Technical Specifications of
Front End Mobile Unit

February 2007
PART I – Real Time Tracking & Monitoring of Vessel (RTTMV) System Design

The RTTMV system consists of an Application Server (first tier) for managing data communication and system functions; a Primary Database Server (middle tier) for data storage; a Web Server and two workstations (third tier) for user applications. Computer apparatus are inter-connected through local area network switches and firewall. A dedicated leased line connection is used between the EPD control centre (CC) and GSM network operator, whereas FEMU are connected to the GSM network operator through the GPRS network. A broadband connection to the global internet is connected to the firewall for providing external access to the web server.

PART II – Front End Mobile Unit (FEMU) System Components Diagram

The FEMU, as illustrated in Figure 1, consists of a data capturing and communication unit, a processing unit, data storage media, a portable printer, a GPS receiver, a draught sensor, a split-bottom control button, a network camera and backup batteries. The FEMU is housed in a waterproof enclosure with key locks.

Data records are sent back to EPD Control Center for real-time monitoring and short dumping detection. Data records transmitted and stored in Control Center should be identical to the corresponding virgin data captured and stored in FEMU.
Figure 1 – Front End Mobile Unit (FEMU)
PART III – FEMU Functional Requirements

- Capture GPS positioning data from GPS receiver.

- Capture draught level from draught sensor and convert it from analog electrical signal to digital data.

- Detect split-bottom control button status.

- Control network camera and take snapshots.

- Interface with key locks for managing system configuration and data downloading.

- Display basic information including date and time, position and speed of vessel, accuracy of GPS positioning, draught level, split-bottom control button status, distance from dumping site etc.

- Process and analyze data in real-time.

- Produce visual and audio signal when vessel enters or leaves specified marine dumping site.

- Produce visual and audio signal on system alerts.

- Generate data integrity signature.

- Store unprocessed (virgin) data with data integrity signature associated to removable non-volatile memory. Capable for storing 12 months virgin data and 2000 JPEG images.

- Communicate with Control Center and send data to Control Center via GSM/GPRS.

- Adjust data recording and reporting interval automatically.

- Authenticate user.

- Change system settings and parameters locally or remotely via GSM/GPRS.

- Take snapshots by request locally or remotely via GSM/GPRS.

- Retrieve data from data storage media and send to printer.

- Retrieve data from data storage media and send copy to removable media.
## FEMU

### Features

| Signal range and data rate: | Analog input: 0 to 20 mA for draught sensor
| Digital input: Open/close detection for split-bottom button
| RS232 input: Baud rate 4800bps for GPS receiver
| RS232 output: User selectable for portable printer
| Network: 10 Base-T or 100 Base-TX for digital camera |
| **Communication:** | Type: Wireless
| Network: GSM/GPRS/EDGE/UMTS 900/1800 MHz
| Protocol: TCP/IP |
| **Display:** | Type: LCD, color or black/white
| Character: Alpha numeric, English and Chinese |
| Indicators/alerts: | LCD, LED, buzzer on events:
| ✦ System status
| ✦ Communication status
| ✦ Sensors and button status
| ✦ Distance from specified marine dumping site
| ✦ Audible signal when vessel enters and leaving specified marine dumping ground
| ✦ Battery level and battery low alert
| ✦ AC power outage (if appropriate) |
| **Input:** | Numeric keypad |
| **Access:** | Key locks
| User ID and password |
| **Settings:** | Updated locally or remotely
| ✦ Loading and dumping site coordinates
| ✦ Vessel information
| ✦ Trip information
| ✦ Data recording intervals
| ✦ Data reporting intervals
<p>| ✦ Usernames and passwords |</p>
<table>
<thead>
<tr>
<th>Data recording and reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data types:</strong></td>
</tr>
</tbody>
</table>
| **Recording intervals:** | 6 user configurable intervals for:  
Idle and far from disposal sites (default 5 minutes)  
Idle and near disposal sites (default 5 minutes)  
Sailing and far from disposal sites (default 1 minute)  
Sailing near disposal sites (default 20 seconds)  
Inside disposal sites (default 10 seconds)  
Dumping (default 1 second) |

| Reporting intervals: | 6 user configurable intervals for:  
Idle and far from disposal sites (default 5 minutes)  
Idle and near disposal sites (default 5 minutes)  
Sailing and far from disposal sites (default 1 minute)  
Sailing near disposal sites (default 1 minute)  
Inside disposal sites (default 1 minute)  
Dumping (default 30 seconds) |

