Differential eLoran trials in Harwich harbour

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Differential eLoran Performance Evaluation

- **Contract:** Trials conducted by the General Lighthouse Authorities of the United Kingdom and Ireland
- **Purpose:** Assessing the performance potential of eLoran, using ASF maps and Differential Loran
- **Targets:**
  - Harbour Entrance and Approach accuracy requirements (8-20 m)
  - IMO A915 accuracy requirements for future GNSS (10 m)
- **Measurements:** 3 days of measurements, 19-21 April 2006
- **Location:** Harwich, 67 miles east of London
- **Results input to:**
  - GLA’s “case for eLoran”
  - Manchester ENC conferenc
Differential eLoran trial logic

- Two measurement set-ups acting as
  - differential eLoran station
  - mobile ASF measurement unit
- Two measurement days
  - Data collection for ASF map generation
  - Data collection for differential eLoran showcase using ASF map of day before and current differential eLoran corrections from reference station
Differential eLoran trial logic - 2

- Wednesday was used for equipment installation and calibration
- Thursday was used to measure the Additional Secondary Factors (ASFs) and create an ASF map of the Harwich area
- Friday a stand-alone eLoran measurement run was done, using the ASF map created the day before. dLoran corrections were applied in post-processing
- Data collection of eLoran TOAs, eLoran Heading, (D)GPS position and velocity information, timing relation between eLoran and GPS
Differential eLoran set-up

- eLoran TOA measurements
- eLoran heading information
- GPS position measurements
- GPS velocity measurements
- GPS vs. Loran time info
Differential eLoran hardware

- LORADD ASF Measurement receiver
- NovAtel OEM-4 GPS receiver (DGPS)
eLoran constellation at Harwich

Distances of eLoran transmitters:

- Rugby: 176 km
- Lessay: 368 km
- Sylt: 564 km
- Soustons: 933 km
- Vaerlandet: 1062 km
Measurement vessel

Vessel used for trials: Trinity House “Ready”

- eLoran antenna
- GPS antenna (reference)
Antenna installation

eLoran antenna

GPS antenna
dLoran reference station

Reference station installed at Trinity House
ASF variations along the track

Distance on track [km]

ASF fluctuations [µs]

Lessay
Rugby
Sylt
Soustons

Harbour
Buoy “Sunk”

6731M
7499X
6731Y
6731Z
7499M
6731X
Creating the ASF maps

ASF map for Lessay
Reference Station measurements
(26 hours, Thursday & Friday)
Reference Station measurements

Single ASF for 26-hour period
Accuracy: 6.8 m (95%)

1-minute correction update based on 10-minutes observation time
Accuracy: 4.8 m (95%)
Reference Station corrections

- Reference Station correction generation (1 hour)
- 10-minute observation interval, 1-minute correction update
Differential eLoran show case

- ASF Map as generated from Wednesday and Thursday measurements
- Differential eLoran corrections collected at Reference Station (no real-time broadcast)
- Data collection of eLoran TOAs and Heading, DGPS position and velocity information
- eLoran positioning results generated in post-processing, no GPS assistance!
- 5-second integrated independent eLoran position solutions (no smoothing), all positions included in the statistics
The scatter plot represents the difference between DGPS and differential eLoran positioning.

Outer red circle: 99% measured accuracy – 11.1 m

Inner red circle: 95% measured accuracy – 8.7 m
eLoran accuracy results presented in Google Earth

Yellow line is difference between eLoran and DGPS positioning
Scale is 10 m/div
Conclusions

- Resulting dLoran positioning error with respect to DGPS:
  - 8.73 m (95%)
  - 11.12 m (99%)
  - <10 m (97.51%)

- Harbour Entrance and Approach accuracy requirements (20 m) are met
- IMO A915 requirements (10 m) are met
- Next step: real-time differential trials
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The End