, but the assumption is that it is due to over tightening of the battery retaining screw in the insert that goes into this boss. McMurdo set limits for the torque on this screw and provides details both in its assembly process and in its battery replacement instructions to consumers about the correct torque to apply to this screw. Copies of both of these documents have already been forwarded to ETSF.

On the cracked unit investigated there was no evidence of excessive over tightening of the plastic. There was no damage to the boss or plastic internally, neither was the insert stripped or loose in the plastic boss. In fact there was nothing to indicate how the crack occurred at all.

McMurdo has subsequently inspected a total of 373 PLBs and has not found a single occurrence of a crack in the top case plastic.

On the assumption that the cracks were caused by over tightening McMurdo ran an extensive evaluation programme to subject cases to varying levels of stress in an attempt to replicate this problem. Details of these trials are summarized below.

The recommended torque level for this screw is 25 cNm. A number of PLBs we subjected to excessive torques to ascertain any resultant possible failure mode.

Firstly a unit was selected at random and was subjected to massive over tightening (screw done up as tight as possible by hand). This resulted in the central collar of the boss being crushed, but no evidence of cracking was found. Note subsequent investigation has determined that it is possible to apply a torque of around 100 -110 cNm by hand to this screw, in order to obtain torques higher than this it is necessary to use mechanical assistance e.g. a pneumatic torque driver or similar.

The next trial involved over tightening 3 units using a pneumatic driver to 50 cNm (*2 recommended torque) and 3 more units to 70 cNm (*3 recommended torque). Two of these units were then placed in an oven at +55C for 17 hours, while two were placed in a freezer at -20C for 17 hours and the final two units were left at ambient temperature. After the 17 hours the freezer/oven pairs were immediately swapped to induce a thermal shock. After a further period of 5 hours at temperature extremes the units were returned to ambient temperature and examined. Visual inspection showed no visible external cracking. The torques on two of these units were then increased using the pneumatic driver until the inserts in the upper cases stripped. This occurred at torques of between 120 cNm and 150 cNm, some 5 times greater than the recommended torque for this part. These units were then stripped down and examined, both units showed signs of deformation of the internal boss (not evident in the returned unit) but neither showed signs of cracking.

Of the remaining 4 units the torque settings on the 2 units that were originally set to 70 cNm were increased to 100 cNm. These 4 units were then subjected to the following further temperature cycling, Freezer (-20C) for 24 hours, Oven (+55C) for 24 hours, Freezer (-20C) for 3 hours and finally the Oven (+55 C) again for 68 hours. On completion, an external visual inspection of both units showed no cracks. On disassembly the 2 units torqued to 50 cNm showed no evidence of mechanical damage or cracking, however as expected the 2 units torqued to 100 cNm had a crushed central pillar. One of these units showed no signs of cracking but the other had a crack in the boss, but on the inner side away from the area where the problem occurred on the ETSF unit. This crack was totally internal to the PLB case and would not have presented a water leak path.

A further 10 units were then put together half of them without the “battery block” which acts as a spacer between the PLB case and the battery pack, in case this was a contributory factor and all were hand torqued to 100 cNm. Some of these units were then left for several days to see if long term over tightening had any effect, other were subjected to various mechanical tests including drops onto concrete from 2 metres, light crushing in a vice to simulate someone standing on a PLB and combinations of these conditions. In most cases deformation of the central collar around the boss was observed and on one of these units an internal crack in the plastic of the boss was observed, similar to that described above, but there was no evidence of external cracking as seen in the ETSF trials units.

In conclusion then McMurdo were unable to replicate the failure mode exhibited by the 2 Fastfind Plus PLBs from the ETSF trials. Examination of a total of 373 PLBs showed no further units with this problem. Further it has been show that this screw can be over tightened by a factor of 2 or 3 times and no damage occurs to the PLB. However if the battery retaining screw is over tightened by 4 or more times (which is as tight as it is possible to do up this screw by hand) then some deformation of the plastic does occur and occasionally it is possible to promote an internal crack in the boss in the plastic. But this remains inside the watertight seal area of the PLB and does not represent a risk. McMurdo’s conclusion is thus that the design of the PLB is fit for purpose and even if the screw is over tightened well beyond McMurdo’s recommended torque settings this does not lead to a crack appearing in the outer case of the PLB. At this time we are unable to explain how the cracks

came about in the 2 ETSF PLBs and we would recommend that it is worthwhile trying to back track the history of these PLBs to see if there is anything unusual about them, particularly in terms of any rough handling, dropping or adverse storage conditions. McMurdo has instigated an extra inspection process to check for any future evidence of this problem and if further faulty units are found further investigations will be carried out.

Conclusions

Four incidental problems were found with McMurdo beacons during the ETSF trials, in all but one case these issues were not directly related to purpose of the trials. These issues have all been thoroughly investigated and the conclusions found are summarized below:

- 1) One Fastfind Plus PLB would not program during the initial beacon recoding exercise before the trials began.

Investigations indicated that this was due to a dry joint on pin 3 of the membrane which is the Anode connection for the IR programming LED. McMurdo believes that this was a one off isolated incident due to human error during the upgrade process. This problem would not have resulted in failure of the beacon to transmit a distress alert in an emergency. McMurdo has modified its internal process instructions and inspection procedures as a result of this finding to increase awareness of this problem and take extra care in this process in future. It has also advised its partner in the USA upgrading the beacons to implement the same tightened controls. All beacons are tested prior to leaving the facility to ensure they contain a valid distress message.

