WORKING PAPER 346

# GAS FACILITIES IN SCOTLAND : THE ASSESSMENT OF RISK IN RECENT SITING DECISIONS

D.J. SNOWBALL AND S.M. MACGILL

WORKING PAPER
School of Geography
University of Leeds

List of Abbreviations

| | |
|---|---|
| ADBJAG | Aberdour and Dalgety Bay Joint Action Group |
| BGC | British Gas Corporation |
| FPA | Forth Ports Authority |
| HSC | Health and Safety Commission |
| HSE | Health and Safety Executive |
| HH | Highland Hydrocarbons |
| NGL | Natural gas liquids |
| SDD | Scottish Development Department |
| SEPD | Scottish Economic Planning Department |
| SNG | Synthetic Natural Gas |
| TOM | Total Oil Marine |

December 1982

# GAS FACILITIES IN SCOTLAND: THE ASSESSMENT OF RISK IN RECENT SITING DECISIONS

## Introduction

The purpose of this paper is to examine the way in which aspects of public safety have been accounted for in various recent decisions for potentially hazardous installations in Scotland. The facilities in question were proposed for sites at Mossmorran, Nigg, Peterhead, St. Fergus, and a pipeline route between St. Fergus and Mossmorran, in conjunction with the onshore processing of North Sea gas reserves. The proposals raised a number of issues of public safety which concerned the respective local authority councils and planning departments, local and national branches of the Health and Safety Executive - the developers seeking planning permission and, in various instances, port authorities, secretaries of state, local public interest groups and other 'public' pressure groups.

It is recognised that aspects of safety will be appraised differently by different individuals and organisations due to such factors as differences in risk perception and associated criteria of risk acceptability, the effect of the decision outcome on their own respective concerns and different statutory and non-statutory responsibilities. One function of this paper is to provide evidence which illustrates these differences with respect to particular case studies. In this way the paper serves to complement the extensive literature where work on risk assessment in a more abstract context is considered. (See Macgill and Snowball, 1982, for a recent review). A second function is to expose and analyse differences between decisions. Each facility has its own distinctive package of safety, economic and environmental attributes. It will be noted that not all differences in safety considerations between decisions appear to be attributable to the differences in their respective packages of attributes. Rather, they would also appear to be due to differences in socio-economic characteristics and other geographical features of the different sites (thus affecting the way latent attributes may be realised in terms of actual impacts), differences in the way different local authorities respond to matters of public safety, corresponding differences between developers at different sites, and to changes that may occur with time in societal comprehension of risk in general and in the role of the Health and Safety Executive in particular. The time period over

which the decisions to be reviewed took place, 1973-1981, is a particularly important one in this last respect, as it saw significant changes in the structure of the Executive in terms of its advisory role for planning decisions. It also saw increased experience on the part of local authorities dealing with planning decisions for potentially hazardous installations. Examination of case study evidence thus illustrates different facets of the interpretation and enactment of UK legislation and policy as it relates to planning decisions for the siting of potentially hazardous installations.

The planning phase is a critical stage in considering public safety aspects of such installations since it is at this stage that statutory approval for particular sites is given: it is appropriate to recall here that the siting of such plants in relation to their surrounding geography (physiographic and population characteristics) is perhaps the most important determinant of their overall safety, remote siting being the (albeit typically unattainable*) ideal in this respect (but see Openshaw, 1982, for a criticism of the corresponding siting criteria for the nuclear industry). The planning phase is also the only stage in which publicly acknowledged scrutiny of safety issues can occur, thus the only stage in which many agencies (public, planners, observers) can exert a direct measure of influence. This is not to deny that publicly acknowledged safety scrutiny of the plant at the planning stage is only a modest beginning to the unseen scrutiny that will occur during the construction and operational phases.

The outline of the paper is as follows: relevant aspects of decision making for each of the sites are first described. The safety concerns of each of the classes of agency referred to above are then evaluated in turn, drawing out distinctive characteristics of individual decisions, and differences between decisions, against the wider interests and responsibilities of each class of agency. Other agencies that were involved to a lesser extent than those mentioned above are not considered in this paper. Some overall conclusions about the effectiveness of the way hazard control policy in the UK seems to be evolving end the paper.

---

*Given institutional as well as geographical features of the UK.

Context

As well as the dry gas (predominantly methane) and the oil to be found from the hydrocarbon reservoirs of the North Sea, considerable quantities of wet gases (natural gas liquids) can also be exploited from some fields, notably Brent. Broadly speaking, the crude oil, gas and natural gas liquids undergo initial stabilisation at the production platform and are either piped ashore or, as is sometimes the case with oil, loaded onto carriers offshore, for transfer to a refinery to be split into various fractions (various fuels and chemical feedstuffs; petroleum, diesel, methane, ethane, propane, butane, natural gasoline). An indication of process linkages for the transformation of North Sea hydrocarbons into commercial products is given in figure 1. This figure locates the gas facilities proposed for the particular sites to be considered in this paper within this chain of transformation. Fuller descriptions of each facility are to be found in table 1. St Fergus is the primary gas reception plant for all gas and ngl pipelines from the northern North Sea fields; and was proposed to be linked by overland pipeline to the other facilities further down the chain (at Peterhead, Nigg and Mossmorran).

Gas is potentially hazardous; an accidental release could lead to cataclysmic fire or explosion. This potential is greatly magnified by liquefication (maintained by pressurisation or refrigeration) to facilitate handling and transport. There are varying views on the degree to which plants handling significant quantities of flammable gases ought to be insulated from a surrounding population. There is also a range of opinion about the consequences (in terms of blast or thermal radiation effects) stemming from some nominal release of products and on sizes of credible spills (Britter and Griffiths, 1982, Institute of Chemical Engineers, 1982 ).

Interest in safety aspects of the 'gas processing' facet of onshore developments associated with offshore oil is sparse when compared with that in their wider strategic planning implications (Begg and Newton, 1980, Paget and Lloyd, 1982). Brief reference to safety aspects may be found in the examination of Environmental Impact Assessment by Clark et al. (1981), the sociological impact of oil exploitation by Moore (1982) and the effects of site selection upon local authority actions (Mann, 1979).

Safety cannot be considered in isolation from other factors in the context of planning decisions, and the perception of the issues that arise can vary considerably between agencies involved. The agencies involved with each plant are indicated in Table 2. An indication of the broad structure of the planning decision process is given in Figure 2.

An appreciation of the location of the proposed facilities in relation to population and other features may be derived from Figures 3 to 7. A brief summary of each decision is now given.

St. Fergus (Phases I and II)

It is convenient to consider the development of the St. Fergus site in three distinct phases:

Phase I: Total Oil Marine (TOM) and British Gas Corporation (BGC) terminals

II: Shell UK Expro terminal

III: British Gas Corporation terminal and Synthetic Natural Gas (SNG) Plant

The decision sequences for Phases I and II are summarised here; Phase III is examined in a later section below.

St. Fergus was BGC's second choice of site for a terminal after a site further north near the Loch of Strathbeg had been successfully opposed on ecological grounds. There were no significant objections to the alternative site and Aberdeen County Council approved the proposals in 1973 without pressure for holding a public inquiry. Permission was granted subject to few conditions and with relatively little detailed consideration of possible impacts.

When Shell submitted an application for a terminal in 1976, (Phase II), an environmental impact study and hazard assessment was commissioned by Banff and Buchan District Council (the local council following local government reorganisation in 1974 - see Table 2) to evaluate the proposals and facilities in terms of safety, environmental protection and pollution control. Since the BGC and Total terminals were, by this stage, either completed or nearing completion, the consultants were able to compile their report in some detail (Cremer and Warner, 1977a, 1.5). This study identified the operations by Shell as presenting a greater hazard to the local community than the Phase I installations since this (Phase II)

terminal handled sufficiently larger quantities of low boiling point hydrocarbons to give rise to potential vapour cloud incidents. The report concluded:

> "The risk of these hazards developing will be minimised by good plant layout and design and engineering practices in accordance with acceptable codes of practice and standards ... We would recommend that the final design should be reviewed by the local authority."
>
> Cremer and Warner 1977a, 2.2

Accordingly, the District Council imposed a planning condition requiring an audit by Shell of their plant design; extra conditions were also imposed (compared to Total's)

(a) to protect the sand dunes from the pipeline landfall and

(b) to limit noise levels.

No such conditions had been stipulated for the two earlier plants (Banff and Buchan District Council - personal communication).

Operations at St. Fergus were placed in some jeopardy by the location of a Ministry of Defence radio station four miles away at Crimond. During 1977, concerns were voiced about the possibility that high frequency transmissions from this station might cause 'break sparks' that could ignite any release of flammable vapour at one of the terminals (New Scientist, 1978). The addition of more transmitters has been opposed by the District Council who do not wish to see the direct employment and indirect commercial benefits of the plants endangered (Aberdeen Press and Journal, 8.9.78). A report from a Steering Committee set up by HSE was unable to reach positive conclusions about the compatibility of the station with the terminal (Health and Safety Executive, 1978b)although a further report (Health and Safety Executive, 1979) concluded that radio signals were:

> "unlikely to induce levels of power in operational fixed plant structures at BGC or Total which could reach even experimentally achieved threshold values at which gas might be ignited by a spark".

The Report recommended that the incomplete Shell plant should be similarly tested before operations commenced. Shell subsequently 'earthed' their entire terminal.

Peterhead

The proximity of Peterhead to St. Fergus and the availability of harbour facilities have attracted several developers to the area. During 1975, Scanitro - a consortium of British and Scandinavian chemical companies - put forward plans to manufacture ammonia from methane in a plant outside the town and to export it in liquefied gas carriers from the harbour. Although this proposal attracted fierce opposition in the town, a public inquiry was held following which the Reporter recommended that planning approval should be given. This was ratified by the Secretary of State. As it turned out the consortium never commenced their operation but the Scanitro plans affected the subsequent decision over proposals by Shell to construct an NGL plant on a nearby site.

Shell had made preliminary presentations of their plans to Banff and Buchan District Council and Grampian Regional Council in February 1975 and in July submitted an application for a site at Cowsrieve. This was 'called in' by the Regional Council but, following examination of this site by the Major Hazards Risk Appraisal Group of the HSE, the site had to be abandoned. HSE recommended that the NGL plant should be sited at least one mile from residential areas and half a mile away from any similar plant (Sprott and Mann, 1976, 1); Cowsrieve was too close to Scanitro's Wellington Farm site. Shell resubmitted an identical application for a site at North Collielaw. The Regional Council required a detailed investigation of the hazards and environmental impacts, possibly influenced by their experience with the Scanitro application. A consultants report commissioned by Grampian Regional Council (Cremer and Warner, 1976) reiterated the concerns first expressed in relation to Scanitro about the suitability of Peterhead harbour (whether large tankers could manoevre there in unfavourable weather conditions). Although expressing satisfaction with the site for the process items and storage tanks, the consultants expressed reservations about the marine facilities:

> "As we have reservations on the harbour and consider it barely adequate for this application, we feel strongly that any further proposed developments involving the use of the harbour would require a complete reassessment of the situation."
>
> Cremer and Warner, 1976

However, they also concluded:

> "In reaching our conclusions on the feasibility of using the harbour to ship out liquid products, we have taken into account the reports and recommendations by authorities such as the Health and Safety Executive and the Scottish Economic Planning Department and are prepared to accept the consensus of informed opinions that the risks involved are acceptable."
> op cit., 100

The Shell application was called in by the Secretary of State and a Public Inquiry was held in May and June 1976. The different local authorities involved took somewhat different stances towards the developments: the District Council (Banff and Buchan) recommended refusal since they were not fully convinced that safety could be achieved at the harbour and required further assurances from the developer. In addition, it was thought that future development west and south west of Peterhead would be severely curtailed by the HSE-imposed separation zone. The Regional Council (Grampian) were also concerned about safety, but considered that high-integrity plants would be possible if suitable safeguards were imposed.

Shell argued at the Inquiry that Peterhead was the only suitable harbour within 100 miles of St. Fergus. (The Scottish Economic Planning Department were anxious to see Shell use Peterhead and were optimistic that sufficient modifications would be achieved.) SEPD owned the Harbour of Refuge (outer harbour) where the jetties would be. They were not the pilotage authority nor the owners of the (inner) fishing harbour however. Indeed, the Port Authority (the Harbour Trustees) objected to the proposals. Shell had apparently not consulted with the Trustees about impacts on other users from traffic using their own jetty (Moore, 1982, 54).

