Environmental Impacts of the Oil and Gas Industries

Introduction
For generations the North Sea has been a valuable source of food exploited by the UK fishing industry. In the last quarter of the 20th century it also became a vital energy source following the discovery of significant reserves of oil and gas (O&G). In the 21st century, it may emerge as a source of renewable energy.

Both the fishing and O&G industries are important to the economy of Scotland and the UK generally, and must co-exist in a marine environment that is sensitive to exploitation and contamination. Fisheries Research Services (FRS) has a significant role, providing advice on the nature and extent of the impact of the O&G industries to their regulator, the Department of Trade and Industry (DTI).

Environmental Effects of Oil and Gas Production

Exploration
Operators investigate the likelihood of hydrocarbons being present under the seabed using high intensity sound (seismic surveys). Commercial fish species are sensitive to sound and, at close range, larval fish might even be killed by seismic sources. Seismic surveys might therefore disturb spawning fish away from territory where they have chosen to aggregate for spawning purposes and this could, in extreme circumstances, be harmful to stock productivity. Disturbing fish away from traditional areas may also affect fishermen’s catches. FRS gives advice on the sensitivity of exploration activities including the definition of ‘no go’ times or conditions.

Drilling
During drilling, a drilling mud is continuously circulated between the well and the platform through a ‘riser pipe’. Mud is used to maintain well pressure and wall stability, to cool and lubricate the drill bit and to carry the rock chips (cuttings) generated during the drilling process away from the cutting head to the platform. Here, the cuttings are partially cleaned and the majority of drill mud re-used. Muds come in a variety of forms, dependent on their fluid base. Amongst these are water based muds (WBM) and oil based muds (OBM). In the past, the bulk of cleaned OBM cuttings were discharged to the seabed along with their residual oily mud contamination. Extensive monitoring studies showed that this caused changes to the seabed via a combination of smothering, organic enrichment and toxicity effects. These were seen to be most severe close to discharging platforms where the ‘pile proper’ formed, but they commonly extended up to a distance of 1 or 2 km. These discharges are no longer allowed.

Production
During production, large amounts of produced water (PW) are recovered with the hydrocarbons. This is cleaned to very stringent standards and some is re-injected to maintain reservoir pressure. The bulk, however, has traditionally been discharged to sea. As fields age and as
the amounts of oil remaining fall, the amounts of PW increase. The turn of the millennium marked the time of maximum recovery of oil in the UK North Sea fields. So although the levels of oil in produced water are very low, and despite improvements in technology which have tended to reduce them, the overall total amount of oil discharged with the water by UK industry will continue to rise in the next few years; it will then tail off as the industry declines. Increased regulatory attention is therefore being focussed on the PW discharge, not least because in addition to oil, it contains residues of naturally occurring heavy metals and radionuclides and oil field chemicals. FRS took part in a recent collaborative research study to look at PW effects. Such studies will inform the continuing monitoring needs and regulatory requirements.

A wide variety of chemicals is used to treat the oil, gas and water that is gathered from offshore reservoirs. These are regulated under a harmonised mandatory control scheme (HMCS) negotiated under the auspices of the Oslo and Paris Commission (OSPAR). As part of its advisory service to DTI, FRS assesses UK operators’ applications to use particular amounts of specified chemicals.

**Monitoring**

In the past, most O&G monitoring concentrated on the near-field effects of cuttings piles discharges at the major drill sites. Although monitoring of the impacts of piles remains a focus of interest, attention is now being directed towards detecting more subtle changes in contamination patterns in the further field. FRS has a resident group of hydrocarbon analytical experts and is advising stratified random monitoring approaches to determine if contamination is decreasing with time (because OBM cuttings discharges have ceased), or increasing with time because other discharges still take place (see produced water section above). Surveys of this type have been conducted in recent years in the Fladen Ground and East Shetland Basin areas of the North Sea. These will hopefully form a snapshot against which changes over time can be assessed.

**Decommissioning**

Although the decommissioning phase of the North Sea industry is now underway, the peak period of decommissioning of installations will likely be in the period 2010-2020. Some decommissioning operations have the potential to impact both the environment and fishing activities. FRS is a key advisor on the implications of individual plans, and has two major areas of interest in the decommissioning context: cuttings piles; and on-surface large pipelines.

Fishing in the immediate vicinity of installations is prevented by exclusion zones. If installations are completely removed at decommissioning and the large cuttings piles beneath them are not, they may spread, if fishing over them is allowed. All of these options, namely complete installation removal, cuttings piles recovery, and the wisdom of allowing fishing over piles if they are exposed, will be the subject of much discussion in the years head. To aid these discussions, FRS has conducted studies where sediment blocks containing fluorescent label were placed on the seabed prior to being fished over (see below).

These showed that no significantly increased environmental risk is likely to flow from the spread of contamination caused by fishing over piles. Any spread over time is predicted to be very slow. The extent, if any, to which it occurs will be followed by individual field monitoring studies and by the stratified random survey approach described above. The peak period of large trunk pipeline decommissioning may be some time after that of installations, since key parts of the export system will need to be retained to service the last producing installations. Fishermen have learnt to live with these large lines. Indeed, some choose to fish along them, alleging they act as aggregation devices for fish. FRS is concerned about the eventual fate of these lines once they are no longer required and will seek to ensure that their potential to interfere with the environment and with fishing activities is minimised.

**Accidental Events**

FRS provides a 24-hour emergency response service as part of the National Contingency Plan designed to cope with transport and offshore oil and gas pollution incidents in UK waters. Significant accidental spills from offshore installations or during refuelling and transport are thankfully very rare events. Were one to happen, advice would be provided to the primary responders and to any Environment Group established. In addition, FRS maintains the sole UK centre for the sensory analysis of contamination in fish and shellfish in order to advise the human health consequences of spillages of oil or chemicals at sea. (See leaflets ‘Ensuring the Quality of Fish and Shellfish’ and ‘Sensory Assessment of Fish and Shellfish Quality’).