Safety and Marine Communications

Chuck Hawley
US Sailing Safety at Sea Course
What are the Goals of Emergency Communications?

- To alert rescue services to your situation
- To get medical or other expert advice
- To alert other vessels of potential hazards
- To relay information regarding another vessel
- To maintain a radio schedule with rescuers
Different levels of severity

• MAYDAY
  Use when there is a risk of life or vessel
  Man overboard, fire, flooding, collision
  “A distress alert should be transmitted if, in the opinion of the
  Master, the ship or a person is in distress and requires immediate
  assistance.”

• PAN PAN
  Use when there is a serious medical issue or damage to vessel
  Loss of rudder, drifting towards danger, injury to crewmember

• SECURITE
  Use for safety oriented messages for other vessels
  Debris in water, navigation aid in wrong location, flare
  demonstration
In a distress communication, what’s important?

- Distress or Urgency Word
- Vessel name
- Position (Lat long if possible; geographic if not), mention if you have AIS
- Nature of emergency
- Number of people
- Description of vessel
- Life saving equipment
How do you broadcast a Mayday?

“Mayday, mayday, mayday.”

“This is the sailing vessel Surprise, Surprise, Surprise.”

“We are located at 24 degrees 15 minutes north, 151 degrees 56 minutes west.”

“We are taking on water, and we can’t find the source of the leak.”

“Surprise is a 38 foot sailboat with a tan deck and dark blue hull.”

“There are 6 souls on board. We have an EPIRB and a life raft.”

“This is the sailing vessel Surprise, standing by on Channel 16.”
If you receive a Mayday…
PAUSE, RESPOND, CALC, LOG

• Pause to see if anyone else responds
  Especially the Coast Guard
• If no one responds, respond to the Mayday
• Calculate whether you’re in a position to help
  Direct assistance
  Standby vessel in distress
  Relay communications
• Log communications in logbook
  Time, name, position, action taken
Portable or fixed mount communications devices?

• Portables:
  Independence from ship’s systems
  Antennas
  Power
  Convenience
  “You CAN take it with you!”

• Fixed mount units:
  Generally better antenna installations
  Longer “battery life”
  Greater transmit power
  Work from below decks
What is GMDSS and why does it matter to me?

• Global Marine Distress and Safety System
• International maritime agreement to standardize all marine communications
• Required of vessels over 300 T
• These are *exactly* the guys who may be in a position to rescue you in the middle of the ocean
So, what are GMDSS devices?

<table>
<thead>
<tr>
<th>GMDSS</th>
<th>Not GMDSS, but useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF-FM Marine Radios with DSC</td>
<td>Conventional HH VHF Radios</td>
</tr>
<tr>
<td>Survival Craft VHF Portable Radios</td>
<td>AIS</td>
</tr>
<tr>
<td>EPIRB</td>
<td>SEND Devices</td>
</tr>
<tr>
<td>SART</td>
<td>PLBs</td>
</tr>
<tr>
<td>NAVTEX Receiver</td>
<td>Satellite Telephones</td>
</tr>
<tr>
<td>SSB Radio</td>
<td>Cellular Phones</td>
</tr>
<tr>
<td>Inmarsat C and F77 Satellite Terminals</td>
<td></td>
</tr>
</tbody>
</table>
With GMDSS, you buy this:

And you get this:
When you use GMDSS tools, you get all this: Ground Stations, Satellites, Networks
Rescue 21 (USA)

- Part of the National Distress Response System (NDRS)
- VHF-based system, coastal PR, and 30 miles out.
- Digitally-based (DSC) system plus voice
- Direction finding ability by Coast Guard using multiple towers or GPS input
- Automated broadcasts
- Completed in the Continental U.S.
- If you don't have a DSC button, give a long radio call for Direction Finding.
Rescue21 Regional coverage analysis of VHF receive antenna based on geographical line-of-sight.