The principal issuesthat emerged were

(i) the necessary amount of separation between the NGL plant and (a) housing estates; (b) Scanitro;

(ii) the proximity of the harbour facilities to housing and industry and

(iii) the safety corridors for pipelines connecting Collielaw and the terminal. Shell had submitted their own hazard evaluations of both the plant and terminal (Shell, 1976) but their evidence on the harbour's suitability turned out to be inadequately researched. Minor differences between Shell and Cremer and Warner about the modelling of releases

of flammable vapour clouds were relatively insignificant against the growing doubts over the protection that existing breakwaters and jetties could provide during the occasionally violent weather experienced at Peterhead. HSE were reluctant to specify a safety zone at the harbour, observing that the marine operations posed a wholly different set of hazards to static plant by virtue of the quantities of material handled and the limited times at which a threat might be present (ie. only during loading or unloading). A witness at the Inquiry explained that the design details were too imprecise to define a figure in metres although HSE saw 'no greater or no less hazard' in the harbour than at the plant (quoted in Cremer and Warner, 1978a, I.11)

Shell calculated that harbour alterations would cost £47 millions and withdrew from the Inquiry prematurely in order to conduct further tests on an experimental basis. According to a press report at the time, Shell had apparently known about the need for modifications in January and February before the Inquiry opened (Aberdeen Press and Journal, 10.6.76).

In September, Shell were apparently still suggesting to the planning authorities that Peterhead harbour could be made to accommodate the demands of the proposed petrochemical industry in the area (Aberdeen Press and Journal, 29.9.76) although by this stage, discussion had begun with local authorities in Fife about industrial sites. In November, the company formally announced its withdrawal from Peterhead (Aberdeen Press and Journal, 10.11.76). Protests from other parties at the Inquiry, including the local authorities, persuaded the Reporter to press for award of expenses against Shell for acting unreasonably in withdrawing (Scottish Development Department, 1977a). This plea was upheld by the Secretary of State.

Mossmorran

The package presented to the Fife authorities following withdrawal by Shell from Peterhead was an expanded one comprising:

1. Shell Expro application for an NGL plant and marine facilities
2. Esso chemical application for an ethylene plant and marine facilities
3. Esso chemical application for industrial development of an undetermined nature on an additional 175 hectares.

There had been little interest by the then developers in siting an ethylene cracker at Peterhead, but the Fife authorities insisted upon this broader set of proposals due to its accompanying employment prospects. The industrially zoned site at Mossmorran lay near to Cowdenbeath, a former coal mining town which in 1977, was experiencing 20% unemployment and would greatly benefit from diversification of its industrial base. A suitable site for marine facilities was identified at Braefoot Bay, four miles to the south of Mossmorran on the Firth of Forth, within close proximity to the communities of Aberdour and Dalgety Bay.

The applications were lodged early in 1977 and called in by the Secretary of State for Scotland between January and March 1977. The local authorities conducted a joint appraisal of the potential economic impacts of the proposals (Fife Regional, Dunfermline and Kirkcaldy District Councils, 1977) and commissioned Cremer and Warner during the informal pre-application consultation period (which had begun when the local authorities were first approached in July 1976) to advise them upon the acceptability or unacceptability of the applications on risk and environmental grounds. The latter report (Cremer and Warner, 1977b) concluded:

> "In our opinion, there is no reason to doubt that the installations proposed for Mossmorran and Braefoot Bay cannot be designed, built and operated in such a manner as to be acceptable in terms of environmental impact and community safety ... provided that relevant and adequate safeguards are agreed and ensured."
>
> Cremer and Warner, 1977b, xxiii

The authorities' own assessment of economic impact suggested that it potentially presented a significant stimulus to the local economy; at the peak construction phase, up to 3,350 jobs onsite along with substantial numbers involved in subcontracting (depending on the competitiveness of local firms) and further permanent jobs and a degree of economic stability in the operational phases (particularly if the installations mentioned in the third application above were to materialise). The considered, collective opinion of the three local councils thus suggested that the balance of advantage lay in recommending approval of the application subject to certain conditions.

Whereas Shell were firmly committed to building an NGL plant, Esso chemical did not finally decide to proceed with the ethylene project until October 1980. Since most of the employment incentives depended upon this project (and allied projects), this uncertainty meant that any assessment of local economic benefit would necessarily be speculative.

In response to vehement local opposition, mainly from the communities of Aberdour and Dalgety Bay, a Public Inquiry into the proposals was held which sat during June and July 1977. Evidence in favour of the plants was heard from the applicants and the local authorities. Three bodies attended as independents (none of whom spoke against the proposals):

(i) Cremer and Warner were examined about their study

(ii) The HSE appeared to express their advisory view on the acceptability in principle of the plant: their representatives concluded that provided the plants were 'designed, constructed maintained and operated to the highest standards currently available in the petroleum industry

> "There will not be an intolerable situation imposed on the surrounding neighbourhood, and there need not be any insuperable objections to these proposals."
> (Foster, 1977)

Spacing between the Shell and Esso plants was to be in accordance with accepted codes of practice; the HSE did not recommend larger separation (cf. Peterhead) because the two plants at Mossmorran were to be interdependent (SDD, 1977d,214). This meant that Shell's plant would be some 150 m from Esso's (a figure which was half the 300 m separation recommended by Cremer and Warner (1977b, 59) and to which Esso objected (SDD, op cit., 109). It was also recommended that the inhabitants of a housing estate at Gray Park, 800 m from the NGL site boundary, be rehoused elsewhere. When pressed on the necessary degree of separation at Braefoot Bay (the shipping terminal within closest proximity to the communities of Aberdour and Dalgety Bay), the HSE quoted a figure of 90 m, based on existing codes.

(iii) The marine jetties at Braefoot Bay were to be constructed by the Forth Ports Authority (FPA) and leased back to Shell/Esso. FPA are responsible for all pilotage in the Forth and had approved the original selection of the Braefoot site; they explained at the Inquiry

that safety was a matter for continuous improvement, and that it was within their remit to make by-laws to tighten controls over safety (op cit., 227).

In contrast to this measure of approval by the statutory authorities, there was strong opposition to the proposals by an Action Group deriving much of its support from the communities of Aberdour and Dalgety Bay, situated on either side of the Braefoot Bay site (see figure 6)*. Expert witnesses at the Inquiry acting on behalf of this Group expressed concern that the marine terminal would be located too close to these settlements and that a release of flammable material could therefore have disastrous consequences. Moreover, the witnesses questioned the comprehensiveness of the consultants' Report and noted how particularly scant attention appeared to have been devoted to safety of the marine terminal operations (and none at all to possible vessel interactions in the Forth itself)(Rasbash and Drysdale, 1977). The validity of this alternative assessment centred upon the definition of 'credible' spills at the jetties; the Action Group witnesses suggested release sizes several times larger than those forwarded by witnesses for Shell, Esso, Cremer and Warner and HSE. In making a judgement on this, the Reporter was not persuaded by the arguments of the Action Group and concluded:

> "... the weight of evidence suggests that the maximum credible spills will be considerably less than the quantity required to result in an unconfined explosion."
>
> Scottish Development Department, 1977d, 415

The Reporter also concurred with the expert witnesses from the developers, and statutory authorities that:

> "... the plants can be designed and operated so that they should not result in an undue hazard effect on the community provided that adequate safeguards are agreed and ensured. ... the acceptable degree of risk which a community, should be asked to accept should be such that a dangerous incident which could cause injury to a member of the public outside the site boundary should not occur more than once in a million years."
>
> opt cit., 414

The quantitative 'yardstick' referred to above is somewhat misleading; the evidence presented on safety was mainly qualitative; the consultants' report expressed probabilities of events occurring as being 'low'; 'very low' or 'extremely low'. Opinions about

*There was also opposition from the Scottish Branch of the Conservation Society, and from individuals from the immediate locality, but the most telling opposition came from the Action Group.

quantification were advanced largely in response to examination by Action Group representatives.

The Reporter concluded from the available evidence that the plants ought to be permitted:

> "Doubts which were raised on safety factors are not sufficient to cause me to believe that these plants cannot be designed to operate within an acceptable level of hazard. The requirement of a satisfactory hazard and operability audit should ensure that level is reached before plants are commissioned."
> op cit., 427

The Secretary of State for Scotland accepted the Reporter's advice and announced a provisional approval decision in March 1978. In the decision letter the Secretary of State for Scotland upheld the Reporter's recommendations and specifically denied that public safety had been sacrificed to economic benefits:

> "... there can be no question of economic need for the developments being balanced against this (hazard) factor: considerations of public safety would automatically rule out the developments if it were shown that they would give rise to an unacceptable level of hazard. The Secretary of State is satisfied that the plants can be designed to operate within an acceptable level of hazard."

Forty-eight planning considerations were attached to the approval of Shell's application, and an almost identical set to Esso's. The most important ones required both plants to be subjected to detailed hazard and operability studies to the satisfaction of the Health and Safety Executive. The Secretary of State's decision was provisional, not final, because a new safety issue had unexpectedly arisen following the public inquiry. The issue concerned the potential hazard posed by radio sparks. The issue was brought into the open by the Action Group (but see also St. Fergus Case study) and it took from March 1978 until August 1979 for the Secretary of State to deem that the issue had been adequately investigated (and that dissatisfaction expressed by the Action Group with the HSE reports on this matter had been adequately answered). The local authorities received further advice from Cremer and Warner (1978b, c) on the sparks issue which did not cause them to change their position.

The sparks issue turned out to be more significant in a procedural rather than in a substantive sense; for example, during the period of delay it caused the Action Group produced their own evaluation of risks from

shipping at the marine terminal (Aberdour and Dalgety Bay Joint Action Group, 1979) based upon methods used in the HSE's Canvey Report (Health and Safety Executive, 1978a). This was submitted to Burgoyne and Partners, a firm of professional consultants for comment. Although it was considered that several criticisms could be made, the consultants concluded

> "Briefly I consider that in general the Assessment has used the methods and data of the Canvey Report in an appropriate way."

Results from this assessment exceeded the widely quoted 'one in a million' figure cited at the Inquiry and suggested the likelihood of higher levels of risk at the terminal. The Action Group had hoped this additional evidence would prompt a reopening of the Inquiry (which would also consider the radio sparks question). In August 1979, however, the Secretary of State announced that there was enough information on the radio sparks issue to permit a decision. Other representations received by him were not considered significant enough to force a reopening of the Inquiry, and permission was granted in principle for all three applications. In contrast to the March 1978 position; the Secretary of State decided that the hazard audits were to be completed to his own satisfaction (in addition to being to the satisfaction of the HSE).

If the Peterhead case is included, the decision for the NGL plant had taken 3 years and Shell's entire package still longer. (A decision on the NGL pipeline from St. Fergus - see following section - was outstanding.) A fuller account of the Mossmorran decision can be found in Macgill (1982a, b).

NGL pipeline

Shell applied for authorisation to construct a natural gas liquids pipeline connecting St. Fergus with Mossmorran in April 1977. The application was made under the 1962 Pipelines Act, requiring a decision by the Secretary of State for Energy (see Table 2). An application to pipe ethane gas to the power station at Boddam was made at the same time. Local authorities in Grampian objected to the proposals on the grounds that insufficient information was available on safety aspects. The Energy Secretary requested the HSE to prepare a report 'to evaluate the hazard and to quantify the risk

presented by the construction' of the two pipelines (Health and Safety Executive, 1978). This was completed in August 1978 and concluded that both pipelines

> "would have the potential to cause harm and damage to people and property in the vicinity but that the frequency of occurrence of such events would be small."
> op cit, i

A report produced by the Pipelines Inspectorate (Paddock, 1978) envisaged only minimal effects upon development and asked that the Inspectorate should be advised of any development proposals within half a mile of the pipeline routes.

The local councils maintained their objections following receipt of these reports based on their concerns about routeing and proximity to inhabited buildings and concentrations of population. An additional reason was that existing arrangements for consultation and separation from cross country pipelines referred only to high pressure methane lines (Scottish Development Department, 1977c) and not to those carrying liquefied products. The NGL line would be the first of its kind in the United Kingdom.

In the absence of any further advice from HSE or other Government Departments, four of the councils - Grampian Region, Banff and Buchan, Gordon and Kincardine and Deeside Districts - prepared their own draft pipeline routeing and development control policy. This was based upon the 1978 HSE evaluation as the Councils did not wish to take advice from any other source than HSE. The philosophy underpinning their decision in this respect was set out in a joint paper produced in January 1979.

> "It ... seems appropriate for local authorities not to make a selection of a certain level of risk as being 'acceptable' but to adopt the assessment of risk (as conducted by HSE) ... and to plan accordingly for the land use effects of an accident. If it is accepted that the local authority must assume responsibility for public safety relating to danger from the pipeline it has to adopt some cautious arbitrary limits relating buildings and population concentrations to proximity to the pipeline."
> Grampian Regional Council, 1979a, p. 6

Under the most adverse weather conditions and largest release size, the HSE had suggested that a release of NGL could remain flammable 1300 m from its point of release (HSE, 1978c, 21).

Therefore, the councils argued, this ought logically to provide the basis for a development control policy:

| Distance from NGL line | Development Control Policy |
|---|---|
| up to 105 m* | No development |
| 105 to 400 m | Populations >50 not allowed |
| 400 to 1300 m | " >100 " " |

(These refer to 'population groupings', GRC, 1979a.)

