GPS/GNSS BACKUP WITH AUTOMATIC RADAR POSITIONING

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PROVIDING SAFE NAVIGATION
POSITION DETERMINATION BY SHOWING TRANSPARENT RADAR IMAGE (GREEN) OVER CHART

RADAR IMAGE OVERLAY

MANUAL RADAR POSITIONING
THIS FEATURE’S MOST SIGNIFICANT ATTRIBUTES ARE:

1. INDEPENDENT POSITION VERIFICATION AT A GLANCE

2. GREATLY IMPROVED RADAR IMAGE INTERPRETATION.
BUOY POSITION CHECKING

OFFSET ERROR DETECTION AT A GLANCE

RADAR / CHART MATCHING
GOOD CHART-TO-RADAR MATCH

CHART-TO-RADAR MISMATCH INDICATES POSITION OR CHART DATUM ERROR

POSITION VERIFICATION AT A GLANCE
RADARFIX POSITIONING WITH REFLECTORS

- PATENTED REFLECTOR DEVELOPMENT
- DESIGN HAS HIGHER RADAR CROSS SECTION AND YIELDS WIDER HORIZONTAL RESPONSE

INITIAL APPROACH WITH CORNER REFLECTOR

MODIFIED CORNER REFLECTOR AS USED WITH RADARFIX

SPECIALIZED REFLECTOR DEVELOPMENT
RELATIVELY EASY REFLECTOR SETUP

PASSIVE REFLECTOR INSTALLATIONS
# Radar Cross Section Examples

<table>
<thead>
<tr>
<th>Description: Type of Vessel / Reflector</th>
<th>m²</th>
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</thead>
<tbody>
<tr>
<td>Small Pleasure Boat 20-30 ft long</td>
<td>2</td>
</tr>
<tr>
<td>Boat 40 to 50 ft long</td>
<td>10</td>
</tr>
<tr>
<td>Fishing Boat</td>
<td>200</td>
</tr>
<tr>
<td>Ship 65 m (213 ft) long, 1,100 ton displacement</td>
<td>1,000</td>
</tr>
<tr>
<td>Ship 83 m (272 ft) long, 2,300 ton displacement</td>
<td>2,200</td>
</tr>
<tr>
<td><strong>MV Atlantic Freighter</strong> 154 m (505 ft) long, 8,661 tons Deadweight</td>
<td>8,500</td>
</tr>
<tr>
<td><strong>MV Caribou</strong> 179 m (587 ft) long, 16,203 tons displacement</td>
<td>16,203</td>
</tr>
<tr>
<td>Conventional Corner Reflector-Trihedral, 0.66 m Corner Length</td>
<td>835</td>
</tr>
<tr>
<td><strong>RADARFIX</strong> Corner Reflector, 0.66 m Corner Length</td>
<td>3,339</td>
</tr>
<tr>
<td>Conventional Corner Reflector-Trihedral, 1.00 m Corner Length</td>
<td>4,142</td>
</tr>
<tr>
<td><strong>RADARFIX</strong> Corner Reflector, 1.00 m Corner Length</td>
<td>16,571</td>
</tr>
</tbody>
</table>

As a rough measure, the Radar Cross Section (RCS) of a ship can be approximated by the ship's displacement in tons.
DETECTING TARGETS IN SHORE CLUTTER

DEEP COVE AREA IN NORTH VANCOUVER WITH HIGHLY RADAR-CONSPICUOUS SHORELINE

RADAR POSITIONING - RADARFIX
• TRIHEDRALS ARE A KNOWN QUANTITY – ALWAYS A POINT SOURCE
RADARFIX TARGET DETECTION

LATER DEVELOPMENTS
RADAR CROSS SECTION VS AZIMUTH ANGLE

RCS (DBSM)

AZIMUTH ANGLE (0)

-40 -30 -20 -10 0 10 20 30 40

RADARFIX CORNER REFLECTOR EXTENDED
RADARFIX CORNER REFLECTOR COMPENSATED
STANDARD CORNER REFLECTOR

RADAR CROSS SECTION
RADAR POSITIONING

• 1988: TRIALS ON FERRY MV ATLANTIC FREIGHTER, THEN OPERATIONAL ON 179 M (587 FT) MV JOSEPH AND CLARA SMALLWOOD AND MV CARIBOU