- 2) One Fastfind Plus PLB was found to have a flat battery during the initial beacon recoding exercise before the trials began.

Investigations have shown that there was nothing wrong with the PLB or the Battery Pack that would explain why the battery was discharged (flat). McMurdo has checked its records and can find no evidence of this problem ever having occurred previously. The cells within the battery have been returned to the manufacturer for investigation, however a report back is not expected for sometime and it is considered unlikely at this time that this will reveal any additional facts or information. It is suggested that we try and track the history of this beacon to see if this might provide any indication of how the battery could have got into this condition. Self testing the beacon prior to going on a trip would have shown up this problem and allowed the user to obtain a replacement unit.

- 3) During the sea trials one Precision EPIRB took longer than expected to start transmitting once it was placed in the sea.

Investigation of this EPIRB could not find any fault with the unit. The sea water contacts on the EPIRB and the battery inside the EPIRB both operated normally and no problems were found with the EPIRB. It can only be surmised that somehow a low level of contamination (a very fine film of grease maybe) got onto one or both of the sea water switch contacts of

this EPIRB before the trial and this caused the delayed activation seen during the trial. The sea water switch contacts on the EPIRB were examined when the unit was first received back at the factory but no obvious signs of contamination were evident. It is further surmised that the intermittent activation seen during the first 10 minutes was due to this film and that movement of the EPIRB in the sea was then sufficient to break through this barrier after 10 minutes which thus then activated the EPIRB. Although there was a slight delay the beacon did work as intended and would have sent a distress alert in a real emergency.

4) During the inspection of the beacons prior to the trials commencing two Fastfind Plus PLBs were observed to have small cracks in the upper part of the case near the lanyard retention / battery retaining point.

McMurdo have been unable to replicate the failure mode exhibited by the 2 Fastfind Plus PLBs from the ETSF trials and at this time do not have an explanation for them. Subsequent examination of a total of 373 PLBs showed no further units with this problem. It has been demonstrated that the battery retention screw can be over tightened by a factor of 2 or 3 times and no damage occurs to the PLB. McMurdo provides guidance on tightening this screw both to consumers and internally within its production processes. McMurdo's conclusion is thus that the design of the PLB is fit for purpose and even if the screw is over tightened well beyond McMurdo's recommended torque settings this does not lead to a crack appearing in the outer case of the PLB. At this time we are unable to explain how the cracks came about in the 2 ETSF PLBs and we would recommend that it is worthwhile trying to back track the history of these PLBs to see if there is anything unusual about them, particularly in terms of any rough handling, dropping or adverse storage conditions. McMurdo has instigated an extra inspection process to check for any future evidence of this problem and if further faulty units are found further investigations will be carried out.