When the pipeline route was reviewed under these criteria, 18 population concentrations were affected. Negotiations on rerouteing between the councils and Shell reduced the number of unacceptable points to two. The remaining problems over those two locations (a residential area and a hospital) might originally have been accepted by the councils; the Grampian Director of Planning noted the 'significant progress' that had been made and was prepared to endorse Shell's suggested reroutes submitted in June 1980. Apart from agreement over routeing, the local authorities were also interested in establishing consultation zones in the vicinity of the pipeline route (zones within which future development of land might be restricted on grounds of safety). In October 1979, the HSE stressed that 400 m would be an appropriate consultation distance; this differed from the half mile (800 m) which had been suggested earlier by the Pipelines Inspectorate, and was a discrepancy that was, in the Councils collective view, further vindication for their stand. This difference was unresolved when a change in circumstances occurred.

Following publication of Energy Paper 44 (Department of Energy, 1980) into the feasibility of bringing greater amounts of NGL's ashore Shell were persuaded that it would be prudent to anticipate additional demand for their line and to increase the diameter from 16" to 24" (increasing capacity by 125%). This rendered the earlier routeing policy obsolete. HSE produced a reappraisal of safety in the light of the increased capacity (Health and Safety Executive, 1980), and concluded that the level of risk 'would not be such as to lead to a recommendation that a Construction Authorisation should be withheld on health and safety grounds' (op cit, ii). The local authority

*There was a precedent for the 105 m swathe in the Cremer and Warner Mossmorran Report. The consultants had advised there that 'as far as possible', the NGL feed line should be located at least 100 m away from any significant buildings (Cremer and Warner, 1977, 2.33).

councils subsequently modified their policy in line with this report, raising the upper limit at which a flammable vapour cloud could pose a hazard to nearby communities from 1300 to 2100 m. Their continued objections to the pipeline necessitated a Public Inquiry which sat at Aberdeen and Perth for a total of 14 days during November and December 1980 and January 1981.

Debate at the Inquiry was strongly polarised; Shell emphasised the improbability of pipeline accidents and drew attention to seven safety features that would go beyond the normal requirements of the construction codes - increased wall thickness, high quality steel, increased soil cover, radiographic weld testing, hydrostatic testing of completed pipeline, remote-control block values and two independent communications systems (Department of Energy, 1981 para 3.13). Neither HSE nor the Pipeline Inspectors foresaw any difficulties in ensuring that these standards could be maintained under the provisions of the 1974 Health and Safety at Work Act. The councils reiterated their arguments about the unsuitability of the advice that had been forthcoming on separation distances. They argued that the HSE advice did not meet their requirements for a basis of a routeing policy (op cit. para, 5.13) and, in light of the compensation problems that refusal of planning permission could produce in the vicinity of the pipeline, deemed it not prudent to advance on such conflicting evidence as they had received.

> "The local authorities consider it essential to have some form of indemnity agreement with the Shell company because they do not wish to be liable for compensation or to acquire land as a result of a planning restriction, or because of a planning decision which would not have been made but for the presence of the pipelines." Grampian Regional Council, 1979b, Discussion Paper

Advice from the Scottish Development Department had in fact appeared two weeks before the Inquiry opened (Scottish Development Department, 1980) dealing purely with consultation. Pending introduction of detailed guidance, this suggested a 400 m consultation zone either side of pipelines containing various specified hazardous substances - including NGL's. The Advice Note emphasised that this did 'not imply that there are likely to be objections to development within that zone' (op cit., 15). This failed to meet the councils' need for a formal routeing policy. A further point of objection was the inability to reach consensus over indemnity with Shell in cases

where planning permission might be refused. It was argued that the community should not have to bear the financial consequences for a development which brought no local economic benefit. (Department of Energy, 1981, para. 5.46).

Two other councils gave evidence; Aberdeen City District were visibly more critical of Shell, criticising the latter for not examining fully the alternative possibility of a submarine pipeline route. They had invited Cremer and Warner to consider the HSE appraisal (a move deliberately spurned by the other four councils on the argument that a technical debate would overshadow their more immediate concerns for advice), but apart from minor points of criticism, the consultants had seen no reason to express a different conclusion. Fife Regional Council emphasised the necessity of imposing as a condition that a hazard audit be completed on the design and construction periods to the Secretary of State's satisfaction, and made particular reference to the guardian role that a local authority had to adopt in this type of situation (op cit., paras 9.4, 9.9).

In his Report to the Secretary of State, the Reporter recommended that authorisation be granted but also drew to his attention the local authorities case that

> "as a matter of urgency, they should be furnished with more specific guidance concerning the appropriate separation distances to be applied in relation to various forms of development in proximity to pipelines conveying potentially hazardous materials."

The Secretary of State's decision was announced in August 1981. He upheld the Reporter's conclusion that provided the pipeline was designed, constructed and maintained to exemplary standards, it would be adequately safe. On the subject of independent consultants, the Secretary over-ruled the Reporter's recommendations that a single Government body should be responsible for overall supervision, and instead required more than one agency to be involved, the appointment of experts resting with him. Pipe standards and safety devices were also mentioned, with Shell being required to use a greater wall thickness where the route approached settlements and to incorporate three types of emergency systems.

St. Fergus

Phase III proposals for development at St. Fergus arose from the anticipated gas gathering system linking various offshore fields which had recoverable NGL reserves (Department of Energy, 1980). British Gas submitted two applications to Banff and Buchan District Council in May 1980; one for a reception terminal and one for a Synthetic Natural Gas (SNG) Plant. The latter would have used NGL's to manufacture natural gas, if other outlets for the NGL's did not materialise.

Both Grampian Regional and Banff and Buchan District Councils were anxious to see gas feedstocks processed in the Buchan area. In a joint contingency plan for petrochemicals, they voiced support for industrial development:

> "The authorities intend to exploit this (Gas Gathering System) opportunity to introduce a new stimulus and stable base into the local economy and with this intention will fully cooperate with any industrial operators whose plans further this aim."
> (Grampian Regional Council, Banff and Buchan District Council, 1980; 19)

BGC submitted a Safety Assessment and Visual and Environmental Impact Appraisals along with their application. After discussion with the District Council it was agreed that these should all form part of the application itself. The safety assessment was conducted by Cremer and Warner for BGC. In the consultants' opinion, the appropriateness of the site both in terms of its separation from the existing terminals and from the community, was not in doubt:

> "If approved, the project can proceed to the detailed design stage in the confidence that any safety problems identified then should be capable of solution by a change in design or internal plant layout - the solution should not necessitate a change in site location nor should it need to involve a major change to the overall project concept".
> Cremer and Warner, 1980a, 96

A continuous process of safety auditing was envisaged:

> "The present safety assessment by Cremer and Warner must (therefore) be seen as the precursor to an ongoing series of safety studies and checks which will include as the next phase a hazard audit running in parallel with the design stage to ensure that no design commitments are entered into which will have intractable safety problems."
> Op cit., 37

The District Council asked HSE to comment upon this assessment. The Executive noted various omissions although in general they considered that the report gave a good general picture of the hazards that could arise (Banff and Buchan District Council, Grampian Regional Council, 1980). There were considered to be no strong reasons on health and safety grounds to refuse permission.

Permission for both plants was granted in October subject to sixteen conditions. One required any re-arrangement of major plant items to be accompanied by an amended hazard analysis (acknowledging the proximity of several major operations with hazardous substances) and one requiring a hazard audit. A Section 50 agreement between Bauff and Buchan and BGC placed additional obligations upon the latter regarding safety; specifically, the preparation of a detailed emergency plan and clarification of some HSE remarks upon the Consultants' Report. The additions to the terminal were processed and permitted rapidly by the local authorities, a measure of the hoped-for speed with which the system of which this formed only a part would be built.

Nigg Bay

Due to the uncertainty surrounding the eventual disposal of NGL's from a proposed North Sea gas gathering pipeline, the unusual situation arose where three companies applied for planning permission at Nigg Bay. Although the potential presented by a Gas Gathering System was widely recognised, agreement upon who would obtain access to the valuable feedstocks had been left to the Government to determine. Nigg was chosen by BGC, Dow Chemical and Highland Hydrocarbons (HH) as a suitable site for an NGL plant (BGC) and NGL plant and cracking plant (ethylene/propylene) by both Dow and HH. Sites elsewhere in both Scotland and England for utilisation of the same feedstock were also being considered by other companies.

Development at Nigg would have necessitated large scale land reclamation from Nigg Sands. However, the potential for large scale activities had been already recognised: (1) the Cromarty Firth Port Authority was established in 1973 expressly to promote industry, purchase land and carry out reclamation; (2) In 1975, planning permission had been granted for an oil refinery (which had not been built); (3) the National Planning Guidelines described

the Firth and its proximity to the oil and gas fields as 'the most promising area for major industries outside the Central Belt' (Scottish Development Department, 1977b, 6) and (4) in the Highland Region Structure Plan, approved in July 1980, sites at Nigg were earmarked for large-scale development. Of additional interest in the context of the present paper is that in a hypothetical safety assessment of various possible sites for such activities (petrochemical plants typical of those which would arise from NGL availability) in Highland Region conducted in 1978 (Cremer and Warner, 1978a), Nigg Bay had been considered one of those suitable (op cit., 104). Taken together, these points presented a compelling case in favour of any development in the Firth, and this could be allied to a strong pro-industry stance by the Region and Ross and Cromarty District Councils.

The three applications referred to above were lodged between February and May 1980. There was some haste as all the applicants wanted to commence reclamation work as soon as possible. The Region (who determined the planning applications since the District Council is not a planning authority) set up Working Parties to consider the various aspects associated with the proposals. These drew upon a wide range of expertise and comprehensive studies on a number of aspects were produced. Two particularly crucial areas stood out: the safety of plant and the hydrological effects of reclamation (McRea and Greaves, 1981; 9).

Thirty objections on a wide range of subjects were received by the Regional Council and were responded to individually by the Planning Department who provided information from the Working Parties. The main task of the Department was to coordinate a scheme compatible with both the individual proposals and the various constraints which optimised plant layout and minimised impacts at the site. This was hindered by the comparative lack of detail submitted by two applicants. Only BGC had provided a detailed safety assessment, the main conclusions of which had been:

> "The siting and layout of the proposed BGC NGL plant and jetty terminals are appropriate in terms of controlling the risk to the external community and neighbouring industries. To avoid constraining the development of the remainder of the proposed reclamation area, the jetty pipelines will require to be designed and protected to specially high standards. Subject to this, and also to certain assumptions which have been made

(Continued/ ... )

> regarding details of design, construction and operation, the risk levels are calculated to be well within the range which should, on the basis of comparison with the existing general risk background, be considered satisfactory."
> Cremer and Warner, 1980b,2

No analogous detail from Dow and HH was forthcoming. However, the Council decided upon a common layout plan which was then used as the basis for consideration of individual proposals.

Following the mandatory notification procedure for major oil and gas related developments, the Secretary of State for Scotland has the discretion to call in such proposals for his own determination (involving a public inquiry) (SDD, 1977b,2). With the amount of information already available, the Director of Planning suggested to the Scottish Development Department that the proposals appeared capable of proper design and control, the Planning Committee endorsed this and SDD agreed that a 'public discussion' (not a formal public inquiry) would be appropriate, and did not 'call in' the applications. The resulting public meeting - in effect, an open session of the Regional Council Planning Committee - sat between 1 and 3 September. All those who had made objections or representations were invited to question members of the technical parties and developers' representatives. Relevant studies and reports were made available. Informality was emphasised and the topics covered included (1) General (2) Pollution and environment (3) safety. The Chairman declared himself impartial, but not neutral as he favoured the developments (Aberdeen Press and Journal, 2.9.80).

HSE representatives who attended were particularly concerned about various aspects of the proposals. The limited information from Dow and HH prevented them from commenting fully upon those proposals. The Chairman ruled that until such information was provided, these applications were effectively invalid.

The sparse residential population densities in the immediate vicinity of the site (54 people within a 2 km radius) meant that the main group exposed to hazards would be workers on the adjacent HiFab construction yard, over which HSE voiced concern (Highland News 4.9.80). A spokesman for the consultants claimed however, that the workers at HiFab faced more danger in their daily work than they would from petrochemicals next door (Aberdeen Press and Journal, 4.9.1980).

Several items relevant to safety were not considered due to the absence of sufficient information: access points, location of jetties, pipelines and possible underground storage of liquefied product in excavated caverns. These were deemed to be reserved matters.

The public meeting was hailed as a success by many of the participants; planning permission was granted at the end of October to all three applicants for reclamation, main process plants and above ground storage. As land below low water mark was reclaimed, it too would qualify for permission. Ross and Cromarty District Council were over-ruled by the Region in their attempt to obtain Section 50 agreements for financial assistance towards infrastructure costs. The 37 conditions attached to each permission specified a common layout of plants and required (a) submission of hazard survey(s) and evacuation of any properties identified in the surveys that were at 'unacceptable risk by reason of proximity to any potential danger'; (b) examination of seismic activities affecting the plants (the Great Glen Fault runs nearby); (c) examination of possible hazard effects of radio transmissions; (d) requirement for Section 50 agreements on land use within safety zones. The Department of Energy were left to determine which of the three applicants for the Nigg site (or possibly one for some other site) should get the feedstock.

