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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1975/B: 4
Gear and Behaviour Committee

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THE POSSIBLE EFFECTS OF BEAM- AND OTTERTRAWLS ON SUBMARINE PIPELINES

by

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Introduction

Fishermen are not anymore the sole users of the natural resources of the North Sea. This fact became more apparent the last five years.
The first new industry to enter the field of marine exploitation was the offshore aggregate industry. On the possible effects of the activities of this industry was reported extensively in 1975 in the "Report of the working group on effects on fisheries of marine sand and gravel extraction" - ICES Coop.Res.Rep. nr. 46.
The next new industry to enter the North Sea was the oil and gas industry. Within ICES the threat of this industry upon fisheries was recognized only quite recently. (See letter C.5. - d.d. 12th of May, 1975 by the Chairman of the Gear and Behaviour Committee).
The following consequences of the marine oil and gas exploitation on fisheries include:

1. The effects of trawls striking pipelines;
2. The obstruction of traditional fishing operations by pipelines;
3. The loss of traditional fishing grounds to drilling operations and pipelines;
4. The aggregation of fish near oil/gas structures and the consequent attraction of fishing operations to these hazardous areas.

The oil and gas industry directly understood the possible damaging effects of fisheries upon pipelines. Pipelines are essential to the industry, as they are the most efficient, economical and safe method of moving liquids or gasses between two points. To overcome the impact of fishing gears and damage by dragging anchors the industry laid down specifications for the sort of coating required.
They were so demanding that for some parameters the concrete coating had closer tolerance than the steel pipe itself (ANON., 1973, 1975). The industry developed tests to simulate what might happen to a pipe on the seabed. Pipes were struck with 60 blows from a one-ton steel hammer at 90° angles and 20 blows at 60° angles, at a speed of four knots.

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Also shear and bending tests were performed on the coating material.
The threat of dragging anchors is also a very serious one KOSTER (1975) summarized the available literature on this subject. He concludes that for the largest of some of the most usual types of these anchors the digging-in into a sandy bottom may be estimated at 2,0 to 2,5 m (Table I). Digging in up to approx. 10 m in clayey or muddy bottom is described in literature.

BROWN (1971) evaluated how deep a pipeline should be burried for protection in relation to the potential damage by anchors and cost of repair. The deeper a pipeline is burried, the safer it is. However, the problem is that the cost of burial increases very rapidly with depth. The digging in of a pipeline can be compared as buying insurance which becomes more expensive with greater coverage. BROWN concluded, on a basis of a comparison of cost of repairs and cost of burial, that it is advisable to dig in the pipeline with a 6 feet (1,80 m) coverage and accept a slightly higher initial capital cost in order to reduce the cost of maintenance. In doing so an amount of money six-times the additional higher initial costs can be saved on the cost of maintenance.

The risks that pipelines run were also understood by several governments e.g. the American federal administrative regulations require that pipelines will be burried if the water depth is less than 200 feet. This is to avoid the danger of anchor dragging, to avoid pipe movement in the events of strong watercurrents in times of intensive storms and preclude interference with coastal traffic and commercial fishing.

<u>The effects of trawls striking pipelines (Fig. 1, 2).</u>

The fact that trawl doors (ottertrawl) and beam trawls will hit now and then pipelines is obvious. Dutch beamtrawlers make annually in several ICES-rectangles between 40.000 - 80.000 actual fishing hours (H 2, 4, 6; J 5, 7; K 6). To quote e.g. a marine survey report for a pipeline in the North Sea (Dutch shelf): "Fairly broad-parallel lines caused by fishing trawler boards were common in the area surveyed" Trawl tracks could be observed several times during our own research with several types of side-scanning sonars on various occasions and by the sector-scanner of the Fisheries Laboratory, Lowestoft (A.R. MARGETTS personal communication).

The test carried out uptill now with a weight up to one ton seem to be irrelevant in respect to the gears used especially by the Dutch beam trawler fleet. The sole beam trawl now in use may be a direct threat to the pipelines and submarine valves. The largest flatfish beam trawlers, 600-700 ton waterdisplacement (250-300 BRT) and 1600-2000 i.h.p., may tow in the southern North Sea beam trawls with a weight of 4000-8000 kg/each.
The shoes alone varies in weight between 500-950 kg/each.
For example a medium type flatfish beam trawler, 1250 i.h.p., is equiped with two beam trawls. Each gear weights approx. 4850 kg: two shoes - 1000 kg, beam - 1250 kg, tickler chains - 1800 kg, small ticklers 100 kg, net 750 kg.

