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The Institute acquired its crest, designed by the College of Heralds, in 1949. Its motto, 'Conjunctione Potiores' (strength through unity), supports a shield portraying the Archaeopteryx, an avian fossil which was found in Jurassic strata similar in age to important oil-bearing formations in the North Sea.

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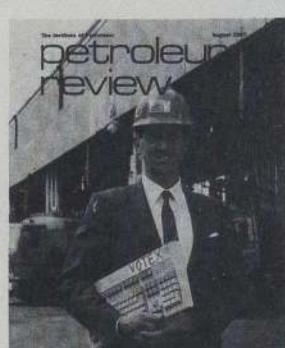

Cover: Nigel Biggs, Managing Director, Simon Storage Group was photographed at the Thames Matex Terminal, West Thurrock, Essex. He is holding the prototype of the Votex 4 system, through which the terminal's customers will be able to access their individual stocks from afar. Photograph by Jon Whitbourne. Article page 7.

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ABC
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10 June

BP says Forties crude oil reserves are estimated to have increased by 319mbls

Ranger Oil find gas and gas condensate in a North Sea basin east of Shetland

11 June

UKOOA president says lower oil prices have proved a spur to ReD programmes for the exploitation of smaller more complex fields in North Sea

Amoco Canada says it will spend $45.8m to expand its Enhanced Oil Recovery programme at Nipisi-Gilwood Unit operating at the Nipisi oil field

Kuwaiti shipping exec. raises possibility of British tankers being chartered by Kuwait in effort to safeguard own shipping from Gulf attacks

12 June

Natural gas and crude oil exports from Canada increased in January for the first time in three years

15 June

Petrofina SA has initiated talks with Neste Oy of Finland to jointly construct a steam cracker plant in Antwerp

Sources say the French govt has asked Elf-Total to resume purchases of Iraqi oil

Latin American leaders are expected to decide to go ahead with a regional plan to supply Nicaragua with oil as the nation's fuel crisis comes to a head

16 June

Norsk Hydro A/S delays phase 2 development of Oseberg Field after Norwegian govt refusal to change controversial decision on oil tax

Occidental Petroleum Corp completes acquisition of Shell Oil Co vinyl chloride monomer business for undisclosed amount

17 June

Finance and admin problems in Argentina's state owned oil company YPF means fuel shortages and decision by govt to import further 1m cubic metres of petroleum products at estimated cost of $140m

Panamanian oil tanker and Liberian cargo ship collides off south-west Japan causing fuel oil to flow into water

Two US Senators challenge proposal to require President to restrict oil imports when import level reaches 50% of domestic use

British MoD dismisses suggestions that Britain had agreed to escort Kuwaiti tankers through Persian Gulf

BP's review of world energy says world's known oil reserves will last 32½ years at present rate of consumption

18 June

All-party UK Energy Select Committee report says govt should do more to ensure North Sea oil and gas tax rates encourage maximum pace of development while prices depressed

MITI in Japan will lift wide range of oil industry regulations ending 53 years of govt involvement in industry's day-to-day operations

19 June

BP Canada Inc says it and Petro-Canada are proceeding with Wolfe Lake 2, second phase bitumen recovery project

Iran's oil exports reach country's agreed output quota for first time this year as direct result of recent halt in Iraqi air attacks on tankers and terminals

22 June

Australia is to deregulate oil industry from 1 Jan 1988, Energy Minister says current quota system will be abolished

Shell signs contract with Pertamina to explore and produce oil and gas onshore and offshore South Kalimantan Province, Indonesia

Escalation of military tension in Persian Gulf resulting in closure of Straits of Hormuz could mean oil supply shortfall of at least 2.4m b/d report says

23 June

Algerian Oil Minister quoted as saying country plans to increase to maximum LNG exports now running at less than half currently installed fuel export capacity

Philippine govt reports Occidental Petroleum Corp's renewed interest in oil exploration and drilling deep-water well in S Philippines

24 June

Amoco Orient Petroleum Corp has discovered oil for second time in China's South China Sea

At least three major North Sea oil and gas field development projects expected to be approved by Norwegian govt in next 12 months

Turkish and Soviet leaders inaugurate pipeline carrying natural gas from Siberia to Turkey

First oil from remote Barents Sea region of Norwegian Continental Shelf discovered by Saga Petroleum

West German govt clears way for new law to ban sale of regular leaded gasoline for cars effective January 1 1988

26 June

Esso Resources Canada Ltd says it will develop Obed natural gas field in Alberta at a cost of $78m

Conoco's president forecasts oil company spending on exploration and development could rise to 5% in 1987

Seagull Corp and Amoco Corp plan to build a pipeline system to transport between 150–200 cubic ft of natural gas daily from Matagorda Island area of Gulf Mexico off Texas Gulf Coast

US Administration re-asserts its opposition to idea of import fee on foreign oil

29 June

Iran has emergency plan to transport 2m barrels of oil exports per day through two overland pipelines

Norwegian Oil Ministry spokesman says 7.5% cutback in planned North Sea output in support of OPEC will extend to end 1987

OPEC reaches agreement on collective productive ceiling of 16.6m b/d for rest of 1987

30 June

Chevron announces results of drilling appraisal well in North Sea which might lead to one of largest finds since 1983

Australian Bureau of Statistics says oil search expenditure reached lowest level for eight years during March quarter

Ecuador Energy Minister says Ecuador will produce crude oil in excess of its 221,000b/d OPEC quota during second half of 1987

1 July

BP concludes $7·4bn takeover of Standard Oil after successful bid for outstanding minority shares

Amerada Hess announces promising oil find in central north sea about 100 miles north east of Petershead

New Zealand Energy Minister says govt plans to sell interests in three petroleum prospecting areas

2 July

NAPC, international consortium developing offshore oil deposits in North Aegean Sea seeks cancellation of last May's legislation allowing state control of its activities

Mexico may soon make a decision on renewing supplies of crude to Nicaragua which have been suspended since 1985 owing to lack of payment

Panhandle Eastern Corp says its subsidiaries have filed requests with US regulators to resume Algerian LNG imports

Concern about the fall in value of the dollar will force OPEC to discuss raising its $18 oil price at Decembers meeting

3 July

British Gas is offering a world-wide service that enables insides of pipelines to be inspected and problems to be located within 1.5m using an intelligent pig

Tanker movements from Larak Island and Sirri terminal will rise rapidly in 1987 when Japan purchases around 250,000 barrels of crude a day from Iran

Petronas says it signed production sharing contracts with two consortiums which will explore and drill for oil off Trengganu and Sarawak in Malaysia

6 July

Abu Dhabi Marine Operating Co says proven reserves in concession area of ADMA–OPCO now exceeds 10bn barrels but declined to give production figures

OPEC president says unless members abide by production quotas market might face worse price collapse than 1986

7 July

Shell and Esso announce plans to develop Kittiwake field at a cost of £350m, first oil to be produced 1991

US Dept of Energy says Chevron Corp agreed to pay $3m under proposed settlement of govt oil overcharge claims against Gulf Oil Corp which Chevron acquired

8 July

AGIP acquires 10% stake in major field off Angolan coast from Chevron

ENI enters into talks with USSR on possible joint ventures in oil exploration and downstream production

9 July

Elf Aquitaine say brief tests at Egrenay well in Paris Basin Evry permit yielded 7 cu metres of anhydrous oil

Occidental Petroleum Corp granted permit by Californian Coastal Comm for exploratory drilling in LA

Official Kuwait news agency quotes senior Gulf sources saying many OPEC members back average reference oil price raise to $20 per barrel

10 July

Elf Aquitaine say exploratory well drilled in North Sea encountered oil and gas deposits

Planning permission for £13m development in GB's biggest onshore gas field in N Yorks being sought by consortium of five energy companies

13 July

Tension over Gulf pushed US oil prices to highest level in 19 months after Iranian gunboat attack set fire to supertanker

Bahraini Development & Industry Minister says he opposes 'mad increase' in oil prices and that $18 per barrel was acceptable

Canadian Energy Minister says privatisation of Petro-Canada to be carried out to general share offer to public

Basque terrorists set fire to 220,000 gals fuel oil at state run storage depot near Burgos

OPEC's liking for $18 a barrel criticised

Alhaji Rilwanu Lukman, President of OPEC, was firm on OPEC's ability to maintain an $18 per barrel price for crude oil, but refused to be drawn on five year prospects — except to express 'optimism' — when he spoke in London a week after the recent OPEC meeting on production quotas

● OPEC, he said when questioned, was ultimately interested in developing the demand for oil — but it was not interested in an artificially high price. That would only bring back the price crisis of 1986

● He expressed disinterest in the 'basket of currencies' idea for the pricing of oil — but felt the fluctuations in the dollar should be monitored for further consideration

● International downstream involvement by OPEC members was sure to continue, he thought, the oil industry not being one that could be divided into compartments

Mr Lukman was in London to address the ***Financial Times Conference Oil and Gas Re-appraised.***

At an earlier conference in London organised by the ***British Institute of Energy Economists,*** a leading oilman, Dr Pierre Jungels, Chief Executive Petrofina (UK), criticised the $18 a barrel price as 'a bad one — and neither here nor there'.

The lessons

Alhaji Rilwanu Lukman, Minister of Petroleum Resources, Nigeria, and President of the Organisation of Petroleum Exporting Countries, who spoke on the subject: Will OPEC countries hold to production quotas? said, in part:

Let me assure you that OPEC is committed to maintaining stability in the oil market, to defending the $18/bbl oil price structure and we will work to ensure that the oil market is in balance by producing only what is necessary to meet oil consumption requirement worldwide.

The euphoria of our success since the implementation of the historic decisions we reached in December 1986 notwithstanding, we will not allow the lessons of the last six years to be lost on us. This is the point we have consistently called on all oil producers and consumers to appreciate. If we fail to learn from past mistakes and to appreciate errors where any existed, we are liable to make the mistakes again. Oil market developments in the 1980s created a situation which made the oil market inherently unstable.

These developments resulted from factors which were generally outside OPEC's control. Prominent among them is the sharp fall of oil demand in the industrial countries, a near precipitous decline from the peak level attained by the end of the 1970s due, principally, to public policy inducement in those countries; in addition, expensive and less efficient energy sources of energy were increasingly substituted for oil.

You will recall that simultaneously with the decline in oil demand, oil supply from non-OPEC sources began to rise sharply and in the process, even though it was much more expensive to produce, this oil backed a substantial volume of the cheaper, more accessible OPEC oil out of the market; this resulted primarily, from the political consideration that the industrial countries wished to consume oil in intra-regional supply before taking oil from OPEC sources.

In consequence, scarce investment money was diverted to exploration and production in hostile and difficult regions while excess and unutilised capacity increased in OPEC countries. The maximization of non-OPEC oil production at a time when world oil demand was falling led to a glut in the oil market which OPEC found it has to single handedly try to manage.

With OPEC production capacity utilisation falling to 50% and OPEC's share in world oil trade falling as low as about 35%, OPEC found that its leadership and its ability to defend the price structure were sharply eroded. Notwithstanding this situation, we valiantly tried to stem the deterioration in the oil market by resorting to production planning and allocation of quotas to each member country. This led to the progressive reduction in total OPEC oil production from 31mb/d in 1979 to 15.8mb/d in the first half of 1987.

No restraint

Non-OPEC oil producers showed no restraint in production and to make matters worse, they engaged in price competition by undercutting OPEC official prices whenever they found it convenient to do so. This readiness to undercut competition on the part of non-OPEC producers led to sharp price fluctuations in the oil market at a time when the market was in a state of excess supply.

Similarly, in the years prior to 1986, our member countries were hard pressed as residual supplier since our per barrel revenue was increasingly eroded because of the price undercutting behaviour of the non-OPEC producers. As a result, we were forced to pursue a policy that allowed us a fair share of the market and from the end of 1985 we tried to defend same for our countries.

The consequence of this market share policy and the inability or unwillingness of other producers to step in and help defend the price structure was the oil market collapse in 1986. One could not but notice the dramatic reversal of the views expressed by critics whose only trade, it would appear, is to blame OPEC for most of the world's problems. Prior to 1986, criticisms were levied on OPEC for keeping prices too high, for keeping the world economy sluggish, for "siphoning" scarce revenue from developing countries and thereby exercabating the latter's debt burden; all other economic problems, real and imaginary were traced by these critics to OPEC's decisions in the years to 1985.

OPEC reaction

However, in 1986, the picture changed as OPEC sought to be competitive just as non-OPEC producers had been in the years since 1981; and in reaction, world oil prices collapsed. The low oil prices were not blamed on OPEC as were the continuing sluggishness of the world economy and the plight of the developing countries to which OPEC member countries belong.

Two inevitable consequences of the leadership role OPEC has played in the oil market were brought to the fore by the end of 1986; once again we had to accept responsibility for market stability and also we accepted to play the role of residual supplier in the market. The latter in particular, is painful and burdensome since in OPEC we have seen our oil revenue dwindle over the years, by about $50 billion in 1986 alone; moreover, many of our member countries are saddled with large external debts while we have had to institute austerity measures as well as budgetary restraint in our respective countries due to the sacrifices necessitated by our commitment to a stable oil market. However, in OPEC we have since come to terms with the necessity to work for stable prices and market balance.

As you are witnesses to our success in maintaining commitment to our respective quotas in the first half of 1987, I need not stress the point that OPEC will hold to production quotas. It is true that sacrifices will be made, that there are problems inherent in a system where the costs and benefits of maintaining stability in the market are not equitably shared by all oil producers — non-OPEC and OPEC alike, that member countries are burdened by financial problems, that there is a minimum production requirement in our countries, yet we are convinced that the defence of stable oil prices is a must.

Worse possibility

There is a sharper awareness in our ranks that without holding to production quotas all OPEC and indeed the world at large will be faced with a situation similar to the price collapse of 1986 or even worse. This is why in the first half of 1987, all OPEC produced at about the ceiling and in some months, lower. Some of our countries did not produce all of their individual quota. This resulted from the combination of both a conscious effort to swing in response to market fundamentals and the working of the fixed price system. The latter works to lower supply when market prices are lower than official selling prices. Either way, leakages and infraction of OPEC production and price agreement have been negligible so far in 1987.

In order to ensure that the vagaries of the oil market do not affect OPEC's ability to defend the price structure, we set up a committee of five heads of Delegation to monitor the evolution of market prices relative to OPEC official prices. Market price deviation from the latter which the committee defines as sufficient to put pressure on the official price structure both in the upward and downward side, would lead to an extraordinary conference at which adjustment to the production level, necessary to stabilise oil prices at $18/bbl would then be made. The trigger point for OPEC response will be agreed by the committee.

To ensure compliance and to encourage member countries to continue with a job already well done, we set up a committee of three heads of Delegation and mandated it to visit some of our member countries and impress on them the importance of continued adherence to the decisions reached on production quotas. In addition, the Committee of member countries experts on Marketing has been instructed to continue with its work, monitoring production, stock, flows and tanker movement in member countries and to regularly report on same to the president of the conference. We are satisfied that these measures will work to ensure that our member countries hold to production quotas.

Instability danger

But the situation where OPEC alone bears the burden of maintaining a stable market is fraught with the danger that market instability could eventually re-emerge. OPEC member countries are developing countries with most of them having extremely low per capita income levels; we are all dependent almost wholly on oil revenues, our economies are not diversified and we are more likely to be severely affected by any adverse occurrence in the oil market; in spite of our efforts, if others do not cooperate with us, our single handed efforts to defend market stability could become the germs of instability. It is gratifying that some non-OPEC oil producers have responded favourably to our call for cooperation and where possible, and to varying degrees, have tried to share the burden of defending the price structure with us. We believe however, that more action is called for. It is clear that all participants in the oil market benefit from oil price stability.

The lessons of 1986 show very clearly what adverse consequences non-OPEC oil producers could suffer when the market is in a mode of uncertainty and oil prices fluctuate. High cost oil producers like the US and the UK suffered losses, perhaps irreparable, to reserve development and production during 1986.

The developing countries among non-OPEC oil producing countries have suffered similar consequences; for Mexico, Egypt, Oman, Angola, Cameron and other similar countries, market instability could be extremely harmful. Like other developing countries, these non-OPEC oil producers, are poor, they are saddled with external debts and need every dollar of their oil revenue for much needed economic development. Market instability and the attendant fluctuation in oil prices could only curtail revenue and impede the pace of economic development in the oil producing developing countries.

The quest for the reduction of dependence on OPEC oil sources is a sour point in the drive to maintain a stable oil market. Similarly, the debate in the US on the need to impose a fee on its oil imports gives cause for concern. We feel any such move will do a lot of harm to our effort to maintain stability in the oil market and will affect the ability of participants in the international oil market to defend prices. We note the recent ruling of a technical panel of the General Agreement on Tariff and Trade that a 1986 variable fee on product and crude oil import into the US is discriminatory and is in restraint of trade. It is our hope in OPEC that leaders in the US will take cognizance of the views expressed by that world body and will help to work towards conditions of freer trade as well as a more stable world oil market.

Cooperation

In our meeting in Vienna, we decided to reinstate the Group of five heads of Delegation which in 1986 was charged with making contacts with non-OPEC producers with a view to securing cooperation from those countries. We are confident we will receive support from most of the non-OPEC oil producers given the benefits of the recovery of the oil market so far this year. We also note the consultation at technical level between oil producers and consumers in Luxembourg in March this year — and hope that such efforts will lead to greater understanding between all participants in the international oil market.

OPEC is fully committed to keeping oil output within its production ceiling; we have assurance from virtually all of our member countries they will adhere to their respective quotas. We are hopeful more non-OPEC producers will cooperate with us and the oil market will chart a course of balance and stability. All of us, producers and consumers alike, will benefit from the realization of this prospect. ●

$18 a barrel not enough, but....

Although an oil price of $18–$20 a barrel was a bad one, which did not satisfy anyone it was, because of this, likely to be a stable price.

This was the view of Dr. Pierre Jungels, Managing Director and Chief Executive, Petrofina (UK) Ltd., and President of The Institute of Petroleum, on the morning after OPEC decided on a production ceiling which should maintain $18.

He was giving the opening address at the British Institute of Energy Economics conference on *Long Term North Sea prospects in the European market place.* He said in part:

If we assume that $18 to $20 a barrel is a stable price — for the time being — the consequence, it must be said, is that it is too low for any significant relaunch of activity for the North Sea.

Most of the fields discovered cannot be economic at that price.

It is too low to restore the cash flow of pure exploration companies since they need to spend enormous amounts just to maintain their reserves.

It is too low for low-income OPEC members.

It is too low to make economic sense of new sources of energy.

It is too low for energy-saving investment, especially as the easy way of good housekeeping has been done. Anything further will require capital investment and that will not achieve a return at $18 a barrel equivalent.

However, it is too high to increase consumption. It is too high for a real reduction in production. It is too high to lead to a restructuring of the oil industry.

It is too high for North Sea governments to urgently provide a significant tax change, although exploration-production is taxed more than any other industry.

$18 to $20 a barrel is a bad price. It is neither here nor there.

The significant reduction in cost — achieved largely through good housekeeping of project management and modular construction rather than new technology — should allow some development to proceed, but a real increase in present levels of activity requires more.

The decision-making process by oil companies has many aspects, all of which play a part. There are also intangible opportunistic factors such as a construction yard taking work on a marginal basis that may sway the whole decision. The decision taken, investment, jobs follow on.