Appendix 4

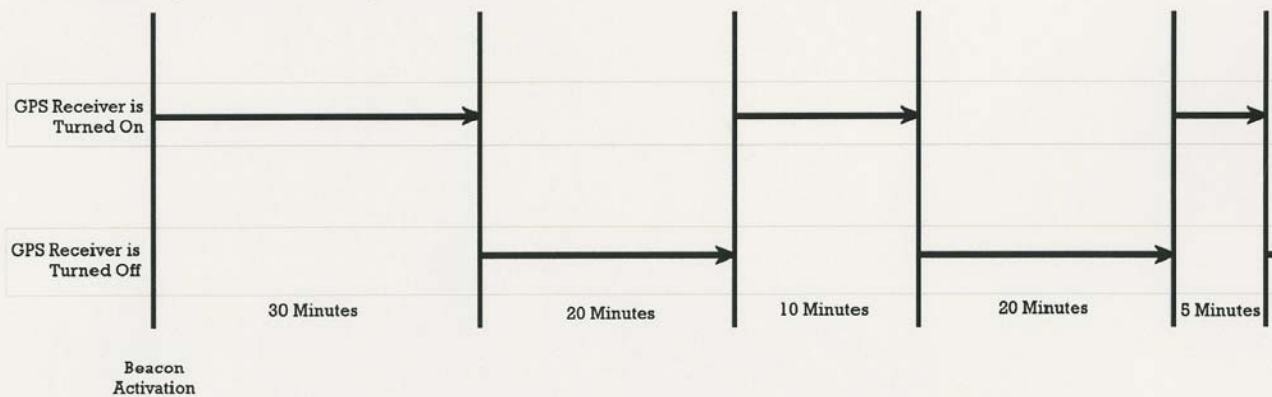
Beacon Operating Schemes

PLB-200 GPS Position Acquisition Scheme



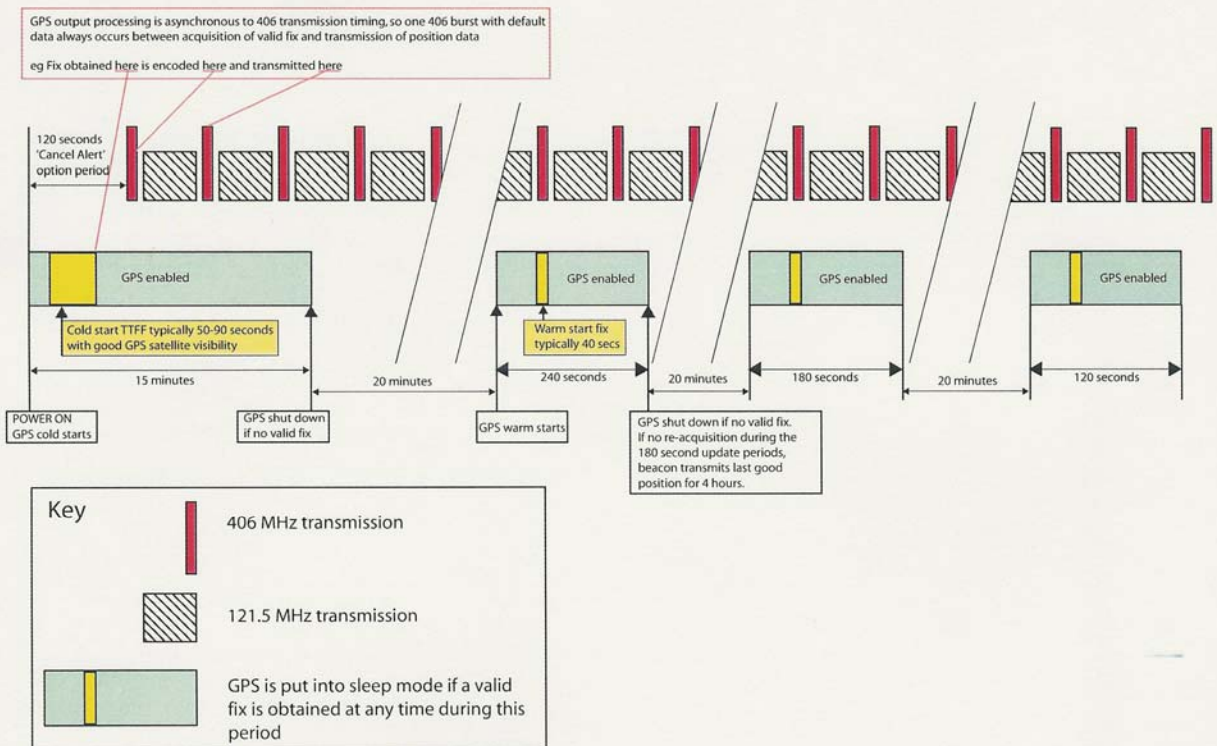
10 November 2005

- * GPS receiver turns off as soon as it acquires valid position data.
- * If no valid position data is obtained during the GPS acquisition periods, the Beacon will continue to transmit the last valid position data for up to 4 hours from receipt of that data.
- * The below times are a worse case scenario. This scheme is developed to allocate as much battery power as possible to the GPS receiver while still insuring successful transmission for 24 hours @-20 C.
- * All times listed are nominal.
- * This scheme is representative of current production.



G4-type EPIRB GPS TIMING - FIRST 90 MINUTES ONLY

NOT TO SCALE

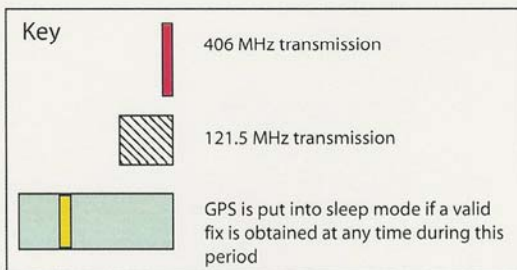
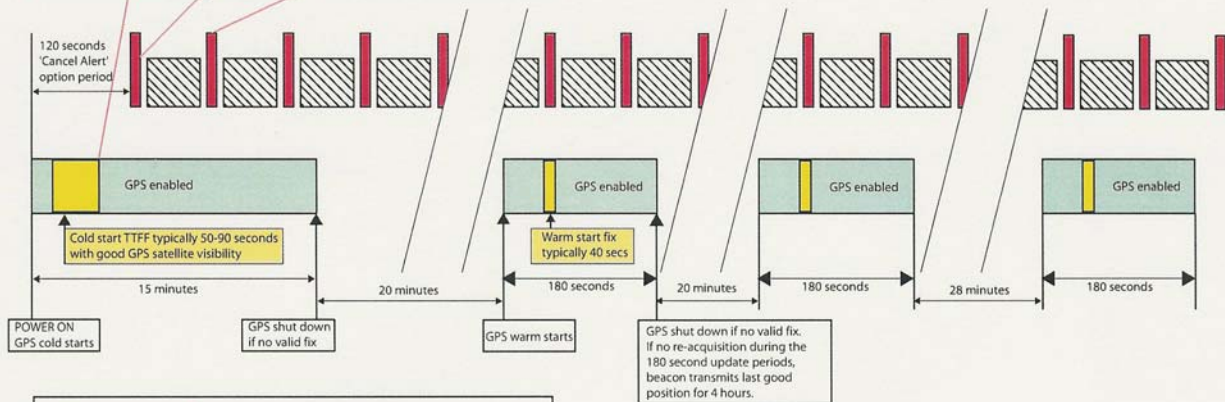


FASTFIND PLUS PLB GPS TIMING - FIRST 90 MINUTES ONLY

NOT TO SCALE



GPS output processing is asynchronous to 406 transmission timing, so one 406 burst with default data always occurs between acquisition of valid fix and transmission of position data
eg Fix obtained here is encoded here and transmitted here



Appendix 5

Knott Report

Report of Independent Observer to Testing

**of EPIRB's / PLB's regarding Acquisition of GPS Generated Location
Carried out by the Equipped To Survive Foundation, at Santa Cruz, CA
During the period July 12th-15th 2005**

- CONFIDENTIAL -

**This report must be restricted in circulation under the
“Non-Disclosure” agreement as per the actual testing.**

As a result of a direct invitation from Doug Ritter, Chairman and Executive Director of the Equipped To Survive Foundation, I attended independent testing of various EPIRB's and PLB's manufactured by both ACR and McMurdo.

