Case Study

Finding a Solution that Minimises the Safety Case

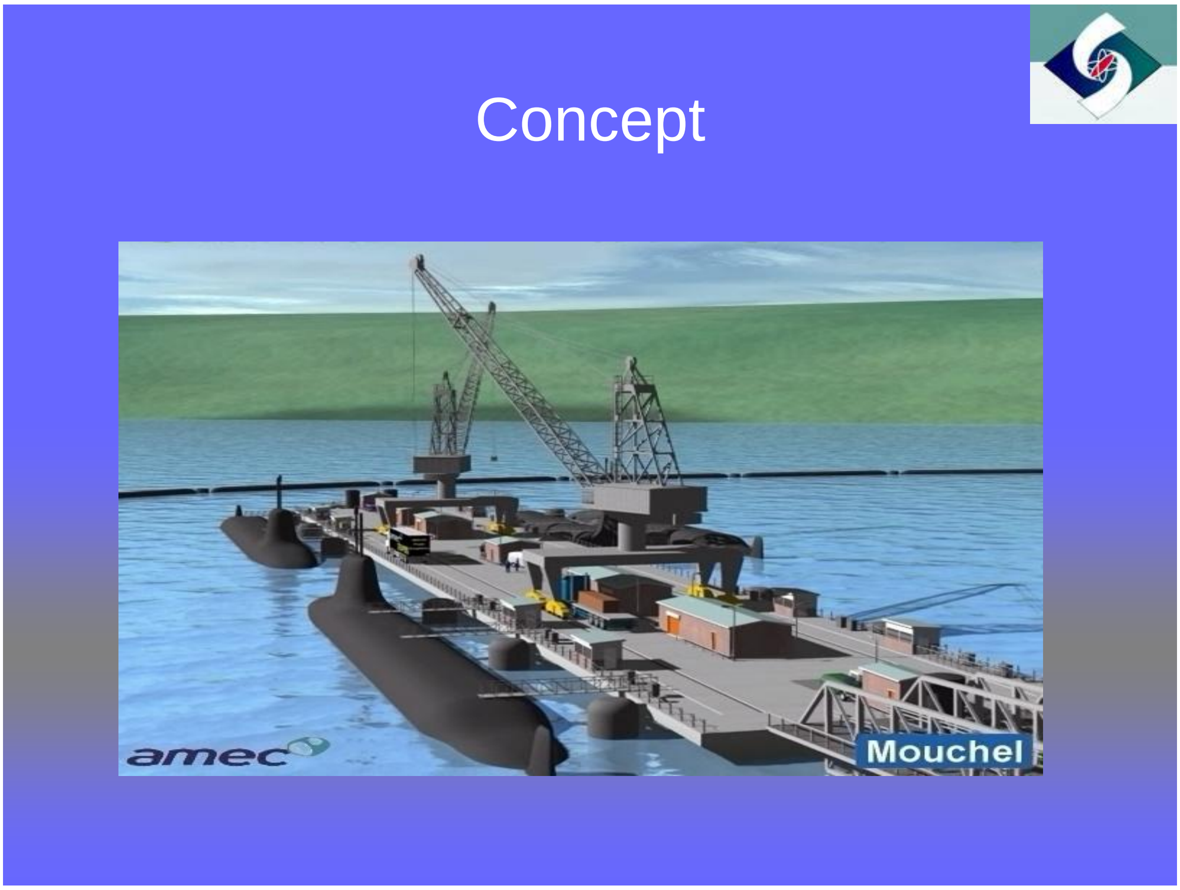
BACKGROUND

The requirement was for cranage in a new facility to be built at the Clyde Naval Base to service and support up to six nuclear submarines of the new Astute class as well as existing “fleet” submarines (S and T Classes). The facility was to comprise a floating concrete pontoon, approximately 200m long by 30m wide, located by 4 large mono piles. Essentially, it was to be an up-market marina.

The project was managed by Defence Estates. Commercial and programme management risk was transferred to Prime Contractor by a maximum price target cost contract, let to Amec.

The potential nuclear hazard in this installation was damage to the submarines’ reactor plants by direct impact due to crane collapse or dropped / uncontrolled lowering of a load or damage to the essential electrical or cooling water supplies needed to maintain the reactor cores in a safe state when the reactor plants were shut down.

This is the concept design:



Note the large portal cranes, with large mass and relatively high centre of gravity.

The following issues that might cause problems in developing the safety case were identified:

- Long history of crane safety case problems;
- New issues introduced by virtue of the floating pontoon (eg, long period ground motion);

These concerns were reinforced by the early feedback from ITA.

FIND A SIMPLER ROUTE TO A SAFETY JUSTIFIED CRANAGE SYSTEM

Two of the Design Safety Principles were relevant:

1. The cranes were to use no software in the safety justification.
2. If the maximum impact could be shown to be less than 3MJ, code compliance would be deemed an adequate justification.

SOLUTION

The solution was to replace the two travelling portal cranes with 8 fixed telescopic cranes with a further crane mounted in a work boat.

This illustrates the crane:

This shows the cranes positioned along each side of the jetty:

It was also necessary to fit a small gantry crane in the centre of the jetty to undertake a particular task.

This solution does lose some of the flexibility of the portal cranes but all defined operational tasks can be accomplished and the safety case is an order of magnitude simpler.

DESIGN SOLUTION

The cane design selected was the Palfinger Marine Crane’s PTM 1700, with 8 model B’s mounted on the jetty and a model A in the work boat. Both have a fixed 12m boom; the ‘A’ has 2 6m sliding booms and the ‘Bs’ have 3 6m sliding booms.

The crane is driven by hydraulics, powered by an electric motor. All motions including winching are hydraulics; the only electrical controls are the solenoid operated by the emergency stop push (fail to safe) and the first set of arc limits.

All the parts on these cranes are standard, albeit that the winch is not the type normally supplied. It is different in that it has a higher factor of safety in the shaft connecting the motor to the drum and has brakes on both.

The trip operates on the hydraulic circuit and it is a two man operation involving access on to the stopped crane to reset it. This is a deliberate feature, to avoid the situation where poor operation might lure the driver into invoking the trip in normal use.

Over-riding the first set of arc stops is controlled by a system of castel keys and another set is used to prevent interaction between crane pairs.

SAFETY CASE

The usual sequence of hazard identification and assessment activities led to safety functional requirements and FMEA, FTA, reliability assessments, etc have been used to establish the justification.

No software is used in the safety justification. A "Wylie" system is used in addition to the basic Palfinger controls primarily for data logging purposes and also provides a very useful operator assist screen to relate load to radius.

When stowed, the crane cannot geometrically strike the submarine. When in use, the maximum impact energy is less than 3MJ, therefore the consequences of failure are tolerable. This allows the safety case documentation to take a less onerous route through 'due process'.

Thus, code compliance is adequate justification. The principal code used is DIN 15018 and to forestall ITAconcerns it was established at the outset that this code is very similar to BS 2573. The other dominant code was the Lloyds Code for Lifting Appliances in a Marine Environment.

Some additional assessment was necessary to explore aspects of the design that the manufacturer was unwilling to undertake. This mainly investigated the effects of "hangman's drop". It was also, of course, necessary to undertake justification of the arrangements for mounting the cranes onto the jetty and onto the work boat.

The crane is an established design with an available operational history.

LEARNING POINTS

Minimise modifications – go with the COTS design

Understand the design limitations

Educate the sceptics!