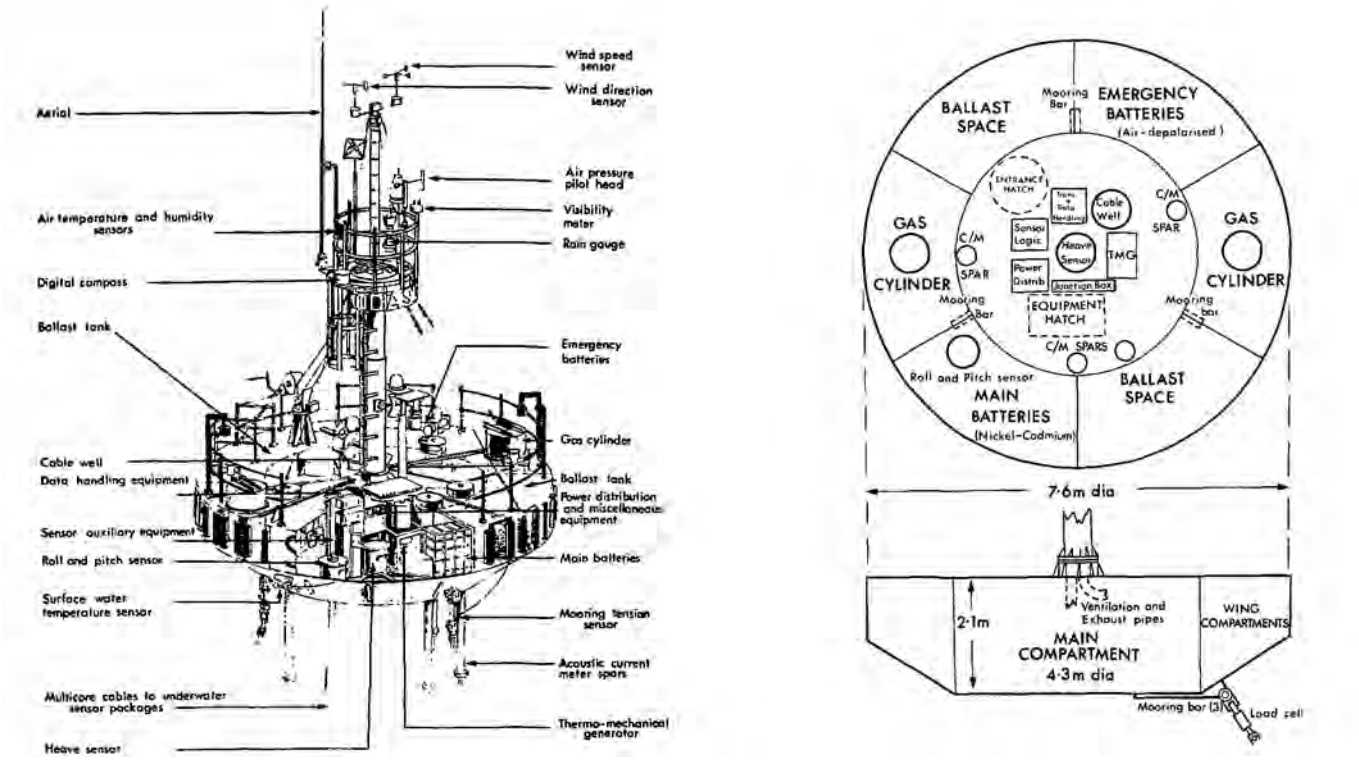
Large Environmental Data Buoy DB1

Peter Collar
April 2016

Background to the project

In the early 1970s, hydrocarbon exploration and exploitation, fisheries, meteorological forecasting, pollution control and coastal protection engineering were only some of the factors driving an increasing demand for operational meteorological and oceanographic data. Long before the advent of earth observation satellites, the development of arrays of moored data buoys was viewed as a possible way to gather operational data from large areas of open sea. At the time data buoy technology was most advanced in the USA, although development was also underway in West Germany, France and Norway. In the UK, the NERC Standing Committee on Ocean Data Stations, comprising a representative from each government department with interests in ocean data gathering, had already identified the need for the UK to be active in this area, with particular reference to the North Sea. The Department of Trade and Industry then commissioned a feasibility study by NIO, which resulted in the recommendation for the construction of a 6m. diameter experimental data buoy, DB1 accompanied by an outline technical specification. The buoy was intended to provide experience in maintaining real-time data gathering reliably over long periods of time, thereby to ascertain the feasibility of achieving a fully operational measurement system. At the same time it would provide a testbed for new oceanographic and meteorological sensors and associated buoy sub-systems. Apart from the DTI, government departments and organisations most closely associated with the project at this early stage included the Met Office, the Ministry of Agriculture, Fisheries and Food (Fisheries Research Laboratory, Lowestoft), and Trinity House. A small team at NIO, which included Mark Carson, Peter Collar, 'Dickie' Dobson, Jack Langford and 'Tom' Tucker, submitted its report and outline specification to the newly formed Ship and Marine Technology Requirements Board of the DTI in September 1972.