<table>
<thead>
<tr>
<th>Virgin data</th>
</tr>
</thead>
</table>
| **Format:** | Syntax: `<1>,<2>,<3>,<4>,<5>,<6>`  
`<1>` = Vessel ID, 000001 – 999999  
`<2>` = Draught (direct analog-to-digital input), 0000 – 9999  
`<3>` = Split-bottom sensor, 0 = activated, 1 = inactive, X = unavailable  
`<4>` = Number of satellites in use, 00 to 12 (leading zeros will be transmitted)  
`<5>` = Complete ‘Recommended Minimum Specific GPS/TRANST Data’ ($GPRMC$) sentence defined in NMEA 0183 Version 2.0, from $GPRMC$ to checksum *hh  
`<6>` = 160-bit integrity checksum, (presented in corresponding 40 ASCII characters of their hex values) |

| **Integrity checksum:** | 160-bit digest computed by SHA-1 algorithm  
Inputs to SHA-1 calculation:  
- 128-bit digital signature of EPD (updated regularly)  
- 128-bit digital signature of barge operator (updated regularly)  
- `<1>,<2>,<3>,<4>,<5>` |
| Storage:          | Removable non-volatile memory  
|                  | At least 12 months complete virgin data records  
|                  | At least 2000 JPEG images at 320x240 resolutions  

| **Data Retrieval** |  
| Peripheral:       | Floppy disk driver  
| Access:           | Key lock  
|                  | User ID and password  
| Output:           | Vessel ID  
|                  | Selected trip information:  
|                  | - Dump site  
|                  | - Dump site position  
|                  | - Trip date (YYYY-MM-DD)  
|                  | - Trip time (From HH:MM:SS to HH:MM:SS)  
|                  | - Number of records  
|                  | Selected data records (copy of virgin data)  
|                  | Selected images  

| **Image Capturing** |  
| Capturing:         | Auto capture during dumping  
|                    | By request (local or remote)  
| Configuration:     | Select preset position (local or remote)  
|                    | Adjust pan-tilt-zoom (local or remote)  
|                    | Change resolutions (local or remote)  
| Filename:          | Syntax: IMGnnnnnnn_c_YYYYMMDDhhmmss.jpg  
|                    | nnnnnn = Vessel ID  
|                    | c = camera Id  
|                    | YYYYMMDD = capture date  
|                    | hhmmss = capture time  

| **Printing** |  
| Peripheral: | Serial impact dot matrix printer  
| Interface:  | Standard RS232, DB9 male  
| Access:     | Key lock  
|             | User ID and password  


Output:
- Vessel ID
- Dump site
- Dump site position
- Trip date (YYYY-MM-DD)
- Trip time (From HH:MM:SS to HH:MM:SS)
- Number of records
- Snapshots taken at records (XX, YY, ZZ …, or nil)
- In each record:
  - Trip time (HHMMSS)
  - Latitude and Longitude (dd.mmmm, ddd.mmmm)
  - Number of satellite signals received
  - Draught level
  - Bottom status (open or close)
  - 8-bit checksum for each record

160-bit data integrity signature (presented in corresponding 40 ASCII characters of their hex values) for all printed records

<table>
<thead>
<tr>
<th>Physical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure:</td>
<td>IP 65 or NEMA 4X weather proof</td>
</tr>
<tr>
<td>Protection:</td>
<td>Key locks</td>
</tr>
</tbody>
</table>
| Environmental:    | Operating temperature: 0 – 60°C (internal)  
|                   | Operating humidity: 20% – 80% relative humidity, non-condensing (internal) |

<table>
<thead>
<tr>
<th>Power</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage:</td>
<td>110/220 VAC</td>
</tr>
<tr>
<td></td>
<td>9 to 40 VDC</td>
</tr>
</tbody>
</table>
| Backup power:     | Battery charger  
|                   | Rechargeable battery, sustainable for 72 hours continuous operation |
### Draught Sensor

<table>
<thead>
<tr>
<th>Features</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Level pressure sensor</td>
</tr>
<tr>
<td>Measure range:</td>
<td>0.25 to 5.00 meters</td>
</tr>
<tr>
<td>Resolution:</td>
<td>±0.06%</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>±0.1% Full Scale Baltic Sea Level (BSL) maximum</td>
</tr>
<tr>
<td>Interface (output):</td>
<td>2 wires</td>
</tr>
<tr>
<td></td>
<td>4 to 20 mA proportional for zero to FS pressure</td>
</tr>
<tr>
<td></td>
<td>Output impedance: 2K ohms nominal</td>
</tr>
<tr>
<td>Temperature compensation:</td>
<td>Built-in</td>
</tr>
</tbody>
</table>

#### Physical

<table>
<thead>
<tr>
<th>Enclosure:</th>
<th>IP 65 or NEMA 4X, immersed in seawater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental:</td>
<td>Operating temperature: -20 to 60°C</td>
</tr>
</tbody>
</table>

#### Power

<table>
<thead>
<tr>
<th>Input voltage:</th>
<th>12 to 28 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection:</td>
<td>Surge arrestor</td>
</tr>
</tbody>
</table>

