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Airing the oil rigs

by Mike Meen

The design methods used for the ventilation of offshore installations must protect personnel and the operation of equipment. Mike Meen describes the engineering practices found at sea.

An offshore installation is basically a self-contained oil processing station that is divided into four basic areas for which ventilation must be provided. These are: drilling and maintenance of the reservoir and wells; production, including separation and pumping facilities; utilities, power generation and support services and accommodation and control rooms, including personnel comfort and protection (see figure 1).

The engineering, procurement, installation and commissioning of ventilation systems on offshore installations is specifically directed to the protection of personnel and, by inference, must protect the operation of equipment. The isolation of rigs from the emergency services inevitably places emphasis on the integration of ventilation systems with fire and gas detection and protection systems, and the reduction of potentially hazardous situations.

Therefore, engineers working in the sphere of offshore operations must be fully aware of the services interfaces and the consequences of their possible failure.

Legislation and standards

In June 1964, the British Parliament ratified the United Nations Convention of the Continental Shelf, providing the basis for international law. Interest in the search for oil and gas in the sedimentary deposits of the North Sea had already begun, and the first gas field started production in March 1967 (BP West Sole). The first giant oilfield, Ekofisk, started production in 1971, with the first UK oil produced by the Amoco Montrose in June 1976.

To control the standard of construction and operation of installation, some form of legislation was required. The *Mineral Workings (Offshore Installations) Act 1971* provided the legal framework. Several *Statutory Instruments* have since been developed from the *Act*. Numbers *289 (Construction and Survey)*, *611 (Fire Fighting)* and *1019 (Occupational Safety, Health and Welfare)* are the primary documents. The associated *Guidance Notes* from the DoE explain the procedures for certification and give interpretations of the *Act*.

The Cullen enquiry into the Piper Alpha disaster has placed a greater emphasis on the integration of safety and the establishment of safe areas for refuge. However, the basic purposes of hvac on offshore installations remain and should:

- ☐ provide appropriate working environments in hazardous areas;
- ☐ dilute and remove potentially harmful concentrations of airborne pollutants in hazardous areas;
- ☐ maintain a pressure differential between hazardous and non-hazardous areas;
- ☐ remove excessive heat in order to protect equipment and personnel;
- ☐ isolate individual areas and control ventilation in emergency conditions by interfacing with the platform shutdown logic;
- ☐ provide combustion and ventilation air supplies for equipment and purge systems (normal and emergency);
- ☐ provide a comfortable environment within the living quarters and normally manned non-hazardous areas.

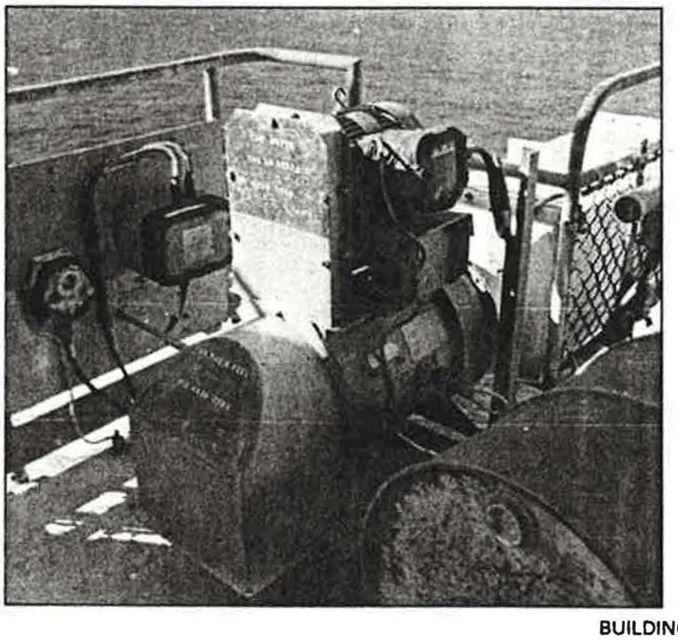
While the above requirements are clearly mapped out, the severe environmental conditions experienced offshore serve to create many unique problems for designers. The latitude varies from 53°N in the Leman field, in the southern sector, to 62°N in the Magnus field, in the northern sector. The effects of the Gulf Stream and 'continental drift' modify the summer and winter temperature conditions significantly from expected values, giving the Southern Basin design temperatures of −2·5-20°C and the East Shetland Basin temperatures of 0 15°C. Consideration of the proximity of external radiant sources (eg flares) must also be given to obtain the 'true' environmental temperature.

