DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2009/62

Fehmarnbelt Fixed Link

Side Scan Sonar Data Acquisition

Survey and Data Report

Jørgen O. Leth & Bernhard Novak

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF CLIMATE AND ENERGY

GEUS

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Contents

1. Introduction

In the area of the planned fixed link across the Femern Belt, a side scan sonar survey has been performed to provide data for biological assessments studies within the near shore areas of Germany and Denmark. The survey was conducted during May and June 2009 including the time of data acquisition and post processing. The project was carried out in cooperation with DHI Water • Environment • Health.

1.1 Scope of Work

Within the 30 km wide area for the multibeam mapping, the areas of the side scan sonar survey have been delimited by water depths between 2 and 6 metres off the Danish as well as the German coastlines (figure 1). As the areas within a 5 kilometre zone around the ports of Puttgarden and Rødby have been surveyed as part of the marine archaeological mapping programme, these parts have been excluded in this context.

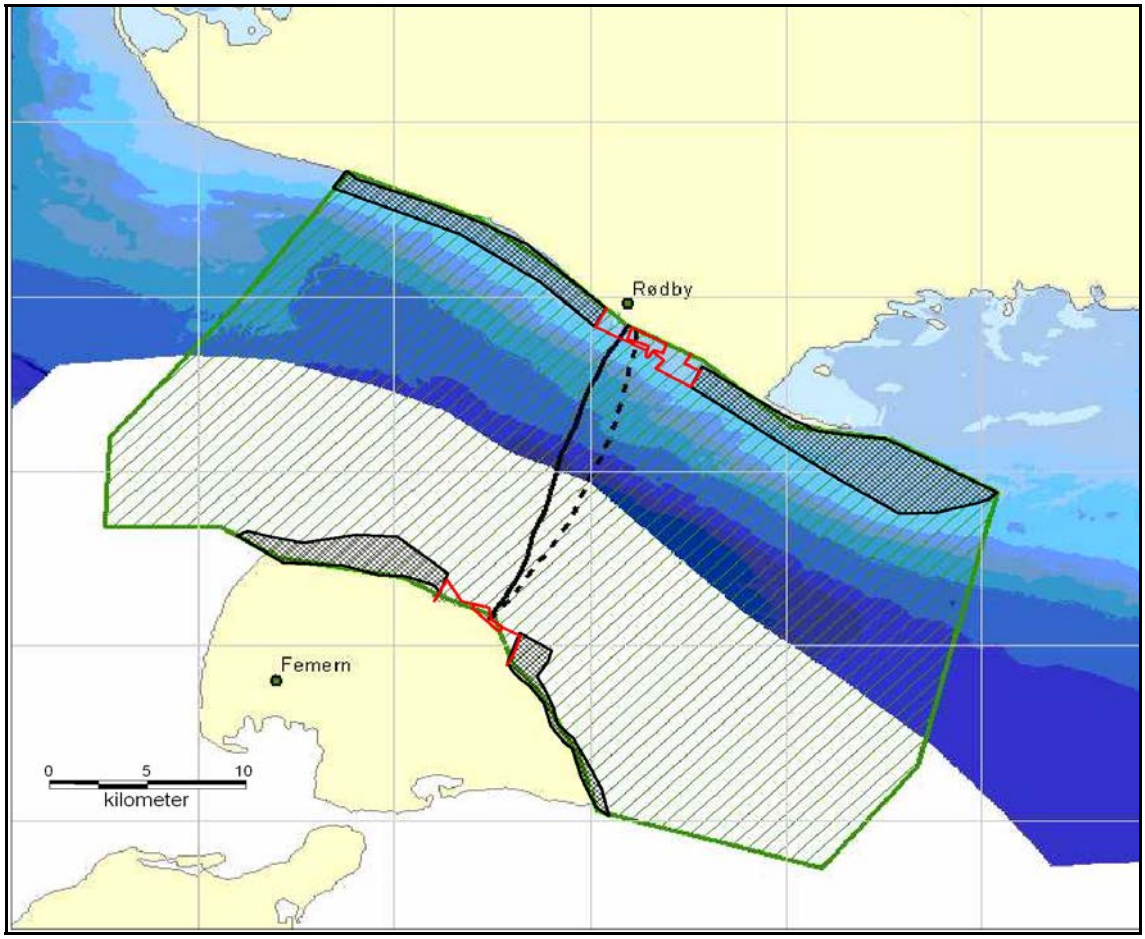

Figure 1. Overview of the Femern Belt region with the multibeam mapping areas (green box). The four areas for the side scan survey is shown by the dark hatched. The areas of the marine archaeological programme are marked by red frames.

1.2 Permissions

The survey programme has been performed in accordance with the special permission from the Danish Maritime Safety Administration reference number 2009-002302 of 7th May 2009.

1.3 Survey programme

The survey programme was subdivided into four separate areas: two along the Danish coastline (east and west of Rødby) and two along the German coastline (east and west of Puttgarden). The four areas with a simplified line grid are presented in figures 2 – 5 below.

The outline of the survey grid was defined to ensure 100% coverage by the side scan sonar. From a starting point the line spacing between was set to 25 meters, but at the deepest part the spacing was increased to 50 meters with a resulting overlap between the lines of 50%.