System requirement: At least 20 nm offshore for a 1 watt VHF-FM Ch 16 signal transmitted form two meters above water surface.
# Summary of Marine Communications

*How far? What type? How much?*

<table>
<thead>
<tr>
<th>Name</th>
<th>Cost</th>
<th>Range</th>
<th>Type of Comms</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH VHF</td>
<td>$100-$300</td>
<td>3-20</td>
<td>Voice</td>
</tr>
<tr>
<td>Fixed VHF</td>
<td>$100-$500</td>
<td>20-60</td>
<td>Voice</td>
</tr>
<tr>
<td>AIS</td>
<td>$500</td>
<td>25</td>
<td>Vessel Data</td>
</tr>
<tr>
<td>EPIRB/PLB</td>
<td>$250-$700</td>
<td>Worldwide</td>
<td>Mayday</td>
</tr>
<tr>
<td>HF SSB</td>
<td>$2000-$3000</td>
<td>25-4000</td>
<td>Voice, Data</td>
</tr>
<tr>
<td>Sat Telephone</td>
<td>$500-$1500</td>
<td>~Worldwide</td>
<td>Voice, Data</td>
</tr>
<tr>
<td>SEND Device</td>
<td>$100-$400</td>
<td>~Worldwide</td>
<td>Data, position</td>
</tr>
<tr>
<td>COB Beasons</td>
<td>$300</td>
<td>~2</td>
<td>Data, position</td>
</tr>
<tr>
<td>Inmarsat M</td>
<td>$3000-$6000</td>
<td>~Worldwide</td>
<td>Voice, Data</td>
</tr>
</tbody>
</table>
# Handheld VHF-FM Marine Radio

<table>
<thead>
<tr>
<th>Range:</th>
<th>3 miles (another boat) to 20 miles (CG tower)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>$100 to $300</td>
</tr>
<tr>
<td>Best Uses:</td>
<td>Cockpit safety, ship to dinghy, small boats (kayaks, inflatables. Autonomous from ship’s systems. <em>Strongly consider models with DSC and GPS built-in.</em></td>
</tr>
<tr>
<td>Limitations:</td>
<td>Some uses are illegal but handy, short range, few chat channels</td>
</tr>
</tbody>
</table>
Fixed Mount VHF-FM Marine Radio

<table>
<thead>
<tr>
<th>Range:</th>
<th>20-60 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>$140 to $1000</td>
</tr>
</tbody>
</table>
| Best Uses:   | Calling the Coast Guard  
               | Calling virtually any marine station of interest  
               | Most cost-effective safety item on board.       |
| Limitations: | Marine only.      
               | Line of sight range.   |
Digital Selective Calling

- Flip the Distress cover and press the button for three seconds
- Monitor channel 16 for a response
- Must have:
  - “Modern” VHF Radio
  - GPS interfaced
  - MMSI number entered
- Radio may allow you to indicate the nature of your emergency
Why not use a smart phone?

<table>
<thead>
<tr>
<th>VHF</th>
<th>Smart Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine only; meets the needs of boaters</td>
<td>Ability to call any phone number</td>
</tr>
<tr>
<td>Direct line to the Coast Guard</td>
<td>Simple user-interface</td>
</tr>
<tr>
<td>Can communicate with vessels and aircraft</td>
<td>Must be used with a shore network</td>
</tr>
<tr>
<td>Greater range</td>
<td>Very short range</td>
</tr>
<tr>
<td>Broadcast</td>
<td>Narrowcast</td>
</tr>
<tr>
<td>Waterproof</td>
<td>Not waterproof</td>
</tr>
</tbody>
</table>

That isn’t to say that smart phones are really useful...
Approved VHF Antenna

15” minimum height
Unity gain

Make sure to use a waterproof coax connector at the masthead
World Special Offshore Spec. Regs
US Sailing Safety Equipment Regs

- Radio shall have 25W output
- Masthead antenna
- No more than 40% power loss due to cable
  - <50’  RG-8X
  - 50-90’  RG-8U
  - 90-140’  9913F
  - 140-230’  LMR600
- Handheld VHF in addition to fixed mount
Automatic Identification System: AIS
AIS
Automatic Identification System

• Automatic broadcasts via VHF frequencies
  Vessel MMSI, status (anchor, underway)
  Lat-long, heading, speed, rate of turn
  Calculates CPA, TCPA
  May include name, time to port, draft, size, type of cargo

• Connects to chart plotter or standalone display

• Virtually unlimited capacity of vessels
  Designed for 4500 vessels
  Prioritizes closest ships
Receive only, Class A, or Class B?