But to bring forward a large number of developments, the single most important factor is tax. Given the right amount of flexibility in the tax regime, the Government could make concessions in bad times and cream off the revenue it requires when the price rises again.

It would seem logical to stimulate developments now in order to have the fields in production when crude prices rise again.

A conference such as this is valuable to help to establish the dialogue that is needed. ●

Independent storage industry's period of opportunity

Nigel Biggs, managing director, Simon Storage Group, (right) at the Thames Matex terminal, West Thurrock, which is managed by Simon Storage, with Roger Bensaid, deputy installation manager

The petroleum and petrochemicals bulk storage industry in the UK is steadily applying new technologies to its storage and distribution facilities as its customers demand from them more specialisation in services

Nigel Biggs, managing director, Simon Storage Group, in an interview with *Petroleum Review*, emphasises that it will be necessary to maintain margins to assure these continued investments

(Please see page 41 for *Petroleum Review's* Annual Survey of Independent Bulk Storage in Western Europe)

Geoffrey Mayhew: The bulk storage industry in the United Kingdom has had to face, or reject, many technological sales and marketing challenges in the past decade?

Nigel Biggs: Yes, it has. In some ways we have had to reject technological change. For many reasons bulk storage has had to rely on simplicity and flexibility to respond rapidly to the changes in customer requirements and we have found that good operating procedures and a willing work force have served us better than large injections of automation. That is not to say that the bulk storage industry is unsophisticated — quite the contrary.

That applies to the industry as a whole as well as to your own concern?

Indeed. My remarks are mainly in general and I think that what I am about to say applies very largely to the whole of the industry.

We have all had to respond to the same market factors. We all have to share the same customer base. We have all been subject to the same changes over the years.

Although we have had to retain our flexibility, we have, at the same time, been called on to provide increasingly more sophisticated specialised facilities, and over the years the major chemical companies have increasingly found it worthwhile to devote their own capital to manufacturing and to allow service industries to put their capital into distributive resources. It is a long steady process to get major chemical, or oil companies, to entrust their reputations to us, but over the years we have succeeded in persuading them that their reputations are safe in our hands. We have got to the point where we are asked to handle quite difficult and sophisticated chemicals, not just liquids, but also chemical gases as well.

My Group, for example, handles Propylene, VCM and Anhydrous Ammonia, all of which require sophisticated facilities. So I think that on the one hand we have had to retain simplicity and flexibility, but on the other hand, where specialist facilities are concerned, we have had to become very sophisticated.

This sophistication has been in some specific areas?

Generally speaking, the sophistication is where a particular user wishes to have a facility which matches his own standards while being contracted out to a third party. It is quite a departure for us and for the major oil and chemical companies as well. I think it is probably going to be an increasing trend.

It is on the threshold of new — expensive — technology?

Very expensive, and we are rather proud, in the Simon Group, in particular, in that we are up with the leaders in terms of software for making these systems work. The major oil companies have had some difficulties, I understand. It is difficult getting these systems in, but we have enjoyed a great success.

Do you get cooperation, in technical terms, from potential customers when you are thinking of putting in big new technology?

We get a lot of cooperation. Clearly our customers have to be satisfied that those facilities will meet their standards. Because we are quite small we can move more rapidly and take investment decisions quicker, perhaps, than some of the larger companies we serve. This also is a benefit to them.

Are you investing more in technology than in, say, tankage?

Yes, I think it is true to say that we are, at the moment, because since the oil shock in the west there has been an over capacity in refining and chemical manufacturing capacity and bulk storage facilities, so that, at the present time, we are not, in the United Kingdom, needing to construct significant amounts of new tankage.

Do you see that as an ongoing prospect?

I think we are moving closer into balance on tankage for independent bulk storage, but I think we are some way off building other than for specialist things. We, ourselves, built only 10 new tanks last year, but they were for specialist facilities, particularly petro-chemicals.

So what special services are the oil companies and the petro-chemical industry looking for from your bulk storage industry?

The change has really come about since the recession when sales worldwide started to fall. When that happened, people started looking to their costs, post 1979, not post 1973, to try and restore margins and more attention was paid to the contracting of services than was the case before the oil shock. What we see now is that there are demands for a much higher level of service, better utilisation of assets, quicker turn around of vehicles, and a sharpening of all the services that have been provided by our industry.

Does it mean that the industry's role is changing at the same time?

Yes, I think it is because we now have got to the position where the information which we provide about customer stocks and movements is produced very rapidly. Sometimes we feed that directly into remote terminals of our customers' own systems and, therefore, there becomes a decreasing need for the work we do to be duplicated in our customers' own offices. I think we can see a closer partnership between ourselves and our customers than has been the case in the past.

But you still see yourselves as an independent bulk storage industry?

Indeed. It is vital to what we do that we can be flexible enough to serve the needs of a wide range of people. All these customers have different information requirements, different ways in which the information has to be presented, different operating procedures, and we have to cope with all of them.

What about the competitive aspects? The bulk storage company operates long term on these high technology facilities, but nevertheless you are working for customers who are very keen on competition. How does that affect you?

Customers recognise that if we are to invest heavily for them then they must allow us a reasonable period in which to recover our investment. When a renegotiation of the contract arrives, one hopes that, because the investment by then is wholly or partly written down, it will enable us to offer the customer positive terms for him to stay, rather than for him to move to a competitor who might have to put in the facilities for himself from scratch.

The bulk storage companies management have to be as sophisticated as that of oil companies?

Yes, but in a different way. We have far fewer people we find on the whole and, therefore, we have fewer specialist departments within our organisations. We cannot afford big administration teams. We have to work with a few people who have a wide range of skills and are very flexible.

You would not have the same sort of back-up on the economics — but you may not need it?

We are essentially a reactive industry. We have not yet found a way of creating a demand for storage! What we try to do is keep close to our customers. We listen in the market place to what is going on and try to form a view on world economic trends. In the normal day to day run of things we need simply to give the customer a quick response to his enquiry.

The environmental factor is becoming increasingly important to your industry?

Yes. We start in a fortunate position, I think, in that our prime function is to prevent loss of our customers' products and that happens to be parallel to the needs of the environment, rather than opposed to the needs of the environment. That in itself is in the right direction.

Our industry also does not create significant quantities of waste, but what we are being increasingly asked to do is to help other parts of the industry to solve their waste problems. For example, in the new marine pollution regulations, we are obliged to receive waste which has been generated at sea in order to prevent it being dumped at sea. I think it is wholly fair that if we live by serving an industry we should play our part in solving their problems. So the environmental factor does increasingly play a part in our lives.

If you want to see a future picture, we have to look at the continent, to some extent. They are further ahead than we are in regulations over there. For example, for certain substances there are new regulations coming in which require fully closed systems and incinerators.

Now, we have not got that far in the United Kingdom yet, but it is reasonable to suppose that these things will follow. We would normally expect to be, perhaps, up to five years behind them — just as a guide line.

These are EEC requirements?

They are national and EEC requirements, and I am afraid at the end of the day all these costs have to be passed back to the manufacturer. He is rather used to this situation. I cannot think of any other way.

New technology may be applied there in some way, perhaps in disposing of waste on shore?

I think there is a great need for that. I think this is almost the last unsolved problem of western industry — if I can put it that way. What to do about waste! Clearly the measures that are being taken meet legislation as it now is. The Department of the Environment in particular is satisfied with the way in which wastes are being controlled and disposed of, but in the long term I think something different has to be found.

Does your industry have any particular ideas of what you are looking at for a more satisfactory, less costly, way of disposal of wastes?

I do not think any members of the United Kingdom storage industry are doing much research on waste disposal methods. If any United Kingdom storage companies are involved in waste, they are using existing technology. Work is, of course, being done on the possibilities of disposal of waste down drill shafts and so on and in due course this may play a part, but for the most part, disposal of waste remains a problem, particularly for chemicals. Petroleum wastes are not a problem to the same degree.

This must lead to an increasing interface between Government and your own industry?

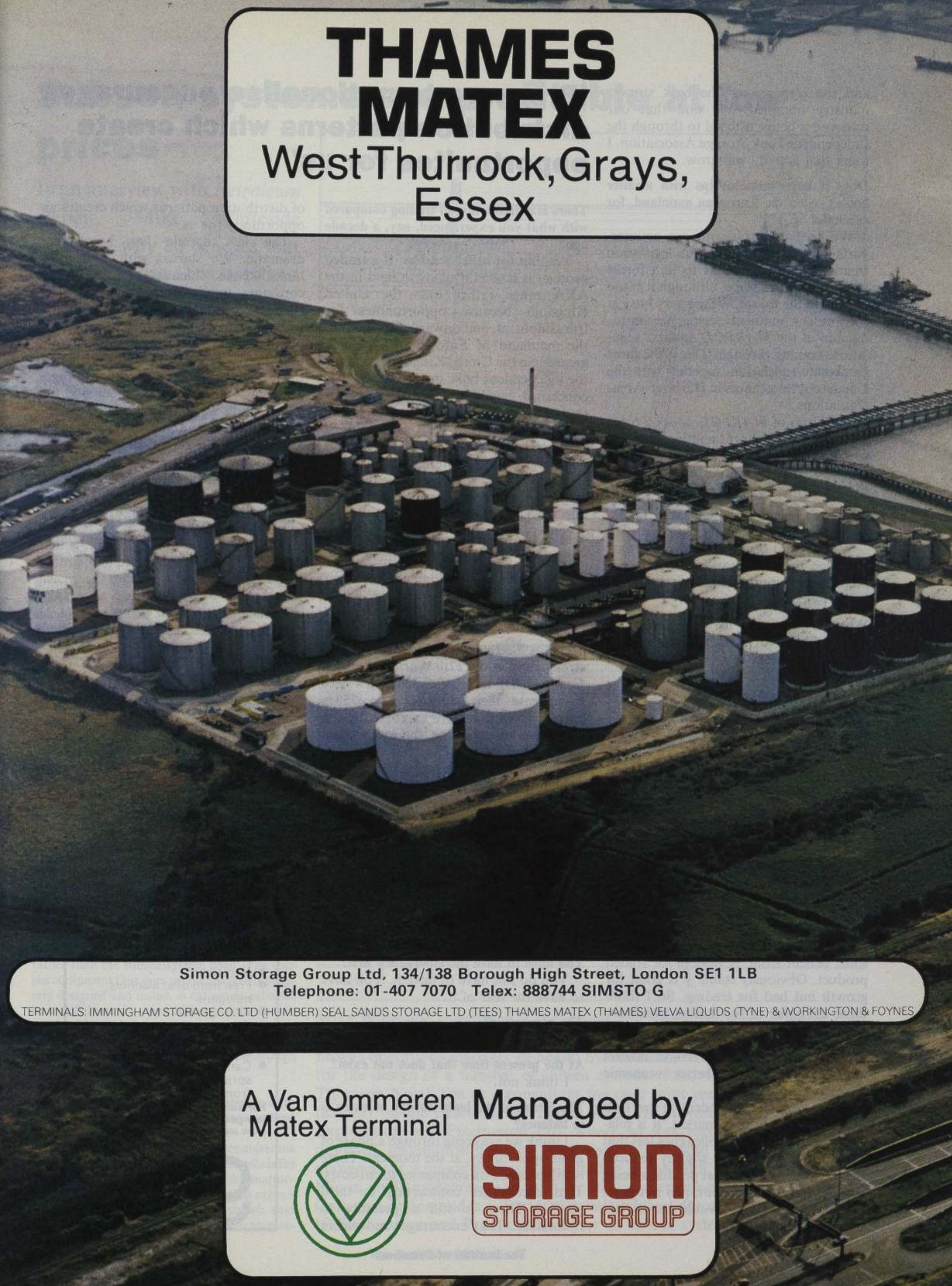
One of the burdens of life is the proliferation of legislation. I think we will see an increasing number of people in our organisation employed solely for the purpose of keeping track of legislation and ensuring that other members of our organisation who carry out the operations are aware of them, familiar with them and know the particular terms applicable to them. We have seen huge changes. We have seen, for example, not just the Oil Warehouse Review coming about two years ago, which was a significant change to HM Customs requirements – we have the *Control of Industrial Major Accident Hazards* regulations which now require safety surveys to be done. We have the *Dangerous Substances in Harbour Areas* regulations and *MARPOL Annex 1 and 2.* The Health and Safety Executive are continually drawing up codes of practice and there are many other factors involved. All this has taken place within the last five years.

You estimate it will continue like this?

I think where you have more and more people involved in forming legislation those people will produce work. So it is a trend I do not think will be reversed.

Can bulk storage companies, as it were, talk to each other on these sort of things?

We have to. Increasingly we have found it necessary to deal with these legislative matters on an industry wide basis rather than as individual companies. In the first place we have not got the staff to do it individually. The normal procedure, in theory, is for draft regulations to be produced for consultation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and the response of the bulk storage industry obtained. We find that our response is better listened to through the Independent Tank Storage Association. I think that activity will grow.

Does it have relationships with smaller bodies — on the European mainland, for example?

We keep in touch with our counterparts on the continent, but legislation trends do not require us to join forces with them at this stage, although it could happen in the future. We are very busy at the present moment seeing the introduction of the *MARPOL Annex 2* regulations coming through. This is the most immediate legislation, together with the Dangerous Substances in Harbour-Areas regulations.

The terms of *MARPOL Annex 2* place an obligation on shore facilities to receive specified tank washings from ships and to organise, their onward disposal rather than allowing them to be dumped at sea.

Is your industry happy with those regulations?

We have not been happy with the way in which the consultation process proceeded, but in a pragmatic sense, I think it will work.

What do you see as the major economic factors likely to affect the independent bulk storage industry over, say, the next five years — the mid. 1990's?

We are experiencing an improvement in the business environment at the moment, but I do notice that everybody is very cautious and slightly pessimistic about how long it may continue. What we need is a period of stability. A period of business confidence with steady growth. I think the forces at work tend to indicate that there will be a relatively stable oil price over the next five years. Producers and consumers will probably find that they can live with a price around the $18 to $20 mark and if that happens it will give economic stability and growth. What, of course, will not then happen, which our industry also derives some benefit from, is storage for traded product. Obviously stability is good for growth but bad for trading. So I think those are some of the factors which are going to affect us over the next five years.

Has the steadying of the futures market assisted this slightly better economic situation?

We are a little ambivalent in our feelings about the futures market. It is relatively new. My Dutch colleagues feel that the futures market has slightly reduced the likelihood of physical products being traded, and to that extent, it is not good for our business, but I would not say it is dramatic, at this stage.

'Pressure to nationalise encourages distribution patterns which create opportunites for us'

There is a diminution of trading compared with what you experienced, say, a decade ago?

Yes, but for other reasons. If a traded product is landed it tends to land in the ARA range rather than the United Kingdom because opportunities for transshipment, and onward disposal into the mainland of Europe are so much greater. So the United Kingdom, as far as the independent bulk storage industry is concerned, has become a backwater for traded product. For example, Rotterdam was full most of last year, as a result of the fluctuating oil prices. That sitution is now reversed and Rotterdam is relatively empty again, but with a case like that you are very unlikely to have it overflowing into the United Kingdom.

You do not see that coming back?

As long as Rotterdam is there, Rotterdam, to my mind, will fill up before the United Kingdom does. There has got to be a very big imbalance before it overflows into the United Kingdom.

The US Secretary for Energy made a strong point at the 12th World Petroleum Congress. He mentioned America's need to improve their stock pile to 750 m barrels. Does that have an effect, or can that have an effect, on the independent bulk storage industry?

I would say not. The capacity of Saudi Arabia to increase production is so great — for example, when the Gulf War started there was a lot of crude at sea in floating storage. So the capacity of producers to absorb this demand for increased stock will be easily sufficient. It is a shortage, of course, which makes people stock up, ironically. If we fear there will be a shortage of a product, we stock up.

You have to have the emergency first?

You do not have to have it. You have to have the fear of it.

The perception?

Yes.

At the present time that does not exist?

I think not.

The future of the bulk storage industry is in balance?

I think we are going through a phase of great opportunity, at the moment. There is still pressure on companies to cut costs. That encourages contracting to third parties. There is still a pressure to rationalise. That encourages movement of distribution patterns which creates an opportunity for us.

The last decade has been very dramatic. We started with what now looks like the golden age of storage when consumer trends were going up. The chemical industry was expanding. Inflation was high and the cost of maintaining stocks in storage was virtually nothing because the increased value of the products exceeded the cost of storage. Suddenly you had this oil shock and the whole world was forced into a recession. You did not hear about the energy crisis any more, but you heard about rationalisation.

So we have been through a lean time in the second part of the decade which I think we are now emerging from.

It has been interesting.

The only major worry, I think, is that our industry must be allowed to maintain its margins because it is from these cash flows that our ability to make investments is assured. ●

Subsea systems are profitable at low prices

In an interview with *Petroleum Review*, Mike Whiteside describes why he believes that once the oil price has stabilised and oil companies are confident it will remain at a reasonable level a number of subsea satellite developments will follow in the UK sector of the North Sea

Geoffrey Mayhew: Have subsea systems a long history?

Michael Whiteside: Yes, although they have only come into accepted use in the North Sea since 1976. They were first used in Lake Erie in 1943 and later off the Californian coast in the 1950s. Originally, wells were basically platform wells put subsea and used purely manual valves. Since that time they have evolved considerably for greater water depths, and using diverless techniques.

What is the advantage of a subsea system as opposed to having a platform on the surface?

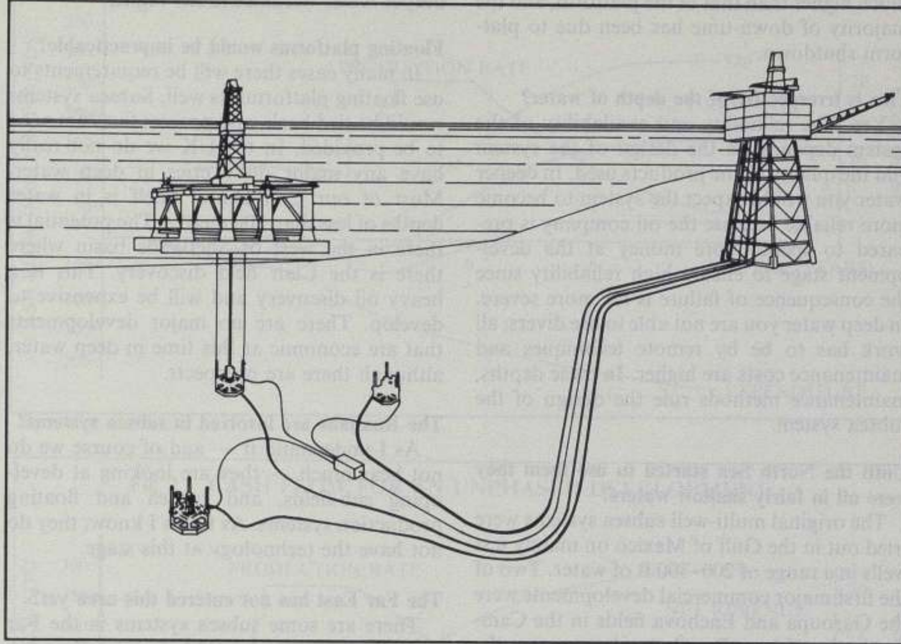
The advantage of a subsea system in general is lower capital cost than the large platforms. In addition, if we can remove the platform we remove a large amount of operating cost. On the other hand, if we do have to work on subsea wells we sustain a large operating cost, since in general we have to use a mobile drilling vessel to perform the work.