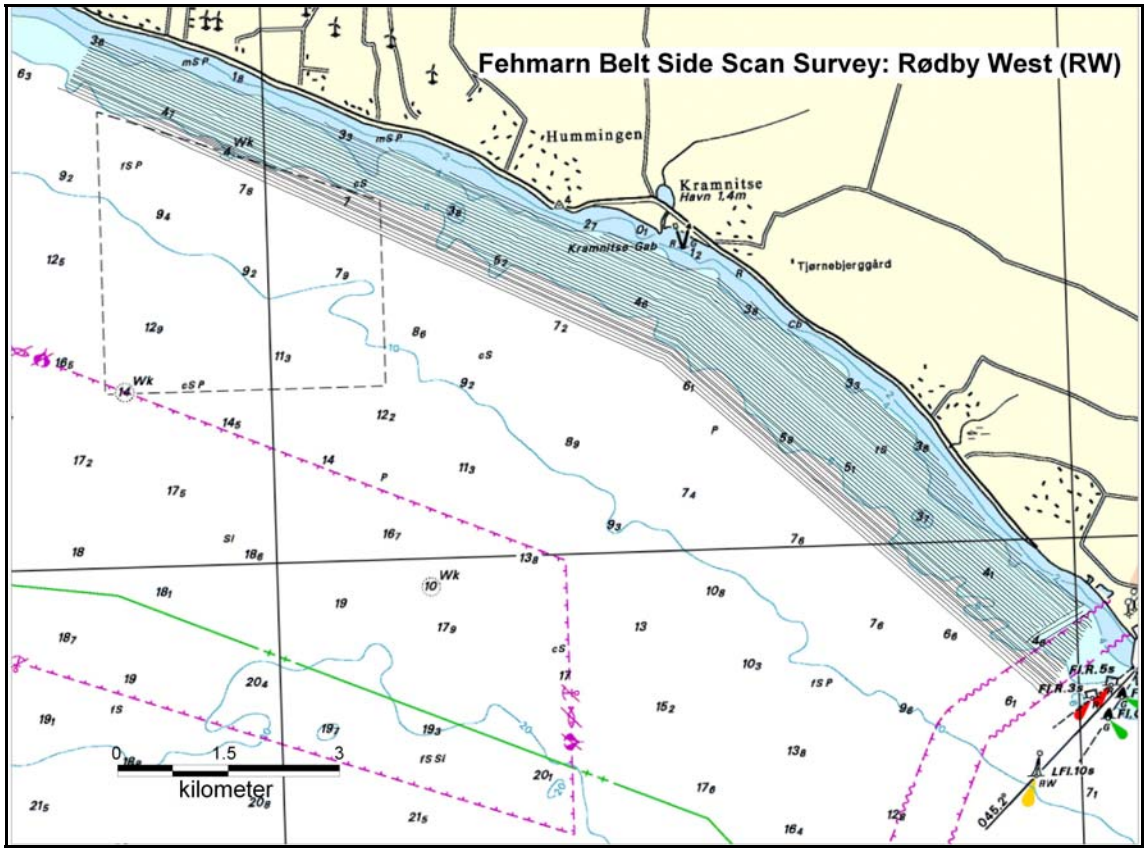

Figure 2: Track plot of the survey area west of Rødby (RW).

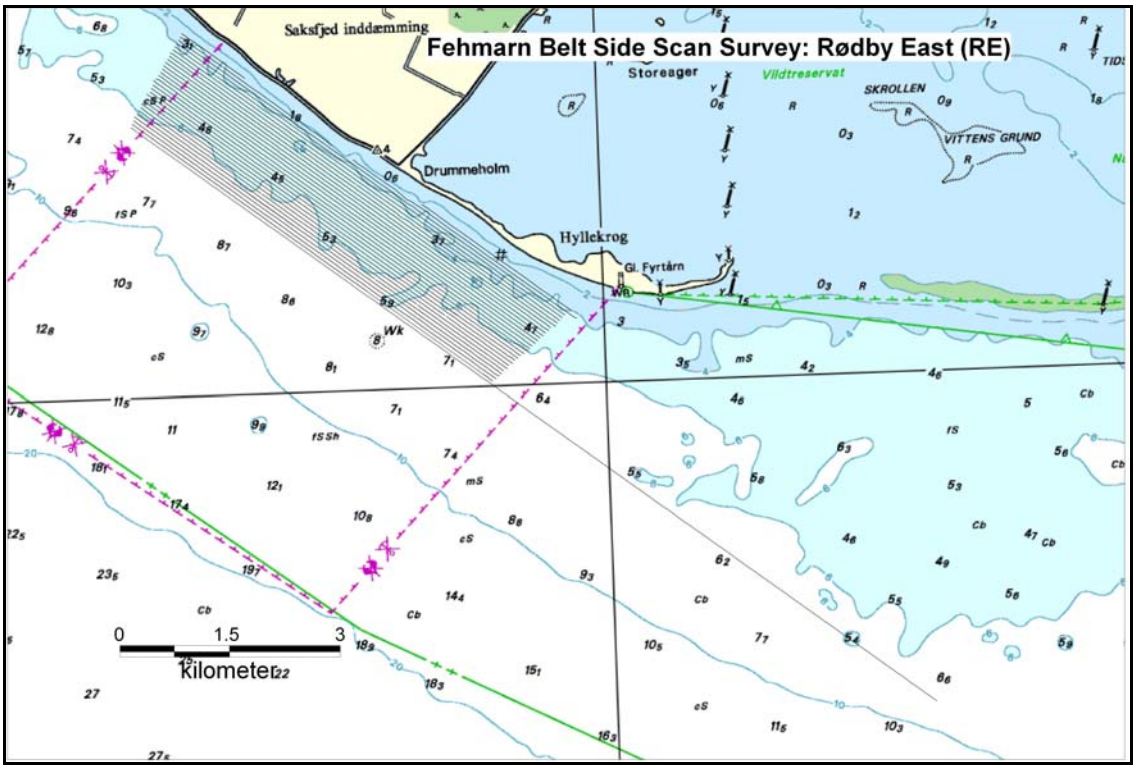

Figure 3: Track plot of the survey area east of Rødby (RE).