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Primarily only the rigid part of the beam trawl, the shoes and beam, are of direct influence on the impact when the gear hits the pipeline. This part of the gear weights approx. 4000 kg. maximal.

Today the otter trawl is only used by a relative small number of older Dutch side trawlers (1100 i.h.p. - approx. 250 BRT). The main part of the Dutch trawler fleet, stern trawlers as well as converted side trawlers, uses the pelagic trawl.
The trawl doors (either Süberkrübb or polyvalent) with a surface area between 3.25 - 8 m2, weighing each 600-1200 kg, will during normal fishing operations never touch the bottom. This, however, happens only under faulty conditions.

A medium sized trawl door makes, during normal fishing, a furrow of approx. 18 cm deep in the bottom. Due to less careful handling in some rare events, the trawl doors will dig themselves into the bottom and even rarer the towing warps inconsequence will break. The shoes of a beam trawl are making furrows of approx. 5 cm deep. However, during shooting of the beam trawl one shoe may dig itself in about 20 cm. This is only for a short while, after that the beam trawl levels and runs parallel to the bottom (DE GROOT (1974)).

For a beam trawler, when the gear strucks, the forces in the towing warps are, as a rule of thumb, about 10 kg and in the top of the gigs about 14 kg for each i.h.p. of the vessels engine.

According to BROWN (1972) 40 blows with a 300 kg steel lined trawl door in the same location will finally remove the concrete from the pipe. It is not unlikely that fishing gear hits on several occasions the same location. This may happen when fishermen use the Decca navigation system for their vessel control. They sail along even Decca lines which might cross pipelines.

In November 1973 in Norway, a special Norwegian Deep Water Pipeline Project Committee was appointed to carry out a research program on bottom trawl influences on submarine pipelines. GJØRSVIK et al (1975) reported how this project was carried out. The results of the work are not given in their paper. Their approach seems to be very sound and thorough. However, they ended the research still in an unfinished stage, it was still only investigated on semi-scale. They used a 150 BRT, 400 i.h.p. trawler, a type of fishing vessel hardly comparable with those in use in the Dutch fleet. Still their general remarks are worth quoting "The theoretical studies showed that the forces, which most likely can damage a pipeline are the impact force and the hooking force. The magnitude of the impact force is greatly dependent on the elastic properties of the pipeline and pipeline coating, as well as the direction of the impact force at the contact point". When hooking by the gear occurs, the maximum force on the pipeline will be, especially in heavy seas, the breaking strength of the warps. This will be depending the gear used between 40 - 70 ton.
According to BROWN (1972) a pipeline which is operated at a high internal presure will be subjected to blow out upon impact of a trawl door.

According to Dutch governmental regulations, pipelines should be buried at a depth of at least 2 m. That this is not always possible owing to certain bottom characteristics is very likely. Also a buried pipeline may in due time become uncovered by scouring or by the moving sand waves. (See e.g. McCAVE, 1971 on the nature of these sand waves). Regular surveys in the North Sea revealed that pipelines were only on a few stretches covered with 2.00 bottom material. Spanning of pipelines occurred especially in the western part of the North Sea. A pipeline with a length of 72 km was for a 16 km partially or fully exposed. The largest span observed 40 m with a depth of approx. 15 cm under the pipe. The deepest span of 100 cm observed had an overall length of 11 m.

2. The obstruction of traditional fishing operations by pipelines.

Fishing within 500 m from a drilling platform or rig is not allowed on the Dutch continental shelf. A special type of valve developed for undersea oil/gas wells are the "Christmas Trees" protruding about 6 - 7 m from the bottom. Up till now only one is used in the Dutch sector. However, it is known that they are more frequently used in the Norwegian part of the North Sea. They are no hindrance to the merchant navy when the water is deep enough. Fishing nets may become entangled notwithstanding the fact that fishing is not allowed on that location. These valves are without any protection from steel domes or tubing and are only marked by a buoy. It is easy to see that areas with pipelines will make normal fishing operations difficult or even impossible.
A more common obstacle is the "tie-in"-connections of the pipelines. They protrude about 2.25 m from the sea-bottom. They are mostly protected by domes or buried with gravel.
There are no regulations at the moment dealing with the fishing near pipelines. It is likely that in near future it will not be allowed to fish within a distance of 500 m at either side of the pipeline on the British part of the Continental Shelf.

It is already known that a few valves were smashed by fishing gear in the North Sea and gas was escaping. Divers found trawl doors and warps entangled on these devices.