- Receive only AIS
  You see them, but they cannot see you

- No Loss Antenna Splitter
  Use a single antenna for VHF and AIS

- Class A/B Transceiver
  See and be seen
## Comparison of AIS Types

<table>
<thead>
<tr>
<th>AIS Class</th>
<th>Class A (SO-TDMA)</th>
<th>Class B SO-TDMA</th>
<th>Class B CS-TDMA</th>
<th>Receive Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit Power</td>
<td>12.5W</td>
<td>5W</td>
<td>2W</td>
<td>Zip</td>
</tr>
<tr>
<td>Includes Display?</td>
<td>Yes</td>
<td>Some do</td>
<td>Some do</td>
<td>No</td>
</tr>
<tr>
<td>Xmit Interval Nav Information</td>
<td>2-10 seconds and 6 minutes</td>
<td>5-30 seconds, 3 minutes if moored.</td>
<td>30 seconds, 3 minutes if moored.</td>
<td>N/A</td>
</tr>
<tr>
<td>Vessel Data</td>
<td>6 minutes</td>
<td>6 minutes</td>
<td>6 minutes</td>
<td>N/A</td>
</tr>
<tr>
<td>Best Use</td>
<td>Commercial</td>
<td>Serious Recreational</td>
<td>Casual Recreational</td>
<td>Only cause it’s free</td>
</tr>
</tbody>
</table>

**SO-TDMA:** Self Organizing Time Division Multiple Access

**CS-TDMA:** Carrier Sense Time Division Multiple Access
To much of a good thing...
AIS targets on the way to Qingdao
AIS Net Buoys to Track Fishing Gear

- 8W of power
- Very inexpensive
- Widely available

[Image of AIS Net Buoys]
EPIRBs and COSPAS SARSAT

- 406 MHz Beacons
  - Category 1
  - Category 2
- Unique ID number for each unit
- Register it with NOAA
  - www.beaconregister.com
- World wide coverage
- Most now have an internal GPS receiver
- Waterproof, reliable, independent, buoyant, rugged
PLBs

- Smaller cousin to EPIRBs
  - Same satellites
  - Same frequencies
  - Same rescue agencies
- Differences
  - 24h vs. 48hr transmit time
  - May not float
  - Won’t sit upright in water
- Best use
  - Personal (hiking, kayaking)
  - Small offshore boats
- Not recommended?
  - Man Overboard
Multiple technologies in one device: SARLink

- Combines the functions of a PLB with an Iridium SEND device
- More on SEND devices in a minute...
Mobile Satellite Communications
Worldwide Coverage Map

The GEO SAR Advantage
Now three different satellite constellations

- **MEOSAR**
  - 21,000km Altitude
  - 720 minutes
  - Navigation Satellites

- **LEOSAR**
  - 850km Altitude
  - 102 minutes
  - Weather Satellites

- **GEOSAR**
  - 35,786km Altitude
  - 1440 minutes
  - Comms Satellites
### Comparison of SAR Satellite Systems

<table>
<thead>
<tr>
<th>Satellite Type</th>
<th>Computes Location?</th>
<th>Always in Sight?</th>
<th>Global Coverage?</th>
<th>Two-way Messages?</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEOSAR</td>
<td>Yes, using doppler, but two solutions</td>
<td>No, periodic</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>MEOSAR</td>
<td>Yes, using TDOA and FDOA</td>
<td>Yes, lots of birds</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>GEOSAR</td>
<td>No, unless self-locating</td>
<td>Yes</td>
<td>Up to 70°</td>
<td>No</td>
</tr>
</tbody>
</table>
Modern EPIRB/PLBs have built-in diagnostics and displays
Official 406 MHz PLB Registration Form

PLB Information
- Beacon ID (Unique Identifier Number)
- PLB Manufacturer
- Model No.