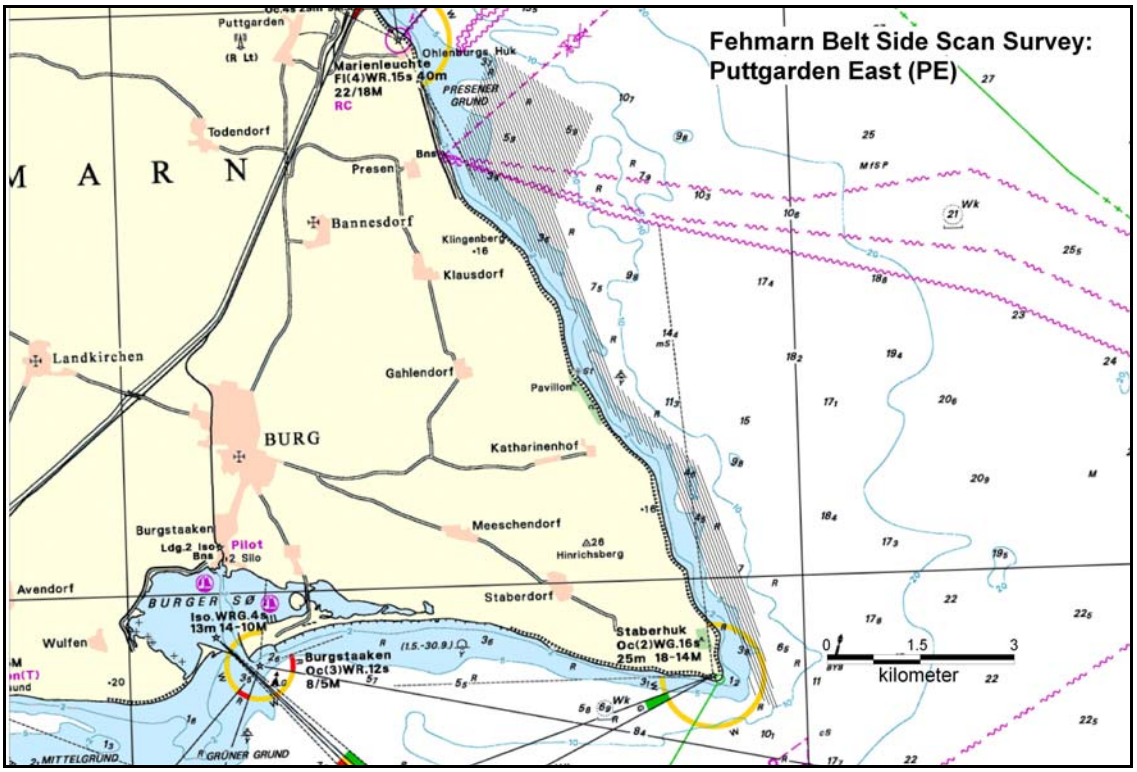

Figure 4: Track plot of the survey area east of Puttgarden (PE).

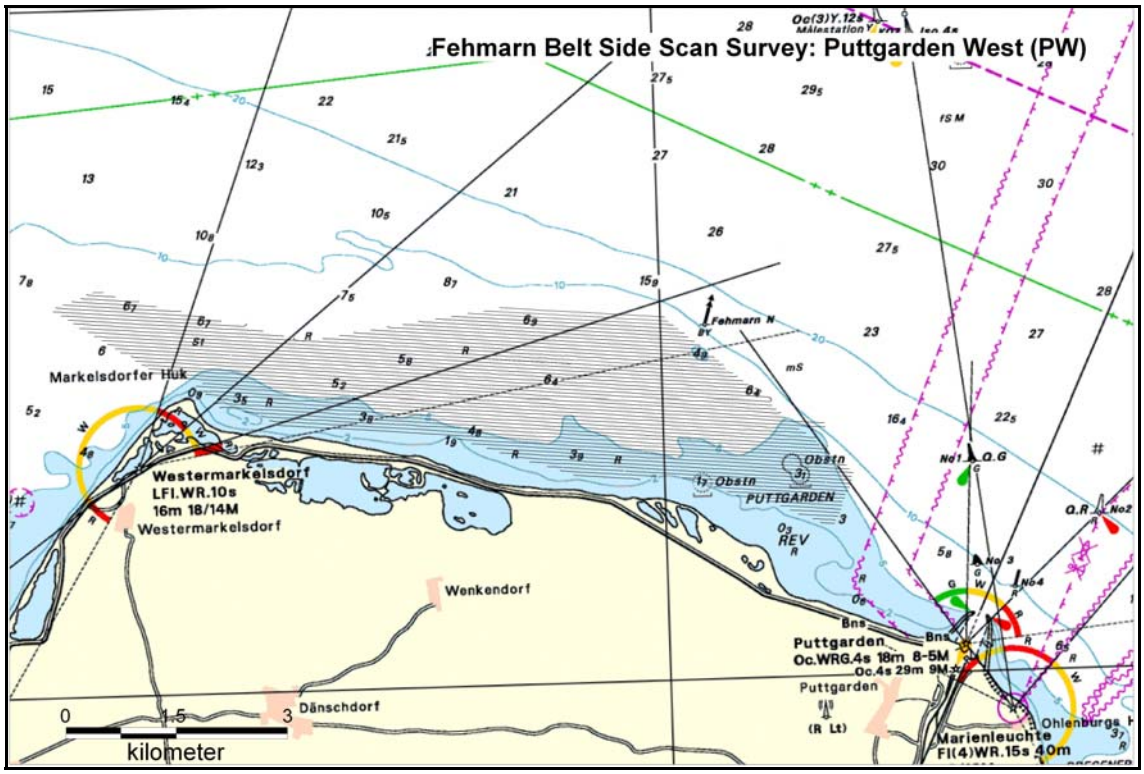

Figure 5: Track plot of the survey area west of Puttgarden (PW).