The tests were carried out at various locations, both afloat and ashore in the Santa Cruz area of California during the week July 11th-15th, 2005 and I was in attendance the 12th through the 15th. My attendance was solely in the role of 'independent observer', not in any way as a participant. (It transpired that due to unforeseen circumstances I was asked, by Doug Ritter, to operate certain test equipment during some on-the-water testing.) The fact of my actions did not in any way influence either the tests or my impartiality.

It was taken as accepted that the various units transmitted both the 406 and 121.5 signals within acceptable standards. The purpose of these tests was to examine the acquisition of a GPS derived position under a number of 'real life' scenarios. It is, however, quite proper for information regarding the 406 and 121.5 transmissions, necessarily gained during the testing, to be included in the final report. This is not a technical report and does not seek to provide either technical information or the results or conclusions of any tests carried out. It is to comment on the manner of testing and of any resulting interim press release or final report.

During my attendance at the testing, I spoke with all those participating and sought their opinions on the manner of the tests. Both manufacturers were (reasonably) happy but expressed some dissatisfaction over minor points. It is my opinion that the testing was as fair and even handed as was practicable under the circumstances. Both companies had small parts of the various test protocols 'expanded' to allow for programming (and alterations) within their particular units.

None of the unit 'types' provided by either manufacturer operated "*perfectly*" under all of the test conditions. Whilst this was expected in some circumstances, there were a couple of 'surprising' results, both good and bad. It is important that these results be reported, without fanciful explanations. These tests were intended to mimic 'real life' situations and the results are, therefore, indicative of those that can be reasonably expected by an end user.

There was an array of test equipment, some computer based, some involving hand held PDA units and some involving remote operators collecting data via NOAA. The information will be collated for the final report and should negate any anomalies that may present themselves.

The PDA equipment, which appeared to be from a common source, was being used by McMurdo as well as by the Equipped To Survive Foundation and should supply the same data to everybody involved. The Equipped to

Survive Foundation also used two separate receivers connected to two computers. This redundancy of test equipment was intended to provide additional data for cross-checking certain test parameters. The reliability and continuity of the data collected was below that we had hoped for, but the redundancy of the test equipment should ensure all tests have adequate data. This was not due to fault on the part of anybody, but yet another 'real-life situation. Care should, however, be taken when interpreting the results provided by this equipment and incorporating the information into any press release or final report.

Since the testing has been completed, the identity of one of the 'test beacons' has come into question. It is not my place to comment regarding this at present. However, if the off-the-shelf units obtained for the tests had been incorrectly labeled or packaged, this would warrant inclusion and comment in any final report as the same could happen to an end user / consumer. This would in itself be a serious safety related matter. I await with great interest the final outcome of this puzzling incident.

The content, emphasis and wording of the final report are of great interest to both the industry and end user. The original report, from which these latest tests evolved, caused a great deal of confusion amongst end users who were presented with what they perceived as a beacon with a fundamental and dangerous fault. What the report actually identified was a problem with one of the ancillary functions of a particular unit and a flaw in the overall system that allowed it to happen. I think it important that this report leave as little room for complaint or miss-use / interpretation as possible.

There is an open opportunity for the Equipped to Survive Foundation to take its place on the world stage, not just within the US, as a leader in consumer advocacy in the survival and safety equipment field. Impartiality *in the extreme* will help ensure this happens to the benefit of both the manufacturers and the various end users. It is my opinion that the testing was as fair and impartial as was possible

Such independent testing should be encouraged and supported. The end reports should be clear, concise and easily understood by all.

Signed

Dated

Captain Eric Knott *AFRIN, CNI*
Director of Training / Commercial and Agency Sales

July 28th 2005

Circulation;

Doug Ritter
Kevin Robertson
Bill Cox
Captain Henry Marx

Equipped to Survive Foundation
McMurdo
ACR
Landfall Navigation
(*Dealer for both ACR / McMurdo,
supplied independent observer*)

Appendix 6

McMurdo Battery Installation Instructions

Battery installation instructions provided by McMurdo to consumers who sent in their Fastfind Plus PLBs for upgrade. Batteries were removed by the owner prior to return, to ease complication and expense that would occur due to HAZMAT shipping regulations if the Lithium battery were still attached. The consumer had to reinstall the battery upon receipt of the upgraded beacon. Salient text: **4. Fit the screw to retain the battery pack and tighten until hand tight, then turn the screw one 360° additional turn.**

How to assemble your PLB

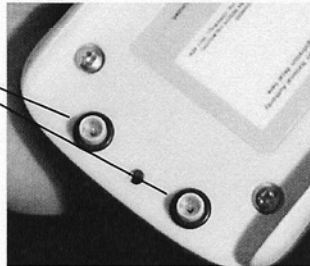
Your upgraded PLB is returned to you ready to fit the registration decal (if appropriate) and the battery. We have supplied replacement 'O' rings and the retaining screw.

