# Statement by on exploring the Forensic Oceanography involving the deaths of at least 27 people in the English Channel over the $23^{\text {rd }}$ and $24^{\text {th }}$ November 2021 

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Issue date: 14 ${ }^{\text {th }}$ July 2023

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| Submitted to: | Marine Accident Investigation Branch |
| :--- | :--- |
| Date submitted: | $14^{\text {th }}$ July 2023 |
| Project Manager: |  |
| Report compiled by: |  |
| Quality control by: |  |
| Security : | OFFICAL SENSITIVE |
| Approved by \& date: |  |
| Version: | Final |

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Statement by $\square$ on exploring the Forensic Oceanography involving the deaths of at least 27 people in the English Channel over the 23rd and 24th November 2021.

1. Introduction

2. The Case
2.1. I was contacted by of the Marine Accident Investigation Branch (MAIB)
(Department for Transport) on the $12^{\text {th }}$ December 2022 by email with the following information and subsequent request:
"We are investigating the death of at least 27 people in the English Channel over the $23^{\text {rd }}$ and $24^{\text {th }}$ of November 2021.
"Our investigation focuses on the UK search and rescue response to the unfolding incident, including the surface searches between notification and the discovery of the casualties. This is approximately 13 hours.
"We would like a written report to try to explain the following:
Question 1 Given the Last Reported Position and the reported Found position, what was the likely track that the casualties took;

Question 2 Given the Found position, where and when did they likely go into the water?"
2.2. Information as to the particulars of the case can be found in Annex 1, but to summarise:

- At least 27 people (male and female, including children) were found.
- Casualties were in at least one inflatable dinghy.
- The dinghy was possibly suffering deflation and/or engine issues.


## 3. Analysis

3.1. In order to predict the trajectory of Missing Persons in the marine environment, the strength and direction of individual physical forces need to be determined and then the resultant trajectory can be determined with a numerical model.
3.2. The UKMO produces what is considered the state-of-the art numerical model of the currents and elevations around the UK (see doi.org/10.48670/moi-00054). This model is the most suitable for this application as it outputs data on a fine grid ( 1.5 km ) and at hourly intervals. Available on the Copernicus server ( Atlantic - European North West Shelf - Ocean Physics Analysis and Forecast | Copernicus Marine MyOcean Viewer)
3.3. The archived wind data are available from the European Centre for Medium-range weather Forecasts (ECMWF) via the Copernicus website (ERA5 hourly data on single levels from 1959 to present (copernicus.eu) (Hersbach et al., 2018) - known as ERA5 and has a resolution of 0.25 by 0.25 degrees.
3.4. These datasets were combined within the Sintef OSCAR modelling suite (Reed et al., 1995a; Reed et al., 1995b; Reed et al., 1996; Aamo et al., 1996), which, whilst originally constructed for oil spills, can be parametrised for Missing Persons. For instance, the buoyancy of the Missing Person can be altered by adjusting the relative density of the oil used and the windage can be altered by the "drag factor".
3.5. For this exercise, the current and wind files were downloaded from the Copernicus website as netCDF files and imported into OSCAR. The domain of the model is relatively small with approximately 1000 grid cells northward and eastward with each cell with dimensions of 15 m by 15 m . A total of 1048 virtual points were released instantaneously into the flow fields and the time step of the model was set as 15 minutes. In all simulations the virtual
particles are designed to be "floaters" and have a "drift factor" of $3.5 \%$ designed to match a single Missing Person floating head down.
3.6. The positions of the Last Report Position (LRP) and the Found Position are shown in Table 1.