Has it been easy to devise a subsea system on the seabed that is going to work satisfactorily for any length of time?

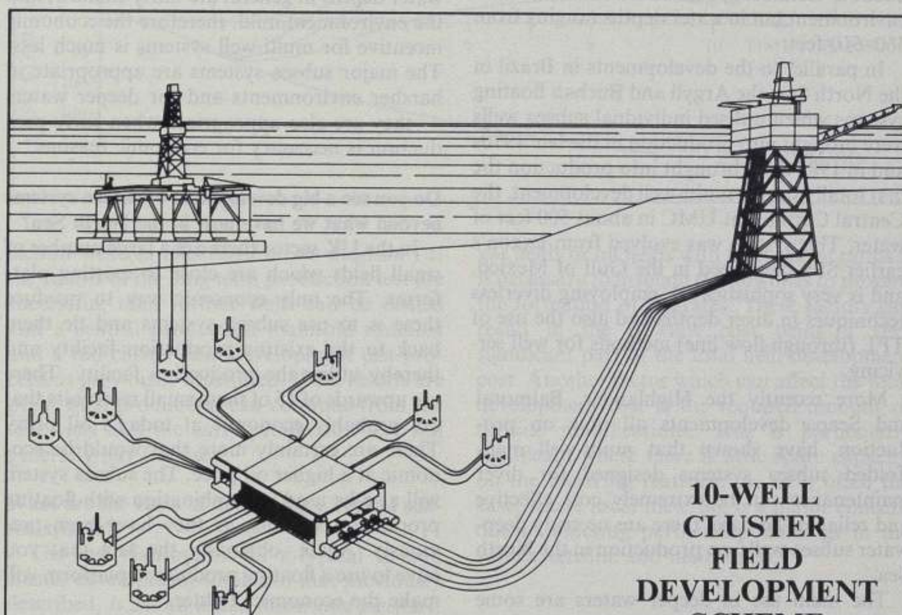
It has not been easy, but the industry has now evolved to a state where subsea systems are very reliable. The average time between maintenance periods for a subsea well is between three and four years. At this stage most of that work is due to downhole problems, rather than the subsea system itself. The subsea equipment that goes on the seabed, if properly designed and tested, is extremely reliable. Some of the main ways of making the system reliable is to design it to be as simple as possible and to fit the purpose to use appropriate high grade materials and to perform thorough pre-installation testing.

Are you indicating that a subsea system is actually less troublesome than a floating or fixed platform?

It has to be designed to be less troublesome because performing work on subsea wells is far more expensive preparation than the maintenance work on a platform. Operating experience on a number of fields has shown that majority of down-time has been due to plat-



EARLY PRODUCTION/APPRAISAL PHASE OF DEVELOPMENT



10-WELL CLUSTER FIELD DEVELOPMENT SCHEME

Mike Whiteside specialises in the design and implementation of lower cost subsea and floating production systems. From November 1984 to May 1987 he was operations manager of Seaflo Systems Ltd, where he was responsible for the design of a number of subsea systems. Prior to this he worked for Thomson North Sea as a consultant for their joint venture operations particularly on the Balmoral and Seapa fields. He previously worked for Esso Exploration and Production Ltd, where he was responsible for flowline designed installation for the Shell/Esso UMC and earlier was project manager for a major platform installation in the Gulf of Mexico. He has a BSc in civil engineering and an MSc in ocean engineering from University College, London and is a chartered naval architect. Recently, he talked to the IP Exploration and Production Group on subsea systems.

form or floating vessel unavailability. An example of this is the Central Cormorant project where the reliability of the subsea systems is much higher than that of the platform, and the majority of down-time has been due to platform shutdown.

This is irrespective of the depth of water?

Yes. The reliability and availability of the system depends on the design of the system and the quality of the products used. In deeper water you would expect the system to become more reliable because the oil company is prepared to spend more money at the development stage to ensure high reliability since the consequence of failure is far more severe. In deep water you are not able to use divers; all work has to be by remote techniques and maintenance costs are higher. In these depths, maintenance methods rule the design of the subsea system.

Until the North Sea started to use them they were all in fairly shallow waters?

The original multi-well subsea systems were tried out in the Gulf of Mexico on mainly test wells in a range of 200–300 ft of water. Two of the first major commercial developments were the Garoupa and Enchova fields in the Campos basin offshore Brazil; to a large extent the Brazilian state oil company Petrobras has pioneered the use of subsea and floating production technology, albeit in a fairly mild environment but in water depths ranging from 360–610 feet.

In parallel to the developments in Brazil in the North Sea, the Argyll and Buchan floating systems which utilised individual subsea wells were brought into production in the late 1970s and in 1983 Shell brought into production the first totally subsea multi-well development, the Central Cormorant UMC in about 500 feet of water. This system was evolved from Exxon's earlier SPS developed in the Gulf of Mexico, and is very sophisticated, employing diverless techniques in diver depths and also the use of TFL (through flow line) methods for well servicing.

More recently the Highlander, Balmoral and Scapa developments all now on production, have shown that multi-well manifolded subsea systems designed for diver maintenance can be extremely cost effective and reliable. To date, there are no truly deep-water subsea wells on production in the North Sea.

The main use in deeper waters are some wells offshore Brazil that have been put in in water depths of over 400 metres. These are single wells rather than multiple well developments. It is likely that the Brazilians will have to go ahead with multiple well subsea developments. They have some large finds offshore Brazil in around 400 metres of water. In addition, the Norwegians are now looking to develop deep water fields. Two major fields they are looking at are Troll — where at an early phase subsea wells will be used to bring Troll gas for injection into the Oseberg field — which will almost certainly go ahead in the early 1990s: and also Saga, on the Snorre field, are looking to develop deep water prospects in around 300 metres of water using diverless techniques. I believe the major deep water developments, within the next five to ten years, will be either in Norway or offshore Brazil.

Why?

Because they have major discoveries in deep water. The cost of converted fixed platforms in deeper water becomes much higher.

Floating platforms would be impracticable?

In many cases there will be requirements to use floating platforms as well. Subsea systems would be tied back, and process facilities need to be provided. In the UK we do not really have any major discoveries in deep water. Most of our Continental Shelf is in water depths of less than 200 metres. The potential is there in the west of Shetlands basin where there is the Clair field discovery. This is a heavy oil discovery and will be expensive to develop. There are no major developments that are economic at this time in deep water, although there are prospects.

The Russians are involved in subsea systems?

As I understand it — and of course we do not hear much — they are looking at developing sub-fields, and subsea and floating production systems. As far as I know, they do not have the technology at this stage.

The Far East has not entered this area yet?

There are some subsea systems in the Far East. Seaflo was responsible for installing five subsea wells in Indonesia, and a number of others have also been installed. However, the water depths in general are fairly shallow, and the environment mild, therefore the economic incentive for multi-well systems is much less. The major subsea systems are appropriate in harsher environments and for deeper waters — they are also appropriate when early production is necessary for economic reasons.

Do you see a big development of subsea systems beyond what we have now in the North Sea?

In the UK sector there are a large number of small fields which are close to existing platforms. The only economic way to produce these is to use subsea systems and tie them back to the existing production facility and thereby utilise the production facility. There are upwards of 15 of these small reservoirs that are probably economic at today's oil price. There are certainly more that would be economic at a higher oil price. The subsea system will also be used in combination with floating production systems, as they have been previously. Again, obviously the fact that you have to use a floating production platform will make the economics tighter.

Will the technology of subsea systems make big advances because of their greater application?

The advances are less likely to be in the UK sector where the basic technology is largely developed. In the UK the main advances will be the reduction of costs, and possibly the development of systems to produce over longer distances. In deep water prospects offshore Norway and Brazil there will be major advances. There have not been any deep water multiple well developments to date, although various trials systems have proven the feasibility of diverless systems.

Covered subsea systems under the sea?

Most subsea systems to date have been wet systems. While one atmosphere systems have been used in the Garoupa field in Brazil and also in the Gulf of Mexico, there have been problems with these to date, and the tendency now is to use wet systems — where valves and modules are exposed to the sea. Modules are retrieved to the surface for maintenance. On the other hand, Mobil and Statoil are developing the SAS, which is a hybrid one atmosphere system and wet system. The subsea trees are conventional wet technology, and the manifold is inside a one atmosphere chamber. There are proposals to use this on the Statfjord Field.

It appears to be the conceived wisdom within the industry that the wet system is the preferred option by most operators. There are major variables in the type of wet system used in deep water, and these depend on the maintenance methods. This includes the drilling vessel maintainable system where all modules are retrieved by a drilling vessel; for this system economics would require a number of subsea templates within a particular field so that you had a drilling vessel on call permanently to retrieve modules or do well work.

Other systems use remotely operated vehicle (ROV) maintainable systems where this vehicle is run from a dynamically positioned vessel and used to retrieve a module — these are still very much under development — and are being proposed for various fields.

A similar system which was evolved by Exxon and used on the Central Cormorant UMC is the component maintainable subsea system, which uses again a remote vehicle run from a diving or similar vessel. In this case the remote vehicle is not a free swimming vehicle and runs down on to tracks on the subsea template and then retrieves individual valves, as opposed to modules or a number of valves. There are a number of proposed wet systems.

As far as the one atmosphere or manned maintained system is concerned, there is only one seriously considered at the present time, although they have been used previously.

Do you see as the immediate future for subsea systems in the UK sector as basically an economics question?

Yes. Subsea systems in the water depths of the UK sector are proven and there are a number of fields adjacent to existing platforms that can be produced by subsea techniques. The economics of these fields are in general very good. What is required are refinements in the subsea system, and the way that the development is phased to improve the economics of the field. Most of these fields, it should be said, are profitable even at today's oil prices — in fact, will need to be brought on to production before the mother platform is abandoned, and can be used to sustain the life of the existing platform.

Do subsea systems relate to platform decommissioning?

In most cases it is very important we bring on these satellite subsea systems now, so that they can utilise existing production facilities. If we were to decomission the existing platforms and then bring on subsea systems that would require a floating production system to be incorporated with the subsea system, and this would greatly increase the cost and vastly reduce the economic rate of return. Therefore, we really need to bring these fields on fairly soon before the mother platform becomes uneconomic.

That means there should be, as you would see it, a big development in subsea systems during the next 20 years?

There will be a large increase in the number of subsea systems over the next five to ten years in the UK. These have been proposed for a number of years now and oil companies have been holding off developing them. Of course, the recent drop in the oil price last year deterred these developments again, but I believe that operators are now realising they have to bring these fields on soon, and the recent Budget incentives may add to this trend.

Are there any technical methods that will encourage the development of these fields in the UK sector?

Yes. The original subsea developments were based on the use of an integrated template and manifold. Development drilling could not commence until the template had been fully land tested and installed. This resulted in a large front end expenditure and late commencement of production. More recently these problems have been to some extent solved on projects such as Highlander and Scapa, where predrilled 'off-template' wells were drilled either as part of the original field appraisal programme or as development wells. These could be produced early in the field development either by connection through the template or directly into the field flowlines prior to template installation, thus providing early cash flow and enhanced field economics.

More recently the concept of doing away with the template and simply drilling individual 'cluster' wells around a central manifold has increasingly come into favour in diver depths where flowline and controls connection are relatively simple. This concept is illustrated for a 10-well cluster field development scheme, and has the great advantage that development drilling can commence almost immediately following field development approval prior to the central manifold being installed. Field production can then commence at a high rate very soon after the manifold is installed and the wells and field flowlines connected to it.

This concept is also favoured by a number of operators who are concerned about the safety of simultaneous drilling and production over a template, since the wells can be spaced at a larger distance from each other and the risk from dropped objects is reduced. In areas of high fishing activity this does have the disadvantage that each well requires an individual protection structure, which can be costly and there is definite scope for development of a low cost integrated protection structure.

The cluster well scheme can also be particularly advantageous where there is a high degree of reservoir uncertainty. This is the case in a large number of the smaller peripheral fields in the UK sector, which tend to be highly faulted and very difficult to appraise by conventional techniques. Such fields lend themselves to development by a phased technique whereby two or three wells are tied back to the production platform, and used to appraise the size of the reservoir by long term production testing and also to provide early production.

Typically an early development phase might incorporate two production and one water injection well (*as illustrated in the diagram.*) If the results of the long term production test are successful, then further wells can be drilled and a central production manifold installed and a full cluster field development can proceed as previously illustrated. If the results are poor, then production can continue from the test wells and the early production test will generally pay for itself.

Fig 1 CASH FLOW FOR A PHASED DEVELOPMENT

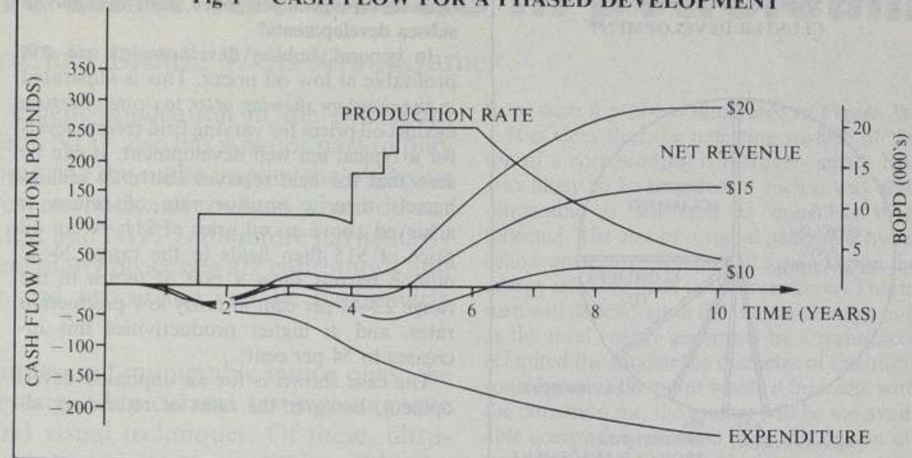
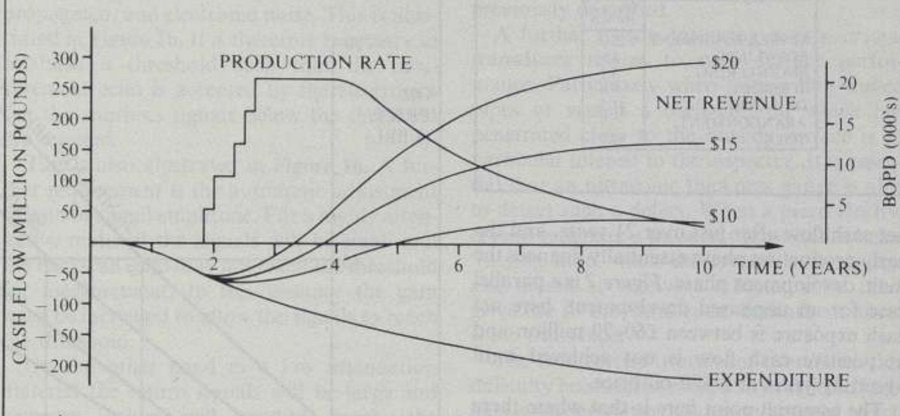


Fig 2 CASH FLOW FOR AN UNPHASED DEVELOPMENT



What are the costs of developing a typical subsea system?

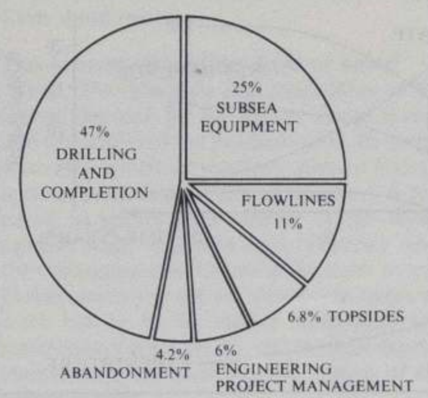
The cost distribution for a typical 10 well cluster development similar to that previously described, *is shown in the illustrated piechart*. The cost will vary from field to field depending on such factors as the depth of the well, the pressure and physical properties of the produced fluids, the distance to the production platform and the ability of the existing facilities to cope with the additional production.

In the case illustrated, 47 per cent of the cost is for development drilling and completion, other major costs are subsea equipment including trees, wellheads, manifold end controls and for flowlines and topsides modifications. This case assumes that the produced fluids are sweet and that field is six kilometres from the production platform. Increasingly there will be a requirement to flow over greater distances and to produce fluids which have high contents of carbon dioxide which will require the use of high alloy stainless steels; in other cases when producing gas fields or oil fields with high gas oil ratios it is necessary to insulate the flowlines to prevent the formation of hydrates. These factors can result in the flowline cost being a very significant part of the total field development cost. Another factor which can affect the total development cost is the required amount of topside modifications. This is particularly significant where there is little spare capacity on the receiving platform or, as is often the case, where fiscal metering is a major concern due to differing partnership holdings in the subsea satellite and main fields.

You mentioned earlier phased and unphased developments. How does the choice between the two affect field costs and cash flows?

Essentially, purely in terms of total field development, an unphased development requires slightly less capital expenditure than a phased development. This is because, in the latter case, additional field tie-ins are required and drilling has to be suspended during the development incurring additional mobilisation costs. This is, however, balanced by the cash flow profile which requires less net cash outflow for the phased type development, as illustrated in *Figures 1 and 2*. *Figure 1* shows the cash flow profile for a phased development, net revenue curves are shown for varying levels of oil price. At all oil prices the maximum cash exposure is about £25 million and at the $20 oil price the field is in positive

COST DISTRIBUTION FOR A 10 WELL CLUSTER DEVELOPMENT



DEVELOPMENT COSTS

	MILLION POUNDS
SUBSEA EQUIPMENT	22.0
FLOWLINES	9.6
ENGINEERING	5.1
TOPSIDES	5.8
DRILLING	41.5
ABANDONMENT	3.7
TOTAL	87.7

net cash flow after just over 2½ years, and the early production phase essentially finances the main development phase. *Figure 2* is a parallel case for an unphased development, here net cash exposure is between £60–70 million and at positive cash flow is not achieved until about 3½ years at a $20 oil price.