1.4 Deviations from scope of work

A wind farm construction site in the Rødby East area influenced the work. During surveying it turned out that an intense offshore work activity including anchoring vessels, dredging and chain lifts, conflicted with the survey activity. It was therefore decided to postpone the survey in the eastern part of the Rødby East area.

2. Acquisition programme and equipment

2.1 Survey period and crew

The survey was performed during the period 8th May to 6th June 2009. Due to the presence of navigation obstacles at shallow water (fishing nets and boulders), the survey work was conducted during daylight only.

The survey lines were planned parallel to the coast lines.

During the whole survey period the ships crews counted two members. One geologist performed the side scan sonar data acquisition and processing. During the periods of mobilization/demobilization and testing the survey crew was supported by the technical responsible engineers and a diver-welder.

During the data acquisition, the geologist in charge was responsible for the quality of the acquired data and the coverage.

The GEUS crew:
Engineer: Lars-Georg Rödel
Diver: Johnny Jørgensen
Geologist: Bernhard Novak

The ship's crew:
Bjarne Tved
Peter Djørup
Palle Nielsen
Hans Hagerup
John Riis.

2.2 Survey vessel

The survey vessel ”Føniks Miljø” (figure 6) owned by Føniks A/S in Copenhagen was used during the entire survey period. The ship’s dimension is: length 18m, width 4m and draught 1.80m. The survey speed was approximately 4 knots.

Figure 6. The survey vessel ”Føniks Miljø”.

2.3 Equipment

2.3.1 RTK Navigation system

An AD Navigation DC200 GPS/GLONASS L1/L2 RTK Long Range Receiver was used for the survey. For technical details of the RTK receiver system see appendix 1.

Details on the RTK reference station for the Femern campaign are included in appendix 2.

2.3.2 Navigation acquisition software

The NaviPac software is an integrated navigation and data acquisition software specifically suited for general navigation and geophysical and acoustic surveying.

The NaviPac system was used for acquisition of navigation data and for the distribution of offset values for the instruments.

For technical details see appendix 4.

2.3.3 Side scan sonar

The Benthos SIS-1600 Series Side Scan Sonar has been used for the survey. It is a fully integrated system that uses advanced Chirp and conventional continuous wave (CW) technologies, single frequency or dual frequency, and an advanced high-speed communications link to acquire high resolution side scan sonar images. For technical details see appendix 3.

The Benthos SIS-1600 is a complete side scan sonar survey system that includes a topside acquisition system and software, a 100-meter tow cable, the CL-160 Communications Link, and the TTV-196D Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in two frequency bands (123 kHz and 383 kHz). Both frequencies have been recorded. The side scan range was set to 50m. The incoming side scan sonar and ancillary sensor data are time-stamped to millisecond accuracy, thereby ensuring the final data products can be properly corrected during processing.

Due to the shallow water depth and to optimize the data quality the TTV-196D side scan fish was mounted at a fixed position at the ships keel. The Triton-ISIS side scan software was used for data acquisition. Apart from acquiring data this software allowed as part as the quality assurance to process and playback data for presentation partly as individual survey lines, partly as side scan mosaics.

Data acquisition was done using the Triton-ISIS-software. All data were stored in Triton-ISIS open XTF (eXtended Triton Format), an industry-standard, non-proprietary format.

3. Data processing procedures

Two different softwares have been used for the processing: The Triton-Isis and the Chesapeake SonarWeb.

3.1 Triton ISIS - Triton Map

All raw data were quality checked during the survey using the Triton-ISIS-software. The post-acquisition processing of the side scan sonar data included time variant gain (TVG) adding and correction for the fish depth above the seabed (slant range correction).

Subsequently, and agreed by the client, the processed files of the 400kHz frequency were mosaiced and exported as geo-tiff files using the Triton Map software. The geo-tiffs were generated in two different resolutions, 0.25m and 1.00m.

During the geo-tiff export, when using the Triton Map software, stripes have been generated due to a software problem. It is seen as blurred bands across the geo-tiff picture files. GEUS has presented this problem to the Triton-ISIS Company, but they didn't have any solution. Fortunately this striping does not influence the production of the side scan mosaic or the evaluation of the seabed sediments. The raw XTF-data and the processed VIF files are not affected by this.

Navigation files were extracted from the XTF-files generating a series of ascii files that could imported to MapInfo.

3.2 Sonar Web

A second processing and mosaicing of the side scan data has been performed by use of the Chesapeake software Sonar Web generating mosaics in both 0.25 and 1.0 meter resolution. This extra processing procedure is considered as a extra quality check of the survey data.

3.3 GIS

Map Info was used during the processing to generate mosaics from geo-tiffs and to generate track plot images. The Sonar Web mosaics were imported into MapInfo and geo-registered. Mosaics from both sets of geo-tiffs 0.25m and 1.0 m were generated. Subsequently, the mosaics were saved as jpg-files in 300, 600 and 1200 dpi.

4. Data products

All data has been copied onto an external hard disc, containing all acquired raw data and all relevant processing products and delivered to the client. The folder structure of the data disc is shown in figure in figure 7.

After the delivery of the data disc the client has asked GEUS to re-process the 400 kHz side scan data with another parameter setting. This work has been fulfilled by the 23rd September. The newly processed data has been transferred to and received by the client via GEUS's FTP-server.

4.1 Nomenclature of the hard disc

4 sub-areas named:

FBPE = Femern Belt Puttgarden East
FBPW = Femern Belt Puttgarden West
FBRE = Femern Belt Rødby East
FBRW = Femern Belt Rødby West

The survey lines are orientated coast parallel (figure 2 to 5). Naming of raw data files has an area code – RW, RE, PW or PE - followed by a number indicating distance in meters from a 0 m reference line. The 0 m reference line defines the termination of the area seawards.