Postscript on case histories

Neither the plants at St Fergus nor at Nigg Bay which had been planned to take advantage of the Gas Gathering System have been built. The combined scheme was abandoned after funds could not be raised in the private sector and the Treasury declined to supply the £2.7 bn needed (Sunday Times, 13.9.81). Instead, it is likely that individual companies will construct their own pipeline systems as and when their economic necessity becomes apparent. The Shell terminal at St Fergus (Phase II) came onstream in 1982; the NGL plant at Mossmorran is due to be completed in 1984. Esso envisage finishing their plant in 1984/5. The NGL pipeline will be completed during 1983.

## Evaluation

It is a statement of the obvious that observable deliberation over issues of public safety within planning decisions for potentially hazardous installations only arises inasmuch as agencies (individuals, institutions and organisations) become involved and articulate various viewpoints. In the light of the case histories summarised above, an evaluation may be made of the concerns and views expressed by each of the main classes of agency-developer, local authority, health and safety inspectorate, professional consultant; 'public' and decision taker. Kates (1978) gives a broad and vivid categorisation of agencies involved with such decisions as hazard makers, risk takers, guardians and assessors. These four broad categories are mapped onto the agencies involved in the decisions reviewed above in table 3.

It is evident from the above case histories that issues of concern to any given class of agency differ between different decisions, this arising partly from a different spread of costs, risks and benefits in each case. There are also additional differences between decisions in the way the different agencies have undertaken their allowable role, and an inevitable build up of experience over time. These differences will be brought out in this section. Since site choice for all but the St Fergus-Mossmorran NGL pipeline, was in principle predetermined within any particular case study it is appropriate to review some of the issues raised by site choice before evaluating the contribution to risk assessment made by each class of agency in turn.

## Site choice

Although broad official guidelines can encourage developers towards particular locations, the onus on site selection rests firmly with the would-be developer. With the exception of the NGL pipeline, each of the sites reviewed above lies within a so-called 'preferred development zone' in successive documents published by the Scottish Development Department (1974, 1977b, 1981). The SDD has sought to encourage local authorities to identify locations within their areas which they deem suitable for large scale industrial activity and, in particular, North Sea oil and gas related developments. There is a presumption towards the granting of planning permission for corresponding planning applications in such areas, and something quite

out of the ordinary - perhaps on safety? - would typically have to emerge for this presumption to be successfully challenged. Notwithstanding these remarks, the case histories above suggest that planning procedures are rather more than rubber stamping activities for decisions that have already been taken.

The St. Fergus site aroused only limited objections and most of these would appear to refer not to safety, but to disruption caused during construction. The site is of national importance both to current and expanded exploitation of gas and NGL's, a position widely recognised. Ultimately, if further terminals and handling facilities are added it is likely to be the close proximity of so many strategically vital installations that will be an influential consideration.

The Peterhead and Mossmorran proposals have both highlighted the importance of guaranteeing adequate marine facilities. The exposure of the inadequacy of the Peterhead harbour caused Shell to withdraw from the Inquiry. This was an important factor, that in the longer term, may limit the area's potential for attracting downstream activities to capitalise on the availability of feedstock. (The support for the harbour by the SEPD was nevertheless in line with Shell's conviction (later to be proved unfounded) that necessary improvements would be made.)

Shell had been searching for an alternative for some time before their formal withdrawal from Peterhead. Their preference for Fife and a site in the Central Belt may have been their only remaining option, since they had already decided (before the Peterhead application) against sites at Cromarty and on Tayside. The designation of Mossmorran as an industrial site provided an attractive inducement, particularly since the site was sufficiently extensive to acommodate other related activities that had not been explicitly considered for Peterhead. A study published jointly by Regional Councils in the area (Fife Central and Lothian Regional Councils, 1979) provided an ex post endorsement of Mossmorran as a site for petrochemical activity and identified Braefoot Bay as one of only four possible harbour locations on the Forth Estuary. A study of marine sites by the Forth Ports Authority (1977) also identified the attractiveness of Braefoot Bay; arguments advanced against the proximity of the site to nearby communities thus had a formidable case to challenge.

The repeated endorsement of sites in the Nigg Bay Area (in Development Plans, ministerial decisions and by national bodies like the SDD) has, paradoxically, not been paralleled by large scale development. In contrast to Peterhead and Mossmorran, the provision of adequate marine facilities here seems not to have been in doubt as the Cromarty Firth is a fine deepwater anchorage.

The NGL pipeline route is not directly comparable with these examples. Moreover, it would appear to be a prime example of 'salami politics' to permit development of gas separation facilities at Mossmorran before deciding whether a suitable route for its feedstock pipeline could be found. This assumption - implicit in the Mossmorran decision - contrasts vividly however with the extensive later deliberations over the ideal route and thereby challenges the suggestion that approval of the route was a foregone conclusion, as a more cynical observer might suggest.

The developer (Applicant)

The planning decision marks an intersection between a company's own business and management strategies (motivated by profit, expansion, diversification, or whatever) and statutory planning procedures for the development of land. It is in the developers interest for this statutory hurdle to be negotiated as efficiently as possible.

The applicants within the above case studies illustrate different examples of the technocentrist mould (cf. O'Riordan, 1981) or what Thompson (1983) in a deeper cultural analysis calls the entrepreneurial tribe. Typically, the technocentrist believes that progress lies in the better understanding and harnessing of scientific, technological and management expertise. Technocentrists may differ in their ideas about how such goals might be realised; with or without concensus to the demands of others (O'Riordan, 1981, pp. 376-7).

To the responsible technocentrist, therefore, safety is primarily a technical issue, to be ensured through high engineering standards, codes of practice, quality of materials, safety devices and emergency shut-down systems and good management practices. These, coupled with the good record of the UK petrochemical industry as regards plant integrity are used as a basis for the argument that safety (by any reasonable yardstick) will be ensured. Reasonable moral and ethical

standards are subsumed within these engineering requirements, and thus generally not addressed directly. There is often likely to be an ideological or cultural barrier between developers and others who do not see safety in this way.

On a number of features, and underlying the view that it is not in their interest to build unsafely, the developers incorporate much more than required by statutory regulations and codes of practice, motivated by factors such as hard (loss prevention) economics, image enhancement, or improved working conditions for employees. Absolute safety is impossible to ensure, however, there remaining a remote possibility of a high consequence disaster. Moreover, in such an event there could be costs which the developer would not have to bear (thus, public and industry may both stand to lose, but lose in different ways). Further, not all issues of public safety (evacuation, sabotage, compensation) are within industry's remit. Thus, the developers' interest do not coincide with those of others in society, and some searching safety scrutiny during a planning decision on behalf of society at large (by HSE, local authorities, or the public themselves) is not only warranted but should reasonably be expected.

Reijnders (1982) has characterised the publicly acknowledged safety debate during planning decisions for hazardous facilities as a clash of rights between industry operating without undue interference from others, and others existing without undue imposition from industry. In a specifically UK context, the Advisory Committee for Major Hazards note:

> "We believe that the best practices must be followed by all companies and that we have reached a state of technological development where it is not sufficient in areas of high risk for employers merely to demonstrate to themselves that all is well. They should now be required to demonstrate to the community as a whole that their plants are properly designed, well constructed and safely operated".
> Health and Safety Commission, 1979, 24

One of the most immediate illustrations of a lack of coincidence of industry and wider societal interests is found over site choice. The Peterhead case study gives examples of two inappropriate choices of site by the developer (the first recommended to be abandoned on HSE advice: the second abandoned by the company). St Fergus

phase I (site near Strathbeg) and the first proposed NGL pipeline are further examples of what in the developers view were originally deemed suitable sites, later ruled to be against the public interest. Thus while not arguing that industry can be expected to have thoroughly probed a site before proceeding, nor suggesting that the onus for site selection should be removed from industry, others would appear to have grounds for probing the basis for industry's choice of site.

Another more general illustration of not entirely coincident interest arises over the timing of safety scrutiny: the best time for 'public' scrutiny of safety (planning decision) is (apparently) not the best time for industry (construction and operation phases). This is clearly shown in the amount of information made available about a developer's proposed installations. There is a general expectation in recent times that more information will be forthcoming. At Nigg, HH and Dow did not meet this expectation, and their proposals were deemed invalid pending further information.

Three years earlier at Mossmorran a planning application had been lodged by Esso and subsequently approved by the Secretary of State for Scotland for potentially hazardous petro-chemical development of an as-yet unspecified nature. (It seems unlikely that permission on such grounds would now be granted.) Cremer and Warner had also noted the difficulty of evaluating Esso's cracker proposals which were 'in a state of flux' (Cremer and Warner, 1977b, 1.3). The approach by BGC makes stark comparison. Their commitment to Environmental Impact Analysis is partly as a means for speeding up the processing of planning applications (ENDS, 1978). If the adoption of such practices also enables a developer to earn favour over rivals (as, albeit, temporarily, at Nigg), then there is further justification for taking the initiative here.

The general move towards more information has come about without any formal change in statutory requirements though is in line with the gradual increased use and comprehensiveness of EIA. On safety aspects it anticipates forthcoming Hazardous Installations (Notification and Survey) Regulations (Health and Safety Commission, 1978) and due to come into force in 1983. The possible adoption of more specific techniques under an EEC Environmental Assessment Directive (House of Lords, 1981) and Major Accident Hazards Directive (House of Lords, 1980) is also

relevant. Thus the Scottish onshore experience has given statutory authorities an opportunity for dry runs of these legal requirements, with the developers - notably BGC and Shell who each figure in four of the twelve case studies considered above - as guinea pigs.

Notwithstanding BGC's evident commitment in these case histories, industry is generally reluctant to divulge certain information. Expense, commercial confidentiality, delay, the sub-optimal freezing of design plans at an early stage and an understandable motive to conceal information from saboteurs combine to influence the publicly visible degree of altruism adopted by industry. The attitude of BGC towards a more exhaustive appraisal routine that might exist under EEC legislation is illuminating, bearing in mind this commitment:

> "In principle we favour the establishment of environmental impact procedures, but we fear that in its present form, the Directive, far from improving the present United Kingdom systems, would introduce an unwieldy bureaucratic procedure for obtaining planning permission, involving unnecessary additional costs and delays."
> House of Lords, 1981, 138.

The above evaluation has depicted the planning process as an opportunity for others to inquire into developers safety criteria with the power to constrain development via a refusal of planning consent or stipulation of planning conditions and section 50 agreements. In the latter respect it is difficult to evaluate whether certain measures are imposed to safeguard the public and the rights of others (ie. to ensure safety will be achieved) or whether they are part of an effort for safety to be seen to be achieved. The Robens philosophy is for the initiative on safety to remain with industry, a philosophy shared by industry. However, we may note that there are cases where design and layout features have been suggested by others and even embedded in planning conditions.

Given the lack of complete coincidence of public and industrial interests, a negative attitude on the part of industry to public safety scrutiny is to be decried and a positive attitude welcomed. We may note, however, that the case study which involved the most critical and difficult scrutiny of public safety (Mossmorran) was not the one with the least positive developer. Moreover, the decision by BGC at St Fergus III, for the 'outside' firm, Cremer and Warner, to prepare

their initial statement on risk, illustrates a developer's acknowledgement that his own 'word', however comprehensive, can never necessarily be enough.

The local authorities

The overall role of the elected local government in a planning context is to shape and control the development of land in their own areas. The achievement of specific goals in different areas is intimately influenced by the relationships between the elected councillors (who sit on planning committees and full councils) and their unelected, full time professional officers (who supply them with information and advice). In an atmosphere where personal allegiances, prejudices and groupings may be significant, it would be unwise not to appreciate the political manoevring that may go on behind the scenes.

Planning applications that raise issues of public safety add an additional complex dimension to the general spectrum of economic and environmental cost and benefits presented by development proposals. The cost-risk-benefit trade-off that inevitably underlies local authority planning decisions is undertaken with varying degrees of sophistication in different decisions, and the adoption of EIA is an attempt to improve the basis of decision taking.

Although it is difficult to point to hard evidence of the nature of any cost-risk-benefit balance that is made, Pearce (1981) and others have argued that such a trade-off is the most reasonable thing that can be done. Moreover, some such trade-off is inevitable given that the raison d'etre of plants is economic, and there is no such thing as absolute safety. There is some evidence for the pre-eminent influence of economic impacts, if not for the precise nature of the process whereby risks are deemed to be acceptable.

The inquiry at Peterhead terminated before the subject of risk had been fully aired although the authorities had expressed their support for the employment and long-term benefits. The Fife councils asked for and received a more complete package of proposals, realising that the NGL plant on its own was probably not a sufficient improvement in local employment prospects. Since Esso did not confirm their intention to build a cracker until October 1980 and the downstream application is still not taken up, this prolonged period of uncertainty

rebounded upon the makers of the original collective decision of net benefit outweighing net risks and costs, and made it more of a gamble than it might originally have appeared.