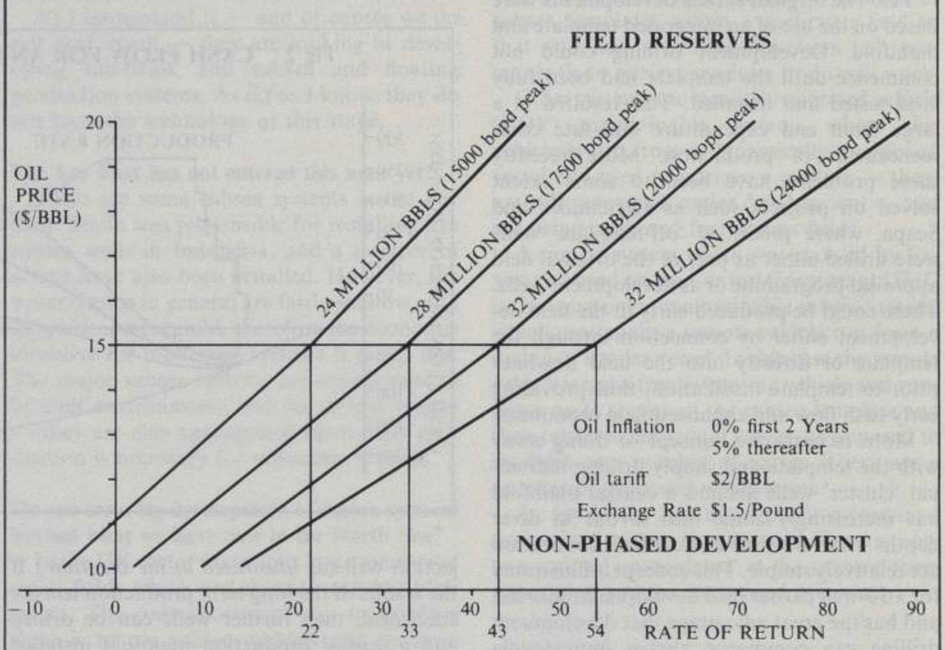
The essential point here is that where there is reservoir uncertainty then the phased type development is a lower risk option, since if the field does not perform as anticipated, then a minimum development can be pursued and in all probability the field will still payout, albeit at a lower level.

At present low oil prices many field developments have been postponed, need this apply to subsea developments?

In general, subsea developments are still profitable at low oil prices. This is illustrated in the *diagram showing after tax rate of return* against oil prices for varying field reserve levels for a typical ten well development. It can be seen that for field reserves above 24 million barrels then a positive rate of return is achieved above an oil price of $11. At an oil price of $15 then fields in the range 24–32 million barrels show a rate of return in the range 22–43 per cent at fairly low production rates, and at higher productivities this increases to 54 per cent.

The case shown is for an unphased development, however the rates of return are almost identical for a phased development. If the economics are risk-adjusted, then the phased development would generally be more favourable.

Once the oil price has stabilised and the oil companies are confident it will remain at a reasonable level, then I believe we will quickly see a number of subsea satellite developments in the UK sector of the North Sea. These will be particularly important where the receiving platform had reduced revenues due to falling production and the low oil price. The additional production from the subsea development will enhance the combined field economics, and may have the effect of postponing the point at which the platform has to be abandoned, thus resulting in additional oil being recovered from the platform wells. ●



NDT equipment and methods in petroleum

By Chris Brook, Wells Krautkramer

Non destructive testing has its most urgent application in the petroleum industry in the continuing quest for safety. NDT also has a major part to play in cost containment, control and planning. As the name implies the objective of NDT is to establish testing procedures, methods and routines which do not affect the process or component under test and NDT is therefore particularly suitable for the petroleum industry where many processes are continuous and where interruption of manufacturing and processing can be particularly costly.

There are several major NDT techniques and inumerable minor ones; the major techniques include ultrasonic testing, eddy current testing, magnetic particle inspection, x-ray inspection and visual techniques. Of these, ultrasonics is the most widely used in the petroleum industry and this will be the major concern of this article although a brief mention of other techniques will be made later.

Ultrasonic inspection

The most widely used ultrasonic testing instrument in the petroleum industry is the ultrasonic thickness gauge. This device allows rapid, accurate and convenient measurement of remaining wall thickness on metal and non-metal pipes, tanks and other vessels. With the exception of one development to be mentioned later the thickness gauge offers the ability to take spot checks by placing a transducer directly on the outer surface, coupled to that surface with a suitable fluid couplant, and giving an immediate digital measurement of remaining wall thickness. The ultrasonic thickness gauge will not work through cladding although it is not significantly affected by coatings which adhere well to the surface such as paints.

Corrosion pitting detection

At first sight the operation of an ultrasonic thickness gauge is very simple. A pulse of ultrasound energy is injected into the material and the echo of this pulse from the back surface is collected by the same transducer.

The instrument measures the time delay involved and having been calibrated for material velocity is able to calculate wall thickness and display as a digital reading. The principle is illustrated in **Figure 1a** as the signals would appear on an oscilloscope or ultrasonic flaw detector. However, the idealised situation illustrated in **Figure 1a** is unreal; in practice there are complicating factors which must be taken into account.

Firstly the transducer has its own delay line separating the piezo electric crystal from the front face of the transducer and therefore the top surface of the material under test. This gives rise to an 'interface' echo and is the point where measurement of thickness begins.

The instrument must therefore be capable of recognising this signal.

Secondly there are always spurious or interfering signals generated by the structure of the material through which the sound is being propagated, and electronic noise. This is illustrated in **Figure 1b**. It is therefore necessary to establish a threshold such that the measurement echo is accepted by the electronics but the spurious signals below the threshold are rejected.

This is also illustrated in **Figure 1b**. A further requirement is the automatic adjustment of gain or signal amplitude. For a highly attenuative material the signals will be small and the backwall echo may not reach the threshold for measurement. In this instance the gain must be increased to allow the signals to reach the threshold.

On the other hand in a low attenuation material the return signals will be large and spurious echos will readily break the measuring threshold. In this case the gain of the instrument must be reduced for reliable measurement.

It follows from what has been said that this simple instrument is more complicated than it first appears. **Figure 2a** and **2b** illustrate the overall principle of measurement using an ultrasonic thickness gauge. It is very important that it is recognised that an instrument which is designed only for general wall thickness measurement will not reliably detect corrosion pitting. It is well known that corrosion, particularly of high performance materials, does not occur by general wall thinning but rather by inter-granular attack resulting in pinhole failure.

For critical applications it is therefore essential that a thickness gauge is chosen which is suitable for the detection of pitting corrosion and the transducer chosen for this purpose is just as important as the instrument with which it is used. The propagation of sound is unlike that of light and the beam of sound beneath the probe should not be envisaged as similar to a beam of light from a torch.

For pitting corrosion detection it is necessary to have a focussed beam which maintains a small diameter for as far as possible into the material whilst giving adequate detection close to the surface where it is most critical. Such a beam profile is best obtained using a twin crystal probe, that is a transducer where the transmitting and receiving piezo electric crystals are separated from one another acoustically as illustrated in **Figure 3a**. An ideal beam profile from such a probe is illustrated in **Figure 3b**.

It is clear that the reflecting surface of the top of a corrosion pit is relatively small. It is also likely to be rounded in such a way that ultrasound is scattered as much as it is reflected. The size of a signal generated by an echo from a corrosion pit will depend upon the energy reflected back to the transducer. This in turn will depend upon the incident energy and as the total energy generated by a transducer is limited the smaller the diameter of the ultrasonic beam at the point where it interacts with the corrosion pit, the greater will be the available energy for reflection. For this reason ultrasonic transducers for thickness gauges are designed to give as near as possible the ideal shape of pulse illustrated in **Figure 3b**. This is best achieved with a two element transducer as previously described.

A further reason for using a twin crystal transducer relates to near surface performance. Particularly when testing thin walled pipes or vessels a corrosion pit which has penetrated close to the outside surface is of particular interest to the inspector. It is essential that an ultrasonic thickness gauge is able to detect such a defect. When a piezo electric crystal generates a pulse of ultrasound it has a 'ringing time' when the crystal is in motion and unable to receive a reflected echo. This gives rise to the 'dead zone' beneath an ultrasonic transducer.

The twin crystal transducer overcomes this difficulty because the reception of reflected signals is carried out by the second crystal which is always passively waiting to receive. Particularly with low frequency transducers, the dead zone can be several millimetres and it is therefore essential to use a twin crystal transducer for such applications.

In addition, the presence of a 'delay line' (that is a material in the transducer between the piezo electric crystal and the front face, and of calculated thickness) allows the dead zone to be absorbed within the transducer and the interface signal to be very narrow, so allowing the measurement of thin wall thicknesses.

(Continued p.17 with Figs. 1–4)

Figure 5: Ultrasonic thickness system: An operator is seen here checking wall thickness of hot pipework high up in an oil refinery plant. Portability of equipment is of paramount importance in this application

1988
IP Annual Dinner

The Institute of Petroleum's Annual Dinner in 1988 will be held at Grosvenor House, Park Lane, London W1, on **Wednesday 17 February**.

Ticket application forms will be sent to all UK individual and collective (company) members as a loose-leaf insertion in their **November** copy of Petroleum Review. Non-UK Members who wish to apply for tickets should contact Caroline Little at the IP at 61 New Cavendish Street, London W1M 8AR as soon as possible. Tel: 01-636 1004. Telex: 264380. Fax: 01-255 1472.

The closing date for receipt of ticket applications will be *Friday 27 November, 1987*.

Figure 1a

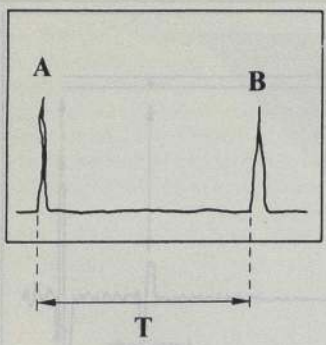
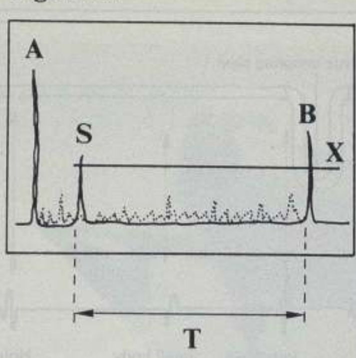


Figure 1b

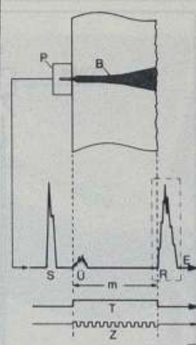


A — initial pulse
B — backwall echo
T — time, equivalent to thickness

S — interface echo at top surface of material
X — threshold

Schematics of ultrasonic thickness meter operation

Figure 2a



Pulse echo method with evaluation by counting
P = TR-Probe
B = sound beam
S = transmitter pulse
Ü = interface echo
R = back wall echo
E = pulse echo pattern
m = measuring value
T = measuring gate
Z = counting value
Zw = intermediate echo
L = pitting

Figure 2b

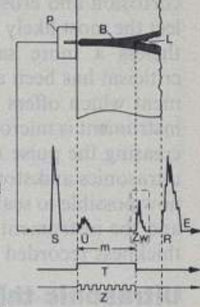
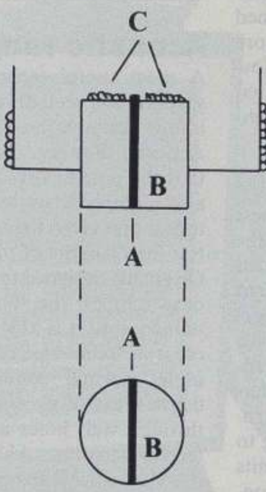


Figure 3a: Twin crystal ultrasonic transducer



A — acoustic barrier
B — delay line
C — piezo-electric crystals

Figure 3b: Ultrasonic beam profile

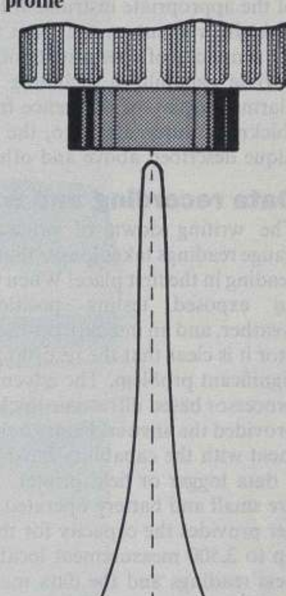


Figure 4a

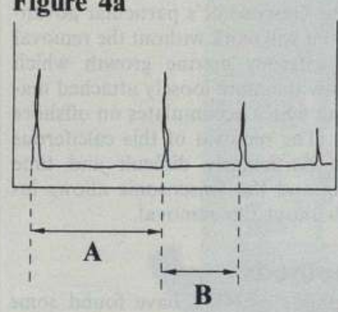
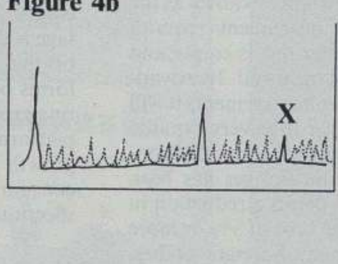


Figure 4b



A — metal plus coating
B — metal only — measured

X — Second backwall echo "lost" in noise

Ultrasonic thickness measurement through coating using repeat echos method — limitations

Single crystal transducers for through paint wall thickness measurement

One method of thickness measurement by ultrasonics has a particular advantage. Using a single crystal transducer and a multiple echo technique it is possible to measure the actual metal thickness beneath a paint coating which may be of significant thickness, for example on bridges or ships. The method is illustrated in **Figure 4a** and depends upon measuring between repeat echoes as the sound bounces back and forth within the metal only. This method, however, can give misleading results and should only be used in very carefully controlled situations and with full knowledge of the limitations.

Firstly, a single crystal transducer has the limitations indicated above. If an instrument working on the principle of measurement between repeat echoes is used on very heavily painted surfaces, the dead zone may be partially lost within the paint and its near surface resolution for pitting approaching the surface may be adequate. However, if such an instrument is used in a more conventional situation the dead zone problem can be critical.

Secondly, a more serious problem is that in many practical applications where the back surface is heavily corroded a repeat echo pattern will not be established. Although the first backwall echo will be clearly seen the second backwall echo may well be lost in the noise as the sound beam is scattered by the rough internal surface. This is illustrated in **Figure 4b**. In such a situation an erroneous reading may be generated.

In principle, therefore, single transducer thickness meters should only be used for thickness measurement and not for corrosion pitting detection.

Thickness measurement on hot surfaces

Parts of a petrochemical plant are maintained at high temperature and are subject to hostile situations where corrosion proceeds more rapidly. Unfortunately the high temperatures involved often result in poor outside surfaces as well as internal corrosion. Conventional thickness gauges may be used in such circumstances employing specially designed transducers with temperature resistant delay lines and specially designed couplants. Outside surface temperatures of up to 300°C can be relatively easily accommodated but above 300°C good results are difficult to obtain. 600°C is the upper limit for the adaptation of standard ultrasonic thickness gauges.

One solution to the problem of high temperature measurement of wall thickness by ultrasonics is to use electromagnetically generated ultrasound. Such equipment is shown in **Figure 5**. The interaction between eddy currents generated in the top surface of the test specimen and a high magnetic field generates ultrasound at right angles to the surface of the material. The reflected ultrasonic signal may be detected by the reverse process. This method works well but is limited by the power requirements for the generation of the magnetic field. Nevertheless, this is an area of future development.

Thickness scanning

One criticism of ultrasonic thickness gauge inspection is that it offers only spot checking; that is, the thickness gauge transducer is placed at one particular point on pipework or a vessel and the minimum thickness at that point is displayed. This says nothing about an area only millimetres away and to that extent ultrasonic thickness gauging offers only sample testing rather than 100% inspection. This criticism is partially overcome by the fact that plant operators know from experience where corrosion and erosion take place and can select the most likely sites for inspection. Nevertheless a more satisfactory answer to the criticism has been achieved in a recent instrument which offers scanning capabilities. The instrument is microprocessor based and by increasing the pulse repetition frequency of the ultrasonics and storing the lowest reading it is now possible to scan a transducer over an area and the instrument will display the minimum thickness recorded in that area.

Ultrasonic thickness instruments

A wide range of instruments is available with a range of capabilities and the above discussion should offer guidance in the selection of the appropriate instrument for a particular task. Instruments range from those designed for simplicity of operation to others with more flexible capabilities including high and low alarms, display of difference from a nominal thickness, automatic zero, the scanning technique described above and other features.

Data recording and transfer

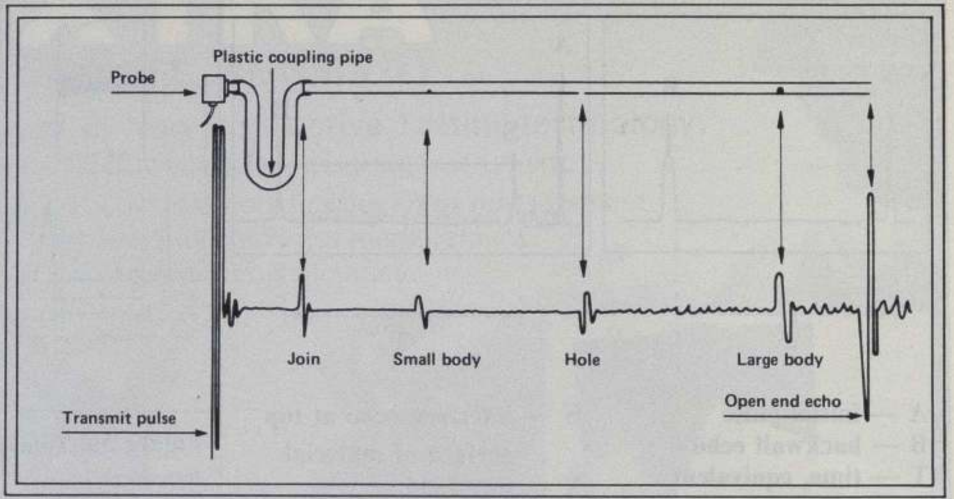
The writing down of ultrasonic thickness gauge readings takes longer than obtaining the reading in the first place! When to this is added an exposed testing position, inclement weather, and an insecure position for the operator it is clear that the recording of results is a significant problem. The advent of the microprocessor based ultrasonic thickness meter has provided the answer. **Figure 6** shows an instrument with the capability for down-loading to a data logger or field printer. All three units are small and battery operated. The data logger provides the capacity for the recording of up to 2,500 measurement location and thickness readings and the data may also then be transferred to a larger computer for processing or archiving. Other data loggers are available, with printers, to perform statistical analysis of the results of the thickness meter survey for inclusion in more comprehensive reports.

Figure 6: **Ultrasonic T.G. with data collection and printing facilities**

Ultrasonic flaw detection

Ultrasonic flaw detectors have an application in the petro-chemical industry for defect detection in castings and weldments. Unlike the thickness gauge an ultrasonic flaw detector requires a skilled and trained operator but is a much more flexible tool with a multiplicity of uses. Ultrasonics is particularly good at detecting crack-type defects. The ultrasonic flaw detector is also used for verifying thickness measurements in critical applications.

Figure 7: **Acoustic Ranger display of tube inspection**



Acoustic ranging

A most useful technique for pipework inspection has been developed by the CEGB and is now available in an instrument known as the Acoustic Ranger. This instrument requires that the pipe or tube under test is empty and also requires access to an open end. Its advantage is that given these two requirements it will test long lengths of pipe or tube very rapidly. Originally designed to detect blockages in condenser tubes, the Acoustic Ranger has been refined until it is able to detect a reduction in cross sectional area of the tube of 5% or more under normal conditions. Foreign bodies, dense areas of excessive corrosion and small through wall holes are just some of the defective situations which can be identified by the Acoustic Ranger. It is not affected by bends in the pipe though it is restricted to defects which have a direct effect upon the internal bore of the tube. It will not find external erosion or small cracks. A typical trace is shown in **Figure 7**.

Underwater inspection

The petroleum industry is of course vitally interested in non destructive testing methods for use in offshore applications. This is a subject on its own and only brief mention will be made here of the types of method available. Conventional ultrasonic testing has been widely employed on North Sea platforms and pipelines. Onshore equipment has been adapted to allow thickness measurements and flaw detection to be carried out.