Approval for the project was given in early 1973 and, following discussions with a number of commercial firms, tenders were invited for the detailed design, construction, deployment and maintenance of the buoy and its shore station while the buoy was on station at a test site. The successful bid was received from Seatek, a consortium of Hawker Siddeley Dynamics Ltd., EMI (Electronics) Ltd. and Green and Silley Weir Ltd., shipwrights. Under the guidance of Stuart Rusby and his small team, NIO (which had by now become IOS) would



Line drawings of DB1 taken from Rusby and Waites (1980)

act as agent and project coordinator for the DTI in liaising closely with the commercial firms and equipment and sensor developers.

DB1 was launched in June 1975 and was moored five miles south-east of Lowestoft in November of that year. In March 1976 a series of experiments were carried out at sea in conjunction with the MAFF Fisheries Laboratory to assess the performance of the sensor suite. DB1 remained on station until May 1977 when it was withdrawn for examination and refurbishment prior to operational deployment at a site on the continental shelf edge, some 150 miles southwest of Lands End. It remained there in service for several years, gathering data for the UK Offshore Operators Association (UKOOA) and the Met. Office.

DB1 being launched in the River Thames and on station off Lowestoft

Technical details

The buoy that was deployed in November 1975 differed but slightly from the original outline specification. The hull was 7.6 m. in diameter and of discus form in order to achieve good surface following and so permit the measurement of directional wave spectra, using Waverider heave, pitch and roll sensors and a digital compass developed at IOS by Charles Clayson. A deck hatch and ladder allowed internal access to the hull and an aluminium central platform equipped with a retractable topmast provided mountings for meteorological sensors. These included wind speed and direction, barometric pressure, air temperature, relative humidity and, initially, rainfall and visibility sensors. In addition to wave data series, oceanographic sensors provided measurements of near-surface currents and sea temperature. Beneath the hull were mounted four spars which carried transducers for a long-path acoustic current meter, developed by AERE at Harwell – and which proved very successful in operation. The buoy had a 3-point chain mooring in order to limit rotation and to reduce the watch circle. Load cells, designed by IOS, permitted the monitoring of mooring tension in relation to wind, current and tidal height.

Power at the level of a few watts was supplied by an efficient Stirling-cycle generator, heated by a propane gas burner, which charged a bank of nickel-cadmium cells. The system had been developed at AERE Harwell. Air-depolarised primary batteries provided an emergency back-up system.

Data handling and transmission to shore were constrained by the technology available at the time. The data handling system offered 90 input channels, which could accept data in a variety of formats. Low power CMOS technology was employed, for microprocessors were not yet available. In situ processing of wave data, for example, was not feasible: a 20 minute series of measurements made at 0.8 Hz. of buoy heave, pitch, roll and yaw was therefore transmitted every 3 hours for processing ashore. Data transmission, likewise, was yet to benefit from satellite communications. With much longer paths in mind than that presented by the test site,

an h.f. transmission system was adopted. The project was fortunate in being able to use an innovative and proven system based on a development by the Diplomatic Wireless Service (Piccolo) for inter-embassy communications, where the ability to operate in low signal-to-noise conditions was important.

The shore station during the first deployment was set up by EMI at the MAFF Fisheries laboratory at Lowestoft. This consisted of twin Racal RA1771 receivers and Piccolo demodulator, together with a DEC PDP11/05 computer, magnetic tape storage and controller. After an initial period a modem link was established which enabled the Met. Office to access meteorological data in near real-time. For the duration of the operational deployment beginning in June 1978 the shore station was situated at the naval air station at Culdrose, giving a predominantly over-sea h.f. groundwave path of 167 miles.