A subscript - A, B.....etc. added to the line name indicates separate parts of a line (A closest to the ports area and B, C continuously more distant from the port)

A few exceptions from these rules are:

1) Three cross lines in the **RW** area are named X followed by a number indicating approximately distance in meters from eastern end of the RW area.
2) One extra line in the **RW** area is named by the area code number, followed by "Extra".
3) Minus lines in the **PE** area are named by the area code followed by a number and a subscript ADD indicating seawards distance in metres from the 0 m reference line

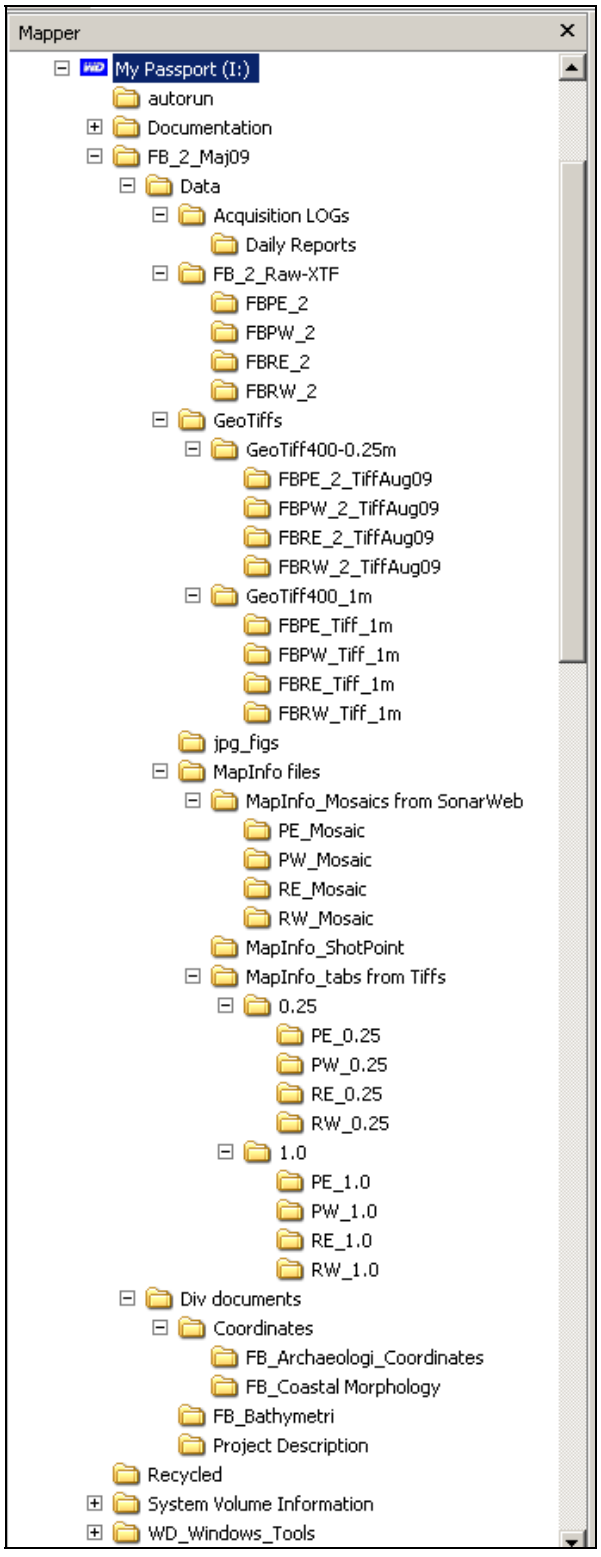

Figure 7. Readme file for the Femern Belt side scan project data disc.

4.2 Data disc structure

FB_2_Raw-XTF:
Raw data in XTF format for the 4 sub-areas

GeoTiffs:
Two sets of GeoTiffs are produced using TritonMap software from the 400 kHz XTF-data sets for each of the four sub-areas:
One set in a resolution of 0.25m: **GeoTiff400-0.25**
One set in a resolution of 1.00m: **GeoTiff400_1m**
The corresponding MapInfo tab-files are stored in the folder **MapInfo_tabs from Tiffs for 0,25m and 1m data respectively.**

Another set of files for mosaicing has been produced using the Sonar Web software. From these files mosaics have been produced in Sonar Web.
jpg_figs: The 4 mosaics from Sonar Web exported as jpg.files in 3 different resolutions (300, 600 and 1200 pixels).

MapInfo Mosaics from Sonar Web: The highest resolution (1200) jpg-files have been imported (geo-coded) into MapInfo and tab-files produced.

MapInfo_ShotPoints: Shotpoint maps (and tab-files) for each of the 4 sub-areas presenting the survey lines used for the mosaicing.

Div. documents = background information related to the project and the other ongoing Femern Belt projects (the Marine Archaeology and Coastal Morphology projects).

Appendices

List of appendices

Appendix 1: Technical specifications of the RTK system receiver system.

Appendix 2: Technical specifications of the RTK system reference stations

Appendix 3: Technical specifications of the The Benthos SIS-1600 Series Side Scan Sonar system

Appendix 4: Technical specifications of the navigations software - NaviPac

Appendix 1:

Technical specifications of the RTK system receiver system.

AD NAVIGATION

SERIES

DC 200

GPS/GLONASS L1/L2 RTK RECEIVER

One Button. Millions of Signals.

Specialists in Precise GPS Navigation

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SERIES
DC 200
GPS/GLONASS L1/L2 RTK RECEIVER

AD Navigation DC200-series

GPS/GLONASS L1/L2 RTK Receiver

With a 19" rack form factor, the new DC-200 series RTK receivers from AD Navigation provide real time positioning data at the 1 cm level while attaining the highest reliability and stability possible. The DC-200 series RTK receivers are specifically designed to meet the most demanding requirements from the hydrographic and dredging industries.