Fitting the battery

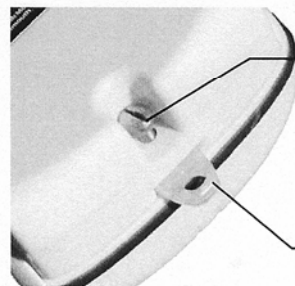
Please take care when fitting the battery. It forms part of the sealing system of the PLB, so it is important to follow the instructions exactly.

1. Fit the two 'O' rings to the battery connectors, as shown below.
2. Clip the battery pack into the PLB, then push the battery pack into place. Take care that the 'O' rings stay in place.

'O' rings fitted to
battery connectors



3. Fit the battery screw block (lanyard securing tag). **It is essential that this part is fitted, as it forms part of the PLB sealing system.**



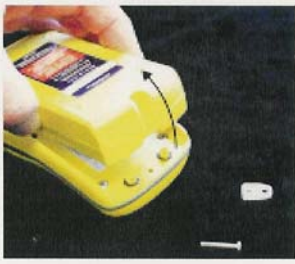

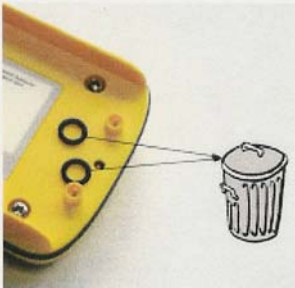
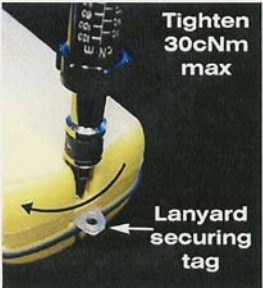


Battery retaining screw

Battery screw block
(lanyard omitted for clarity)

4. Fit the screw to retain the battery pack and tighten until hand tight, then turn the screw one 360° additional turn.
5. Perform a self-test, as detailed in the Owner's Manual. If the PLB does not pass the self-test, repeat it once. If the PLB still does not pass the self-test, contact McMurdo or your dealer.

Battery installation instructions provided by McMurdo to dealers who sent in their Fastfind Plus PLB in stock for upgrade. Batteries were removed by the dealer prior to return, to ease complication and expense that would occur due to HAZMAT shipping regulations if the Lithium battery were still attached. The dealer had to reinstall the battery upon receipt of the upgraded beacon. Salient text: **Fit the screw, and tighten it securely to the torque shown. Do not over-tighten (1 turn from contact is sufficient).**

<p>Remove the battery retaining screw.</p>		 <p>Fit new 'O' rings</p>	<p>Fit the new 'O' rings supplied with the kit.</p>
<p>For clarity, the optional lanyard has been omitted from these illustrations</p>		 <p>Fit new battery</p>	<p>Assemble the new battery pack to the PLB, ensuring that the 'O' rings remain in place.</p>
<p>Remove the battery. If necessary, remove the lanyard securing tag and lever the battery free.</p>	<p>IMPORTANT: Dispose of the old battery in accordance with local regulations.</p>		<p>Refit the lanyard securing tag. It is essential that this is fitted, as it forms part of the PLB sealing system.</p>
<p>Remove and discard the 'O' rings.</p>	<p>Inspect the battery pins on the PLB to ensure they are not bent or corroded.</p>	 <p>Tighten 30cNm max</p> <p>Lanyard securing tag</p>	<p>Fit the screw, and tighten it securely to the torque shown. Do not over-tighten (1 turn from contact is sufficient).</p>

continued....

Appendix 7

**McMurdo Review
Of
Draft Report
&
ETS Foundation Response**

McMurdo Limited
Silver Point, Airport Service Road,
Portsmouth PO3 5PB
United Kingdom

Telephone: +44(0)23 9262 3900
Facsimile: +44(0)23 9262 3996
www.mcmurdo.co.uk



7th November 2005

Mr Doug Ritter
Chairman & Executive Director
Equipped To Survive Foundation, Inc.
313 W. Temple Court
Gilbert
AZ 85233
USA

Dear Doug

Draft Beacon Test Report

Further to your email of 31st October 2005 advising us that the draft report was available for review please find herewith McMurdo's comments:

- 1) Executive Summary, Page 6, last but one paragraph, second to last and last sentence

I do not believe the last sentence clearly represents the situation. McMurdo confirmed to ETSF in writing in 2004 that the company planned to participate in the trials and has maintained that position throughout the intervening period. I would recommend that this last sentence is removed completely. The second to last sentence correctly states that we were not in favour of field upgraded beacons being used in the trials, but fails to explain why, which I believe can lead to a false impression. We would like to see the following sentence added at the end of this paragraph. "McMurdo stated that its concerns over the inclusion of consumer owned beacons were due to the fact that there could not be any confidence as to the condition of such beacons due to possible rough handling, poor storage etc., and it represented a disparity between our trials beacons and those from other manufacturers."

- 2) Executive Summary, Page 7, Baseline testing table

The ACR Aquafix acquisition time is reported as 2:41 on page 7, but as 1:41 on page 30 in the results table in the main body of the report.