Three of the most successful techniques for offshore use are as follows.

1 Magnetic particle inspection. MPI reveals surface breaking cracks in ferrous materials and finds extensive use in the offshore industry. Marine growth must be removed from the testing surface before MPI is carried out.

2 Alternating current potential difference equipment enables an assessment of the depth of surface breaking cracks and as such is often used in conjunction with MPI. Equipment is available for both onshore and offshore use.

3 Gascosonic. A development by the British Gas Corporation has resulted in equipment using the ultrasonic technique which will reveal whether or not an oil platform leg has water in it or not. The presence of water implies a through wall crack which under pressure has allowed the ingress of water as the legs and cross members are initially empty. The Gascosonic's particular advantage is that it will work without the removal of the calciferous marine growth which forms below the more loosely attached marine growth which accumulates on offshore platforms. The removal of this calciferous growth is particularly difficult and time consuming and the Gascosonic allows inspection without this removal.

Other methods

All the methods of NDT have found some application in the petroleum industry. Eddy current and magnetic coating thickness gauges are used to measure paint layer thicknesses, magnetic particle inspection is used to reveal surface breaking defects, and x-ray inspection is used for the examination of welds, particularly during plant construction.

A final method to be mentioned is that of low frequency ultrasonic detection. At low frequencies in the KHz range ultrasonic energy is transmitted through the air. Ultrasound at these lower frequencies is generated by many processes though the frequencies are not in the human audible range. For example, a pressurised leak, even at low pressures, will generate ultrasound, as will electrical breakdown of insulators and bearing-wear on pumps and other machines. Equipment is available to detect these ultrasonic frequencies sometimes from hundreds of feet away from their source and so allow defects to be traced and repaired.

Conclusions

Non destructive testing has a significant part to play in the petroleum industry both onshore and offshore. In particular, NDT makes a significant contribution to both safety and cost control and assists in the planning of maintenance and component replacement. The application of microprocessors to conventional NDT techniques is overcoming the problems of the large amounts of data produced from petroleum and chemical plants and there is now no reason why NDT data cannot be integrated into the data collection and subsequent statistical control that is so much a part of a modern plant operation. ●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COMMUNICATIONS

Non destructive testing: a renaissance

By Matt Gallagher, Metal and Pipeline Endurance Limited

Both the strength and the weakness of the independent non destructive testing industry lie in the high technical skills embodied in the inhabitants.

These lead, on the one hand, to individuals capable of tackling complex inspection tasks unsupervised and unaided; and, on the other, to small embryonic outfits set up by independently minded individuals determined to exploit their expertise to their own profit.

The result is a large somewhat kaleidoscopic sector containing everything from multi-disciplined established companies employing hundreds worldwide to literally dozens of firms that are little more than one-man bands. The scenario is tailor-made for ferocious competition. That has indeed been the case in the reduced markets of recent years.

On the face of it, the situation offers an embarrassment of riches to the user of NDT services.

Users tend to evaluate the quoted price against their perception of the supplier's ability to manage, control and staff the NDT programme they have in mind. This could be a complex long-lived operation involving several locations. That is not to say that the smaller firms inevitably fail such examinations. Indeed, some are perfectly capable of sustaining quite substantial inspection campaigns. However, smallness does imply some shortcomings.

What it does mean is that the companies favoured for the major projects are usually those with a wide breadth of experience, and ample staff and organisational resources. A user could well look for an international track record spanning the construction, oil, gas, offshore, petrochemical and nuclear industries. Such suppliers can offer the full gamut of services — from all the now numerous forms of radiography through ultrasonics to magnetic particle and dye-penetrant examination. Equally important, they will — because their livelihood depends on it — be actively seeking techniques and methods to improve both technical and operational performance.

Increased development and diversification

This is in fact one of the chief user benefits to have emerged from the heightened competition. After a period of sluggish development, the last few years has seen quite remarkable expansion of innovatory thinking in the NDT industry. It may be inspired by commercial selfishness — the instinct for survival — but it is welcome for all that.

There has also been a diversification of activities. Some companies have sought new markets for their skills — in inspecting and repairing concrete structures, for example — and have developed or adapted techniques to satisfy NDT needs in non-traditional industries. Vendor inspection — the practice of checking supplies at the factory on behalf of the buyer — is being undertaken to a growing extent by NDT specialists. And, with appropriate inevitability, more substantial members of the industry have entered the quality-assurance arena, offering QA packages covering everything and anything from advice and planning to the implementation of audits, design studies and full QA campaigns.

The upshot of all this is that the independent NDT sector can apply a greater armoury of skills, equipment, techniques and resources to its work then ever before. It faces few difficulties in selecting cost-effective and relevant methods to establish fitness-for-purpose of any structure, installation, pipeline, fabrication or component.

Leaner organisations

It is equally true that the experience of the last five years — with some key markets declining and competition besieging every business opportunity — has injected a greater professionalism into the sector.

With the recent technical advances — and more to come — some have also identified the need not only to enlarge the workforce pool but to enhance the skills of the individuals within it. With the support of the tradespeople themselves, academic, in-house and on-job training schemes have been devised to demystify the data processing, micro electronics and suchlike that figure in many of the newer NDT practices and equipment. There is, of course, a risk that this will intensify the skills of, and hence the demand for, the relatively small band of people populating the industry at present. However, time will remedy that. As more emerge from training so the total pool of broadly-trained labour will expand.

Service Inspection Group

One of the forces involved in the industry's reshaping is the Service Inspection Group of the British Institute of Non-Destructive Testing. Set up 10 years ago, the Group has earned justifiable recognition as an authority in NDT and engineering inspection.

All its members, now numbering close to 40, must satisfy specific standards in administration, technical competence, quality control, training, qualification and site/operational experience. The high representation from private NDT companies says something for the importance the independent sector attaches to the Group's aims.

All the organisations in the Group agree to abide by a code of ethics on professional behaviour. They must accept only those tasks for which they possess or have access to the necessary competence and organisation and undertake to discharge their duties with complete fidelity. Specifically — and this must border on the unique outside the professional sector — they agree to carry out each task solely in the legitimate interests of each client with all reasonable skill, care and diligence. They will not poach staff from clients or each other nor set up any links prejudicial to their impartiality without informing the client. The code ranges onwards through respect for professional standards and personal and corporate reputations, to an embargo on payments for business introductions.

This unusually rigorous code has a clear value to the NDT user. But the Group also has a role in representing the interests of its members and, by implication, the NDT industry to the official world at large.

Eliminating subjectivity

There is no gainsaying the skill of most NDT practitioners. However, equally there is no disputing the element of subjectivity resident in some NDT techniques. Ultrasonics, eddy-current and magnetic particle inspection are particularly vulnerable to interpretation.

Research in the industry has been directed towards eliminating these opportunities for debate. One result has been computerised equipment — suitable for automatic, semi-automatic and manual-assisted use — designed to largely dispel the subjective element.

A novel recent innovation is a computer assisted and admirably portable system for ultrasonic inspection. Remarkably inexpensive considering its performance, the system does away with the inherent subjectivity of the manual test by controlling and recording the key activities of equipment calibration and defect plotting.

The weld test data which is automatically logged in the systems computer can be re-examined in the relative comfort of a site office by the contractors or clients supervisory or auditing staff. The permanent record produced in hard copy, disc or video facilitates comparison with previous and subsequent test results. Importantly the system has been designed to complement and not replace the technician's own expertise.

Similarly, work is well underway on the development of computer assisted and recordable surface inspection methods.

Renaissance

It is likely that over the next few years we will see significant advances in NDT technology as the industry benefits increasingly from the rapid advances made in microprocessor electronics.

Real time radiography and computerised image enhancement is already available.

More user friendly and practical acoustic emission systems are appearing on the scene.

The accuracy and reliability of ultrasonic and surface inspection techniques will be much improved with the advent of the new generation of computer assisted systems.

Backed by this high technology, the re-energised NDT industry is regaining confidence and competence after a bleak spell. Certainly it is becoming better equipped — in resources, skills and temperament — to meet market demands efficiently and economically. ●

ECOLOGICAL IMPACTS OF THE OIL INDUSTRY

4th and 5th November 1987 to be held at The Institute of Petroleum

A symposium sponsored by

The Institute of Petroleum

The Oil Pollution Research Unit of the Field Studies Council

OPRU is a small group of about twenty scientists with particular expertise in marine and coastal ecology, chemistry and sedimentology. The findings of OPRU's research into the impacts of discharges to the marine and coastal environment will be presented. The main focus is on experimental work and field surveys within the oil port of Milford Haven, developing to research in other parts of the world.

Early studies concentrated on experimental applications of oil and dispersant in the field and the recording of impacts on species and communities. As experience and understanding of effects developed, the expertise was applied to providing specialist advice during spills and to increasing numbers of monitoring and impact studies associated with refinery discharges, coastal terminals and offshore oilfields, both in temperate areas and the tropics.

Presentations have been selected from the last ten years of research. Subject matter includes survey and monitoring techniques and approaches, impacts on intertidal and subtidal rock and sediment communities, and the fate of oil in sedimentary systems. These main themes are illustrated with case studies. The emphasis throughout is on the application of research findings to forward planning, environmental management and protection.

The concepts and data put forward are relevant to a wide audience, especially oil companies and government authorities, as well as scientists working and training in this and related disciplines.

4th November

The Origins and Growth of the Oil Pollution Research Unit
Authors: J. M. Baker and B. Dicks

Rocky Shore Monitoring
Authors: K. Hiscock and A. E. Little

Oil in Wetlands
Authors: J. M. Baker, J. A. Bayley, J. Oldham and M. Wilson

The Effects of Oil and Dispersants on Seagrass
Authors: S. Howard, J. Baker and K. Hiscock

Sediment Macrobenthic Communities — from Oil Ports to Offshore Oilfields
Authors: D. Levell, D. Rostron and I. M. T. Dixon

Determination of Hydrocarbons in Environmental Samples: Sampling and Analytical Variability
Authors: S. E. Howells, N. M. Dodd and C. Turner

5th November

The Role of Dispersants in the Persistence and Fate of Oil in Sediments
Authors: D. I. Little and J. M. Baker

Sediment Contaminant Transport in Milford Haven
Authors: D. I. Little and P. McLaren

Refinery Effluent Discharges into Milford Haven and Southampton Water
Authors: B. Dicks and D. Levell

Monitoring the Sullom Voe Terminal
Authors: S. S. C. Westwood, G. Dunnet and K. Hiscock

Environmental Sensitivity Mapping and Oil Spill Response
Authors: B. Dicks, R. Wright and S. Howard

For a copy of the registration form, please contact **Caroline Little,** The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: 01-636 1004. Telex: 264380. Fax: 01-255 1472.

Wind of change hits the spot, forward and futures markets

The rumble of a minor revolution in the way oil is being traded worldwide provided the general thrust to the recent conference on *Spot, Forward and Futures Markets* held recently at the Institute of Petroleum in London. It posed the question: Who uses them and why? Are they efficient?

A packed lecture theatre made up not only of a diverse cross-section of oil company representatives but also of traders, brokers, academics, students, and members of the press, heard a number of startling viewpoints and theories put forward by a team of expert speakers.

- A Wall Street refiner, who believed that such a term would soon disappear from the industry's vocabulary, said it was no longer unthinkable that oil resources could not be bought and sold under long term pricing agreements while they are still in the ground.
- A leading consultant said that the only people who are seeking to make the spot markets more efficient are those who are not a part of them.
- And Mr Robert Mabro, Director of the Oxford Institute for Energy Studies, described the Brent Forward Market as a club whose entry was restricted by the willingness of its principal members to deal with those wishing to join.

Chairing the morning session, **Silvan Robinson**, President of the Shell International Trading Co, said that no area of the industry has undergone greater changes than that of market trading. It now required completely new expertise and a degree of knowledge across a wide range of subjects.

First to speak was **Joe Roeber**. He described spot markets as a challenge to the traditional ways of doing business and one that had previously been dubbed as provocative and even shocking. However, in more recent years spots have lost their power to shock as an issue and become altogether more efficient.

The only people who are really seeking to make the spot markets more efficient, according to Mr Roeber, are those who are not in them. The spot market is itself a symptom, not a cause, of changes which came in afterwards.

Mr Roeber went on to compare East and West markets, more specifically those of Singapore and Rotterdam. The latter had been blessed with natural geographic advantages, located as it is at the mouth of the Rhine. It possesses the necessary liquidity and banking facilities. There was space and opportunity for a growth in refining and storage which had direct access to trading with northwest Europe.

On spinning the globe, Singapore also looks geographically marvellous, but Mr Roeber pointed out that the dissimilarities with the great Dutch port are crippling.

Despite advanced harbour and banking facilities, Singapore suffers from having been a late starter in comparison with Rotterdam which was underway 20 to 30 years ago. Distances in Asia are tremendous, incurring considerable price/time risk. This was also true of the trans-Atlantic market, which has developed with futures. In Mr Roeber's opinion, Singapore would not grow as far as generally expected unless it developed along very different lines to Rotterdam. He allowed that Singapore offers large business in the tender trades and is an obvious location for 24-hour trading.

To close, Mr Roeber underscored the rise of risk management in an industry which had always been risky and always handled it as part of the normal run of events.

Robert Mabro, the director of the Oxford Institute for Energy Studies, drew attention to the fact that, since the seventies, the structure of the industry had begun to change and its own subsequent integration had provided the platform for the emergence of outside markets. Markets that had begun as spot physical markets had diversified over time, developing into forward markets and, when circumstances permitted might develop still further into futures.

Rules like all clubs

Comparing the market in Brent Crude with that of Russian gasoil, Mr Mabro described the Brent forward market as a club and one that has its rules like all clubs. Entry into it, he said, was restricted by the willingness of its main members to deal with those wanting to join.

The number of players in the Brent market has never been very great and while the round number of a hundred had been bandied around, Mr Mabro believed that only about 30 are doing sufficient business to really be called players.

Activity in the Brent market divides into hedging and speculating and everybody is doing both. You can be explicitly one and implicitly the other, he pointed out. Hedging was a form of buying insurance at a premium, while speculating was the higher risk area whereby you had to pay out in the event of an accident.

The markets carry on because of a successful balance between the two and clearing houses function to correct mistakes and misunderstandings as well as to process the paper. The physical oil of Brent was in the hands of but a few giants such as Shell, BP and Conoco and it is they who ensure the 'smooth wetting' of clearance.

Mr Mabro said that the whole thing has grown very fast since the 1976 price collapse and now appears to be in good shape. There was no doubt, he emphasised, that the Brent market was a different animal from futures because of who can participate. There is a strict limit to the number of people who can actually purchase 600,000 barrels of oil. But there are virtually no limits on who can buy a seat or who can trade on the New York Mercantile Exchange (NYMEX), where, for the outsider, it was essential that prices were available on the board.

The Russian gasoil market was the most efficient at price prediction. Mr Mabro demoted Brent to third place for efficiency in this limited sense, with NYMEX only slightly better.

The Russian market had very few players, usually those who had direct access to Soviet gasoil. The rules of their game were noticeably more informal. The Russian market was important because it probably accounts for around 80% of gasoil *traded* in Western Europe. Mr Mabro called this far from insignificant as Russian gasoil plays a barometric role on the market price which, while it does not fix it, affects it closely.

A capsule history of the forward markets in oil was provided by **Nigel Graham**, Managing Director of Neste Petroleum (Products) Ltd. The major forward markets were those in: Brent Blend, Russian Gasoil (Russian Roulette), Naphtha in northwest Europe, Heavy Fuel for nominal delivery at Littlebrook in the UK (Littlebrook Lottery) and Number Two Heating Oil cargoes in Boston Harbour (Boston Bingo).

Attempts had been made to start a forward market in motor gasoline and a naphtha contract for delivery in the US Gulf was currently under discussion. He outlined how the widespread wet movements of the sixties and seventies gave way as companies lost access to their oil and the number of traders proliferated. Overheads for traders were low. Paper contracts, invented by the industry and primarily developed by the oil brokers, were keyed to fixing prices and timing and deals could often therefore be clinched in a matter of minutes.

However, Mr Graham warned that when a trader had to make a physical delivery on a paper contract he can sometimes be caught out. Unable to find the identical specification to that on paper he is sometimes forced to provide an improved quality product.

In this atmosphere, no one is precluded from negotiating an individual contract. But Mr Graham called for improvements in standardisation, which he believed should be forthcoming from the major oil companies themselves, as they have the resources at their disposal.

Mr Graham listed the following advantages of the forward markets: the speed of sealing deals, high liquidity, transparency and their use as a good hedging tool. The disadvantages are that they are adequately regulated, contracts are sometimes too loosely worded, there are few players doing business and some may not be considered appropriate because of the restrictions in the areas and products they serve.

David Salomon, Vice-President of the Oil Division of J Aron and Co of New York, began by stating that the term 'Wall Street refiner' would disappear within one or two years. We see ourselves becoming more fully integrated traders in the future, he said.

Mr Salomon went on to predict that companies like J Aron would become increasingly active players in both the wet and paper markets by assuming risk and either guaranteeing or hedging the margin.

Masters of destiny

He gave examples of his company's role in trade with producers and refiners. Pricing can be delayed instead of fixed at the time of the sale. We buy or sell wet crude, Mr Salomon explained, and then allow pricing over days, weeks or even months — in small amounts or as a whole. We may resell oil before the price is fixed. In this way, we allow producers to become the masters of their own destiny.

Wall Street institutions like J Aron deal with refiners in much the same way. The business of refining is to realise a margin on the product, he said. Refiners can lay off risk and lock in the return on their dollar through margin assumption and guarantee.

Two years ago everyone was sceptical about options, Mr Salomon recalled. Now the options markets are one of the fastest growing sectors in the entire history of American exchanges. They act as a form of insurance and help to forecast prices based on market consensus.

What does the future hold in Mr Salomon's view? More and more, spot, forwards and futures will be the tools of the trade in the years to come. Oil will be looked at as a financial asset in the coming years. It is now a commodity. It is no longer inconceivable that oil will not, one day, be traded under long term pricing agreements while still in the ground.

David Salomon wound up by saying that companies such as his would exist in risk management only as long as they provided value to the market.

Russell Seal, General Manager, Oil Manufacturing, Supply and Trading Department of BP Oil International, spoke on the use of the markets by a major oil company.

In the supply line between the production of crude and sale of products to the end customer there are several places where trading in some form or other adds value and, in current volatile markets, is probably essential. It permits risks to be managed, refinery economics to be improved, and supply/demand to be better balanced. This development had led to the growth of spot markets for both crude and products, the introduction of forward trading, and the evolution of an increasingly complex set of instruments for dealing in futures.

To Brent and Russian gasoil we have now added Boston gasoil and the Littlebrook Lottery. It seems that as new needs develop there will be no shortage of new ideas for instruments to meet those needs.

The structural significance of the range of new instruments is mainly concerned with hedging: speculators provide essential liquidity to futures markets, but the principal obejective is to set up financial arrangements to link supplier and customer, and enable them to share risks and minimise their financial exposure.

We now have options as an extension of straightforward futures markets, the possibility to hedge several years ahead and better suit the individual needs of sellers and buyers, and EFP (exchange of futures for physicals) to allow flexibility in choosing delivery terms.