Unique Advantage of Seamless Combination GPS and GLONASS

The heart of the AD Navigation DC-200 RTK receivers is built around the world's most advanced GPS/GLONASS L1/L2 technology. By seamlessly combining the GPS and GLONASS system, the DC-200 series RTK receivers access the total of 40 positioning satellites. During normal operation, the DC-200 series RTK receivers track 30-50% more satellites than does a GPS-only system.

Integrated High Quality UHF Receiver

The DC-200 series RTK receivers integrate a UHF receiver. By using diversity receiver techniques (dual antenna system), reception of the UHF signal is significantly improved, even under difficult radio conditions. The base station sends CMR corrections at up to 5Hz. The diversity receiver technique, in combination with high update rate of CMR correction broadcasts, results in operational RTK up to 80 kilometres from the RTK base station!

Optional Heading

As an attractive option, the DC-200 series can offer precise heading. With two GPS/GLONASS antennas installed, accuracies of 0.01 deg are achieved at 10 times per second. The unit contains no moving parts, and neither calibration nor maintenance is needed.

User Friendly 19" Rack System

This state-of-the-art technology is available in a 19" rack form factor, making your installation very easy. GPS/GLONASS, UHF radio, and PPS TTL device, are all built into one box. User configuration is minimal; the receiver installation is plug and play.

RTK Reference Station

For RTK Operation, AD Navigation supplies the compact DC201B as GPS/GLONASS L1/L2 Reference Station.

Specialists in Precise GPS Navigation

Let the waves rock your boat
... not your GPS

User Experiences

For some time now, the Survey and Dredging Departments of the Port of Rotterdam Authority have been using this technology from AD Navigation on all of their hydrographic vessels.

"We have been using various RTK positioning systems for almost a decade, and up until now, have seen inconsistent GPS performance. With the DC-200 series RTK receivers from AD Navigation, our down time as a result of poor GPS/RTK performance and satellite drop-outs is now reduced to zero, even under the most difficult satellite tracking conditions close to large vessels, buildings, bridges and container cranes."

Jeroen van Reenen
Head of the Hydrographic Department
Port of Rotterdam

Highlighted Features

- **GPS/GLONASS L1/L2 Tracking**
- **5 Hz Update Rate (20 Hz optional)**
- **Precise Heading Option**
- **Integrated UHF with Diversity Reception**
- **WAAS/EGNOS Capability**
- **Integrated PPS with TTL Pulse, RS232**
- **4x DB9 Com Ports**
- **19" Mounting Rack System**

One Button. Millions of Signals.

AD NAVIGATION

Technical specifications

Tracking:
20 Channel Dual Constellation (DC) GPS/GLONASS L1/L2
Cold start: < 60 seconds
Warm start: < 10 seconds
Reacquistion: < 1 second

Processing: Co-op Tracking and Advanced Multipath Reduction

DC200 Series RTK Positioning[1] and Heading Accuracies[2]:
Horizontal: 1 cm + 0.15 ppm RMS (DC201/202)
Vertical: 1.5 cm + 0.15 ppm RMS (DC201/202)
Heading: 0.01 degrees RMS (DC202 only)

Update Rate:
Positioning: 5Hz (DC201/202) 20Hz Optional
Heading: 10Hz (DC202 Only) 20Hz Optional

RTK Initialisation[1]: Typically 10-30 seconds

Operating Range[3]: Up to 80 km

Built-in UHF Radio Modem:
Frequency Range: 380-470 MHz
25 Khz Channel Separation
19,200 bps on Air Transmission
Diversity Reception (Dual Antenna System)

Timing:
External PPS Output
PPS to TTL converted to RS232 Interrupt Signal

Output formats:
GPS based NMEA-0183 Messages
Proprietary ASCII and Binary Output Formats
CMR/RTCM, Differential Corrections

Input Formats:
CMR/RTCM, Differential Corrections

Accessories:
GPS/GLONASS L1/L2 Marine Antenna
AC and DC Power Cables
DB 9 Serial Cables

Physical specifications

Power input: 12-28 VDC or 110-230 AC

Size: 2U 19" rack unit, 254 mm (d), 89 mm (h)

Weight: 4.8 kg

Environmental: Vibration, EMI: EN 60945

Temperature:
Operation: -20 to 55°C
Storage: -40 to 70°C

Communications:
4 x RS232 com ports, DB9, 115,200 bps
1 x RS232 TTL , DB9
1 x PPS output, BNC-F
1 x GPS antenna input, TNC-F (N optional)
2 x UHF antenna input, TNC-F (N optional)

[1] *Performance is dependent on GPS/GLONASS satellite geometry, environment, ionospheric conditions and distance to the base station*
[2] *Antenna separation > 10 meter*
[3] *Operating range is depending on availability of differential correction data*

Note: Specifications subject to change without notice.

www.adnav.com

SERIES
DC 200
GPS/GLONASS L1/L2 RTK RECEIVER

AD NAVIGATION

AD NAVIGATION AS
SANNESUNDVEIEN 6 - POBOX 399
N-1702 SARPSBORG - NORWAY
PHONE: +47 69 15 00 14
FAX: +47 69 12 55 47
EMAIL: INFO@ADNAV.COM

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Appendix 2:

Technical specifications of the RTK system reference stations

Client: **GEUS**
Lars Rödel

Femern campaign.
RTK: Reference stations.

Positioning Systems

Ref: Femern
Date:19-06-2009
Ver: final_ver1

Prepared by John Dahl
(jd@dansurvey.com)
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DK-3550 Slangerup
www.dansurvey.com
Phone +45 45354585

1. INTRODUCTION

EON operates one RTK reference station at Rødsand-2HR2. The RTK reference signal are broadcasted to all vessels via UHF, at frequency 449.100Mhz
This reference station is intended to be used initially throughout the area.