3. The loss of traditional fishing grounds to drilling operations and pipelines.

Pipelines running from the sea to the shore, or from platform to platform will mostly be buried in trenches. The jetting in operations resemble those of dredging. The jetting in operation and also the fluidization method, disturbs the bottomfauna in the immediate area of operation, approx. 15 meter wide.
A temporary turbid condition is created due to the resuspension of sediments which, upon resettling may harm the benthos. The amount of sediments resuspended depends on the size of the laid pipeline, the trenching method and the bottom type.
As a rule of thumb the amount of disturbed bottom material will be 10 - 12 m3/m pipeline (ANON., 1974). In some cases it is known that pipelines which could not be buried in, were covered with gravel.

The main cause of broken pipes in the United States waters up till now are ships anchors. Data of massive oil spills showed that the existing fish stocks were not depleted, however, the fishing industry suffered more economical losses from indirect causes.

On the other hand there are a few, perhaps benificial statements, e.g. by . KLIMA that automatic fishing platforms could be temporarily erected near drilling platforms to harvest the concentrated fishes round these structures. Even light fishing techniques could be used in conjunction. (ANON, 1971; KLIMA and WICKHAM, 1971).

4. The aggregation of fish near oil/gas structures and the consequent attraction of fishing operations to these hazardous areas.

Oil and gas drilling rigs provide for two basic needs of marine life, a safe hiding place and abundant food. Numerous organisms attach themselves to the legs, braces and cross-members of the offshore structures, in fact they serve the same function as shipwrecks. The "non-productive" areas of the sea are made productive by the installation of relief structures. It was observed that "fishes appeared within hours after construction of each reef". Initially the man-made structures attract fishes from surrounding areas. Gradually the attached plants and animals form a typical ecosystem. What happens to the rigs and platforms and pipelines is quite similar to what happens to artificial reefs. STEIMLE and STONE (1973) gave 396 references in their bibliography.

TREYBIG (1971) pointed out that in the Gulf of Mexico commercial fishing rose five-fold since the first drilling platforms apeared in 1940. About 2200 offshore platforms are now present in the Gulf. TURNER et al (1969) studied in detail the artificial reef ecology. They found that, "by material, most of the fishes were attracted to concrete shelters, averaging 1053 individuals per observation, the streetcar attracted the least 635. Between these extremes were automobile bodies 826 and quarry rock 870".

Conclusions

From the above mentioned facts it seems very likely that increasing numbers of platforms, rigs and pipelines in the North Sea will attract fish to these structures on the sea bottom. This, in consequence, makes such areas more attractive to commercial fisheries and, thereby, increasing the already existing possibility of damage to these structures by fisheries and to fishing gear.

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TABLE 1.

Theoretical digging in of a number of stockless anchors of some of the usual types (After Koster, 1975).

digging in (m)	weight (tons)	angle hand-shaft (o)	length fluke-shoulder (m)
1.70	9	40	1.67
1.80	14	30	3.38
2.20	18	40	3.43
2.30	20	40	3.48
1.90	23	45	2.49
2.10	30	45	2.75

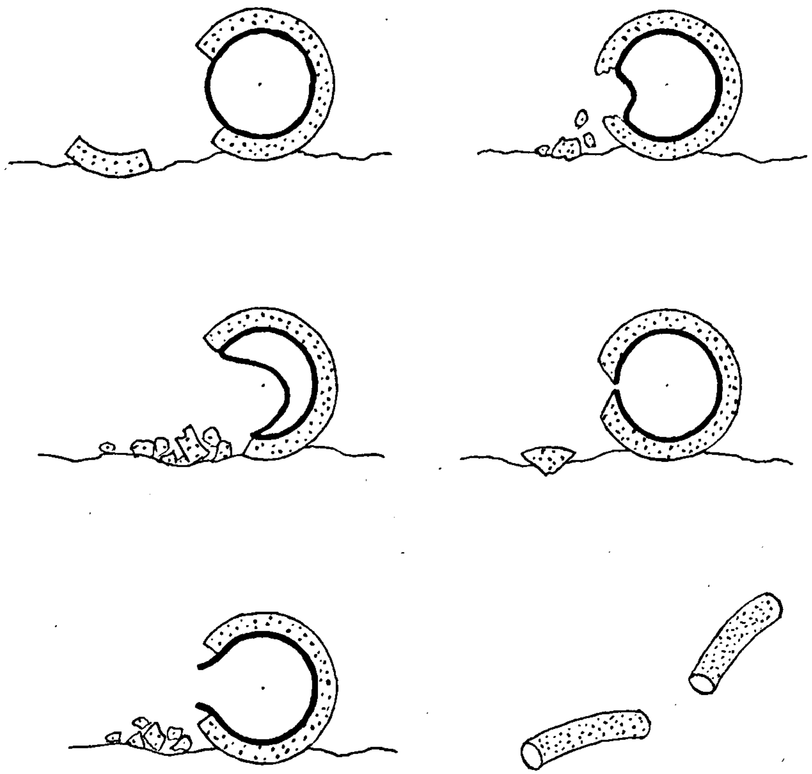

Fig. 1. - Types of damage that can occur (After Brown, 1972).