- 3) Executive Summary, Page 2?, Inland testing table

As far as we can see in the report there is no analysis on the failure of the Aquafix prototype in Inland Scenario Bravo. From our records we believe that this PLB was tested at a time when satellite coverage was recovering (see 14:05 local time in chart below). The report rightly states that coverage for a Garmin was 2-3 satellites. However, we know that for more sensitive receivers the coverage was higher: 3 on the Garmin GPS296, 5 on the Magellan GPS310. To quote ACR's comment from the report, the prototype Aquafix contained a GPS receiver "better than any... in the general market". Based on this should there not be a comment on this failure to acquire in the report?

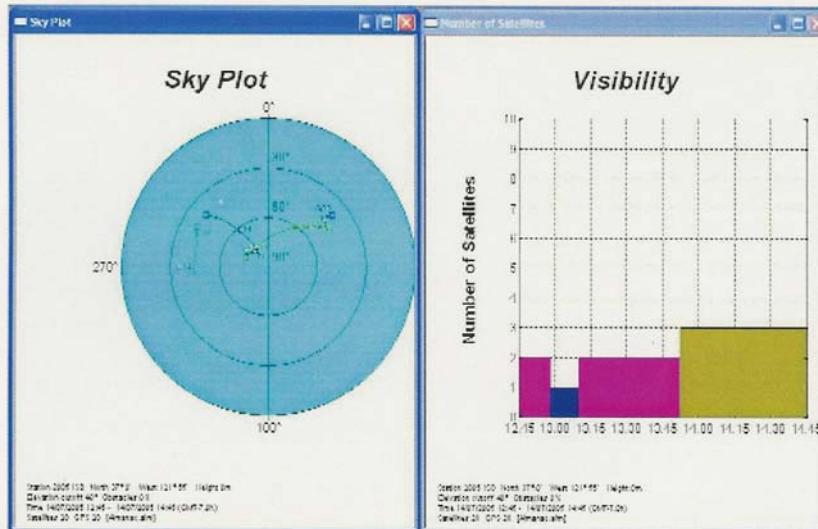
Registered in England No. 746603
Registered Office: 1650 Parkway,
Whiteley, Fareham, Hants, PO15 7AH
VAT NO GB 421 1393 92



MEMBER OF CHEMRING GROUP PLC

McMurdo Limited
Silver Point, Airport Service Road,
Portsmouth PO3 5PB
United Kingdom

Telephone: +44(0)23 9262 3900
Facsimile: +44(0)23 9262 3996
www.mcmurdo.co.uk



4) Field tests, pages 25 and 33

I believe that the issue regarding transmissions only containing coarse location raised in the last but one paragraph on page 25 and in the last paragraph on page 33 is worthy of further investigation. Did the local receivers pick up the complete message correctly, were subsequent transmissions containing the fine location picked up by the GOES satellite. Exactly what did the GOES satellites pick up if anything in place of the fine location, a default location, an error message. This may potentially indicate a possible problem in the system, perhaps in beacons warming up and the modulation not being quite right initially, or with the BCH error correction algorithms for some data sets, or with the decoding software in the LUTs or at the MCC, or even the hardware on the GOES satellite itself. We feel that a recommendation to investigate this issue further is warranted.

5) Inland Scenario Foxtrot, page 37

The successful acquisition of a GPS position in the gorge by the McMurdo PLB is largely discounted in the report. One reason cited is the disparity of the positioning of the beacons on the gorge floor. In our opinion the beacons were not that far apart as the following photograph shows. (If anything, the McMurdo PLB at the top of the picture has the disadvantage of being slightly closer to the side of the ravine.)

Registered in England No. 746603
Registered Office: 1650 Parkway,
Whiteley, Fareham, Hants, PO15 7AH
VAT NO GB 421 1393 92



MEMBER OF CHEMBURG GROUP PLC

McMurdo Limited
Silver Point, Airport Service Road,
Portsmouth PO3 5PB
United Kingdom

Telephone: +44(0)23 9262 3900
Facsimile: +44(0)23 9262 3996
www.mcmurdo.co.uk



As all the beacons were operated concurrently we believe that they all had substantially the same opportunity to acquire. While we accept that it is unlikely that every beacon would acquire in these circumstances we believe that this demonstrates the improvements that McMurdo has made to its beacons recently. We feel that this should be acknowledged in the conclusions for this test on page 38.

6) Maritime Scenario Alpha, page 41

In Maritime Scenario Alpha, our trial records show that it was the prototype Aquafix that took over 15 minutes to acquire, not the standard Aquafix. Have we got this confused? We believe that the Aquafix that struggled had an ID of 3293242.

7) Maritime Scenario Golf, page 46

In the table of results for Maritime Scenario Golf two sets of overlapping times are given for the prototype Aquafix.

8) Maritime Scenario Hotel, page 46

In the table of results for Maritime Scenario Hotel two sets of overlapping times are given for the prototype Aquafix, in addition there seems to be something wrong with the location data for this test (large error).

Registered in England No. 746603
Registered Office: 1650 Parkway,
Whiteley, Fareham, Hants, PO15 7AH
VAT NO GB 421 1393 92



MEMBER OF CHEMRING GROUP PLC

McMurdo Limited
Silver Point, Airport Service Road,
Portsmouth PO3 5PB
United Kingdom

Telephone: +44(0)23 9262 3900
Facsimile: +44(0)23 9262 3996
www.mcmurdo.co.uk



9) Conclusion 5, page 47

We feel that this conclusion is slightly confusing in that on the one hand, it says that beacon performance and handheld GPS receiver performance is "an unreliable comparison". Yet in the next sentence it says that these beacons can be expected to "perform comparably". We suggest removing the words "which can prove to be an unreliable comparison." from the end of the first sentence to improve understanding.