PLB Registration
- New PLB Registration
- Replacement of PLB Decal
- Renewal of PLB Registration
- Check here if this PLB is a replacement for a previously registered PLB.
- Change of PLB Information or Ownership
- Please enter the old PLB unique ID number

Owner/Operator Information
- Name (Last, First, Middle Initial)
- Mailing Address
- City
- ZIP (Postal Code)
- Country
- E-mail
- Telephone

General Use Data
- Usage:
  - Commercial
  - Non-commercial
  - Government Military
  - Government Non-military
- Specific Usage
  - Hiking
  - Hunting
  - Fishing
  - Other
- Type
  - Land Vehicle
  - Boat
  - Aircraft
  - None
  - Other
- Additional Data

Emergency Contact Information
(Please indicate someone other than the owner)
- Name of Primary 24-Hour Emergency Contact:
- Name of Alternate 24-Hour Emergency Contact:
- Telephone
  - Home
  - Work
  - Cellular
  - Fax
  - Other

Signature
Date

If you have any questions about this form or with PLB registration in general, please call 1-888-212-SAVE (7283) or 301-817-4515. For information on the U.S. Search & Rescue Satellite-Aided Tracking system, please visit: www.sarsat.noaa.gov

OMB (0648-0095) Expires: 31 JAN 2009

www.noaa.gov
Check your battery when you check your registration...
• DISTRESS. On 22 January 2005, Coast Guard Group San Francisco received a MAYDAY call via VHF-FM CH-16 from the operator of the vessel HAWKEYE stating his vessel was taking on water near Pigeon Point, San Francisco, CA. He manually activated his 406 MHz EPIRBs before making the call. The Coast Guard diverted a helicopter and launched a motor life boat to the area to assist him. The helicopter located and dropped pumps to the vessel. After the vessel was dewatered and the leak was patched, two nearby "good sam" vessels assisted the disabled vessel further. The motor life boat transferred the 2 POBs to the vessel Queen of Hearts and the vessel Raddon towed the distressed vessel into port.

• TWO OF THE EPIRBs CARRIED ABOARD THE VESSEL WERE REGISTERED TO THE VESSEL SOLACE. THE OWNER OF THE HAWKEYE WAS USING THEM ABOARD HIS VESSEL.
Single Sideband Radios
# HF, SSB or Single Sideband Radios

<table>
<thead>
<tr>
<th>Range:</th>
<th>50-4,000 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>$2,000 to $3,000 plus installation</td>
</tr>
<tr>
<td>Best Uses:</td>
<td>Long distance ship to ship and ship to shore Coast Guard monitors 4 bands Rugged, marinized designs.</td>
</tr>
<tr>
<td>Limitations:</td>
<td>Learning curve Complicated installation Time sensitive High current draw when transmitting.</td>
</tr>
</tbody>
</table>

Icom AT-130 Antenna Tuner
HF (SSB) Antenna Considerations

• Two general types
  23’ fiberglass whip antennas
  Insulated wire antennas

• Requires an antenna tuner to match frequency to wire length

• Requires a “counterpoise” in contact with water or coupled to water
E-mail via SSB or Ham

• Requires a radio, laptop, and TNC (Terminal Node Controller, $650)
• Slow transmission rates
• Several non-profit services (Sailmail and WinLink)
• 10 minute per day limit (Sailmail)
• Very inexpensive compared to other options
• HAM transmissions limited by non-commercial rules
## Iridium