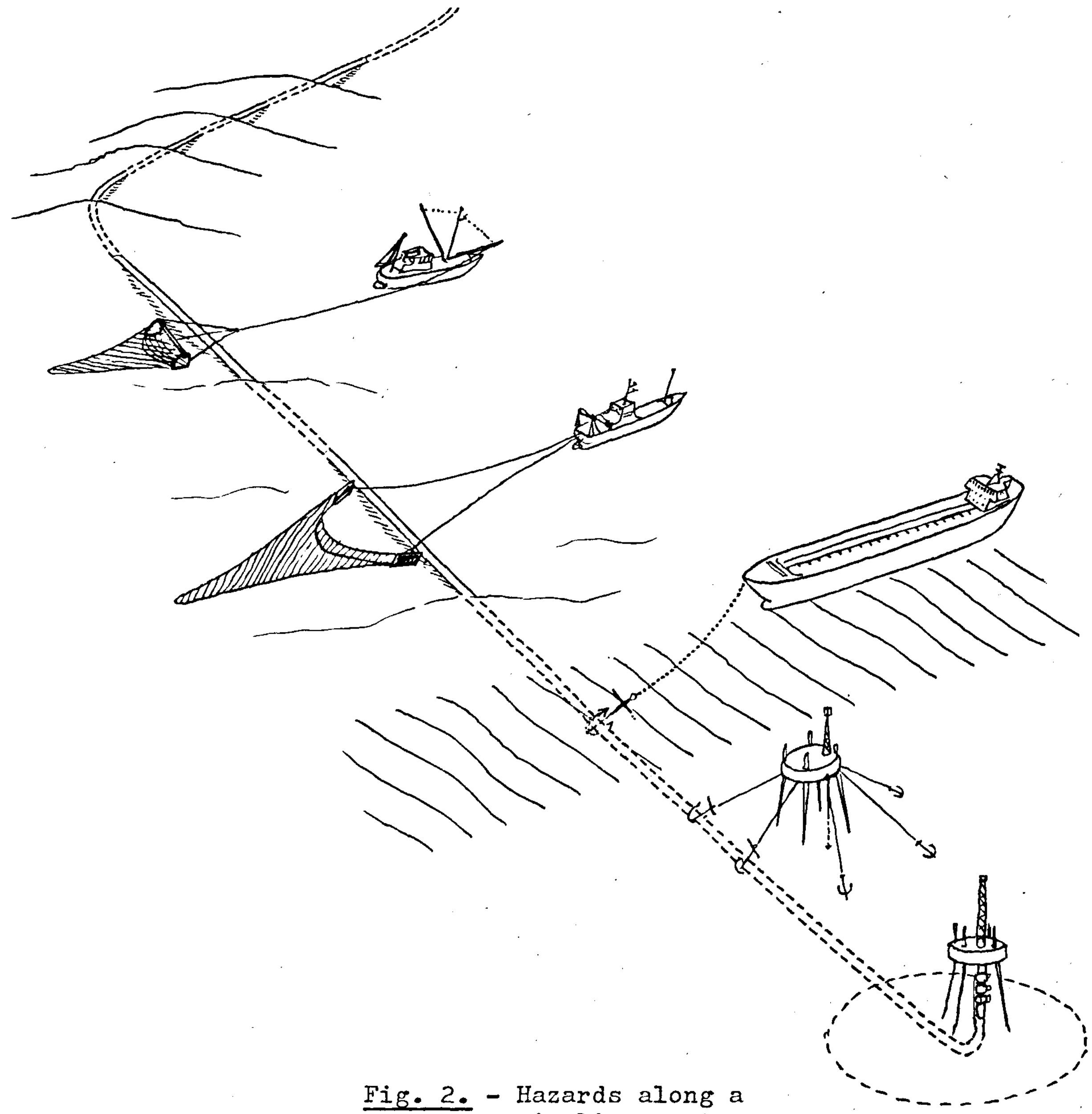

Fig. 2. - Hazards along a pipeline route.