The base line is 10-28 km for the reference station at Rødbyhavn. The worst case accuracy is 5.5cm (XYZ, Equipment spec: 1.5cm+1.5ppm)

Starting with in-survey and geological investigations in 2006, this reference station has been used for the entire work.

The reference station coordinates has been verified by a chartered surveyor, using GPSnet-DK. Survey report can be requested.

For additional information, report malfunctioning etc.
Please contact Dansurvey.
Phone +45 45354585.
Mail jd@dansurvey.dk

2. GEODETIC PARAMETERS.

Geodetic Parameters: **UTM-EUREF-89. Zone 32N**
Vertical reference, DVR90

As there is no official transformation between WGS84 and EUREF89 at Rødsand 2, a 7 parameter transformation cannot be provided.
Presently work concerning a transformation between WGS84 and EUREF89 is in progress by officials. (KMS)

3. HEIGHT REDUCTION TO VERTICAL REFERENCE DVR-90.

The geoids model DVR-90 is an attempt to be MSL in 1990±10y. The model is accurate for the in-ways Danish water, and may not be absolute accurate to MSL at the Fermen area
In 2004, officials decided at all surveys, charts, C-maps and construction work shall use DVR-90 as vertical reference.

The height reduction to DVR90 can be carried out in one of three ways.

a.) The official geoids model, filename 'dvr90g2002.01'
This is a binary data file, which can only be handled by GPS manufactures and acquisition software,, which equipment are custom designed to import this file format.
b.) Fixed separation. A fixed separation can be calculated by use of the official program KMSTrans2007.
c.) Use interpolation model in sub-contractors acquisition software.

Link to Transformation software.:
http://www.kms.dk/English/Geodesy+and+Surveying/Transformation/

Download the program KMSTrans2008, and the responding geoids model dvr90g2202.01

4. PRIMARY POSITIONING SYSTEM. (ROVER)

The primary positioning system shall be RTK using GPS L1/L2. The GNSS receiver shall be capable of operating at long baselines
The accuracy archived all depends on the rover supplied by the subcontractor.

Please pay notice to the installation of the rover antenna. The GNSS antenna should have best possible free view to the horizontal above 12 degrees. Alternative there's a risk that the rover measurements gets unstable, running on multi path signals."

The elevation mask on the rover should be set to 12'. Our experiences indicates that - using not too low elevating mask when working on long baselines with different GNSS antennas.

The UHF antennas must be mounted in sufficient height to receive the reference at Rødbyhavn, (Line of sight) and further the antennas must have free horizontal view to avoid obstructions to block out the signal.

The UHF radio shall have 1-way connection only on the serial connection. This to insure the vessels rover can't cause the UHF radio to transmit, and by this interfere/jam the signals from the reference stations.

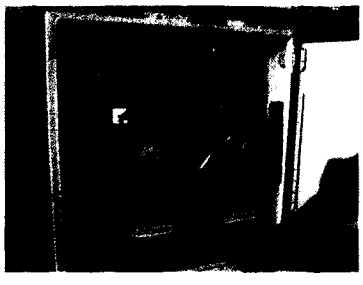
A positioning verification shall be carried out and demonstrated prior to the contractual work is initiated.
All systems and software used for navigation and transformation to DVR-90, shall be included in the verification.
(GNSS receiver, Acquisition software, Vessel reference unit, Vessel local reference measurement, etc.).

5. RØDBYHAVN RTK. REFERENCE, SPECIFICATION.

ID1: Reference Station: Rodbyhavn	
Station Name	**Station ID No: 1** Short ID: Rodbyhavn Long ID: Rodsand2
Reference Station co-ordinates. Geo_EUref 89 (WGS84) (WGS84)	Lat 54 39'18,81503 N Lon 11 20'57,32698 E Ellipsoid h = 90,314 m (Ant. APM to APC = 0.054+0.002m) Base-station h. 90.370 m (Entered value)
Reference Station co-ordinates. EUref 89 UTM Zone 32N	N 6058961.349 m. E 651550.376 m. DVR_90 h = 51.865 m. Geoide sep. 38.449 m (DVR90)
GNSS RTK receiver.	AD-Navigation model DC201B. L1/L2 GPS/GLONASS RTK receiver.
Measurements sent.	CMR format. (Reference coordinates = Antenna APC) GPS CA/L1,+P/L2, GLONASS L1 Update rate 5 hz. Time slot. 0.5 Period 0.25sec TX delay, 0.0s,
TX UHF radio specifications.	Telemetry: Satel 3AS Epic **Frequency 449.100 Mhz**, No addressing. TX power 10watt. Baud rate (Air) 19200. Omni directional antenna. (5db)
Rover telemetry: RX UHF Radio. (Recommended)	Telemetry: Satel 3AS Epic. Space diversity (Two antennas) **Frequency 449.100 Mhz**, . No addressing. Baudrate (RS232) 19200. Programmable. RS232 Connector DB9-F. RXd pin2.GND pin5. **Pin 3 (TX) must not be terminated due to risk of interference.**
Additional Information.	a.) DC-UPS, 30hours back up at 24volt. b.) Internet connection, fixed IP c.) GSM alarm & control. (SMS)

Figure 1: Rødbyhavn
GNSS antenna (LH) & UHF.