Table 1. Timing and Location information for the Missing Persons.

| Name | Latitude | Longitude | Time/date |
| :--- | :--- | :--- | :--- |
| Last Reported Position <br> (LRP) | $51^{\circ} 9.04600^{\prime} \mathrm{N}$ | $001^{\circ} 45.5668^{\prime} \mathrm{E}$ | 0221 UTC 24/11/2021 |
| Found Position | $51^{\circ} 5.58^{\prime} \mathrm{N}$ | $001^{\circ} 43.41^{\prime} \mathrm{E}$ | Approx. 1300 UTC <br> $24 / 11 / 2021$ |

3.7. The output from the first simulation is shown in three formats - the draft positions in MS Excel, an ArcGIS plot and a "mp3" movie. For each 15 minute time period the highest probability 15 m by 15 m cell was chosen to present the most likely position for the Missing Person. Figure 1 shows the working diagram of the cloud of particles (only the on the top of the hour and the half hour shown for the sake of clarity along with the highest probability location). Note the "area" of each precidition increases initially along the line of transport and then more widely once the tides turn South-westward. The ellipse follows an anticlockwise trajectory


Figure 1- The evolution of the cloud of particles representing the Missing Persons (working version -only the on the hour and half shown).


Map showing the Last reported Position(LRP),
The Found position and the ellipse created in the model. Also shown is a heat map from the 14:00 run showing the distribution of the particles within the time envelope.

The heatmap shows the number of virtual particles in each 15 m by 15 m cell.


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Figure 2 - ArcMap showing the individual estimates of the location of the Missing Person using the Last Reported Position at various time steps. The LRP and Found position are shown along with the heatmap of the variability associated with the 14:00 prediction. The legend shows the number of particles in each grid cell.

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Figure 3 - Screen shot of the movie showing the time evolving currents and the virtual particles presenting the Missing Persons. Also shown is the hatched box (start position - LRP) and the Found position (Hatched "eye"). The time is shown in the bottom right hand corner. The wind direction and strength is also shown.
3.8. It can be seen in Figures 1, 2 and 3, that the virtual particles representing the Missing Person(s) do not reach the Found position. The nearest they come to the FOUND position was at $12: 45$ on the $25^{\text {th }}$ Nov at a distance of approximately 5.3 km (Figure 2). The wind strength and direction over the 12 hours are typically light ( $<1.5 \mathrm{~m} / \mathrm{s}$ ) and northerlies. Leeway in these conditions would be negligible when compared to the strength of the strong tides.
3.9. Upon interpreting this finding, the results were reported to the MAIB and the scope of the project was changed in 2022. The multiple runs with differing parameters (e.g., windage) were deleted but one additional run was requested as per the following request from MAIB:
"Question 3 - if the Missing Persons did get the engine restarted, how far would they need to travel to enable them to be recovered at the FOUND position."
3.10. In order to explore potential locations where the engine was restarted (question 3), a number of assumptions are required. In this scenario, I assume that the transit time is fixed at 1 hour and the direction is due south. A number of runs have been undertaken with the speed of inflatable vessel (see Annex 1) increasing from 1 knot to 2.5 knots. The case of 2.5 knots is shown below with a start point where the outboard motor fails at 51
6.590N, 145.5668 E i.e. 2.5 nm due south of the LRP position. From this position the virtual particles representing the Missing Person arrive at the FOUND position just after 14:00 which fits the known recovery (see Figure 4). Note the ellipse when compared with the LRP ellipse is slightly narrower and orientated at approx. 20 degrees.
3.11. This scenario is just one of many that could result in particles arrive at the FOUND position at approx. 14:00. For instance, just assuming the same release point, but on the ebb tide, results in a series of locations just to east of the LRP that would also fit the time bounding required.


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Figure 4 - Map showing the original ellipses starting at the LRP and a second ellipse showing the virtual particles released from new release point representing a scenario where the Missing Persons have restarted the outboard motor and travelled 2.5 nm south of the LRP. Note - positions are shown every 30 minutes to aid clarity.

## 4. Sources of error

4.1. The largest source of error is likely to be the accuracy of the recorded position of the incidents. However, there is no method available to this author to check these figures, and/or determine the confidence that can be assigned to these value, and thus the positions are taken "as is".
4.2. In order to capture the small-scale variability due to turbulence generated in both the atmosphere, within the water column and from waves, $I$ show the envelope of the particles every 30 minutes in Figure 1 and in Figure 3 as a heatmap. This at 14:00, has a diameter East-west of 2.8 km and north-south of 2 km . Within each of the horizontal distributions, estimating the "centre of gravity" of these distributions will create an error.
4.3. Tidal ellipses are generated by numerous independent factors and can be used to assess the accuracy, orientation and magnitude of those directly from the current predictions as in this study and shown in Figure 5. Whilst the modelling in this project takes account of local winds and riverine freshwater inputs as well as good boundary conditions, these compare very favourably with the relatively simple five tidal constituent tidal models.


