Mooring Design Best Practice Document

Oceanographic moorings are used extensively by NERC scientists to deploy a wide range of oceanographic instruments from the NMEP. Activities range from month long shelf moorings in water depths below 200m to 2 year deployments in the deep ocean. Two different designs are used depending on the water depth. On the shelf a ‘U’ shape mooring is used. One branch of the U has a surface marker with a light & radar reflector, the other branch supports the instruments using a sub-surface buoyancy unit. In deeper waters a single point mooring is used with typically no surface marker. Only in the case of real-time telemetry is a surface marker used.

To aid the design process a number of software packages are available. SHAPE (IOS) & CABLE (WHOI) are coded in FORTRAN whilst MDD (University of Victoria) and the KIEL package are MATLAB routines. The preferred package at the moment is the KIEL package. The packages output the tensions throughout the mooring line, the required anchor weight and the knockdown for any given current profile. The KIEL package also outputs the launch tensions for anchor last deployments which is the standard procedure for deep water moorings. More emphasis is placed on the design of deep water moorings, shallow water moorings use standard designs which have been developed over many years. With deep ocean moorings the drag on the mooring lines over the entire length is an important factor in determining the design of the mooring. This is not the case with shallow water moorings where survival outweighs any drag considerations. Shallow water moorings are usually subjected to far stronger tidal/wave/wind induced currents and usually far greater fishing intensity.

The aim is to design a mooring which is fit for purpose, crucially any pressure rated components must remain within their rated pressure. The anchor must be sufficient to hold the mooring in place for any given current profile. The WHOI formula is used which takes account of the vertical (buoyancy) and horizontal (drag) forces on the anchor. One of the problems with any mooring deployed in a new location is the lack of knowledge on the current regime. In the absence of any available data, whether observed or modelled, an estimate is used. This is a classic chicken and egg situation. An important feature incorporated within the mooring design philosophy is the requirement for reserve buoyancy. The mooring is designed to ensure that even if the mooring line parts due to a component failure then there is always sufficient reserve buoyancy to recover the remaining part of the mooring using an acoustic release. An Argos or Iridium beacon is always fitted to the shallowest buoyancy unit thus enabling an alert and tracking capability in the event of a component failure. When an alert is received from a mooring which has come adrift then there is a limited time window for recovery dependent on the battery life of the beacon. During this period the parted mooring is at far greater risk simply by being on the surface. The remaining part of the mooring can be recovered by means of the acoustic release in the usual way.

Despite there only being a handful of people within the NERC community will the skills and experience to design oceanographic moorings, it is important that the designs are checked over by another mooring specialist.

The choice of materials is crucial to ensure the survival of the mooring. Mooring lines must be able to withstand the risk of fish bite. Corrosion is always a major consideration and different metals must be insulated to avoid galvanic corrosion. Mooring hardware is always discussed at the European mooring meetings held every two years. The meetings provide an ideal forum to discuss new materials.

In an ideal world all components should be tested prior to deployment but this is simply not practical. One component that is tested routinely is the Acoustic Release. This is deployed to the required depth and all functions are tested. This is usually performed along with a CTD cast at the mooring site which is standard practise for calibration purposes. It is good practise to battery the release for a duration at least double the planned duration. An additional precaution for heavily instrumented moorings is the deployment of two releases in parallel.

Real-time telemetry poses a major challenge for deep ocean moorings. Components at the surface are exposed to extreme forces. It is important to distinguish between real-time applications and the issue of data security. Inductive techniques can be used to send data up or down the mooring line.
A data logger attached to the mooring line near the bottom can collect the data from components above and is at fair less risk than any real-time telemetry system on the surface. Data can still be transmitted to the surface by using acoustic techniques to send data to a nearby sea-bed lander which could release data pods at regular intervals to the surface (MYRTLE).