Coming up soon



6. PUMPESTATION: RTK. REFERENCE, SPECIFICATION.

ID2 Reference Station: Pumpestation	
Station Name	**Station ID No: 2** Short ID: PumpeStation Long ID: Rodsand2
Reference Station co-ordinates. Geo_EUref 89 (WGS84) (WGS84)	Lat 54 04.65043N Lon 11 28 18.00532 E Ellipsoid h = 45.5157m (Ant. APM to APC = 0.054m) Base-station h. 45.5697 m (Entered value)
Reference Station co-ordinates. EUref 89 UTM Zone 32N	N 6055086.8232 m. E 659591.4277 m. DVR_90 h = 7.154 m. Geoid sep. 38.3615 m (DVR90)
GNSS RTK receiver.	AD-Navigation model DC201B. L1/L2 GPS/GLONASS RTK receiver.
Measurements sent.	CMR format. (Reference coordinates = Antenna APC) GPS CA/L1,+P/L2, GLONASS L1 Update rate 2 hz. TX delay, 0.25s, 0.25 time slot. Period 0.5sec
TX UHF radio specifications.	Telemetry: Satel 3AS Epic **Frequency 449.100 Mhz**, No addressing. TX power 10watt. Baud rate (Air) 19200. Omni directional antenna. (3db)
Rover telemetry: RX UHF Radio. (Recommended)	Telemetry: Satel 3AS Epic. Space diversity (Two antennas) **Frequency 449.100 Mhz**, . No addressing. Baudrate (RS232) 19200. Programmable. RS232 Connector DB9-F. RXd pin2.GND pin5. **Pin 3 (TX) must not be terminated due to risk of interference.**
Additional Information.	a.) Internet connection, fixed IP b.) Not 24 hours accessible

Appendix 3:

Technical specifications of the Benthos SIS-1600 Series Side Scan Sonar system

The Benthos SIS-1600 Series Side Scan Sonar is a fully integrated system that uses both advanced Chirp and conventional continuous wave (CW) technologies—single frequency or dual frequency—and an advanced high-speed communications link to acquire high resolution side scan sonar images. The Benthos SIS-1600 is a complete side scan sonar survey system that includes a topside acquisition system and software, a 100-meter tow cable, the CL-160 Communications Link, and one of two available tow vehicles: the TTV-196 Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in a single frequency band; and the TTV-196D Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in two frequency bands simultaneously.

The Benthos TTV-196D side scan sonar tow vehicle.

System Highlights

▲ CL-160 Communications Link

▲ 100 kHz, 100m range

▲ 400 kHz, 100m range

▲ Topside sonar processor

System Features

The TTV-196D Tow Vehicle includes the transceiver electronics, the processing and communications electronics, the port and starboard side scan transducer arrays, the pitch, roll and heading sensors, and the optional sensors.

Features

■ Dynamic range - high frequency data up to 150m
■ Enhanced resolution
■ Repeatable transmitted waveforms
■ Constant temporal resolution
■ The pulse characteristics are programmable
■ Stainless steel construction

SYSTEM SPECIFICATIONS

Software

Application: Third party data acquisition and display (i.e.TEI “Isis Lite”, Chesapeake, “Sonarmap”)

Operating System: Microsoft® Windows® XP Professional

Hardware

Processor CPU: Intel® Pentium® 4 processor

Memory: 512 DDR SDRAM

I/O Ports: Wireless keyboard/mouse

RS-232 serial

Parallel

Ethernet 10/100 BaseT

Graphics Processor: Integrated high resolution graphics

Data Sorage: High capacity hard drive, CD/DVD-RW drive

CL-160 Communications Link

Physical Characteristics

Construction: 316 stainless steel

Dimensions: 11.4 cm (4.5 in.) outside diameter by 177.8 cm (70 in.) long

Weight in Air: 34 Kg (75 pounds)

Weight in Water: 25 Kg (55 pounds), approx.

Operating Depth: 1,750 meters

Towing Speed: 1 to 8 knots operational

Input Power: 144 VDC, 32 watts nominal

Side Scan Sonar

Acoustic Source Level: +225 dB re 1uPa @ 1m.

Range: 25 to 500m each channel

Frequency Range

Chirp Frequency Range:

(TTV-196D): Simultaneously sweeps in the 110 kHz to 130 kHz and 370 kHz to 390 kHz bands

CW Frequency

(TTV-196D): Simultaneous 123 kHz and 383 kHz

Transducer Radiation

(TTV-196D): 0.5 degrees horizontal, 55 degrees vertical (110 kHz to 130 kHz band), 0.5 degrees horizontal, 35 degrees vertical (370 kHz to 390 kHz band)

Appendix 4:

Technical specifications of the navigation software - NaviPac

Navigations software – NaviPac

The NaviPac software is integrated navigation and data acquisition software specifically suited for applications like:

- General navigation
- Hydrographic & oceanographic surveying
- Geophysical & seismic surveying

MODULARITY – NaviPac is modularity through use of multi tasking, multithreading and networking capabilities of the Windows NT, Windows 2000 and Windows XP operating system. The software is highly flexible and user configurable and the user interface adhere to The Microsoft Interface Guidelines making it very intuitive and easy to operate (figure 4).
NAVIGATION SET-UP – The NaviPac set-up module provides easy selection of geodetic parameters, navigation systems, devices, offsets and port settings.
DEVICE I/O DRIVERS – A vast number of field-tested device I/O drivers are provided for most available positioning systems, GPS/DGPS receivers, gyros, motion/attitude sensors, tide-gauges, single beam echo sounders, magnetometers, dynamic positioning systems, autopilots, etc. Generic I/O drivers allow definition or customization of own device I/O drivers. Data is interfaced via RS232, a LAN or via a digital I/O interface
TIME SYNCHRONIZATION – Time stamping of sensor data, incoming as well as outgoing, can be done in two ways, either by the internal computer clock or by he PPS output available from most GPS receivers. Using the PPS output data are synchronized relative to the GPS/UTC time frame, resulting in an accuracy of a few milliseconds.
SURVEY PLANNING – NaviPac allows for survey planning through quickly creation of planned survey area and survey lines. A variety of methods for creation of survey lines is provided, e.g. by click-and-drag (of mouse/trackball), input of survey line coordinates, offset (parallel) survey lines, cross lines, circles, arcs etc. Survey lines can easily be adapted to fit a defined survey area. Creation of templates allows input of other data formats.