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Figure 5 - Map showing the results of the modelling compared with tidal ellipses from independent numerical model (only 5th shown for the sake of clarity).

## 5. Conclusions

5.1. In response to Question 1 - Given the Last Reported Position and the reported Found position, what was the likely track that the casualties took?
The tidal currents on the $23^{\text {rd }}$ and $24^{\text {th }}$ Nov 2021 have been recreated with the highest resolution and accuracy numerical model available and are shown in Figure 3 and in the associated excel files. The trajectory by natural drift due to wind and tide from the LRP will not arrive at the FOUND position. In order to achieve this, some other agent needs to be included.
5.2. Question 2 - Given the Found position, where and when did they likely go into the water?" was not taken forward in this exercise due to the modification of the request from MAIB following initial results.
5.3. In response to Question 3 - if the Missing Persons did get the engine restarted, how far would they need to travel to enable them to be recovered at the FOUND position?

Assuming the Missing Person restarted the outboard motor and headed south for 2.5 nm (taking 1hour) and then the outboard failed, it is consistent with the Missing Person being recovered at the FOUND position ( $516.590 \mathrm{~N}, 145.5668 \mathrm{E}$ ). However, there is naturally a range of different assumptions in direction, duration and speed that could result in a rediscovery at the FOUND location. A full exploration of the range of these positions is beyond the scope of the study.
5.4. In summary, it is not possible for Missing Person located at the LRP to be transport by wind and tide to the FOUND position. An external agent or action is required to enable this. There is a whole set of possibilities in terms of potential source locations that could have been utilised.

## 6. Inclusions

MS Excel files
i. Qtr hours positions with times.xls
ii. Start and stop locations.xls

## 7. References

Aamo, O. M., K. Downing, and M. Reed, 1996. Calibration, verification, and sensitivity analysis of the IKU oil spill contingency and response (OSCAR) model system, Report No. 42.4048.00/01/96, 87pp

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Reed, M., O. M. Aamo, and K. Downing, 1996a. Calibration and testing of IKU's oil spill contingency and response (OSCAR) model system. Proceedings of the 1996 Arctic and Marine Oilspill(AMOP) Technical Seminar, pp689-72

## 8. Declaration

This report has been prepared in accordance with the Criminal Procedures Rules (CPR 2020 Part 19 as amended).

## 9. Signature



## Annex 1 - Case description as provided by MAIB

This is the last confirmed position of the casualties:-

Last Reported Position (LRP): $51^{\circ} 9.04600^{\prime} \mathrm{N} 001^{\circ} 45.5668^{\prime} \mathrm{E}$

Time of last known position: 0221 UTC 24/11/2021

Source: Mobile phone GPS
Condition of casualties:

1. The casualties were in at least one inflatable dinghy
2. The dinghy was possibly suffering deflation at this time
3. The dinghy's outboard engine was most likely not functioning

Several persons were found deceased in the water in the found position below.

Found position: $51^{\circ} 5.58^{\prime} \mathrm{N} 001^{\circ} 43.41^{\prime} \mathrm{E}$

Found time: approximately 1300 UTC 24/11/2021
Source: GPS from a fishing vessel that discovered the casualties

Condition of casualties:

1. Range of body types including females, males and children - exact details unknown.
2. An unknown number of casualties were wearing lifejackets or personal floatation devices

MAIB have made the following assumptions/acknowledgements:

1. All casualties were probably found in the water
2. All positions are complete positions with no typo errors or rounding applied by the sender or any systems used to transmit or record the position
3. The exact positional error from the GPS devices is unknown
4. The LRP and Found positions and times are used to represent all persons in the water
5. All persons were affected by tidal conditions the same
6. The type and efficacy of personal floatation devices are unknown
7. Casualties were probably fully clothed when found
8. Casualties probably wore no special maritime clothing such as wetsuits/floatation suits etc.