The argument advanced by councils at the pipeline inquiry that they should not be forced to bear costs for an activity from which they stood to gain no benefits also does not provide a clear cut example of an explicit trade-off. First, the councils had expressed an unease about objecting to a nationally important development. Second, it was not fully established whether they would have adopted a different stance if benefits had been forthcoming and, third, this argument conveniently reinforced their case about provision of compensation by the developers. Contrasting with these explicit mentions, the benefits from installations to be built at St. Fergus and Nigg were implicit in the generally favourable attitudes of relevant local authorities towards particular categories of industrial development within their areas.

Evaluation of risk cannot occur without some prior risk estimation. Risk estimation in turn can be of varying degrees of sophistication (from simple mental recognition that some hazardous event could occur to sophisticated fault-tree calculation of risk probability and hazard consequence, bounded by sensitivity tests). It may be pertinent to enquire into the sophistication of risk estimation on which a local authority's risk evaluation is based. Evaluation can, of course, be revised in the light of additional risk estimation evidence, but a hysteresis effect may inhibit revision of views that have already been formed.

Typically local councillors and officers in planning departments are not (and cannot be expected to be) experts in risk estimation. Thus the movement towards impact appraisal techniques (meeting the perceived need for planning decisions to be better informed) has stimulated the outside commissioning by local authorities of risk assessment reports for planning applications in which significant issues of safety are raised. (We may note the paucity of such assessment for the first phase at St. Fergus, but considerably more thereafter; the exception of the Dow and HH proposals at Nigg met with due consternation.)

The subsequent assimilation of risk estimation evidence and advice falls back on planning officers. It may be suggested that for the earlier decisions, such advice may (necessarily) have been uncritically accepted: used as an assurance about safety but not exhaustively probed. As experience with hazard-related proposals increases, so too does the competence of local authorities on risk and hazard. Largely unqualified acceptance of an externally-prepared risk assessment (St. Fergus II, Peterhead, Mossmorran) thus seems to have changed to a desire for an expert second opinion or scrutiny of a risk assessment report (BGC at Nigg and St Fergus III, NGL pipeline). More ambitious still was the local authorities decision over the NGL pipeline to present their own technical case.

This proved, perhaps predictably on the basis of the information available, to be a biased attempt, highlighting worst case events. Nonetheless, attention was drawn to the motive for producing it in the first place and since it was not intended to be a definitive statement, but rather, an outline policy which could then be modified after discussion with HSE, it is to miss the point to criticise it on technical grounds. In its format, the policy challenged the HSE to justify the apparent discrepancy between hazard distances in their evaluations and in their advice to the planners. Using a hybrid technical approach was seen as the only realistic course for the planners to follow - they had to play to the Executive's rules. A similar argument applies to the ADBJAG assessment since a challenge to the 'official' creed had to be made in technical language; paradoxically, this renders such attempts more vulnerable to critical rejection on grounds of incompleteness or over-simplicity.

The learning process that may be seen by way of this evidence still does not make local authorities risk experts (it would not say much for trained risk analysts if they were!). In a related context it is hopefully correct to assume that any 'hazop' planning conditions to be carried out to a local authority's satisfaction (as at Peterhead) would in fact be scrutinised by professional consultants acting on the authority's behalf.

Notwithstanding increased technical sophistication, decisions remain political. There is a growing literature on the as yet insoluble problems presented by decision taking on complex technical development (Conrad, 1980, Griffiths, 1981, Council for Science & Society, 1982). Resolution of difficulties is inevitably denied by the uncertain state of available knowledge. The degree of accountability (albeit too little for some) enables decision taking to be scrutinised and weaknesses (some which are inevitable, some not) identified; these become magnified with the inevitable benefit of hindsight.

The relationship between local authorities and the Health and Safety Executive is of some interest as both are key agents in societal risk management. Although both acting 'in the public interest', they do not always agree . Both have a finger in the same pie (guardians of a community potentially at risk), are sometimes after the same piece (whose judgement should count in making the decision on risk acceptability? Who should have the final say on the control of development on land in the vicinity of a hazardous installation?) and might differ over whether a particular piece can be cleanly cut (clear-cut guidance for safety zones, hard evidence on risk estimation). Such considerations are aired spasmodically, depending upon the way in which the safety debate progresses at different locations. Peterhead and the pipeline raise significant questions about the nature and extent of development that should be permitted in the vicinity of plant, similarly the criteria for isolating marine activities bears interesting comparison between Peterhead and Mossmorran. The changing attitude towards the robustness and comprehensiveness of written assessments by both local authorities and HSE has been referred to above.

Apart from changes that have occurred with gradual maturity over time, given increased experience with such applications, there are additional differences between different local authorities. In

the case of the NGL pipeline, the local authority were pre-occupied in terms of risk estimation with hazard consequence rather than risk probability (California style!). It is difficult fully to account for this pre-occupation in one particular decision: plainly, relatively more detailed information was available in this case, and there was also the hard-cash question of compensation, but it may be arbitrary to argue this on grounds of safety for one decision but not others.

Other notable differences arose (i) over matters of principle (eg. Grampian R.C. argued for approval of Peterhead, subject to conditions; Banff and Buchan D.C. argued for refusal). Whether the different councils each saw different absolute levels of safety here, or different balances of a given level of safety is difficult to evaluate. The discrepancy between the view of Aberdeen D.C. and other councils over approval of the pipeline raises similar questions. (ii) over matters of detail - whether independent consultants should scrutinise the HSE report on pipelines (was this due to a genuine concern for safety or more political strategy?). (iii) more subtle differences between the three Fife local authorities over the degree of support for the Mossmorran applications. Again, the degree of accountability in the UK enables such differences to be seen (there must be many more that are unseen!). We may ponder about the relative merit of visible disagreement (in an area where human judgements are bound to differ) or unamimity (in an area where a critical mistake can lead to disaster). Hazardous installations pose problems that institutions can inevitably only tackle with some difficulty. It may be more realistic to aim for improvement in approach to outstanding difficulties rather than resolution of them. In their guardian capacity, the role of the local authority must be to keep probing developers without unduly deterring them.

## The Health and Safety Executive

During the period covered by the decisions reviewed in this paper, changes have occurred in the HSE's approach to major hazard advice, both in the development of a more visible role during planning decisions and in attempts to improve the nature of the advice and assistance they provide to local authorities. The creation of a Major Hazards Assessment Unit within HSE during 1979-80

anticipated the increasing demands that new legislation and greater local authority perception of major hazards would make upon the Executive (Barrell, 1981).

It is appropriate to distinguish between the seen advisory role of the HSE during planning decisions for potentially hazardous installations and their unseen enforcement role for installations under construction and in operation. Their more positive role in the former can smooth the latter (eg. by identifying critical lay-out and other broad design features early on), it can hopefully also enhance the image of public accountability and better satisfy the requirements of planners. However involvement in the former is not necessarily a true guide to the effectiveness of the latter.

Evidence of the more positive advisory role is found in the nature of HSE advice in each of the decisions reviewed above. The relatively scant evidence on their safety scrutiny for St. Fergus Phase I involved the old HM Factory Inspectorate prior to HSE creation in January 1975. A brief but quite effective statement was issued at the first Peterhead site applied for by Shell (advising refusal); a general statement of approval in principle was given for the second Peterhead site (which Shell later withdrew from on grounds of safety); similarly general statements of approval in principle was given for the Mossmorran applications; reservation of comment pending further information for two of the applications at Nigg (no similar refusal given corresponding lack of information on the third application had arisen over Mossmorran); a relatively detailed risk assessment of the NGL pipeline (though not strictly comparable with more complex installations and different amount of design detail); a scrutiny of a private consultant's risk assessment for St. Fergus Phase III (very effective use of limited HSE resources, which they seem pleased to encourage).

That planners are still dissatisfied with certain aspects of HSE advice (eg. dissatisfaction with the most exhaustive HSE approval of pipeline) is not necessarily to suggest that HSE should change: each institution has its own function and personnel, and should not necessarily be expected to coincide. The Mossmorran advice issued by the HSE fell short of planners requirements, and in anticipation that this would be the case, Cremer and Warner long since had been commissioned. HSE scrutiny of that report at the time might have

been very beneficial in achieving a more comprehensive, publicly acknowledged safety scrutiny (cf. the view of the Advisory Committee for major hazards that safety should bee seen to be achieved) More recent practice more closely meets this ideal (St. Fergus III). The stipulation that a hazard and operability audit should be conducted on major hazard installations to the satisfaction of the Health and Safety Executive and not merely the local authority, was first adopted for the Mossmorran plant. This again has rapidly become a standard practice (anticipating forthcoming legislation both in the United Kingdom (HSC 1978) and the EEC (House of Lords, 1980)).

The Mossmorran experience was a particularly interesting test of the public image of the Health and Safety Executive (See Macgill, 1982a), the only one of the cases reviewed above which involved a significant degree of public opposition on grounds of safety. 1. They were relatively unprepared for vociferous criticism of the basis of their hazard control policy (on what criteria do installations qualify for cordon sanitaire and is it not arbitrary that Braefoot Bay - 'the most hazardous link' - does not qualify· how can a quantitative yardstick of risk acceptability be meaningful in a context where a quantitative assessment has not been performed?). 2. There were also differences in technical judgement over the size and behaviour of accidental gas releases - to be probed in the less than ideal condictions of a Public Inquiry (if the Action Group's case was legitimate then the whole basis of UK hazard control policy was brought into question). 3. An apparent change in policy over marine activities. 4. A two year delay between Inquiry and decision during which the HSE could be seen to be paying heed to the relatively less significant issue of radio sparks but not (at least not publicly) to other (more significant) issues that had arisen.

With hindsight, Mossmorran can be seen as something of a landmark in the HSE advisory role (before the effects of restructuring could be felt). It is difficult to assess how the course of this decision might have differed had the restructuring already occurred (or, indeed, how much the Mossmorran experience influenced or confirmed the need for restructuring). Not the least most significant determinant of the Action Group's view of the unacceptability of the risk may have been their lack of confidence in the HSE as the public guardians of safety.

Willingness to adapt suggests the HSE are 'accommodators' (in the environmentalist and cultural categorisations of O'Riordan - and Thompson - respectively). There are firm constraints, though on what can be done: public accountability is inevitably limited by the nature and philosophy of their work (confidential scrutiny of industrial activity, with the onus for safety lying with industry and subtle suggestion more effective than public prohibition). Independence both of inudstry and of government are qualities that the Inspectorate must be seen to achieve and fight to maintain (see also Council for Science and Society, 1976).

Professional consultants and other independents

Private consultants have found something of a growth industry in the technically complex and sociologically tantalising subject of risk. Particularly notable in the above case studies has been the niche they have filled between local authorities and the HSE. Their role is not confined to this niche however; all that is needed is a client requiring a risk assessment. Without any suggestion that their professional judgement is compromised, a consultant's job is to work to the brief of his client (something the HSE could not and should not do, regardless of time and resources).

In all the above case studies, the reports subsequently produced by consultants have reinforced the safety viewpoints of their clients (Cremer and Warner, Rasbash, Burgoyne's). Cynically one could conclude from this that, deliberately or not, risk assessments simply reflect what the authors want. On the other hand, the very idea of establishing something as nebulous as safety permits wide divergence of genuine opinion.

It may be more appropriate to question whether clients have accepted advice uncritically. In this regard the recent practice of expert scrutiny of expert reports that are to be used as a basis of a statutory decision (only occurring in the BGC at Nigg and St Fergus III cases) would seem to be a marked improvement on earlier practice. However, where great divergence of expert opinion exists, (as between, say, Cremer and Warner and Rasbash at Mossmorran), it is uncomfortable that it is (inevitably?) politically judged rather than scientifically resolved. The less significant expert divergences are less serious than these (Cremer and Warner/HSE at Mossmorran;

Pipelines Inspectorate/HSE over NGL pipelines; nonetheless, any such disagreement may be less than reassuring to lay parties).

In a more positive vein we may note that consultants have been a vital catalyst in the societal learning process into managing technological hazards, have made what local government see as significant practical contributions (for example, planning conditions) and provided (at a price) readable risk assessment reports that others can learn from (though whether the informed lay party can distinguish between competent and less than competent risk assessments remains an open question). That the developer rather than the local authority paid for the most recent consultants' reports (Nigg and St Fergus III) has given a new answer to the question of who should pay for reasonable inquiry into the safety of development proposals.

The Port Authorities are another significant third party interest in the above decisions and their approval of jetty facilities and pilotage arrangements is an important step towards the official approval of individual sites. It is notable, therefore, that an apparent failure to obtain approval from the Peterhead body (Harbour Trustees) by Shell or the SEPD was to be a costly omission.

The public

Public opposition to gas facilities on grounds of safety in the UK has arisen on a site-by-site basis (through ephemeral pressure groups protesting against proposals in their own vicinity) rather than through national environmental movements. Mossmorran stands out amongst the present case studies as involving by far the most significant public campaign of opposition. Although the Scottish branch of the Conservation Society also opposed the developments at this site, their campaign was modest by comparison.