The advantages of spot, forward and futures markets are clear — they are free, are not controlled and have prices which are market related. The prices are transparent. Hedging of course allows financial risks and exposures to be minimised.

There have also been criticisms. Futures trading is accused of creating volatility and speculators may attempt to manipulate prices. There have been problems with specific markets such as the daisy-chain collapse early in 1986.

Essential features must exist, particularly liquidity, but also properly constructed contracts and willing players. These characteristics must be flexible to changing circumstances, for example Brent and PRT changes and the new Financial Services Bill.

Spot oil markets are useful and necessary, and are likely to continue. They will also develop and change, probably quite rapidly, as needs change. The Rotterdam market looks healthy, and paper trading in Brent and WTI will continue. NYMEX futures are well established, and so is the IPE gasoil contract.

But what comes next? Why don't we have a successful fuel oil contract? New financial/trading instruments will evolve as they are needed and useful; for example, options are developing successfully. They can of course be deceptively simple and fiendishly complicated. They pose great challenges for the development of systems and even greater problems of control. But so long as they continue to serve the needs of the oil industry, producers, refiners, traders and consumers, they will continue.

Rosemary McFadden, President of NYMEX, gave a talk on Energy Trading and the New Financial Markets. She said, in part:

Ten years ago, OPEC set the price of oil unilaterally, while other suppliers and consuming nations exerted little influence.

Today, the price of oil is determined by producers, refiners, traders, marketers and consumers, both large and small, from every corner of the globe.

In short, the financial markets of the late 1980s bear little resemblance to the same markets of only a decade earlier.

Commoditisation, the process by which a product or service becomes available to the marketplace in ample quantities from a variety of sources, has occurred in a number of industries, including the energy industry, during the past 10 years.

Securitisation, the creation of a standardised fungible financial instrument backed by a specific pool or quantity of goods or services, has expanded into virtually every sector of finance and industry.

And globalisation, the international integration of the world's capital and commodity markets, has become a fact of everyday life for companies and investors around the world.

These three forces acting together have had an enormous impact in shaping the course of finance and industry in the 1980s and beyond.

Not only has oil become a commodity, it has emerged as the most volatile of the major physical and financial products traded on world markets. Saudi Arabia's decision in late 1985 to seek a 'fair share' of the global oil market was the primary impetus for the unprecedented price volatility.

But perhaps the best illustration of the impact that commoditisation can have on a product can be gleaned from the following fact. On one day in April 1986 the price of oil dropped by nearly $5 per barrel. That one day price move was 10 times as large as the change in the price of oil in the 13 years between 1947 and 1960.

This kind of extreme price volatility, which almost always accompanies commoditisation, sets the wheels in motion for securitisation.

In fact, securitisation is a direct result of volatility in a product's price. Volatility puts a premium on the marketability of a product.

By repackaging commodities or financial obligations into easily tradable units, securitisation speeds the development of a secondary market. Eventually, this process greatly broadens the number of available sales outlets for a product.

In the case of the energy industry, it was NYMEX that began the securitisation process when it began trading a heating oil futures contract in 1978.

Rapid pace

The securitisation of energy has proceeded at a rapid pace since then. In 1981, the International Petroleum Exchange (IPE) introduced Europe's first exchange-traded energy futures contract.

At NYMEX, meanwhile, heating oil was followed by crude oil and gasoline futures; and later, by crude oil options, introduced last 14 November. Heating oil options opened on 26 June, and propane futures will follow later this year.

Although energy futures started slowly, they gathered momentum following the deregulation of crude and gasoline in the US, and as OPEC's price setting power gradually weakened.

Today, energy futures and options contracts are well established risk management tools enjoying active participation from all segments of the oil industry.

Reflecting the growing use of energy futures by the oil industry, trading volumes and open interest at NYMEX have soared in recent years. In 1987, crude oil futures volume at present pace will exceed 12 million contracts traded — the equivalent of more than 12 billion barrels of oil.

At NYMEX, in particular, foreign participation has grown.

According to the Exchange's recent survey, approximately 15% of the largest position holders in the energy futures and options markets during the last six months of 1986 were companies organised and operating outside the US.

That figure increased from 10% in a previous survey covering the first six months of that year.

Another 6.5% of the top participants during the last six months of 1986 were non-US trading companies with US operations.

If the survey results are indicative of the overall breakdown of business on the Exchange, then more than 20% of the positions held in NYMEX energy futures and options can be traced directly or indirectly to foreign origin.

Futures exchanges like NYMEX facilitate globalisation for a number of reasons.

First, unlike spot markets, futures market prices are transparent and readily available to anyone who wants them on a real-time basis through advances in telecommunications technology.

Secondly, trading volumes and open interest figures are publicly reported.

Third, market participants trade anonymously through floor brokers who help them execute large transactions without unduly influencing the price.

Fourth, futures markets offer equal access to all, providing the kind of liquidity that is necessary to support global participation.

Fifth, market surveillance and rule enforcement assure consistency and fairness for all market participants.

Sixth, futures exchanges act as intermediaries to guarantee contract performance, relieving participants of concerns over the creditworthiness of their trading counterparts.

Today's oil prices at NYMEX reflect the activities in the market of consumers, suppliers, traders and investors all around the world.

As a visible manifestation of supply and demand imbalances in the world oil market, these prices serve as benchmarks for oil transactions tens of thousands of miles away from the Exchange's New York trading floor.

Meg Annesley, a consultant to the IPE, was the last speaker of the day. She said in part:

Prior to the 1970s, when oil companies controlled both the supply of oil and its markets, when prices were predictable and stable, and when outside influences on oil prices, from both traders and markets, were negligible, spot markets were insignificant and forward oil markets had yet to be created.

The gradual loss of control of production to OPEC, the consequent deintegration of the oil companies and proliferation of trading companies during the seventies promoted the growth of spot markets.

However, it was not until the fall-out from the forcing up of oil prices by OPEC was felt, that forward markets developed.

Lower oil consumption and OPEC's inability to sustain production controls, produced over-supplied markets and weak oil prices.

Consequently, most oil companies resorted to buying their supplies from the spot markets, rather than under term contracts with OPEC. The oil companies established active spot trading departments in the process. Furthermore, the established trading companies as well as oil companies increasingly needed to protect the risk of holding or carrying stock, creating a need for hedging vehicles.

The attraction of a 'new' concept, that of being 'short', became obvious. Traders felt the desire to hold a balanced portfolio of long and short cargoes, ie; to be hedged.

It was during the early eighties that circumstances combined to create a favourable environment for both forward and futures markets. Although futures had been around for some time in the USA, their performance was lacklustre in the period of prosperity and rising oil prices of the late seventies. By the early eighties the NYMEX and IPE contracts gained the gradual acceptance of the oil trade, but a constant deterrent to wider use was the need for management approval, control systems etcetera.

Physical cargoes

By contrast, selling physical cargoes short was only a variation on spot trading and was therefore quickly adopted by the international cargo traders, mainly based in London, who could also accomplish the short sales of physical cargoes without any special approvals from their management.

Standardisation of contracts aided short selling. It reduced the risk, by increasing the opportunity for buying exactly similar cargo to cover an existing short sale. Furthermore, it concerned trading activity within the standardised grades, thereby creating liquidity. The liquidity in turn encouraged speculation.

The grade eventually chosen for crude oil, the oil companies and cargo traders strategic trading need, was Brent blend.

The selection of the grade was determined by considering, from the alternative physical options, a grade of oil where:

- physical delivery was easy (via Sullom Voe Terminal)
- the production was under the control of the oil companies not OPEC.
- the production level was high, stable and rising
- many of the producers were also companies dealing in the market
- there was a diversity of supply
- some producers had no downstream interests so the production would likely be traded on the market
- BNOC had a large share of production with no downstream disposal

All these points contributed to the safety of the short seller when he wished to cover.

Once contracts were standardised, it was only a short step from selling spot to selling forward, encouraged by the increasingly uncertain price climate.

The particular aspects of the forward markets that appealed to the participants can be summarised:

Traders like it because it is easy to use, hedge, speculate and so forth. There are no margins of financing requiring approval of other departments or management and a clubby atmosphere has developed.

Physical delivery excludes any participants except those with the capability of making and taking delivery. The players in the market are known and their trading philosophy and strategy is assessable by the other players.

On the other hand, there are problems with forward markets. Since they evolved from spot markets, they are entirely unregulated and only disciplined indirectly; ie by threat of exclusion.

They are open only to companies able to take physical delivery of oil, which limits the participants and liquidity, and therefore are more easily manipulated than futures markets.

The limiting of participants, and exclusion policies, makes them liable to threat of anti-trust and anti-competitive practices.

They are without any form of guarantee of performance, or security.

Delivery problems are caused through the formation of long 'daisy chains'.

Liquidity is restricted by inefficient use of available credit.

Bookouts that shorten the daisy chains and improve the credit are vulnerable to the 'gaming Acts' of 1845 and 1892.

The price transparency mechanism is clumsy, inefficient and subject to manipulation.

The trading method of canvassing the market by telephone and use of brokers is also cumbersome, inefficient and expensive.

The support staff to check contracts and to track daisy chains is another inefficiency and expense.

The significant default at the time of the price collapse in early 1986 highlighted many of these weaknesses. It also prompted a more general review of the market by the oil companies' managements who were, perhaps for the first time, motivated to analyse the efficiency and overall utility of the market.

After the default, the oil companies decided on balance that they could afford the disadvantages of the market, most probably because of the value of the tax shelter, although they clearly found it useful for the other purposes mentioned.

By early 1986 several of the powerful Wall Street banks were already trading in Brent and after the default they seized the opportunity to provide the liquidity for the markets, which had hitherto been provided by a diverse selection of oil trading companies, many of whom were now considered financially too weak to participate in an unregulated market, without a security mechanism.

We have mentioned the possible anti-trust/anti-competitive aspects of the forward markets. The next issue of legal significance occurred late last year and is the change in the method of assessing PRT.

Without going into the details, the overall benefit of the previous system has been severely curbed. Since one of the particular attractions of the Brent market was for tax shelter, the question to be posed is to what extent this diminution of benefit will change the attitude of the producers? Will they continue to sponser its inadequacies?

It may not have occurred to many that the Financial Services Act, due to come into force later this year, may well be relevant to the Brent market and other forward oil markets, traded from London.

The Act is but one measure in a process of regulation designed to promote order over markets in which speculation and hedging occurs. One of its aims is to encourage price transparency.

I would also draw your attention to the

names of the forward markets apart from Brent: Boston Bingo, Littlebrook Lottery, Russian Roulette. Even these imply a high level of speculation in the forward markets. The speculation, hedging and degree of similarity to the futures markets is what puts them at risk under the act.

I have outlined some of the recent changes, and indeed some of the uncertainties being experienced in the forward markets, particularly that for Brent. I cannot tell whether they are enough to change the preference of the oil companies to trade in the forward markets.

However, there are some other questions to consider. Is the lack of a liquid international crude contract the reason for the predilection for forward markets? But if that is the case, why then is there a Russian gasoil cargo contract when there is an active IPE contract?

There are views from the traders that the Russian contract is much less popular now that the volume on the IPE gasoil contract enables cargo-size business to be transacted with ease. Also that the contract is not that robust, and may fade away gradually over time.

With the growth of futures over the last few years the skills of these markets are gradually being acquired, although less quickly in Europe than in the US. With the acquisition of these skills, the weight of advantage between using forward and futures may change in favour of the futures.

Likely outcome

I believe that the most likely outcome might be that, over the next few months, there will be enough uncertainty over the benefit of the Brent market to curtail its use. Indeed, this already seems to be happening with volume down to some 20 deals a day. A sustained reduction of volume would have the advantage to the producers of reducing its exposure to the FSA, as it would better resemble a commercial market. Hedging for crude could then be conducted on the NYMEX.

If this occurs the need for a crude oil hedging and trading instrument, more closely geared to the international market, will be keenly felt in Europe.

Furthermore, London's role as the traditional centre for oil trading will be threatened through curtailment of their most active market (Brent) and there will be motivation to look at new avenues, from the traders themselves.

There are two possibilities already being developed.

Firstly, the IPE have developed a contract for trading by computer a physical delivery, 600,000 barrel cargo lot size of Brent, to be supplemented by a cash settlement contract.

Secondly, a clearing house idea first proposed by the oil trading arm of Goldman Sachs, who have now passed the proposal to the First Chicago Bank to develop further.

The IPE compromise of trading cargoes through a futures mechanism, combines the benefits of the futures markets with the ability to trade crude oil in cargoes and for the oil companies/traders to have a direct presence in the establishment and use of the market.

Limited trading rights would be available to purchase, providing a cheap efficient trading system for users, combined with the security, guarantee and clearing processes offered by authorised futures exchanges.

Combining the benefit of the futures with the cargo delivery and direct participation of the oil trade should overcome many of the problems of the forward markets, outlined earlier, and should stimulate activity and interest on the contracts from existing market users.

The exact status of the clearing house proposal is not known. However, I understand that the concept is to continue with the trading methods used hitherto in the Brent market. Subsequently, the deals would be registered with the clearing house which would be managed and operated by the First Chicago Bank, but owned by market participants.

The clearing house would operate a system of margins and deposits similar to that of a futures market, and would clear matched contracts, which, like the IPE proposal, would eliminate daisy chains.

On the debit side it would not aid price transparency and would most probably be less effective in anti-trust compliance than a futures markets.

It would definitely need clearance from the regulators, the SIB, and also the EEC commission, and the outcome of their applications, which I believe have already been made, will probably not be known for some time.

This is clearly a less complete change to the markets than would be effected by the IPE proposal, but, paradoxically, could take longer to implement, because of the regulatory and other legal aspects.

It will only be the market participants who can determine what if anything changes. I hope I have clarified for you some of their likely considerations. ●

'Emphasis on margin protection should increase focus on risk'

Walter Greaves, who chaired the afternoon session, expressed the following view:

The forward market in Brent Crude oil has been dissected by Robert Mabro in his recent book, *The Market for North Sea Crude Oil*, but this conference provided the first serious discussion of the role of the other forward markets, which have become so important in the spot trading of products. Nigel Graham gave an admirably precise description of the various forward markets, how they developed and the ways in which they are used in trading.

The forward and futures markets exist because oil companies and independent traders need to protect themselves from the risks of price volatility by hedging. Most of this hedging is intended to protect the relatively narrow margins obtainable from the incremental refining of crude oil and cargo trading. Unfortunately, most academic discussion of the petroleum forward and futures markets fails to recognise the importance of margin protection.

All the important forward markets are based on cargo delivery, with the cargo size that most frequently traded in the spot market. This precludes participation by smaller traders and potential hedgers, such as end-consumers, who are not involved in physical trading in that particular spot market, as well as the non-trade speculators who boost the liquidity in the futures markets.

The Wall Street refiners provide hedging facilities — at a price — to those companies unable to use the forward markets, and those who may not wish to trade US futures for legal, tax or other reasons. David Salomon's 'advertisement' was a good introduction to their commercial activities in selling price protection.

The current set of futures, forward markets, and financial intermediaries (the Wall Street refiners) has grown haphazardly to meet the evolving requirements of an industry learning to hedge its activities at high price volatility. The futures markets were started by existing commodity exchanges, and the forward markets by physical brokers. It is only in the case of the Brent '15 day' forward contract that there has been active leadership by major oil companies (BP and Shell) to modify the contract following the problems experienced in February 1986.

There are good reasons for believing that the current mix of futures and forward contracts is not the most efficient set in terms of the oil industry's hedging needs. There are sound arguments for viable European crude oil and heavy fuel oil futures contracts.

Existing futures and forward contracts are difficult to replace because of the inertia implicit in their continuing high liquidity. The potential hedger of a large cargo will prefer the known basis risks of an existing high liquidity market to the uncertainty of closing a large hedge in a new contract of doubtful liquidity. New contracts need the support of the oil industry but the problems of organising the collective support of those who want the change remain to be resolved.

The current success of OPEC in controlling prices around their $18 target level has significantly reduced price variability. The implied volatility of crude oil option premiums has halved since December 1986 and there has been some reduction in the volumes traded on the futures markets.

The price changes resulting from supply and demand imbalances in both crude oil and product markets are however still high compared with the average margins obtained from crude oil refining and cargo trading. We might therefore expect some reduction in the use of the markets by producers, end-consumers and speculators but a continued high volume of hedging by the increasingly sophisticated protectors of refining and trading margins.

These trends suggest a decline in the volumes traded in the WTI futures and Brent forward markets and a low volume of trading in the Dubai forward market. The emphasis on margin protection should result in an increased focus on the reduction of basis risk in all contracts.

The oil industry still has the problem of deciding what it needs in futures and forward contracts, and how to get what it wants. ●

Evaluating the investment prospects of forecourt automation

By Glen Peters, Price Waterhouse, Management Consultants, London

Over the past few years, petrol retailers have increasingly been looking towards forecourt automation as a means of maximising the utilisation and profitability of their retail sites. Some of the benefits associated with automation are as follows:

- Reduction in financial arrangements with credit card companies
- Speed up of POS activities
- Enhanced sales analysis, giving improved marketing opportunities
- Greater inventory control
- Greater control and accuracy in site accounting and reduction in administrative activities
- Unattended service allowing extension of opening hours and reduction in staff numbers

The Oil Advisory Unit in Price Waterhouse has been studying various areas of forecourt automation, and we have found it convenient to consider the subject in terms of the following three interdependent levels:

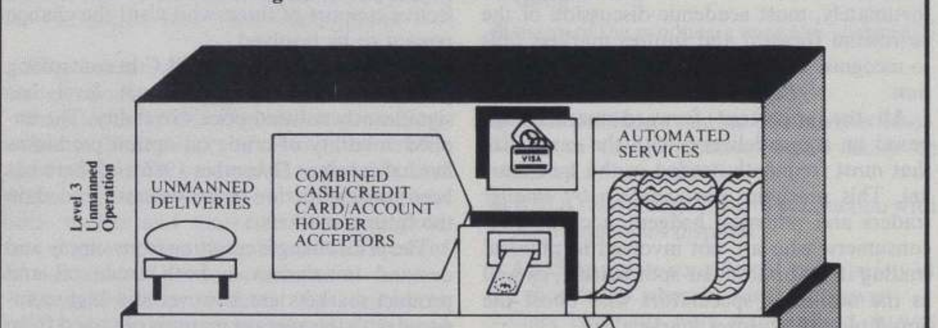
Level 1 — The automation of all credit card transactions by the use of electronic point of sale (EPOS) technology.

Level 2 — The automation of all site accounting, administration and associated management information on sales, stocks, turnover and staff.

Level 3 — Automating all methods of payment and site operations to enable unmanned operation of the retail site.

Automation of credit card transactions can provide the retailers with leverage in seeking more advantageous financial arrangements with credit card companies, who offer some reduction on each transaction. At its most basic level, this form of automation requires a card-swipe reader to capture the data, which is transmitted overnight to a polling service bureau for processing. More sophisticated functions, such as price look-ups, reports and pump controllers are also available in electronic tills with full electronic funds transfer point of sale (EFTPOS) functions.