### GPS Receiver

<table>
<thead>
<tr>
<th>Features</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver:</td>
<td>12 channels</td>
</tr>
<tr>
<td>Acquisition times:</td>
<td>20 seconds warm (all data known)</td>
</tr>
<tr>
<td></td>
<td>60 seconds cold (initial position, time and almanac known)</td>
</tr>
<tr>
<td></td>
<td>10 minutes search the sky (no data known)</td>
</tr>
<tr>
<td>Update rate:</td>
<td>1 second, continuous</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>20 meters RMS</td>
</tr>
<tr>
<td>Interfaces:</td>
<td>RS-232 compatible with baud rate 4800bps</td>
</tr>
<tr>
<td></td>
<td>NMEA 0183 version 2.0 ASCII output (GPGGA, GPGSV, GPRMC)</td>
</tr>
</tbody>
</table>

#### Physical

<table>
<thead>
<tr>
<th>Antenna:</th>
<th>Outdoor weather proof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental:</td>
<td>Operating temperature: -20°C to +80°C (internal)</td>
</tr>
</tbody>
</table>

#### Power

<table>
<thead>
<tr>
<th>Input voltage:</th>
<th>9 to 30 VDC, unregulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backup power:</td>
<td>Internal rechargeable battery</td>
</tr>
</tbody>
</table>
## Digital Camera

<table>
<thead>
<tr>
<th>Features</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Image/video compression:</td>
<td>JPEG or MJPEG</td>
</tr>
<tr>
<td>Image/video resolutions:</td>
<td>640x480, 320x240, 160x120</td>
</tr>
<tr>
<td>Pan, tilt and zoom:</td>
<td>±45° Pan, &gt;30° Tilt and &gt;4x optical zoom</td>
</tr>
<tr>
<td>Preset positions:</td>
<td>3</td>
</tr>
<tr>
<td>Sensor type:</td>
<td>CCD 300,000 pixels</td>
</tr>
<tr>
<td>Focus:</td>
<td>Auto</td>
</tr>
<tr>
<td>Exposure:</td>
<td>Auto</td>
</tr>
<tr>
<td>Illumination:</td>
<td>Minimum 1 lux</td>
</tr>
<tr>
<td>Interfaces:</td>
<td>10 Base-T or 100 Base-TX</td>
</tr>
</tbody>
</table>

### Physical

| Enclosure: | IP 65 or NEMA 4X, outdoor weather proof |
| Environmental: | Operating temperature: 0 to 40°C (internal) |
| | Operating humidity: 20% to 80% relative humidity, non-condensing (internal) |

### Power

| Input voltage: | 110/220 VAC |
| | 9 to 30 VDC, unregulated |
## PART V – Communication Protocol

### FEMU – to – Server

#### Front-End Mobile Unit Minimum Sensor Reading (MSR)

$FEMUMSR,<1>,<2>,…,<n>*hh<CR><LF>

- `<1>` = Number of virgin data records, 0 – 9
- `<2>`…<`n`> = Virgin data records

#### Front-End Mobile Unit System Status Information (SSI)

$FEMUSSI,<1>,<2>,<3>*hh<CR><LF>

- `<1>` = Vessel ID, 000001 – 999999
- `<2>` = Battery level, 00.00 – 99.99
- `<3>` = AC/DC power source, A = available, U = unavailable

#### Front-End Mobile Unit Captured Image Data (CID)

$FEMUCID,<1>,<2>,<3>,<4>*hh<CR><LF>

- `<1>` = Vessel ID, 000001 – 999999
- `<2>` = Filename
- `<3>` = Size in bytes of image data, 00001 – 99999
- `<4>` = Image data, binary data string

#### Front-End Mobile Unit Response to Command (R2C)

$FEMUR2C,<1>,<2>,<3>*hh<CR><LF>

- `<1>` = Vessel ID, 000001 – 999999
- `<2>` = Response to message type, RAR; RCI; SCP; CRI; CCI; SDS
- `<3>` = Response,
  - ACK = Acknowledged,
  - NAK = Not acknowledged

#### Front-End Mobile Unit User Specific Response (USR)

$FEMUUSR,<1>,<2>,<3>*hh<CR><LF>

- `<1>` = Vessel ID, 000001 – 999999
- `<2>` = Response message length, 0000 – 9999
- `<3>` = Response message content, text/binary data string
### Front-End Mobile Unit Recording and Reporting Interval (RRI)

```plaintext
$FEMURRI,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>*hh<CR><LF>
<1> = Vessel ID, 000001 – 999999
<2> = Recoding interval of idle and outside disposal site, 000 – 999 seconds
<3> = Recoding interval of sailing outside and away from disposal sites, 000 – 999 seconds
<4> = Recoding interval of sailing near disposal sites, 000 – 999 seconds
<5> = Recoding interval of sailing inside disposal sites, 000 – 999 seconds
<6> = Recoding interval of dumping, 000 – 999 seconds
<7> = Reporting interval of idle and outside disposal site, 000 – 999 seconds
<8> = Reporting interval of sailing outside and away from disposal sites, 000 – 999 seconds
<9> = Reporting interval of sailing near disposal sites, 000 – 999 seconds
<10> = Reporting interval of sailing inside disposal sites, 000 – 999 seconds
<11> = Reporting interval of dumping, 000 – 999 seconds
```

