Implementation of WGS84 and GPS for Marine Navigation

Dr Terry Moore
Institute of Engineering Surveying and Space Geodesy
The University of Nottingham
The Project Consortium

- IESSG, The University of Nottingham
- General Lighthouse Authorities
  - Trinity House Lighthouse Service
  - Northern Lighthouse Board
  - Commissioners of Irish Lights
- Port of London Authority
- United Kingdom Hydrographic Office
Project Overview

Implementation of WGS 84

- WGS 84 for Navigation Charts
  - UK Hydrographic Office
- Coordination of Port Facilities
  - Port of London Authority
- Coordination of Aids to Navigation
  - General Lighthouse Authorities
- WGS 84 as a Vertical Datum
  - Port of London Authority
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- **Precision Navigation**
  - Port of London Authority

- **GNSS Systems Integration**
  - Port of London Authority (VTS)
  - General Lighthouse Authorities (Loran-C)

- **GNSS Integrity Assessment**
  - All Partners
Chart Datum Transformations

- Test areas in UK and Ireland
- Current chart shift parameters show good agreement on average with transformed coordinates
- Variations (up to 20m at long range)
- Agreement between OSTN97 and UKHO method better than 2m
- UK and Ireland OK - but what about other regions?
- What if no published datum, or known parameters?
WGS 84 as Vertical Reference Datum

WGS84 Position of Vessel

Underkeel Clearance

WGS84 Referenced Seabed

Ignores Sea, Tides etc..
Port of London Trials

GPS Antennas
River Thames Trial Trajectory
GPS Accuracy Evaluation

Mean = 3.589 m   RMS = 5 mm
Height of Vessel

![Graph showing height of vessel over time](image)
GPS Heights of Survey Boat
GPS River Level

Height (m) vs. GPS time (second)

- RTK GPS
- Tide Gauge at Tilbury
## Aims

- Assess **Quality** of Existing Coordinates
- Identify Potential Problems
- Define Survey Procedure(s)
- Estimate Effort Required
- Estimate Scale and Cost of WGS84

## Implementation
Quality of Existing Coordinates

Radar Site Number vs. Coord. Difference (m)

- Site 1: 100 m
- Site 2: 50 m
- Site 3: 25 m
- Site 4: 0 m
- Site 5: 50 m
- Site 6: 0 m
- Site 7: 200 m
- Site 8: 25 m
- Site 9: 0 m
Why then no Incidents?
Coordination of Navaids to WGS 84

Lighthouses

Radionavigation

Buoys

From the Air or at Sea
Implementation of WGS84
Coastal Aids to Navigation

Sound of Mull

Shannon Estuary

Thames Estuary
Shannon Estuary Survey Ship
## Classification of Surveyed Points

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
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<tbody>
<tr>
<td>Lighthouse</td>
<td>6</td>
</tr>
<tr>
<td>Leading Light</td>
<td>4</td>
</tr>
<tr>
<td>Navigational Light</td>
<td>2</td>
</tr>
<tr>
<td>Radar Site</td>
<td>1</td>
</tr>
<tr>
<td>Tide Gauge</td>
<td>1</td>
</tr>
<tr>
<td>OSI Mark</td>
<td>7</td>
</tr>
<tr>
<td>Buoy</td>
<td>3</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>
Approach

Surveyed WGS84 Coordinates

Transformed to Chart Coords

Chart Coordinates

7 parameter OSI Transformation (0.5m Accuracy)

Compare
Lights and Lighthouses

Coordinate Error (m)

Reference Number

1 2 3 4 5 6 7 8 9 10 11 12
VTS Radar

945m!
Brown’s Castle B’Bunnion Landmark

6534m !
However,

Rubbish In

Transformation?

Rubbish Out
Size of the Task

• Lighthouses
  - THLS 67
  - NLB 196
  - CIL 80

  343

• Buoys
  - THLS 413
  - NLB 185
  - CIL 147

  743
The Broad Financial Implications

### Fixed Aids to Navigation
- **Requirement**: 10cm Accuracy
- **Approach**: Static GPS positioning
- **Production**: 5 points per day (average)
- **Resources**: 2+1 staff, plus equip & mobility

### Floating Aids to Navigation
- **Requirement**: 10m Accuracy
- **Approach**: DGPS positioning
- **Production**: 10 points per day (average)
- **Resources**: 2+1 staff, plus equip & mobility
A Recommended Approach : Navaids

1) Re-Position All Fixed Facilities

2) Re-Position all Critical Floating Aids to Navigation

3) Transform Coordinates of Non-Critical AtoN
   Provided the transformation is extensible

4) Verify Coordinates of Non-Critical AtoN
   Preferably during routine operations