Figure 1: The three levels of automation



Moving up a level to the automation of site accounting and administration could substantially reduce the level of administrative effort required for book-keeping, stock accounting and other administrative activities. Suitable packages, varying in scope and sophistication, are available to run on back-office micros for a fairly modest outlay. However, to gain maximum advantage from these packages, they would generally require to be linked with modern electronic tills as described above.

Automating all levels of payment and site operations to enable unmanned operation of the site could be achieved by the installation of forecourt card readers with PIN pads and note acceptors, resulting in manpower savings on larger sites and increased volume of sales on smaller sites with limited opening hours. Automation could be extended to dispensers for cans of oil, drinks and other merchandise.

The economics of automation

Before investigating the feasibility of each of our automation levels, let us split sites up into four categories, based on the approximate annual fuel sales volume: see **Figure 2.**

Having defined our different site categories, we can now comment on the viability of each of the three levels of automation for each category.

Level 1 — automating all credit card transactions

Credit card transactions, on average, constitute 40% of forecourt sales. The service charges levied by the credit card companies vary from just under 2 to 2.5% on the fully tax-paid cost of the sale.

In an industry where margins seldom exceed 4% (including all site costs, depreciation etc.) this charge is unwelcome.

Petrol retailers, therefore, are keen to use technology to provide leverage in seeking more advantageous arrangements with the credit card companies. Credit card companies, in turn, offer some reduction on each transaction, but

Figure 2

ANNUAL VOL	APPROX CHARGES BY CREDIT CARD COMPANIES PA
A Vol exceeding 1m gal pa	£25,000
B Between 0.5m and 1m gal pa	£15,000
C Between 0.2m and 0.5m gal pa	£9,000
D Sales vol below 0.2m gal pa	£3,500

how far do they need to go in order to induce some of the smaller sites to invest in this new technology?

The following are the implications for the return on investing in EPOS for each of our four site categories:

1. The installation of an appropriate EPOS till, with card swipe within the kiosk and pump controllers, for a typical five pump configuration is unlikely to be below £10,000. On this basis a Category D site would only return its investment in three years, on the assumption that the credit card companies were prepared to enter into a no-charge agreement over that duration. This is highly unlikely and automation, using EPOS alone, gives rise to considerable doubt as to its economic viability for these lower volume sites.

   Cheaper solutions do exist for very low volume sites, with one supplier offering a stand alone device, not linked to pumps, for under £1,000. These cheaper systems, however, have limitations and may not suit the requirements of all petrol retailers in this category.
2. On Category C sites, payback could be achieved within three years provided there was substantial inducement from the credit card companies to the order of a 35% reduction in the charges currently levied.
3. Both Category A and B sites could comfortably realise their return on investment over the three year period with only moderate support from the credit card companies, with some benefiting from a substantial return on that investment for the higher volume sites.

The above justification is based on the important assumption that communication is achieved via the public switched telephone network (PSTN) and transmitted at infrequent intervals during the normal 24 hour daily operations cycle.

Level 2 — automating the administrative functions on the site

The provision of site accounting systems could, in many cases, substantially reduce the level of administrative effort required for book-keeping, stock accounting and other administrative activities. Estimates of the cost of this activity vary greatly from about a quarter of a man year, (approximately £2,000 pa), to about a full man year (approximately £8,000 pa) on the Category A sites.

A typical package, running on a back-office micro, is likely to cost in the region of £2–3,000 depending on its sophistication and scope of its functions.

For this outlay the smaller sites could benefit from the use of these systems. However, they would generally require to be linked with modern electronic tills used in EPOS systems described above. It is unlikely therefore that Category D sites could afford this investment, whereas its prospects look more attractive to the larger A, B and C Categories where their expenditure on book-keeping activities are higher.

The benefits of better information are usually attributable to the overall management of the network. Better and more up-to-date performance information gives retail brand managers a better understanding of network performance and helps in the optimisation of deliveries and distribution operations. However, little empirical evidence exists because of the relatively few sites which have been automated to provide appreciable control and analysis data.

Making an investment decision, purely on the basis of improved information, must therefore remain purely an act of faith. Alternatively the business may use an automation initiative as an excuse to set performance targets for its own business plans. For example, better site information could permit the use of Just-in-Time replenishment techniques thereby helping to improve wet stocks turnover. The business could make a positive attempt to set a target improvement of say 10% and invariably, given the right attitude, this would be achievable. One would have to put up a very convincing case, however, to attribute this improvement purely to the introduction of new systems.

Level 3 — automation of all methods of payment for unmanned operations

Automation does not end at EPOS and administrative systems. Administration of all methods of payment could enable a site to run unmanned for 24 hours a day, if necessary. In automating payment on the forecourt, it would be imprudent to forget the customers who pay in cash and who account for 60%, on average, of sales.

Combined automatic cash acceptors (a technology revived recently after a poor introduction in the 1970s), together with card readers and PIN number pads, could avoid the cost of up to four shift staff on some of the larger sites.

Estimates for provision of combined cash and credit card acceptors vary quite considerably. Costs for this equipment should fall substantially in the next year and it is likely that equipment, around the £10–15,000 bracket, will be available to meet the requirements of an average five pump configuration site. The benefits of unmanned operation permit even the smallest sites in Category D to consider investment in this new technology. In addition to the savings from unmanned operation, many rural outlets may be able to take advantage of increased sales volume of up to 20% in some cases, as a result of 24 hour opening. As a Sussex motorist recently commented: "I never use my village garage because it is always shut when I want it".

Sites which could avoid staffing costs obviously stand to make significant gains as illustrated in **Figure 3.**

Figure 3

CATEGORY		POTENTIAL MANPOWER REDUCTIONS	BENEFITS PER ANNUM
A	24 hours	up to 4†	32
B	24 hours	up to 2†	16
		up to 2	16
C	Daytime	up to 1	8
D	Daytime	1	8†*

†*Not all staff saved. Always needs site present on high volume sites.*
**Additional benefit of increased sales due to 24 hour opening £2,800,000 pa.*

Incremental costs for complete automation can vary from £5–20,000 depending on the number of cash/card swipe points that are installed. The technology, although readily available on the Continent, has been slow to gain acceptance in the UK. However, the economics show that unmanned operation has benefits in all site categories with a payback frequently under one year.

None of the above discussions have so far covered the prospect of using the forecourt for non-traditional wet stock sales, the introduction of convenience stores, franchising operations, automated services (car wash), and kiosk sales. These all help to increase the turnover of sales volume for a retail outlet. Non-fuel sales where margins are higher, are likely to improve the payback potential of some of the areas of investment referred to in this paper.

Conclusions

Whereas the investment prospects of automation on higher volume sites appear to be attractive, lower volume sites need to approach automation selectively. This modular approach to automation underlines the importance of deciding on an appropriate strategy to ensure uniformity and conformity.

The following factors would significantly affect the investment prospects of automation:

- **a** a future rise in the oil price
- **b** the growth of non-fuel related sales
- **c** the increasing usage of company/debit/credit cards
- **d** greater co-ordination by the independent retailers to enter into joint negotiating arrangements with the credit card companies and suppliers of technology.

The Price Waterhouse Oil Advisory Unit would be pleased to hear from both vendors and users of forecourt automation systems, goods and services to enrich our understanding of the economics of automation.

Planning and implementation

The selection and implementation of a suitable forecourt automation system is a complex and demanding task. It is possible to split up the process into a series of well defined steps:

1 Definition of requirements

In order to build up a clear statement of requirements, a number of diverse factors need to be considered:

- Cost constraints
- Business objectives
- Site turnover and characteristics
- Existing capability and links to central computer systems
- Number of sites to be included

The final document needs to be an achievable and realistic expression of business requirements.

2 Selection of supplier

The process of supplier selection will vary greatly with the complexity of the requirements.

In the simplest case, the retailer is likely to have a number of companies offering very similar solutions to his problems.

The other end of the scale can be quite different. There will have to be discussions with multiple hardware, software and communications suppliers, and in-depth comparison and evaluation will need to be carried out. There may be a need for bespoke software development and integration with existing systems. Selection must be managed effectively as mistakes can be expensive and are likely to have long-term cost and operational consequences.

3 Development

This can range from simply putting together an off-the-shelf package to a systems development project requiring a number of man-years of effort from professional computer staff.

Will the organisation have the expertise or the staff available? Should external resources be used? What alternative development strategies are available? These are some of the questions which might arise during this phase of the project.

4 Pilot trial

A pilot trial is vital for a successful implementation at a later date. The experiences gained from the initial set-up will be invaluable when the time comes for widespread automation.

All the functions of the system should be tested in an operational service station over a period of time. The trial should be carefully monitored both in terms of its functionality and site user ergonomics.

At the end of the trial period, a detailed evaluation may result in changes to the system and a further trial, or a firm acceptance/rejection of the system.

5 Full implementation

This can be a major logistical exercise, whatever the size of the system. Some factors which need to be taken into consideration are:

- Hardware installation and integration
- Software delivery and set-up
- Communications installation

Running costs will be dependent on the scope and complexity of the system.

Communications will be a major factor, with costs affected by transaction volumes, time of day, security/privacy considerations and the hardware/software used.

A variety of third-party services are available and may be provided by the suppliers. It is possible that a private data network may be cost effective.

Communication costs can be limited by effective planning and management.

There are also operational considerations.

- Extend pilot to all sites
- Problem solving procedures
- Liaison with all involved parties

The retailer must not underestimate the importance of ensuring that adequate backup/recovery procedures are established. The level of support available from the supplier must be known and procedures to be implemented in the event of system failure need to be properly planned.

Due to the diverse and complex nature of the operation, careful consideration must be given to agreement and contracts between all parties involved, covering both supply and maintenance commitment.

Summary

We hope that this document has given the reader an insight into some of the issues involved in forecourt automation. Inevitably we have had to generalise in a number of areas, and we would certainly concede that any retailer hoping to automate his site will have to look at the situation in terms of his own specific requirements. Despite this, we have tried to highlight the variety of potential benefits and give some impression of the economics involved.

The section covering planning and implementation is not intended as a step by step guide to successful automation, but merely an indication of some of the considerations and problems likely to be encountered.

To summarise, service station automation is a difficult and challenging area requiring specialist managerial and technical skills. Success can only be achieved by a methodical approach, based on detailed and careful planning. ●

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Foreword by H.J. RAMEY, Jr

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UKPIA statement on the use of plastic tanks for the storage of heating oil and diesel fuel

Abstract

Plastic tanks for the storage of heating oils and diesel fuels are now being manufactured by several companies in sizes up to 5,000 litres capacity. These tanks offer potential advantages to users in that they will not corrode and require minimal maintenance. However, a small number of customers have encountered some operational difficulties with combustion equipment where such tanks have been installed. Research investigations have shown that these problems have been caused by photo-oxidation of the fuel: a light-induced oxidation resulting from the use of translucent plastic materials for the manufacture of the tanks. The UK petroleum industry is therefore advising that only opaque tanks should be used for the storing of petroleum products. There is also concern over the lack of any relevant British Standard for the design, manufacture and safe usage of plastic fuel tanks. Discussions with the tank manufacturers and other parties are now taking place regarding the development of such a standard; in the meantime assurance that a tank is suitable for a particular application should be obtained from the manufacturer.

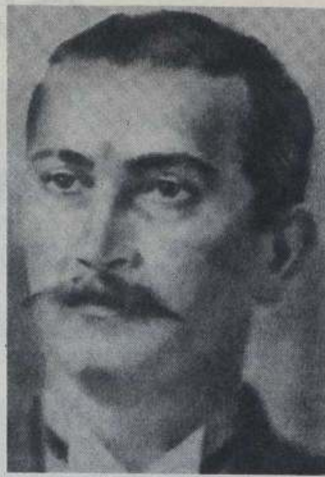
Statement

In recent years, developments in the chemical industry have led to the introduction of fuel storage tanks made out of plastic materials. These tanks offer several advantages to users including less maintenance and no risk of corrosion. They could be particularly suitable for coastal locations where steel tanks are very prone to corrosion. However, a small number of users who have installed plastic tanks have noted deposit formation and discoloration of the fuel, excessive filter deposits and problems with their combustion equipment. As these tanks are relatively new to the UK market, and also because there is no British

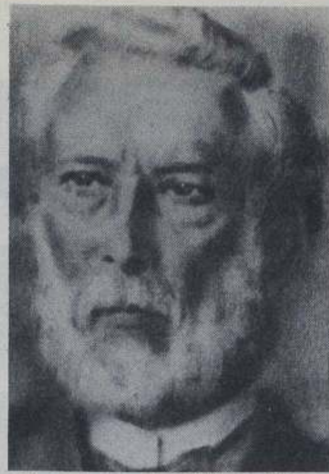
Continued on page 64

José Gregorio Villalañe Jr.

Carlos González Bona.



Pedro Rafael Rincones.



Manuel Antonio Pulido Pulido.

Journey from Petrolia

In 1878, six Venezuelans began drilling for oil. They were the pioneers of Venezuela's petroleum industry. Their struggle is told in a new book *'The Journey From Petrolia'* by Anibal R Martinez.

Most national petroleum companies have beginnings as humble as those of Petroleos de Venezuela — the state owned petroleum company that is an indirect descendant of that first company, Petrolia, which the six pioneers founded. The history of Petrolia was first chronicled by Dr Martinez in 1979 and published in Spanish under the title *'El Camino de Petrolia.'* In 1985, this work was translated into English to commemorate the tenth anniversary of Petroleos de Venezuela's corporate existence, entitled *'The Journey From Petrolia'*.

In his preface to the new book, the President of Petroles de Venezuela, Brigido R Natera, says: 'The history of our petroleum industry really begins with a remarkable, all-Venezuelan company called Petrolia. This was founded by a group of enterprising Venezuelans back in 1878, near Rubio, a town in the Andean state of Tachira. The company's objective was to carry out exploration and production activities and to exploit the oil deposits whose presence had been revealed by an earthquake in the region in 1875.'

The field in which the six partners drilled was named La Alquitrana, and according to Dr Martinez it was 'located in a totally unfavourable position within the sedimentary basin that comprises it, almost outside its limits. So it was that the fate of the operations had been predetermined from the first moment, due to the modest size and nature of the accumulation.

'The history begins September 3 1878, with the granting of a concession named Cien Minas de Asfalto (One Hundred Asphalt Mines) to Manuel Antonio Pulido Pulido by the President of the administrative branch of the Government of the Sovereign State of Tachira, to permit work in the zone of petroleum seeps that had been very active since the devastating earthquake in Cucuta in 1875. A month and a half late, very appropriately on El Dia de La Raza (Colombus Day), a company was established that would fulfill all the tasks pertaining to an integrated petroleum company.'

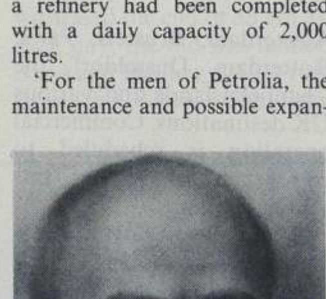
From that day up until 1911, lack of technology, labour and experience meant that work on the field was slow and arduous. However, by 1882, not only had the first well been abandoned, but a refinery had been completed with a daily capacity of 2,000 litres.

'For the men of Petrolia, the maintenance and possible expansion of their operations continued to be the fundamental objective. New opportunities and clients were hunted tirelessly.'

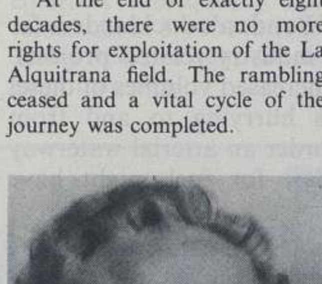
However, in 1911 the last of the founding group of Petrolia died, and the heirs of the partners bought in new contractors to run the business. From then until 1927 the fortunes of Petrolia changed for the better, indeed in 1919 the shareholders were paid their first dividend of 28 bolivars per share.

Fortunes changed when a US contractor was drafted in 1928 to add his experience to the company on the understanding that he could increase production. Unfortunately he did not, and consequentially when the concession on La Alquitrana field expired on April 8 1934, it was not renewed by the Government despite numerous petitions by the descendants of the six partners.

'At the end of exactly eight decades, there were no more rights for exploitation of the La Alquitrana field. The rambling ceased and a vital cycle of the journey was completed.



Ramón María Maldonado.



José Antonio Baldó.

'On September 3 1978, the second century of the national hydrocarbon industry began. It is the passing of 100 years of the exploitation of the God-given wealth of our subsoil, 60 of commercial production on a grand scale, and two and a half of national operations.

'Dependence on oil has increased. It would be incorrect to suppose that oil in Venezuela is only 58% of the national income, which is the figure used. In fact petroleum is the very foundation of the country's life in every place, at every level, in all activities. It is the beginning and the end. To believe in an independence that does not exist is dangerous. Courageously, let us recognise that more and more the exchange of the hydrocarbons for money is what makes the unusual situation work.

'The challenge of the second century is liberation.

'The spirit of the humble, simple pioneers who began the Venezuelan petroleum industry with Petrolia was one of struggle and determination. The lesson they left to us is one of work and discipline. The road they pointed to us requires great brave action, high moral standards and a clear understanding of the authentic national sense and faith.

'Something to reflect on, a spirit, lessons, when Venezuela is in the second century of a journey from petroleum.' ●

Robert J Hawkins

'The Journey From Petrolia' by Anibal R Martinez is available from: Edreca, Apartado 57 423 Caracas 1050-A, Venezuela, for US $25.00, £18.00 per copy, including handling and airmail postage.

Oil seeps into London's docklands

A De Havilland Dash 7 making its final approach into the London City Airport which is scheduled to commence commercial operations in October. The Dash 7, a short take-off and landing aeroplane, will be in service with both airlines operating at London City. This artist's impression provides a unique contrast with docklands as it once was.

The massive redevelopment of London's docklands is far from being a magnet for oil industry related projects. New bitumen roads carrying increased volumes of diesel and petrol powered vehicles hurrying to and from Thameside locations which border an arterial waterway where a flotilla of ships thirst for fuel might have appeared likely.

But in fact, docklands redevelopment and the petroleum business are mixing like oil and water.

BP's fuelling of Stolport, the short take-off and landing London City Airport is the nearest oil companies have come so far to large-scale presence in the area.

Even there, BP are cautious. The fuel farm will initially consist of three 40 × 9ft tanks (a configuration adapted to handle two full tanker loads). Staffing levels will start off with three senior airfield operators and a supervisor. They will report to Bob Simpson, BP's manager at Gatwick who will take on board the responsibility for both airports.

London City is designed to use the De Havilland Dash 7 aircraft exclusively. With a range of 400 miles and the ability to make a final approach at an angle of 7.5 degrees instead of the normal jet's 3.5, the Dash 7 will go into service with Brymon and Eurocity airlines. These two carriers will offer services to Amsterdam, Brussels, Paris, Rotterdam, Dusseldorf, the Channel Islands and various UK destinations. Commercial operation is scheduled to commence in October this year.

While the airport is proceeding to time-plan, BP are several months behind with their site and will offer temporary alternative arrangements during the early stages to fuel London City services.

Site problems

'The problem was with the site we were allotted,' said Colin Hallett, manager of the aviation operations branch at Air BP International. 'We found a lot of toxic waste substances from an old paint plant and even part of an underground railway when we went in. This meant excavating far deeper and installing a special membrane. A lot more groundwork had to be done than was originally envisaged,' said Mr Hallett.