<table>
<thead>
<tr>
<th>Range:</th>
<th>Worldwide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>$1500 plus $20 per month plus $1.50 per minute</td>
</tr>
<tr>
<td>Best Uses:</td>
<td>Portable voice at sea Calls where there is no cellular, or where phone calls are prohibitively expensive. Independent of the ship’s systems</td>
</tr>
<tr>
<td>Limitations:</td>
<td>Slow baud rate (2.4k, 9.6k with compression) Ridiculously complicated pricing</td>
</tr>
<tr>
<td>Range:</td>
<td>Continental and Coastal</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Cost:</td>
<td>$500 plus $50 activation plus $1.09 per minute</td>
</tr>
<tr>
<td>Best Uses:</td>
<td>Portable voice communications where there is no cellular, or where phone calls are prohibitively expensive. Independent of the ship’s systems</td>
</tr>
<tr>
<td>Limitations:</td>
<td>Not worldwide, complicated pricing schemes</td>
</tr>
</tbody>
</table>
## IsatPhone Pro

<table>
<thead>
<tr>
<th>Range:</th>
<th>Worldwide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>$575 plus $50 activation plus $1.43 per minute</td>
</tr>
<tr>
<td>Best Uses:</td>
<td>Portable voice communications where there is no cellular, or where phone calls are prohibitively expensive. Independent of the ship’s systems. Free inbound SMS</td>
</tr>
<tr>
<td>Limitations:</td>
<td>Complicated pricing schemes “Units ≠ Minutes”</td>
</tr>
</tbody>
</table>
S.E.N.D. Devices

- SMS/e-mail capable
- Standardized or customized messages
- One-way or two-way
- SOS button
- Allows others to track your progress
- May be worldwide
- Integrates with smart phones
S.E.N.D. Devices

• Other options include tracking only (for valuable items)
• Different satellite constellations
• This is changing so quickly that you have to investigate the latest changes.
Iridium GO Satellite Wifi Hotspot

• Allows you to use your mobile devices anywhere in the world.
• Voice, text, data.
• SOS button connects you to GEOS in TX.
• Battery operated for portability.
• Up to five devices
• $.80 to $1.15/min for voice
What about Crew Overboard alarms?

Man Overboard Beacons have gone through phases
- Mini-Class B EPIRB
- Cessation of Transmission Device
- Personal Locator Beacon
- Personal MOB Alarm using AIS/DSC
Today’s faster boats have a problem…

<table>
<thead>
<tr>
<th></th>
<th>5 kts</th>
<th>7 kts</th>
<th>10 kts</th>
<th>14 kts</th>
<th>20 kts</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 sec.</td>
<td>84’</td>
<td>118’</td>
<td>169’</td>
<td>236’</td>
<td>338</td>
</tr>
<tr>
<td>20 sec.</td>
<td>169’</td>
<td>236’</td>
<td>338’</td>
<td>473’</td>
<td>675’</td>
</tr>
<tr>
<td>30 sec.</td>
<td>253’</td>
<td>355’</td>
<td>507’</td>
<td>709;</td>
<td>1013’</td>
</tr>
<tr>
<td>60 sec.</td>
<td>507’</td>
<td>709’</td>
<td>1013’</td>
<td>1418’</td>
<td>2026’</td>
</tr>
<tr>
<td>10 min.</td>
<td>0.8nm</td>
<td>1.2nm</td>
<td>1.7nm</td>
<td>2.3nm</td>
<td>3.3nm</td>
</tr>
</tbody>
</table>

So how do you find sailors who fall overboard?
121.5 MHz Beacons
Cessation of Reception Beacons
Personal Locator Beacons
AIS/DSC Beacons
AIS/DSC Beacons
Please enter your MMSI into the box below, and select any DSC options you want to enable

Enter MMSI: MMSI

☑ Enable DSC Relay

Enter Group MMSI: GROUP MMSI

Next  Help Me!  Restart  Load
Final thoughts

- Rescue 21 works best with DSC: meet the CG halfway
- AIS is an excellent anti-collision tool, presuming the other guy has it.
- Don’t compromise on your VHF antenna installation
- A SEND device has its place, but start with an EPIRB
- A MOB beacon will allow your vessel and the fleet to find your MOB
- Don’t be too creative: use the stuff the pros use