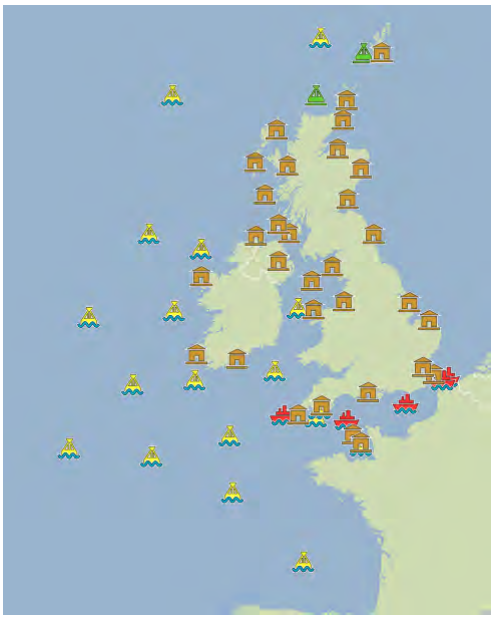
The shelf edge site was considerably more exposed than the earlier test site. In its first two years of operation there DB1 experienced a number of force 10-12 storms, but weathered these – and on at least one occasion seabed trawling activity – successfully. Servicing, nominally at quarterly intervals, was not without its problems, seasickness often proving a potent enemy. In spite of some failures, DB1 nevertheless maintained its operational status: in the winter quarter of 1979, for example, the percentage data return for all sensors was 97%.

It is not possible to describe here in detail the design and layout of the buoy and its systems, or to analyse the nature and wealth of experience gained with the operation of DB1 and its shore station. References 2 and 3 in particular provide a comprehensive review.

The legacy of DB1

While some early ideas of a European network of large data buoys did not come to fruition, two further discus buoys were subsequently constructed and deployed by commercial interests on the northwest shelf edge. This was to obtain environmental data essential for subsequent oil and gas exploration and exploitation in that area. Furthermore, the invaluable experience gained with DB1 undoubtedly helped the UK Met. Office in the establishment of its network of more modestly sized meteorological buoys.

Finally, it could be said that the DB1 project clearly demonstrated how the knowledge and skills existing in a research institute could be combined with the expertise available in leading industrial firms to achieve a successful outcome.



UK Met Office network of marine observations. Offshore data buoys in yellow

Bibliography

1. Lee, A.J., Collar, P.G., Carson, R.M., The Large UK Data Buoy Programme, Proceedings of the Society for Underwater Technology, 2, (3), pp. 14-27, 1973.
2. Rusby, J.S.M., Hunter, C.A., Kelley, R.F., Wall, J. and Butcher, J., The construction and offshore testing of the UK data buoy (DB1 project), Proceedings of Conference Oceanology International 78, (Brighton, 1978).
3. Rusby, J.S.M. and Waites, S., The deployment and operational performance of the DB1 data buoy system in the southwest approaches to the British Isles, pp. 548-55, Proceedings of the IEEE Conference Oceans 80, Seattle, 1980.
4. Butcher, J., Twist, B.H. and Wall, J., Data handling and power systems for the prototype UK data buoy, in: Proceedings of Conference on Instrumentation in Oceanography, Bangor, September 1975. IERE Conference Proceedings No 32.

5. Cooke-Yarborough, E.H., Franklin, E., Geisow, J., Howlett, R. and West, C.D., The thermo-mechanical generator: an efficient means of converting heat to electricity at low power levels, Proc. IEE, Vol. 121, pp. 749-751, 1974.
6. Bayley, D. and Ralphs, J.D., The Piccolo 32-tone telegraph system in diplomatic communications, Proc. IEE, Vol. 119, pp. 1229-1236, 1972. [A summary of their earlier paper is available **here**]
7. Gaunt, D.I. and Hunter, C.H., The design of long term submerged equipment associated with the UK data buoy, in: Proceedings of a meeting on the technology of buoy mooring systems, Society for Underwater Technology, London, 24th October 1975.
8. Proceedings of the UK data buoy (DB1) Symposium, Wormley, 23rd November 1976, IOS Report No. 44.
9. Collar, P.G., Near-surface current measurement from a surface-following data buoy (DB1), Pt. I, Ocean Engineering, Vol.5, pp. 181-196.
10. Collar, P.G. and Vassie, J.M., Near-surface current measurement from a surface-following data buoy (DB1), Pt. II, Ocean Engineering, Vol.5, pp. 291-308.