10) Conclusions 10, page 49 (and Recommendation 2, page 50)

Conclusion 10 states that the standard beacon self test does not ensure that the GPS portion of a beacon is functioning. All McMurdo GPS beacons (EPIRBs and PLBs) contain a built in GPS check as part of the standard self test routine. While this does not power up the GPS receiver long enough to download a GPS position it does power up the GPS receiver at each self test and ensure that communication between the GPS receiver and beacon is functioning correctly which provides a good indication of the overall satisfactory functioning of the GPS receiver. We see this as a benefit offered by McMurdo beacons that we feel should be mentioned in the report.

11) Recommendations 7, page 51 and Beacon Test Anomalies page 6

McMurdo would like to point out that the differentiation between its GPS enabled beacons and its non-GPS beacons (both EPIRBs and PLBs) is significant at all levels. Firstly the consumer packaging for the beacons is different with clear "GPS" markings on the boxes of the GPS beacons. Secondly the beacons themselves are clearly marked as being different in the labelling of the beacons on their front face and in the user manuals provided with the beacons. Finally the colouring of ancillary parts such as gaskets and membranes is different for the GPS beacons as well. Thus unlike with the ACR beacon in question we do not believe that it is possible to mistake the identity of our beacons. We would like to see this acknowledged in the report.

I trust that you find these comments helpful, we look forward to receiving the final version of the report in due course.

Yours sincerely,



C P Hoffman
Technical Director
McMurdo Limited



**ETS Foundation Response to Issues Raised
by
McMurdo's Draft Report Review**

(Pursuant to the agreements with the manufacturers, the manufacturers have received a preview of the draft report and were invited to offer a response including comments and corrections, if desired. Equipped To Survive Foundation was not obligated to either respond or to edit the report as a result of any comments or corrections, but agreed to publish any such response in the report.)

Item 1: For purposes of clarifying your position, we have edited this to read as requested.

Item 2: Corrected, thank you.

Item 3: We believe that this situation is appropriately explained in the full report. We have added a footnote to the Summary table directing readers to that portion of the full report for further explanation.

With regards ACR's quoted comments in their response to the failure of their beacon to acquire during the Marine Scenario Foxtrot test, that is no more subject to a comment in the report than any other of the many efforts by both manufacturers to promote their products at every opportunity. With regards this test, from our data, as illustrated in the full report, this beacon didn't receive an equal opportunity to acquire and that is the only conclusion that we can make from the facts at hand. Readers will make their own conclusions from the results, of course. The inclusion of your comments in the full report will offer you the opportunity to make your counterpoint.

Item 4: We agree that this bears further inquiry and have added a recommendation to this effect.

Item 5: After full and due consideration, we have concluded that your explanation and support for your position is not conclusive and we must leave this as is. We believe that the Fastfind Plus' performance speaks for itself, but with regards to the test itself we cannot make any other factual determination or conclusion. Your alternative point of view has been added to the body of report with reference to your review of the draft report for additional supporting information.

Item 6: We can confirm that the table is correct and that it was the standard ACR AquaFix (PLB-200) that took 15:58 to transmit a location. This is consistent for both our manually recorded data and the computer collected data.

We are unable to identify the beacon ID provided. We have only 15 digit hex IDs and serial numbers and the ID number you reference obviously doesn't match up to either of those.

Item 7: Corrected, thank you.

Item 8: Corrected, thank you. The location error was a typo and has been corrected.

Item 9: We have edited this Conclusion in an attempt to clear up any confusion, as we think the point we are trying to make is still valid.

Item 10: We have edited this Conclusion to address your clarification, thank you. We do not believe that Recommendation 2 requires any change.

Item 11: We have edited this Recommendation to address your clarification, thank you.

####

Appendix 8

**ACR Review
Of
Draft Report
&
ETS Foundation Response**

Paul D. N. Hardin
Vice President, Sales & Marketing



11 November 2005

Dear Doug;

Following is our feedback on the ETSF beacon test.

1. Page 5 Executive Summary. Please state that ACR is a subsidiary of Cobham PLC... We are no longer a Chelton Group Company.
2. On the "Page 2" that follows Page 7 "Summary of Inland testing" the "Under forest canopy 2-3 satellites in view" you list the results for McMurdo Fastfind Plus PLB as "2-3 Inconclusive NA". We find this confusing and inconsistent. Did it acquire or not? You note "Success" or "Fail" in all other tests.
3. On the second Page 7 it appears that you are sorting your samples based on the evidence of cracking. In a proper test of randomly pulled beacons this would not be permitted.
4. Page 37 Inland Scenario Foxtrot, paragraph 4. The result is more a case of the beacon having a strong transmitter than it is a "lucky shot". Without ample power a reflected signal could never make it to the GOES 12 satellite.
5. On page 39 Inland Golf table the time delta column is absent.
6. On Page 49, #9 you seem to pan external GPS interface features. While we agree with your first statement, there is no reason to express your opinion and in our opinion it is a very valuable feature for the boating and aviation community where a NMEA compatible navigation system is commonly on all the time and where interfacing equipment with your onboard GNSS is a common practice.
7. On Page 49 #10 we agree with your assessment and recommendation, but as you know we are prevented in transmitting the GPS data in a test burst. You fail to mention that ACR is the only manufacturer to include a full GPS acquisition test in ALL our GPS enabled beacons. Although we don't transmit the coordinates, we go as far as allowed by the various standards.
8. Page 52 #12 is a fool hardy recommendation-we vehemently oppose this recommendation! It would be far better to recommend that EPIRBs be tethered outside of a life raft as they are intended to be used. I've NEVER had one single survivor of an emergency at sea tell me the strobe was an annoyance. I've actually heard the opposite from more than one including a recent rescue where the survivor was in the water for 30 hours.
9. Page 52 #13 you make a recommendation and you fail to mention that ACR has developed an Electronic Witness Seal for the PLB-200 that does what you recommend.