Public campaigns on a similar scale were notably absent at other sites*. Initial opposition to the site near the Loch of Strathbeg was placated with its subsequent relocation at St Fergus. The Scanitro Inquiry at Peterhead, which preceded Shell's proposals, could conceivably have sapped the energies of local groups to respond to the latter proposals. Moore (1982, 48-9) suggests a general feeling of impotence in the town in the aftermath of Scanitro.

*Reasons for this were both sociological (in terms of the size and risk awareness of neighbouring populations) and relating to the magnitude of risk potential.

The only significant expression of public opposition to the NGL pipeline was by a small number of farmers (25 out of the 330 owners who might be affected) and by ADBJAG who took the opportunity once again to question if the way in which the HSE's evaluation of pipeline safety had been fairly arrived at. A situation analogous to that at Peterhead may have existed at Nigg: a series of inquiries and development proposals during the 1970's (including the plan to build an oil refinery which the Secretary of State for Scotland had approved against his Public Inquiry Reporter's recommendation) could also have left the hard core objectors feeling impotent in the face of a strong pro-industrial lobby. The utility of the informal public meeting that was held (as an alternative to a formal Public Inquiry) for the gas plant applications for the Nigg site is difficult to evaluate for the same reason.

The local authority enthusiasm for the Mossmorran plant was paralleled from the start by scepticism and opposition from individuals in the communities of Aberdour and Dalgety Bay. The socio-economic make-up of these communities makes stark contrast with that of Cowdenbeath, the only other main settlement in close proximity to the proposed developments. The weight of opinion in the predominantly middle class villages of Aberdour and Dalgety Bay opposed the installations, whereas that in the run-down former mining town of Cowdenbeath supported them (various factors may be advanced to account for the stark difference in view). Initial opposition was voiced on many grounds - environment and amenity as well as safety - but the last soon dominated. Criticisms were voiced about planning procedures (the one-site nature of the decision process being seen as giving inappropriate momentum to a particular location) about opportunities for participation (over time, information and expense), and over what in their view were inadequate assurances on safety from the statutory authorities (the knowledge and stringency criteria of the The Forth Ports authority, the local authorities, the Secretary of State and the Health and Safety Executive were contested). The campaign has been variously appraised as a voicing of legitimate concern, and of questionable motive. However, it was sustained by factors including not only a perception of unacceptable risk, but also (i) genuine logistical deficiencies in the UK planning system (over available detail about proposed installations and equal consideration of alternative sites);

(ii) philosophical difficulties (over the definition of risk acceptability and the uncertain nature of knowledge about heavy gas flow), (iii) logical discrepancies (over the criteria by which installations may be designated as major hazard installations, and the failure to consider issues in proportion to their relative importance - cf. sparks and shipping).

In spite of bland statements about democracy, minority views that cannot be constitutionally represented pose intrinsically difficult problems in planning decisions. It is difficult to imagine a procedure that does not have any logistical, philosophical or logical difficulties and would thereforeprovide no legitimate substance for public opposition. However, in a recent paper (Macgill, 1982b) one of the authors has concluded that the procedures as enacted over Mossmorran left many grounds for improvement, some of which have been achieved in more recent practice.

Decision Taker

The decision taker (the local authority council or Secretary of State, or the appropriate officers and civil servants) is faced with reconciling society's high ideals with what is reasonable and practicable (and politically expedient). The final decision, as the culmination of an exercise in muddling through uncertain knowledge and contested opinion, is likely to be one of judgement rather than resolution.

A strong national interest component may be identified in each of the above decisions due to their connection with North Sea gas reserves. In the face of this great argument stopper - local concerns almost by definition have less standing than national concerns - something out of the ordinary would have to emerge to warrant refusal (particularly, one might suggest, when a Secretary of State is the decision taker; and more particularly when he is the Secretary of State for Energy). It is nevertheless interesting to inquire into the extent of divergence of interest between local and national government. At Nigg, a concurrence of interest is evident. Over the NGL pipeline we see a divergence between local and national government (as well as divergence between different authorities at the local level). For Peterhead, the press carried reports that district councillors suspected behind-the-scenes Government

interference. For Mossmorran, far from overriding local government interests in a decision of approval, the Secretary of State was criticised for delaying his decision of approval while the sparks issue was dealt with.

Difficulties which are inevitably encountered in political decision taking on complex technical issues in which the decision taker is unavoidably less than fully competent have been alluded to above. The individual strongly held views by the Action Group at Mossmorran or the Grampian Councils call into question the wider issues of the democratic processes whereby safety criteria are agreed upon and defended by public guardians. In a more positive vein we note here that judgements of the decision taker in successive decisions have reflected a gradual societal learning process in handling decisions of this type.

## Conclusions

The decisions reviewed above, representing a concentrated burst of onshore gas-related activity each have individual idiosyncracies but in aggregate illustrate some of the changes that have occurred over time in the societal appreciation of risk. This is manifest in the changing attitudes of bodies towards the provision of information, greater acknowledgement of considerations that need to be brought to bear in estimating risk, and the intrinsic discrepancies in individual evaluations of risk. The overall conclusion must be that risk management is getting better! This is not intended as a remark of congratulation; more as one of relief based on the inadequacy of earlier decision mechanisms viz-a-viz the difficult and uncertain factors that were being addressed (political decisions on complex technological issues raising philosophically unresolved problems). The remark is made with a 1982 view of risk about decisions that go back to the mid-1970's, and the intervening time period would seem to have been a long one for the risk business.

In an earlier paper an attempt was made to evaluate the utility of risk assessment on the three classic criteria of effectiveness (the actual safety of the eventual plant), efficiency (achieving safety by the most parsimonious means) and equity (fairness and individual rights respected). Successive decisions (or at least, the way the issues involved were handled by the statutory authorities) show an

improvement on all three counts. (Mossmorran is something of an exception, because procedures were locked at an early stage and the decision could not easily be seen to benefit from the increased experience that had accrued during two years of delay). However, as long as gas remains potentially hazardous, safety not demonstrably seen, and there are legitimate winners and losers from associated decisions, continual review and critical examination is required.

The events described suggest that the means whereby society and its institutions will move towards a better understanding of how to handle safety questions will be very much a hit and miss affair, ultimately dependent upon the unique nature of each decision where safety figures prominently. Consistency may be unattainable, and may even be undesirable. Flexibility, however, creates enormous pressures upon those bodies who act on behalf of the public and have to reconcile their interests with those of local, national and private importance. Risk from non-nuclear installations moved up the agenda of societal problems in recent times; it may well be moving down again at the moment ... until the next bang.

Acknowledgement

Financial support to David Snowball from the Northern Ireland Department of Education is gratefully acknowledged.

This paper was presented at the Institute of British Geographers' Annual Conference in Edinburgh : 6th-8th January, 1983.

References

Aberdour and Dalgety Bay Joint Action Group (1979) Shipping hazards, mimeo.

Banff and Buchan District Council, Grampian Regional Council (1980) Joint report on British Gas Corporation's proposals for a gas terminal and SNG plant at St. Fergus, Aberdeen.

Barrell, A.C. (1981) The work of the major hazards assessment unit, in *Oyez Scientific and Technical Studies: Planning for Major Hazards*, Oyez, London.

Begg, H.M. and Newton, K. (1980) Strategic planning for oil and gas related development, *Town Planning Review, 51*, 76-85.

Britter, R.E. and Griffiths, R.F. (1982) *Dense gas dispersion*, Elsevier Scientific, Amsterdam.

Conrad, J. (ed.) (1980) *Society, technology and risk assessment*, Academic Press, London.

Council for Science and Society (1976) *Superstar Technologies*, Barry Rose Publishers.

Council for Science and Society (1982) *Technology and Government*, Council for Science and Society, London.

Clark, B.D., Bissett, R. and Wathern, P. (1981) The British experience, in O'Riordan, T. and Sewell, W.R.D. (eds.) *Project appraisal and policy review*, John Wiley, Chichester.

Cremer and Warner (1976) *Report on the environmental impact of the proposed Shell UK (Expro) NGL plant at Peterhead, C1061*, Cremer and Warner, London.

Cremer and Warner (1977a) *The environmental impact of the natural gas terminal at St. Fergus, C1136*, Cremer and Warner, London.

Cremer and Warner (1977b) *The hazard and environmental impact of the proposed Shell NGL plant and Esso ethylene plant at Mossmorran and export facilities at Braefoot Bay, C1164*, Cremer and Warner, London.

Cremer and Warner (1978a) *Guidelines for layout and safety zones in petrochemical developments, C2056*, Cremer and Warner, London.

Cremer and Warner (1978b) *Radiofrequency hazards at Mossmorran and Braefoot Bay: an outline report*, Cremer and Warner, London.

Cremer and Warner (1978c) *Radiofrequency hazards at Mossmorran and Braefoot Bay*, Cremer and Warner, London.

Cremer and Warner (1980a) *Safety assessment of a proposed gas reception terminal and substitute natural gas plant at St. Fergus, Scotland, C2276*, Cremer and Warner, Aberdeen.

Cremer and Warner (1980b) *Safety assessment of a proposed NGL fractionation storage and export facility at Nigg Bay, Scotland, C2276*, Cremer and Warner, Aberdeen.

Department of Energy (1980) *A North Sea gas gathering system*, Energy Paper 44, HMSO, London.

Department of Energy (1981) *Report of the public local inquiry into an application by Shell UK Ltd. for authorisation for the construction of a pipeline to convey natural gas liquids between St. Fergus and Mossmorran*, Pipelines Inspectorate, London.

Environmental Data Services Ltd. (1978) BGC: EIA is good business, *ENDS, 9,* 5-8; 19-20.

Fife Regional Council, Dunfermline District Council, Kirkcaldy District Council (1977) An assessment of the Shell and Esso proposals for Mossmorran and Braefoot Bay, The Joint Councils, Glenrothes, Fife.

Fife, Central and Lothian Regional Councils (1979) Forth Estuary Study, The Joint Councils with the Scottish Development Department.

Forth Ports Authority (1977) Investigation of marine terminal sites within Forth Estuary, mimeo.

Foster, R.V. (1977) Statement of Evidence at Mossmorran Public Inquiry.

Grampian Regional Council (1979a) A suggested policy for the routeing of a natural gas liquids pipeline, Department of Physical Planning, mimeo.

Grampian Regional Council (1979b) Discussion Paper on the question of indemnity, Department of Physical Planning, mimeo.

Grampian Regional Council, Banff and Buchan District Council (1980) Contingency plan for petrochemical industries, Aberdeen.

Griffiths, R.F. (ed.) (1981) *Dealing with risk,* Manchester University Press, Manchester.

Health and Safety Commission (1978) *Hazardous installations (Notification and Survey) Regulations 1978,* Consultative Document, HMSO, London.

Health and Safety Commission (1979) *Advisory Committee on Major Hazards - Second Report,* HMSO, London.

Health and Safety Executive (1978a) *Canvey: an investigation of potential hazards from operations in the Canvey Island/Thurrock area,* HMSO, London.

Health and Safety Executive (1978b) *Report of the steering committee on radio frequency ignition hazards at St. Fergus, Scotland,* HSE, London.

Health and Safety Executive (1978c) *A safety evaluation of the proposed St. Fergus to Mossmorran natural gas liquids and St. Fergus to Boddam gas pipelines,* HMSO, London.

Health and Safety Executive (1979) Report of a working group on radio ignition hazards at St. Fergus, Scotland, HSE, London.

Health and Safety Executive (1980) *A reappraisal of the HSE safety evaluation of the proposed St. Fergus to Mossmorran NGL pipeline,* HSE, London.

House of Lords (1980) *Select Committee on the European Communities. Major Accident Hazards, Session 1979-80, 33rd Report (HL 157),* HMSO, London.

House of Lords (1981) *Select Committee on the European Communities. Environmental Assessment of Projects, Session 1980-81, 11th Report (HL 69),* HMSO, London.

Kates, R.W. (1978) *Risk assessment of environmental hazard, Scope 8,* John Wiley and Sons, Chichester.

Institution of Chemical Engineers (1982) *The assessment of major hazards Symposium Series No. 71,* Institution of Chemical Engineers, Rugby.

McRea, M. and Greaves, J. (1981) Nigg Bay Petrochemical Developments, A successful alternative to a public inquiry? *Scottish Planning Law and Practice,* [illegible], 8-10, 19.

Macgill, S.M. (1982a) *Decision case study: United Kingdom, Mossmorran-Braefoot Bay*, CP-82-40, IIASA, Austria.

Macgill, S.M. (1982b) Mossmorran-Braefoot: aspects of a risk debate, in O'Riordan, T. and Turner, R.K. (eds.) *Progress in Resource Planning and Environmental Management, Vol. 4* (forthcoming).

Macgill, S.M. and Snowball, D.J. (1982) What use risk assessment? *Applied Geography* (forthcoming).

Mann, G. (1979) Implications of preferred sites at district level, in *Planning Exchange Forum Report 16, Site Selection for large industry*, Planning Exchange, Glasgow.

Moore, R. (1982) *The social impact of oil. The case of Peterhead*, Routledge and Kegan Paul, London.

New Scientist (1978) Changes planned in radio hazard rules, *Vol. 77*, (1086), p160, 18th January.