• CONTINUOUS USE OVER SIX YEARS AT PORT AUX BASQUES AND ARGENTIA

• 1991: ACCURACY AND SUITABILITY TRIALS BY CANADIAN COAST GUARD
INTEGRATES ALL AVAILABLE NAVIGATION SENSORS

DOCKING AT PORT AUX BASQUES, NFLD
• OPERATIONAL SYSTEM INSTALLATIONS ON MV CARIBOU AND MV JOSEPH AND CLARA SMALLWOOD

• PRIMARY USE: HARBOUR APPROACH AND DOCKING (BERTHING) IN REDUCED VISIBILITY CONDITIONS

• DIFFERENTIAL LORAN-C INTEGRATION FOR OPEN WATER

• SYSTEM STARTS TRACKING AT 22 km WHEN IN SIGHT OF TARGETS AND “LOCK-ON” AT 13-15 km
FERRY OPERATIONS

- NOTORIOUS FOR HAZARDOUS APPROACH, FOG, HIGH WINDS AND SNOW STORMS

M.V. JOSEPH AND CLARA SMALLWOOD:

M.V. CARIBOU:
DOCKING MANEUVER IN HEAVY FOG

PORT AUX BASQUES INSTALLATION
MV JOSEPH AND CLARA SMALLWOOD ARRIVING AT PORT AUX BASQUES

AUTOMATIC RADAR-POSITION INTEGRATION WITH DGPS
MV CARIBOU DEPARTING P.A.B.

PORT AUX BASQUES INSTALLATION
MV JOSEPH AND CLARA SMALLWOOD DEPARTING PORT AUX BASQUES

PORT AUX BASQUES INSTALLATION
“Rain and Snow. Before the introduction of the early system, radar positioning, we were more or less on our own when docking at PAB. Many a time during the winter months we would be waiting outside PAB for weather conditions to improve. With the introduction of the first electronic system on board the vessels, times began to change and entrance into PAB due to heavy rain and snow became a thing of the past.”

“Dense Fog. We worked in this scenario nearly every day for several months during the Summer. We experienced no trouble with equipment during these conditions.”

“Ice Conditions. Using just radar, when operating close to Port Aux Basques, you had to visually see where you were. Ice and the land became one. With the radar assisted positioning on the Electronic Chart, all that changed…When zero visibility came about during the winter months, with ice close to the land, you had faith in the system and proceeded accordingly. At all times we used caution, but it was a really reliable system.”

“Docking and berthing. That is what it was all about. Dense fog in Argentia and PAB. Without the "system", we would be almost blind the last 2 to 3 hundred yards.”

Captain Ian Dalgarno, Senior Master, MV Joseph & Clara Smallwood
RADARFIX can extract measurements from existing radar targets of various shapes in an advanced manner to yield accurate range and bearing information. Detailed parameters about the size and shape of these targets are determined by RADARFIX after a precise position is established.

This allows the radar to work not only with isolated point sources, but to use information from larger structures, such as faces and corners of buildings, edges of docks, and line-ends evident on jetties.

Using existing structures
LEADING RADAR RANGE MARKERS

PERMITS SIMPLE IN-BOUND AND OUT-BOUND USE OF RANGE IN ANY KIND OF VISIBILITY

LATER DEVELOPMENTS
IMO’s e-navigation strategy includes risk-control option #5: improved reliability and resilience of on-board PNT systems.

Radar positioning is a terrestrial-based backup to GNSS/GPS. Automatic radar-position integration with GPS considering requirements.
IMMEDIATE AUTOMATIC RADARFIX BACKUP UPON GPS / GNSS LOSS

- AUTOMATIC ACQUISITION ADDS TARGET TO TEMPORARY STORAGE WITHIN A FEW SCANNER ROTATIONS
- WILL SEARCH FOR DATABASE BUT IMMEDIATE RESPONSE IN NEW AREA
- MOVED TO PERMANENT DATABASE AFTER ADDITIONAL PROCESSING
- ON-LINE STATUS INDICATORS
- WILL ALWAYS WORK WHEN WITHIN RADAR RANGE
- ACCURACY IS RELATED TO RANGE AND GEOMETRY

AUTOMATIC RADAR-POSITION INTEGRATION WITH GPS

LATER DEVELOPMENTS