ACR Electronics, Inc. Page 1 of 2
5757 Ravenswood Road, Fort Lauderdale, FL 33312-6645
+1(954)862-2115, Fax : +1(954)983-5087, e-mail: pdhardin@acrelectronics.com, www.acrelectronics.com

— A Cobham Company —



10. Collectively, there seemed to be a large number of problems with the McMurdo beacons; (i.e. programming issue, water contact issue, cracking issue, flat battery issue). While you dutifully and fairly report these issues, you do not observe in your conclusions that there is a high percentage of "problems" overall with these beacons. This may be significant in such a small beacon population.
11. On all tests you do a good job of reporting the number of satellites present. However, the satellite constellation geometry is equally important. I believe you took HDOP (Horizontal Dilution of Position) and VDOP (Vertical Dilution of Position) into account but you make no mention of it. Satellite geometry can be expressed as an Average Value at the time of each test. We think this can further explain why one beacon might acquire at any one given moment and another might not, when in fact it is a perfectly good beacon.

ETS Foundation Response to Issues Raised by ACR's Draft Report Review

(Pursuant to the agreements with the manufacturers, the manufacturers have received a preview of the draft report and were invited to offer a response including comments and corrections, if desired. Equipped To Survive Foundation was not obligated to either respond or to edit the report as a result of any comments or corrections, but agreed to publish any such response in the report.)

Item 1: Corrected, thank you.

Item 2: The reasons for this are explained in the text of the report and readers curious have that available to them. Unfortunately, when dealing with the real world, sometimes things don't work as desired. In this case, a review of the GPS information recorded shows that we would be comparing apples and oranges. Someday we'll have access to a GPS simulator where we have absolute control. The only fair thing under the circumstances was to say that the results were inconclusive.

Item 3: An explanation for this is included in the text of the report and we have edited it to clarify that this was limited only to those few maritime scenarios where the beacon was likely to be immersed. We recognize that ideally selection would be entirely random, however we believe that our selection means ensured that the primary purpose of the test, to evaluate the GPS capability of the beacons, would not be defeated by unrelated issues and that it was still a fair selection process that did not adversely affect the results.

Item 4: After full and due consideration, we have concluded that we must leave this as is and your alternative explanation has been added to the body of report.

Item 5: This is presented identically to the previous report. No time delta is provided since it does not provide useful information as we do cannot definitively correlate that in a manner that relates to GPS receiver performance, just an overall time since initial acquisition which may not be relevant to any useful purpose absent additional information. Our primary interest was whether or not the beacon updated its location when moved, that is all.

Item 6: We do not agree that we "pan" external GPS features. In fact we say it is an added benefit. However, we have edited this Conclusion to add a note regarding marine and aviation specific installations where this may be a particular benefit.

Item 7: We have edited this Conclusion to address your clarification, thank you.

Item 8: We respectfully disagree with your opinion. Note that we do not advocate eliminating the strobe, which we believe to be a significant advantage in many survival scenarios. We feel that a survivor being able to manually terminate the strobe is a viable OPTION and believe it would provide a benefit to survivors when used in these particular situations. As COSPAS-SARSAT has taken notice, these beacons are not necessarily used as intended and in some cases cannot be so used. A bright strobe running in an enclosed space could

have adverse consequences for survivors with no benefit to them. Lacking that capability, we recommend a small roll of duct tape as part of any mariner's selection of survival gear, which can be used to cover the strobe, among many uses.

Item 9: We have edited this Recommendation to address your clarification, thank you.

Item 10: While we agree there were collectively an unusual number of peculiar problems, we believe that the explanations provided in McMurdo's report do not indicate a generic or specific problem, nor could we identify such problems ourselves. Some of the beacons were from customers in the field and we have no way of ascertaining definitively whether or not they were abused. Nor did it negatively impact the primary purpose of the testing in any meaningful way. As such we do not believe we can draw any specific conclusions from this and to do so would be irresponsible. Readers will draw their own conclusions, of course. We did not ignore this issue in our conclusions and recommendations, rather we conclude that this experience does emphasize the need for owners of all beacons to inspect and test their beacons and ensure they are not obviously damaged or non-functioning prior to relying upon them and so recommend that to readers of the report.

Item 11: We agree it would potentially useful to present this information for all the beacons tested, along with the considerable explanative information necessary for a lay person to make some intelligent judgment regarding it. However, the Foundation has very limited resources and they must be spent to give us the best return. We did perform analysis of the GPS data when we felt it would clearly help to determine if a beacon that did not perform well was given a fair shake. This was done on all beacon failures to acquire and was noted in the report when it was an issue. All the data will be supplied to the manufacturers who have the resources to make good use of it in analyzing their beacons' performance.

####