MAIB will be guided by you [Cefas], but suggest the following scenarios:-

1. Casualties entered the water unconscious at the LRP
a. In the water - no floatation device
b. In the water - wearing an unknown personal floatation device
c. In the water with semi-inflated dinghy
2. Before entering the water, casualties remained in a drifting inflatable dinghy for:
a. 1 hour
b. 2 hours
3. To account for the uncertainty of the initial position, twelve positions around the LRP at a bearing of $000^{\circ}, 060,120^{\circ}, 180^{\circ}, 240^{\circ}$, and $300^{\circ}$ range 0.5 nm and 1.0 nm

## Annex 2 - Details of Numerical Model

The ocean physics analysis and forecast for the North-West European Shelf is produced using a forecasting ocean assimilation model, with tides, at 1.5 km horizontal resolution coupled with a wave model. The ocean model is NEMO (Nucleus for European Modelling of the Ocean), using the 3DVar NEMOVAR system to assimilate observations. These are surface temperature, vertical profiles of temperature and salinity, and along track satellite sea level anomaly data. The model is forced by lateral boundary conditions from the UK Met Office North Atlantic Ocean forecast model and by the CMEMS Baltic forecast product BALTICSEA_ANALYSISFORECAST_PHY_003_006. The atmospheric forcing is given by the operational ECMWF Numerical Weather Prediction model. The river discharge is from a daily climatology. Further details of the model, including the product validation are provided in the CMEMS-NWS-QUID-004-013. The wave model is described in NORTHWESTSHELF_ANALYSIS_FORECAST_WAV_004_014. Products are provided as hourly instantaneous, quarter-hourly, and daily 25-hour, de-tided, averages. The datasets available are temperature, salinity, horizontal currents, sea level, mixed layer depth, and bottom temperature. Temperature, salinity and currents, as multi-level variables, are interpolated from the model 51 hybrid s-sigma terrain-following system to 33 standard geopotential depths (z-levels) and from the model rotated grid to a regular lat-lon grid. The product is updated daily, providing a 6-day forecast and the previous 2-day assimilative hindcast. See CMEMS-NWS-PUM-004-013_014 for further details.

## About us

We are the Government's marine and freshwater science experts. We help keep our seas, oceans and rivers healthy and productive and our seafood safe and sustainable by providing data and advice to the UK Government and our overseas partners.

We are passionate about what we do because our work helps tackle the serious global problems of climate change, marine litter, over-fishing and pollution in support of the UK's commitments to a better future (for example the UN Sustainable Development Goals and Defra's 25 year Environment Plan).

We work in partnership with our colleagues in Defra and across UK government, and with international governments, business, maritime and fishing industry, non-governmental organisations, research institutes, universities, civil society and schools to collate and share knowledge.

Together we can understand and value our seas to secure a sustainable blue future for us all, and help create a greater place for living.

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Innovative, world-class science is central to our mission. Our scientists use a breadth of surveying, mapping and sampling technologies to collect and analyse data that are reliable and valuable. We use our state-of-the-art Research Vessel Cefas Endeavour, autonomous marine vehicles, remotely piloted aircraft and utilise satellites to monitor and assess the health of our waters.

In our laboratories in Lowestoft and Weymouth we:

- safeguard human and animal health
- enable food security
- support marine economies.

This is supported by monitoring risks and disease in water and seafood; using our data in advanced computer models to advise on how best to manage fish stocks and seafood farming; to reduce the environmental impact of man-made developments; and to respond to serious emergencies such as fish disease outbreaks, and to respond to oil or chemical spills, and radioactivity leaks.

Overseas, our scientists currently work in Commonwealth countries, United Kingdom Overseas Territories, South East Asia and the Middle East.

Our customer governmental o
ships are broad, spanning Government, public and private sectors, academia, nons), at home and internationally.

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