The design wind speeds for southern sectors are 38 m/s, with gusting of up to 50 m/s. These conditions cause very high concentrations of seawater spume.

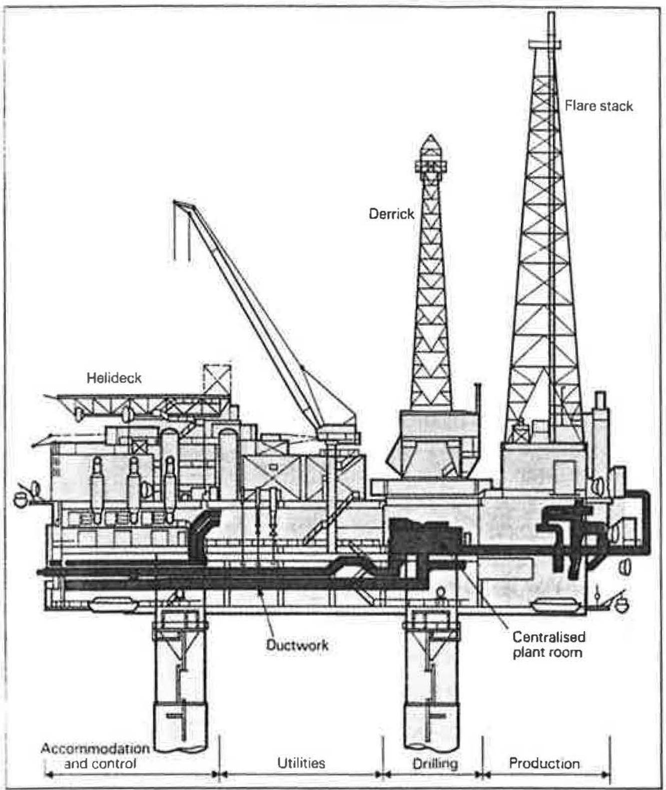
The potential presence of gaseous hydrocarbons, exhaust fumes, cement, sands and gravels, paint flakes and other process and maintenance-generated contaminants add to the environmental problems.

Internal environment

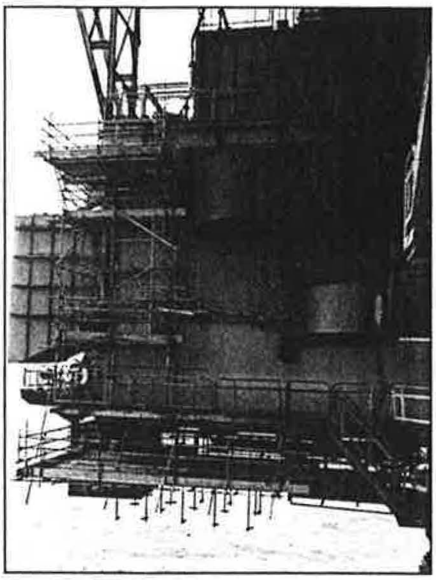
With the exception of accommodation and other manned areas, internal temperatures are allowed to float in a wide band, with the operation of equipment defining the maximum and minimum conditions. These are typically between 0°C and 35°C. Where the manning of areas dictates, the temperatures may be raised locally to acceptable levels by unit heaters.



Left: Mixed flow fan with explosion proof components.