### Front-End Mobile Unit Existing Disposal Sites (EDS)

```plaintext
$FEMUEDS,<1>,<2>,<3>,<4>….,<5>*hh<CR><LF>
<1> = Vessel ID, 000001 – 999999
<2> = Number of vertices
<3> = Latitude of vertex 1, ddmm.mmmm format (with leading zeros)
<4> = Longitude of vertex 1, dddmm.mmmm format (with leading zeros)
Repeat <3>,<4> for all vertices
<5> = Entering or leaving disposal sites alert distance, 0000 – 9999 meters
```

*hh = Checksum for parity checking based on algorithm used in NMEA 0183.
Server – to – FEMU

### EPD Control Center Request Ad-Hoc Readings (RAR)

\[ \text{\$ECCRAR,<1>*hh<CR><LF>} \]

\(<1> = \text{Vessel ID, 000001 – 999999}\)

### EPD Control Center Request Capture Image (RCI)

\[ \text{\$ECCRCI,<1>,<2>,<3>*hh<CR><LF>} \]

\(<1> = \text{Vessel ID, 000001 – 999999}\)

\(<2> = \text{Image resolution,}\)

\(0 = 160 \times 120,\)
\(1 = 320 \times 240,\)
\(2 = 640 \times 480,\)
\(3 = 176 \times 144,\)
\(4 = 352 \times 288,\)
\(5 = 768 \times 576.\)

\(<3> = \text{Image quality,}\)

\(0 = \text{Lowest quality,}\)
\(1 = \text{Normal quality,}\)
\(2 = \text{High quality.}\)

### EPD Control Center Set Camera Position (SCP)

\[ \text{\$ECCSCP,<1>,<2>,<3>*hh<CR><LF>} \]

\(<1> = \text{Vessel ID, 000001 – 999999}\)

\(<2> = \text{Preset position, 1 – 9, M = move or zoom}\)

\(<3> = \text{Move direction,}\)

\(L = \text{Move left,}\)
\(R = \text{Move right,}\)
\(U = \text{Move up,}\)
\(D = \text{Move down,}\)
\(Z = \text{Zoom in,}\)
\(P = \text{Pan out.}\)
**EPD Control Center Change Reporting Interval (CRI)**

$ECCCRI,<1>,<2>,<3>,<4>,<5>,<6>*hh<CR><LF>

- **<1>** = Vessel ID, 000001 – 999999
- **<2>** = Reporting interval of idle and outside disposal site, 000 – 999 seconds
- **<3>** = Reporting interval of sailing outside and away from disposal sites, 000 – 999 seconds
- **<4>** = Reporting interval of sailing near disposal sites, 000 – 999 seconds
- **<5>** = Reporting interval of sailing inside disposal sites, 000 – 999 seconds
- **<6>** = Reporting interval of dumping, 000 – 999 seconds

**EPD Control Center Change Recoding Interval (CCI)**

$ECCCCI,<1>,<2>,<3>,<4>,<5>,<6>*hh<CR><LF>

- **<1>** = Vessel ID, 000001 – 999999
- **<2>** = Recoding interval of idle and outside disposal site, 000 – 999 seconds
- **<3>** = Recoding interval of sailing outside and away from disposal sites, 000 – 999 seconds
- **<4>** = Recoding interval of sailing near disposal sites, 000 – 999 seconds
- **<5>** = Recoding interval of sailing inside disposal sites, 000 – 999 seconds
- **<6>** = Recoding interval of dumping, 000 – 999 seconds

**EPD Control Center Set Disposal Sites (SDS) (revised on 1-AUG-2005)**

$ECCSDS,<1>,<2>,<3>,<4>,<5>,<6>..,<7>*hh<CR><LF>

- **<1>** = Vessel ID, 000001 – 999999
- **<2>** = Index, 0 – 2
- **<3>** = Zone ID, 000 – 999
- **<4>** = Number of vertices, 3 – 6
- **<5>** = Latitude of vertex 1, ddmm.mmmm format (with leading zeros)
- **<6>** = Longitude of vertex 1, dddmm.mmmm format (with leading zeros)
  Repeat **<5>,<6>** for all vertices
- **<7>** = Entering or leaving disposal sites alert distance, 0000 – 9999 meters

*hh = Checksum for parity checking based on algorithm used in NMEA 0183.