Openshaw, S. (1982) The siting of nuclear power stations and public safety in the UK, *Regional Studies, 16*(3), 183-98.

O'Riordan, T. (1981) *Environmentalism*, Pion, London.

Paddock, K.F. (1978) Report by Pipelines Inspectorate on Shell/Esso proposals for an NGL pipeline, mimeo

Paget, G.E. and Lloyd, M.G. (1982) Resource management and land use planning: natural gas in Scotland, *Journal of Environmental Management, 15*(1), 15-23.

Pearce, D.W. (1981) Risk assessment: use and misuse, *Proceedings of the Royal Society of London A, 376*, 181-92.

Rasbash, D.J. and Drysdale, D.D. (1977) *Fire and explosion hazard to Dalgety Bay and Aberdour associated with the proposed Fife NGL plant*, Department of Fire Safety Engineering, University of Edinburgh.

Reijnders, L. (1982) Societal interest, in Kunreuther, H., Linnerooth, J. and Starnes, R. (eds.) *Liquefied energy gases facility siting: international comparisons*, CP-82-S6, Laxenburg, Austria.

Scottish Development Department (1974) *Coastal planning guidelines*, New St. Andrews House, Edinburgh.

Scottish Development Department (1977a) *Inquiry into proposed NGL plant at Peterhead*, Decision Letter Ref: P/PP/2/GB/2/4.

Scottish Development Department (1977b) *National Planning Guidelines for petrochemical developments*, New St. Andrews House, Edinburgh.

Scottish Development Department (1977c) *High pressure methane gas pipelines*, Planning Advice Note 17, New St. Andrews House, Edinburgh.

Scottish Development Department (1977d) *Report of the Public Inquiry into the Shell/Esso Mossmorran/Braefoot Bay proposals*, New St Andrews House, Edinburgh.

Scottish Development Department (1980) *Commercial pipelines*, Planning Advice Note 25, New St. Andrews House, Edinburgh.

Scottish Development Department (1981) *National planning guidelines*, New St. Andrews House, Edinburgh.

Shell UK Expro (1976) Supporting document for the outline planning application to construct Natural Gas Liquids Separation and Storage facilities at Peterhead and their transshipment through Peterhead Harbour.

Sprott, T.F. and Mann, G.L. (1976) Consolidated planning report to joint meeting of Planning, Property and Development Committee Grampian, Regional Council and Planning and Development Committee Banff and Buchan District Council, Aberdeen.

Thompson, M. (1983) To Hell with the Turkeys!, in Kunreuther, H., et al. (eds.) *Risk analysis and decision processes: the siting of gas terminals in four countries*, Springer-Verlag (Forthcoming).

TABLE 1. Facility Descriptions

| | | | NIGG BAY | | |
|---|---|---|---|---|---|
| Type of plant | Gas reception terminal | Gas trea terminal | NGL separation & export | NGL separation & cracker & export | NGL separati & cracker & export |
| Operator | BGC | Total | BGC | Dow Chemical | Highland Hydrocarbons |
| Throughput | | 60 mcmd | 7.5 mtepa | 7.5 mtepa<br>0.5 mtepa | 7.5 mtepa<br>0.5 mtepa |
| SYSTEMS COMPONENTS | | | | | |
| (a) PIPELINE | Linked to Shell/Total Input to National Grid | 225 mile shore li from Fri | St.Fergus to Nigg Bay (102 m) | | |
| (b) PROCESS | | | | | |
| No. of units | 2 | 5 (4 in ation at one time | 3 | ? | ? |
| (c) STORAGE | | | | | |
| Material | | Condensa | Butane<br>Iso-butane<br>n-butane<br>Nat.Gasolene | | |
| Number of tanks | | 4 | 2<br>2<br>2<br>2 | ? | ? |
| Capacity | | 3800 $m^3$ | $60x10^3m^3$<br>$15x10^3m^3$<br>$25x10^3m^3$<br>$12x10^3m^3$ | | is |
| (d) TRANSFER SYSTEM | | | | | |
| Number of vessels p.a. | | | 200 | c 224 | c 200 |
| Largest size | | | 60,000 $m^3$ | | |

TABLE 2. Party Involvement

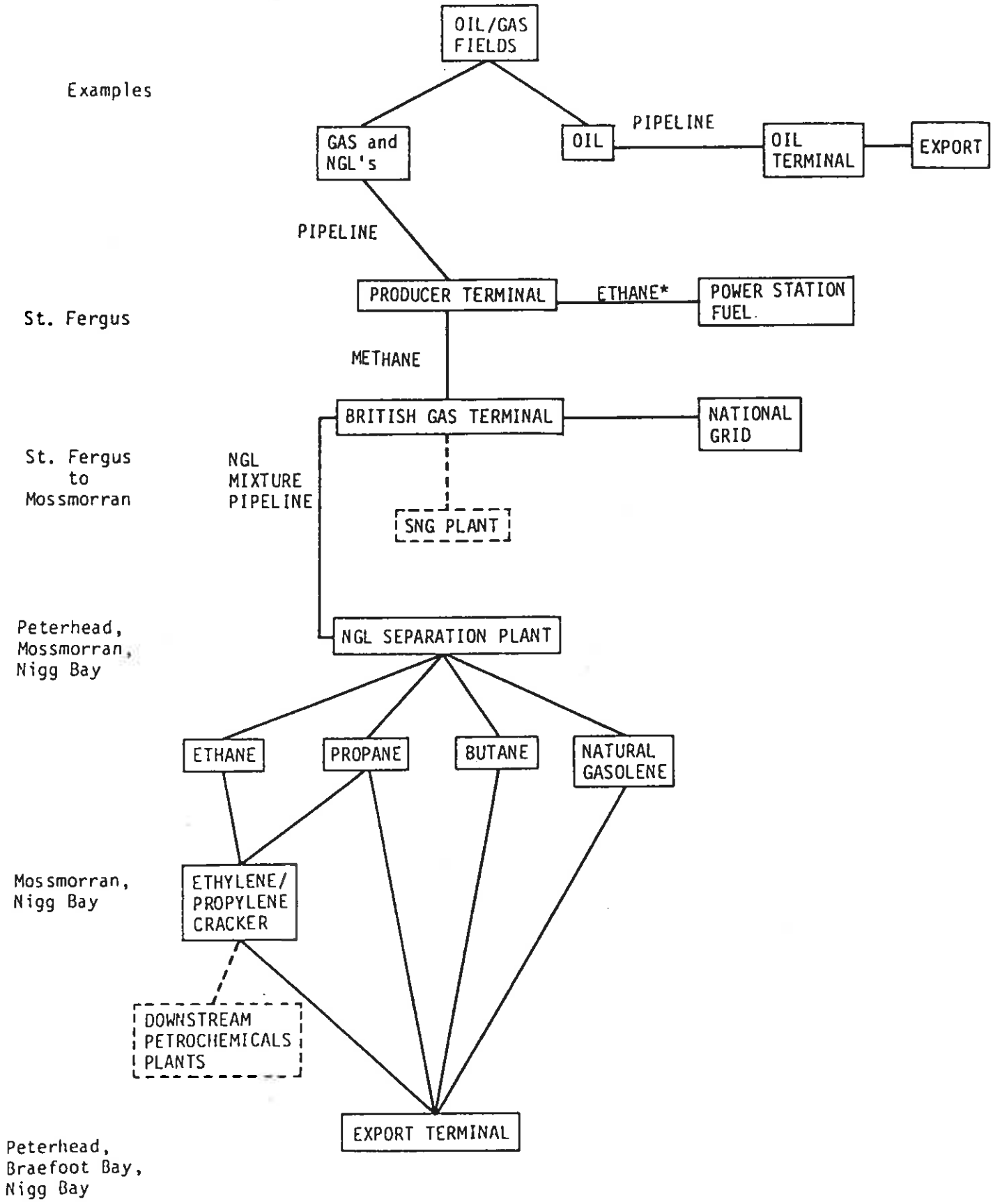
| Site | Applicant(s) | Host local authorities | Decision taker | Independents | Public Groups |
|---|---|---|---|---|---|
| St. Fergus | British Gas<br>Total Oil Marine<br>Shell UK Expro | Aberdeen C.C. (until 1975)<br>Banff and Buchan D.C. } after 1975<br>Grampian R.C. } after 1975 | Local Authorities | Cremer and Warner | |
| Peterhead | Shell UK Expro | Banff and Buchan D.C.<br>Grampian R.C. | Secretary of State (Scotland) | Cremer and Warner<br>Scottish Economic Planning Dept.<br>Harbour Trustees | Several local industries |
| Mossmorran | Shell UK Expro<br>Esso Chemical | Dunfermline D.C.<br>Kirkcaldy D.C.<br>Fife R.C. | Secretary of State (Scotland) | Cremer and Warner<br>Forth Ports Authority | Aberdour and Dalgety Bay Joint Action Group<br>Conservation Society |
| NGL Pipeline | Shell UK Expro | Banff and Buchan D.C.<br>Gordon D.C.<br>Kincardine and Deeside D.C.<br>Aberdeen City D.C.<br>Grampian R.C.<br>Fife R.C. | Secretary of State (Energy) | Pipelines Inspectorate (Department of Energy) | Aberdour and Dalgety Bay Joint Action Group |
| Nigg Bay | British Gas<br>Highland Hydrocarbons<br>Dow Chemical | Ross and Cromarty D.C.<br>Highland R.C. | Highland R.C. | Cremer and Warner<br>Cromarty Firth Port Authority | |

HSE INVOLVEMENT IN EVERY DECISION AS PUBLIC GUARDIANS

TABLE 3. Archetypal risk assessment roles

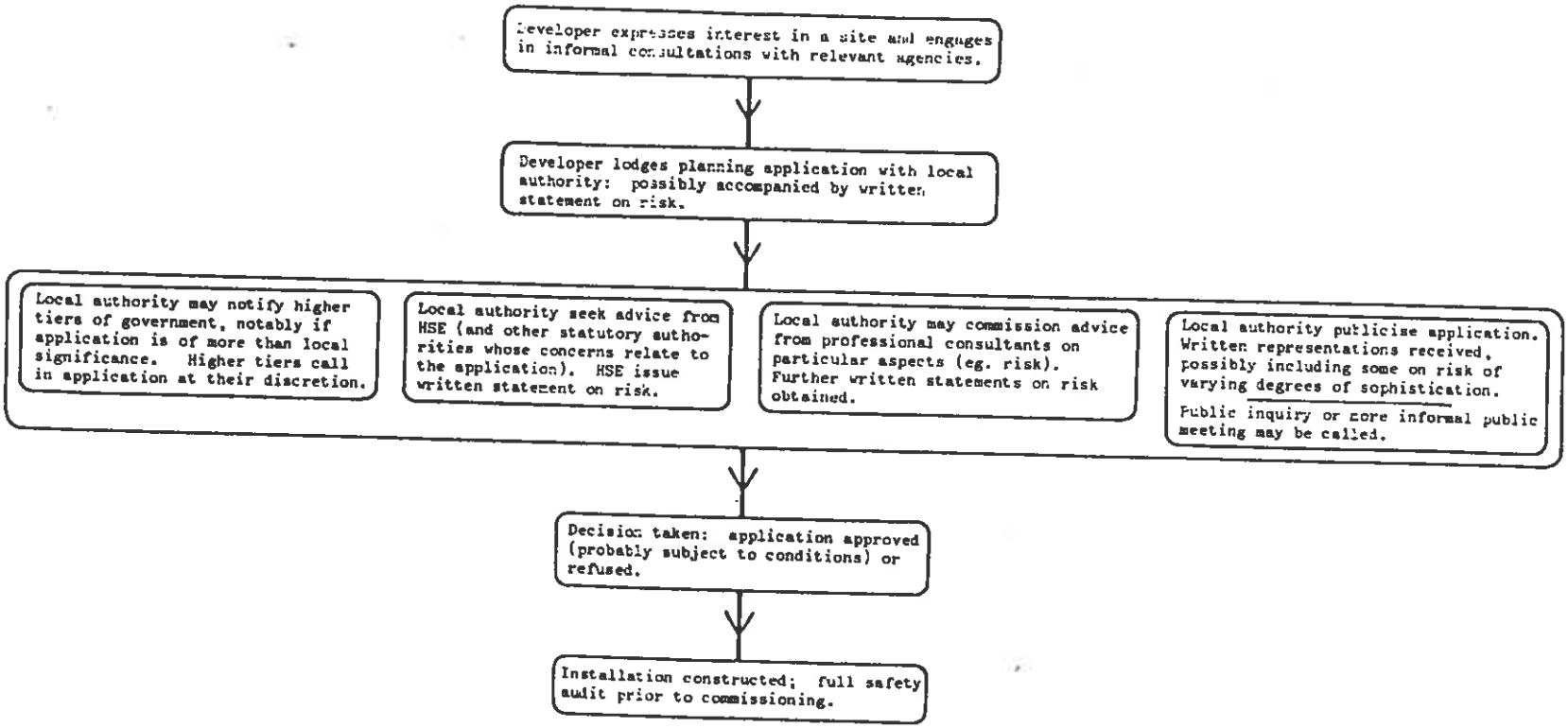
| | |
|---|---|
| Hazard makers | Industry |
| Risk takers | Local communities<br>Local Authorities |
| Guardians | Health and Safety Executive<br>Local Authorities<br>Other statutory bodies (eg. Port Authorities) |
| Assessors | Independent experts<br>All other parties, to a varying extent, are likely to claim some role as assessor |