Left, figure 1: Schematic of a typical offshore production platform showing the centralised plantroom and ductwork.



Right: Centralised plantroom. Note that the scaffolding is in place for routine maintenance – even simple duties require careful planning.

The heat loads within areas may require cooling to be provided, and the estimation of heat loads is critical in the preliminary stages of design. It is surprising the number of early designs that omit the radiant effect of process piping.

The accommodation modules are essentially treated as 'high class' hotels, with close control of temperature and humidity. Depending on the area, a temperature of between 18-22°C (db) and a relative humidity of 40-60% are specified. The DoE now recommends that the design must consider *legionella* bacteria and any other airborne contaminants. As such it will be interesting to see the reaction of both clients and designers when the impact of this statement is realised.

Systems

There are many variations on the types of system installed. Platform accommodation modules are invariably mechanically ventilated, whereas for drilling, production and utilities there are three basic schemes: a centralised plant room serving all areas of the platform, modular systems and natural ventilation.

The need to shut down individual areas, coupled with space and weight restrictions, have gradually favoured the use of modular systems and research has also shown natural ventilation to be a viable option in certain cases. Current design practice is to couple modular mechanical ventilation for non-hazardous areas, including those used for accommodation, with open, naturally ventilated hazardous modules.

This practice allows pressurisation of selected areas however, due to the variable nature of wind speed and direction, secondary ventilation may be used. A further advantage is the dual effect of saving weight and, should an explosion occur, pressure will immediately be released without damaging the primary structure.

Equipment

When selecting equipment, the design contractor must consider several factors apart from costs and duty criteria. For example, the weight of packages and systems is critical in the overall design; an approximate estimate is that one tonne of topside weight requires ten tonnes of subsea steelwork.

Most offshore installations have a self contained power station. The ventilation services form a small proportion of the total power requirement so energy has not been high on the list of priorities. There are, however, savings to be made when considering the weight penalties on inefficient or oversized equipment.

Reliability of manufactured items is a desirable attribute, and a proven track record is sometimes required. The quality of components is controlled by *BS 5750 ISO 9000* quality assurance procedures, and the design contractor will request fully documented checks and tests. The design itself also follows a controlled route from concept to commissioning.

The ease of maintenance and availability of spares is common to building services design, but the traceability of components to enable speed of replacement is improved by the use of extensive 'tagging'. This usually takes the form of an alpha numeric identification system that enables equipment data to be readily retrieved. Certain companies operate computerised maintenance information systems giving last dates of inspection, spares used, contacts and other useful data.

Standards of construction for offshore installations are similar to industrial plant. Specialist components are used, which allow equipment to function safely in potentially explosive atmospheres, akin to those specified in *BS 5501*. The exceptions are the use of high efficiency primary filtration equipment, fans operating with very large static pressure margins and fire dampers with centralised control of open and closing facilities.

Primary filtration equipment was originally designed for shipping to prevent saline mists from entering the air intakes. The units typically consist of a coalescing matrix sandwiched between two internal vane eliminators.

Axial fans are not normally specified for offshore use as the performance characteristics do not allow guaranteed volume delivery against a high variation in applied velocity pressure caused by the high winds. Historically, backward-curved centrifugal fans have given good volume and pressure characteristics and have thus been used extensively. Limitations in terms of space and weight, however, exclude the use of centrifugal fans in some cases and has given rise to the development of 'mixed flow' fans specifically for offshore use.

Fire dampers sited on offshore installations perform a variety of safety-related functions. Of primary importance is the ability to maintain the fire integrity of bulkheads, for which fire tests are performed and certification given.

Conclusion

The ventilation services on offshore installations are designed to reduce both the risk of 'incident' and provide comfort for the occupants. The equipment must be designed and constructed to operate for 24 hours a day, 365 days a year in a hostile environment. Engineers working on all aspects of the design of these installations must continually assimilate data, and review and modify methods to improve the safety of both construction and operation.

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