Fig. 1 Process linkages (actual and proposed) for disposal of North Sea hydrocarbons




*Shell Expro to Boddam (Peterhead)

**Fig.2** The main stages of the planning decision



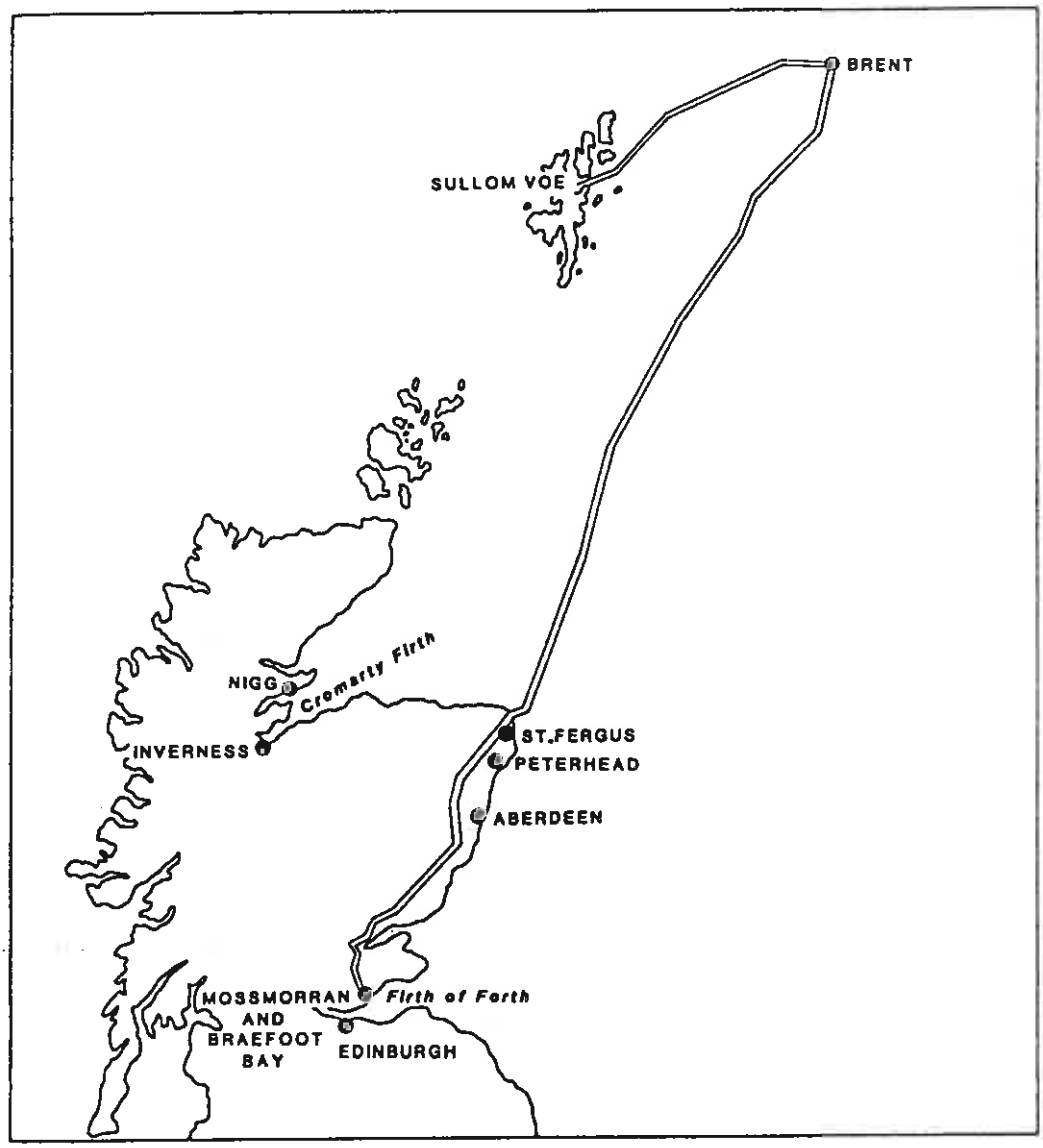



Fig. 3: The location of sites considered

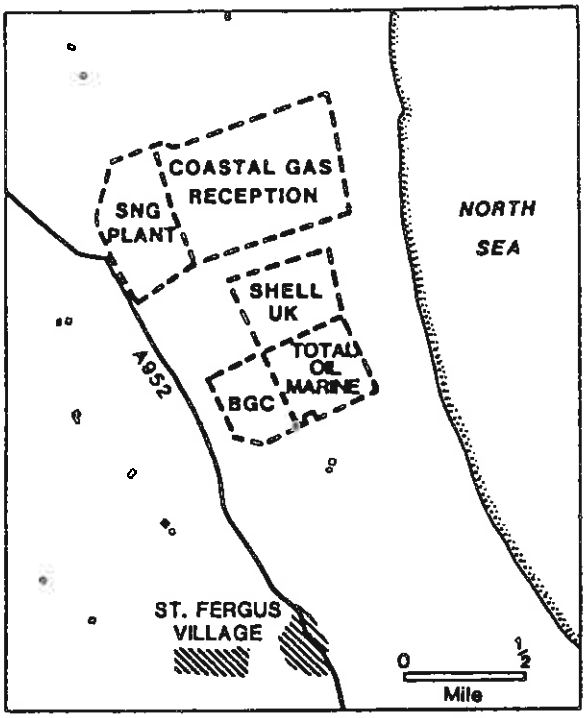



Fig. 4:
The St. Fogus sites

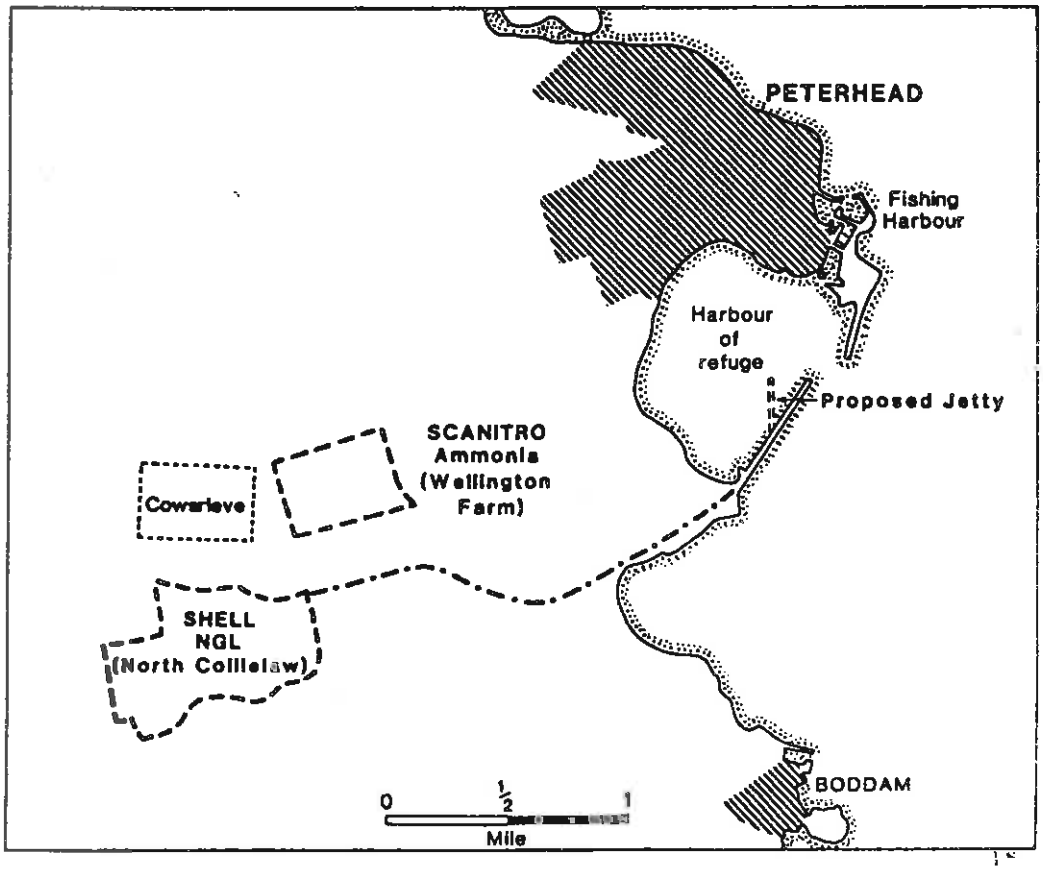



Fig. 5: The Peterhead sites

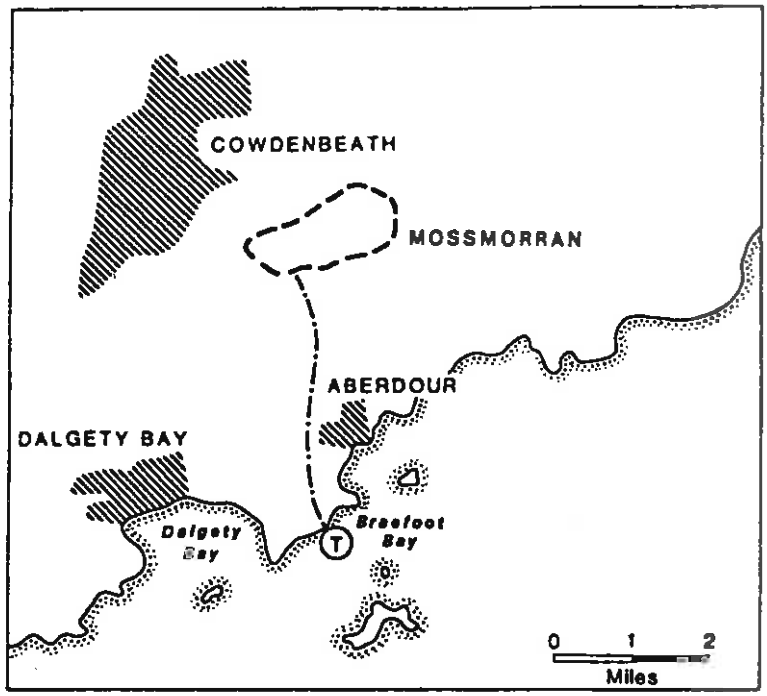



Fig. 6: The Mossmorran Braefoot sites

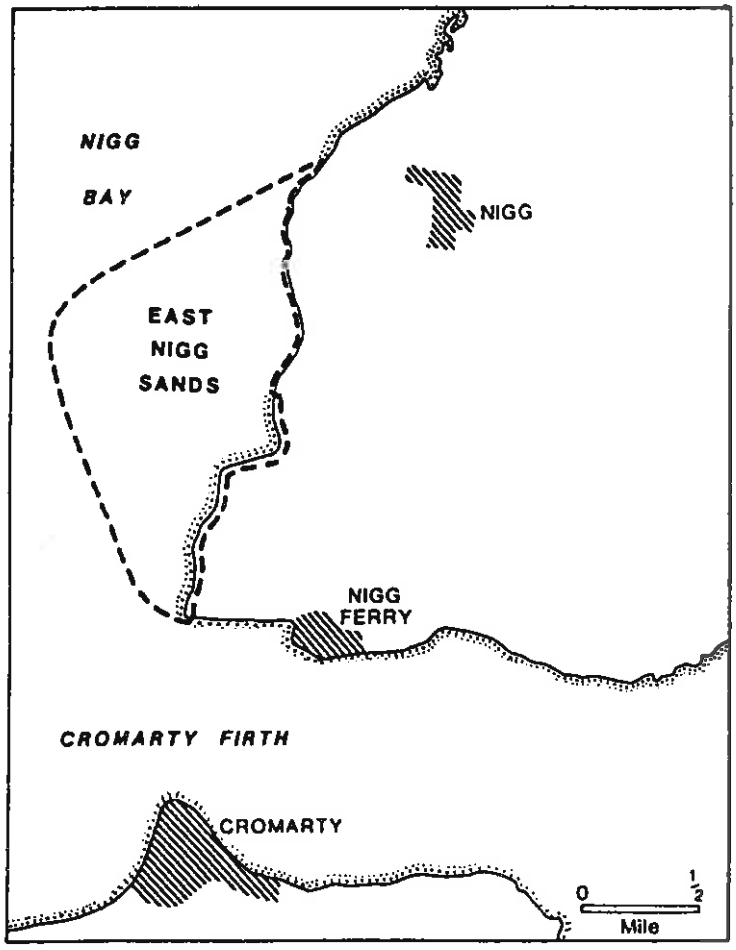



Fig. 7: The Nigg site