Some oil companies were sceptical about the new airport's chances of proving a winner. However, there was 'intense competition' between the eight or nine who eventually submitted tenders.

Three vehicles have been refurbished to cope with the smaller loads required: two small rigid Bedfords and a short articulated tanker.

BP, whose initial investment is just over half a million pounds, views this project as having tremendous growth potential. The company already has another site tailor-made for an additional

4,000-tonne vertical tank as soon as demand warrants its installation.

Big business

With London City Airport revving up for an autumn take-off, docklands is no longer a drawing board dream; it is a tangible big business. Yet the vast majority of oil companies report no direct involvement, current or planned, in the area.

Esso are revamping a forecourt site at Poplar to cope with increased traffic caused by property development. Texaco has plans (but no rigid time frame) for a filling station in Queen Katherine's Dock which will be known as the Highway Service Station.

Two Dash 7 aircraft on the apron at London City Airport *photo courtesy of Mowlem*

It is only in a very roundabout way that the oil industry plays a part in another docklands-related project. This is the building of pollution control vessels by Blackwall Engineering of Poplar.

They constructed a prototype called the Goblin for a designer client who later went into liquidation. Having funded all of the £160,000 outlay themselves apart from a £50,000 grant from the Department of Energy, Blackwall are now pressing to market the project through Seahorse International Ltd.

The prototype, which was launched at Millwall Docks on the Isle of Dogs by HRH Prince Philip in December 1984, consists of a catamaran format with two rotating steel drums between the twin hulls which pick up pollutants not only on the surface but beneath it as well.

While the prototype is small and intended for river work only, Blackwall Chief Executive Brian Masterson said there is no reason why the concept cannot be custom-made to operate in coastal waters and, with a mother ship to offload the collected waste, in the open ocean.

Historic

Blackwall Engineering's headquarters occupies an historic part of dockland. Company staff have literally witnessed the end of an era as, each day, the old was demolished and the new swiftly rose from the debris. The firm, which has a large manufacturing plant in Middlesborough, employing about 80 men, has a London workforce of just 46. Skilled welders abound in the capital area and this is one reason Mr Masterson is anxious to resist being pushed out of such a prime site to make room for lucrative property development.

The other advantages are being at the hub of UK communications and in direct contact with local design companies.

Blackwall Engineering relied on the oil industry for as much as 60% of its business as recently as 1982. Oil-related contracts subsequently bottomed out at 5–10% in 1985. Today they account for no more than 30%.

With deepwater on the threshold, the site was ideal for the construction of North Sea platforms and the company has built ballasting systems for 25 since 1975. The firm has done work for giants like Esso, Shell, Mobil and Occidental. But the changing face of London's docklands has undermined Blackwall's waterside advantage insofar as the petroleum industry is concerned.

It is somewhat ironic that Blackwall Engineering's main hope for increased oil industry business now rests with the pollution its products occasionally cause. ●

Jim Berry

The Goblin pollution control vessel built by Blackwall Engineering afloat on the Thames with HRH Prince Philip at the helm.

Effective use of manpower vital to industrial future

It is now time to build a new industrial future for Britain based on highly trained personnel producing top quality products, according to Bob Reid, Chairman and Chief Executive of Shell UK Limited.

Mr Reid, who recently became Chairman of a new tripartite Council set up to improve the quality of management education in Britain, also chairs the Foundation for Management Education.

The new Council, made up of representatives from industry, universities and the Government, has set out to launch and gain wide acceptance for a Development Charter.

Such a Charter would outline a code of practice in management development, making specific commitments to prepare and communicate individual training and development plans. It would also reimburse tuition expenses for approved self-education programmes. Companies subscribing to the Charter would help disseminate good management practices through their own commercial links with suppliers and contractors.

Addressing the London Chamber of Commerce recently, Mr Reid pointed out that, after the war, Britain had found it difficult to re-adjust to peace-time preeminence.

'But slowly and surely it has got home to the British people that the national imperatives have changed,' said Mr Reid. 'Productivity is the key to overcoming international competition. Productivity comes from applying minimum resources to gain maximum production. Achieving the reduction in applied manpower resources has been a violent battleground, made worse by quantum leaps in technology and leaving the human resource as the most feared blockage to economic progress. Britain, starting in 1945 from victory as opposed to building out of defeat, should have had a physical advantage. In Japan and Germany, starting again and working together to create wealth had been an immediate imperative in the post-war world. The balance of power and wealth had changed.

By the late seventies the gap was too well defined to be ignored. Highlighted by the ravages of a second oil crisis in the early eighties, the need for radical change was clear to all those involved. The stark threat of losing whole industries gave industrial leadership a second chance.

'I believe that this change is being taken by all involved and that a process of change is under way in our society,' said Mr Reid. 'The primary problems of minimising the manpower resource involved in production, and ensuring that the resource is utilised in the most effective and flexible way, are now being resolved.

'It is important that this is not seen in terms of victory and defeat. Change has common ownership. It can inspire violent reaction — as when horses took over from men in pulling canal boats at Ironbridge and spinning jennies emptied the factories in Lancashire — but in the end it is inevitable.

'What is exciting is that as the improvements are achieved, the intelligent factor of production emerges again as an asset, not only because of its skills and its thinking capability but also because it is able to contribute to the enterprise. It is able to create wealth by its ingenuity and ability to see and seize opportunities.

'The huge workforces of the past have begun to disappear and will not return. With them go their structured, inflexible payment systems. The employer no longer looks and pays for the discharge of carefully prescribed duties. He sets out to reward contribution, to pay for talent and initiative and to put a premium on performance. As this happens the process does not stand still — the contribution grows and the rewards with it. The individual becomes a key player and his training, preparation and development a matter of primary national importance.'

Mr Reid added: 'What we have to recognise is that for too long now too many of our best minds have operated in private professions, where individual brilliance cannot be substituted, but where organisational skill and motivational talent is irrelevant. In industry today, professionalism is the international order and we must follow our competition by preparing our managers in quantity, in depth and in quality. This will not be an easy task and it will not show quick results but in the end it is the foundation on which greatness is built.

'It is not enough for all the usual names to be associated — the ICIs, the Shells, the Fords. What is critical is that the small companies in the UK must see the merit of harnessing the human resource and realising its full potential.' ●

Field managers' survival training

A new training course for onshore senior geophysical field managers has been specially created to meet their needs in survival situations where self-reliance takes on a whole new meaning.

The first such programme was drawn up to address real problems which have been encountered in the past, sometimes with tragic consequences.

For instance, how should a field manager organise a search and rescue in desert terrain when a vehicle crew is long overdue and radio contact has been lost?

How does an ex-patriot successfully communicate with 700 local labourers in an African hinterland who are on strike due to an unwitting infringement of a local custom?

Is there a difference between heat exhaustion and heat stroke? If there is, is the treatment the same for both?

These situations need instant answers with little possibility of a second chance if the first attempt fails. Therefore, the Petroleum Training Federation (PTF), in conjunction with the International Association of Geophysical Contractors (Europe and Middle East), set up a training programme to help provide a solution.

The first seven days were tutored by the School of Survival from Hereford, run by John Wiseman and Paul Brown. They have developed a unique range of expertise highly pertinent to the needs of geophysical field operations.

Paul Brown is a paramedic trainer and practitioner. John Wiseman is a recognised authority on survival training, having recently published a book on survival, now available in five languages, and prepared television programmes for the BBC.

He took the delegates through the theory of survival and how to survive in all climates and conditions. This was interspersed with practical field craft in the training area, drawing on his vast knowledge.

Both John and Paul showed delegates how to improvise and apply survival medical techniques in circumstances when conventional equipment was not available. They also took delegates through basic watermanship using small boats on inland and coastal waters, and a river crossing without boats, emphasising always the safe management of these situations. Their final inputs were concerned with radio communication and the management of helicopters in jungle, desert or arctic environments.

Delegates also experienced a day of fire fighting at the PTF fireground in Maresfield where particular attention was paid to fire prevention and the techniques to be employed when conventional fire fighting resources are in short supply.

The rest of the programme was devoted to various aspects of on-shore seismic management, energy sources, training for safety and presentation skills. Each topic was tutored by an experienced lecturer from the industry.

Field trials have been very successful and the course has since been retuned more precisely to the needs of seismic operations. Programmes have clearly defined objectives and standards, for tutors and delegates, and are acknowledged to be achieving their prime aim of improving the performance of managers in the field.

Although a British initiative, support has been international as delegates have come from Germany, Holland, and the US. PTF and IAGC member companies have helped by providing equipment and other resources so that the courses meet the high standards of training demanded by exacting environments where good safety practice and management is of the essence. ●

Self development schemes grow

By Jim Roxborough, Director of the Foundation for Management Education and member of the Institute's Education and Training Committee.

A recent report which surveyed management development in Japan, West Germany, France, the USA and Britain, comments that self development is a constant theme within all these countries — for managers throughout their careers in industry. It may go under slightly different names such as self enlightenment (Japan) or self education (USA) but in essence it has much the same meaning. Associated with self development is the perception that continuing education is an investment in the future and there are identifiable moves in all these societies towards managers acquiring credentials. This renewed emphasis on self development is based on the recognition that nobody is better placed to assess personal strengths than the individual.

We do not need to look very far in industry or business to see examples of the high achievers who did it their way; by taking a large measure of control for their own development and making full use of the opportunities which came their way.

Inevitably external factors will have a part to play in self development. Opportunism is an important element, but there also need to be mechanisms for growth. This may be a mentor, but something more is needed. There is an appropriate American slogan: 'Individual initiative and corporate support.' This support should include programmes of training and education, both within and outside of the working environment. In these circumstances the individual is encouraged to become largely responsible for his or her own learning and development, to take on responsibility earlier, experiment is endorsed and failure (providing it doesn't become the norm) is forgiven, in recognition of wider development and achievement.

Regrettably in the UK many programmes of management education have taken insufficient notice of the work-a-day world. Not many managers can afford one or two years away from work to take a Masters qualification and there are still too few who are dedicated enough to be able to set aside two or three years to attend part-time programmes to achieve a similar result.

There is now hope that the next few years will witness very considerable additions to the provision of management education — in type and content and in the way in which it is taught. The aim must be to make highly flexible programmes available to most practising managers within (let's say) no more than 30 miles of their places of work. ●

John North (second from left), top student on the Postgraduate Diploma course in Offshore Engineering at Robert Gordon's Institute of Technology, Aberdeen in the 1986/87 session and Bryan Moseley (third from left), the most outstanding student on the MSc course in Petroleum Geology at the University of Aberdeen in the 1985/86 session, were recently presented with IP Student Prizes. Also in the photograph are Bill Adams (left), the retiring Chairman of the Institute's Aberdeen local branch, and Professor Alex Kemp, Professor of Economics at Aberdeen University and Director of Aberdeen University Petroleum and Economic Consultants (speaker at the meeting).

Diary dates

New Technology in Training Conference at Novotel Exhibition Centre, London. 10th to 12th November 1987. Details of this MSC sponsored event from Conference Co-ordinator, Queensdale Exhibitions and Conferences Ltd, Blenheim House, 137 Blenheim Crescent, London W11 2EQ.

Publications

The Making of British Managers. Sweeping changes are needed in the British management training system to provide up to 40,000 extra business qualifications a year. Report available from BIM, Management House, Parker Street, London WC2B 5PT.

The Making of Managers: Management Education, Training and Development in Five Countries. British management education effort compares unfavourably with that of the United States, Japan, France and West Germany. Report available from NEDO Books, Millbank Towers, Millbank, London SW1P 4QX.

Paying for Training. A comprehensive guide to sources of finance for adult training for employers, training providers, business and education advisers. Publications available from the Manpower Services Commission, Moorfoot, Sheffield S1 4PQ.

The National Council for Vocational Qualifications. Its Purposes and Aims. Three booklets available from NCVQ, 222 Euston Road, London NW1 2BZ.

Video available

A copy of the careers video *The Oil Business*, which was reviewed in the February 1987 edition of *Petroleum Review* (page 46), is now available from the Institute on free loan to members. This VHS video, which members may wish to use at schools' careers evenings, has a running time of 20 minutes. The free loan period is one week and as much notice as possible should be given when ordering the video from the Institute's Information Department. (Tel: 01-636 1004.)

The changing market for petroleum additives

By Dr Ray B Dawson, European Marketing Manager, Ethyl Petroleum Additives, Bracknell, Berkshire

With the introduction of new premium grades of gasoline and diesel fuels across Europe, the question of fuel quality is once more the focus of attention for the fuel marketer and a subject of increasing interest to the motorist.

Ethyl Corporation, the parent company of Ethyl Petroleum Additives, recently celebrated its centennial.

Maintenance of consistent, good fuel quality is of major importance to the engine manufacturer. Both for gasoline and diesel engines the OEM (Original Equipment Manufacturer) is striving to produce more power from smaller units to improve fuel efficiency. At the same time, impending legislation will define limits for the emissions from the vehicle exhaust into the environment. In order to design his engine in the best way to meet these various demands, the engineer needs to be sure of the continued availability of good quality fuel. The proper use of petroleum additives helps achieve this target.

In order to control vehicle emissions from a modern gasoline engine, fuel injector systems will replace the carburettor found on most of today's vehicles, it allows more precise control of the quantity of fuel mixed with the air which is the key to controlling exhaust emissions. If the injectors become blocked, fuel delivery becomes impeded and control of the air to fuel ratio is lost and the driver is also likely to experience rough idling and poor acceleration.

Fortunately, the addition of detergent additive systems can keep injectors clean and ensure continued good performance. If an injector should become partly blocked through use of a poor fuel, then treatments present in a fuel, such as Ethyl's HiTEC 4400 range, can restore the injectors to full working order before it is time to fill up again.

Fuel quality is also the key to the efficiency of the diesel engine. Proper treatment of the fuel with a balanced petroleum additive package will ensure the fuel has necessary consistent performance in terms of ignition quality, cold flow properties and keeping the fuel system clean.

Petroleum additives have played a major role in automotive lubricants for many years, improving the wear protection afforded by the lubricant. Thus, the drain interval for engine oils has been increased significantly as additive technology has improved. Petroleum additives also improve the viscosity characteristics of a lubricant, effectively reducing the variation of viscosity with temperature. This has led to the development of multigrade oils which possess both summer and winter characteristics.

The position is not static. As the automobile engineer has developed engine and transmission technology, so the demands on the lubricant have changed, presenting both a challenge and an opportunity to the petrol additive technologist.

The introduction of turbochargers means that as well as increased power, sump sizes have tended to reduce to save weight, venting systems have been redesigned to help reduce emissions and the net result is that a lubricant is having to function in a tougher environment.

The diesel engine is also developing. The power developed per unit capacity has increased significantly as weight reductions have been sought to improve fuel economy and increase payload. This has led to the development of 'super high performance diesel' engine lubricants.

As technology has developed, it has become possible to marry performance characteristics of different working fluids into a single fluid. Perhaps the best example of this is given by universal oils used in agricultural tractors. These are sometimes known as STOUs (Super Tractor Oil Universal).

Benefits to the end user are simplicity and the removal of potential filling errors (a diesel engine lubricated by a hydraulic fluid is soon an expensive liability!). Versatility without compromising quality is the result of the application of advanced additive technology found in products such as Ethyl's STOU lubricant additive pack.

As operating conditions change, as demands from engines and transmission systems become more severe, and as environmental constraints tighten, then companies such as Ethyl Petroleum Additives have the ability to provide the right solutions to many of the industry's problems.

These improvements are achieved through the use of chemical additives — materials often used at very low concentrations but which can have a big impact on product quality.

Their benefit is not only found in fuels. The properties of almost every product coming from a refinery can be enhanced by the proper use of petroleum additives, and additives act as process aids in the refinery enabling units to run in a flexible and economic manner.

Because petroleum additives are generally used at low concentrations, there is limited appreciation of why they were developed. Figures from the Technical Committee of Petroleum Additive Manufacturers in Europe state that $100m per year is spent on the research and development of additives in Europe.

But what are the driving forces for the changing and increased use of petroleum additives?

Market demand is not met by the natural split of the barrel and this imbalance is likely to grow, placing increased pressure on refinery processes. The use of petroleum additives can help the refinery increase its flexibility and capability and minimise heavy capital investment.

For example, in order to meet demand, it will become more necessary to upgrade light cycle oils from the cracking units for use in the middle distillate pool rather than seeing them used in heavier fuel applications. However, such products need stabilisation or else there can be unacceptable colour degradation and sediment formation. Stability can be conventionally improved by plant processes. But to take this processing route can prove very much more expensive than the proper use of a well balanced petroleum package.

Such stabiliser systems were recently introduced by Ethyl Petroleum Additives Limited as part of its $HiTEC_R$ range of performance chemicals. The use of such a package can save a typical refinery as much as $5 million a year.

These latest generation stabiliser systems are not a single chemical but carefully balanced formulations of differing chemical species. Indeed, it is possible for a stabiliser system to be custom formulated for an individual refinery thus ensuring optimum performance.

A Ford tractor is used at Ethyl's R and D facility in Bracknell to evaluate the performance of a tractor lubricant containing an additive package

The Pipeline Industries Guild (PIG) announced recently the appointment of **Arthur Reed** as secretary and technical officer.

Richard Connor was recently appointed by Alpha Offshore as its general manager.

Hunting Oilfield Services recently promoted **Ed Lorimer**, above, from technical director to managing director. Mr Lorimer was previously engineering director with the Oilfab Group.

Following the recent decision to relocate Solus Schall's corporate headquarters to Aberdeen three new appointments were made: **Steve Ginns** to general manager with responsibility for Project and Contract Management, Vendor Inspection and Marketing and the expansion of the Cathodic Protection Department. **Tony Young** to safety manager. Mr Young is also a licentiate member of the British Institute of Non-Destructive Testing and a RoSPA safety inspector. **Ken Cruickshank** to projects/contracts manager, controlling Yemen, Turkey, India and Angola projects.

The Board of British Petroleum plc recently announced the appointment of **Sir Robin Nicholson** as a director with effect from 1 October 1987, following the retirement of **Sir James Menter** from the Board on 30 September 1987.

C Richard Clark has been elected a vice-president of Production Operators Inc, and vice-president and general manager of its oil and gas producing subsidiary, Kamlok Inc. Prior to joining Production Operators, Mr Clark was division production manager of Williams Exploration Company.

Max van der Schalk, above, has been appointed technical director and deputy managing director of Shell UK Exploration and Production, succeeding **George Innes** who becomes managing director of Shell companies in Brunei. Mr van der Schalk was previously managing director of the Shell upstream companies in Malaysia. he joined Shell in 1962 and has also worked in Libya, Brunei, Oman and Spain.

BP Detergents announced recently the appointment of four new sales managers. **Robert Semple** will cover Scotland and the North of England. **Grahame Cook** is responsible for the Midlands. **Mike Gouger** takes over the South West and **Mike Taylor** will head the South East sales force.

Joseph F Snape has been appointed president of Occidental Petroleum (Caledonia) Ltd. He will assume responsibility for all aspects of the company's oil and gas activities in the UK. Mr Snape joined Occidental in 1975 as chief reservoir engineer, and in 1981 was appointed general manager of Occidental's North Sea Operations.

Captain Mike Garnett has been invited to join the board of directors of OMI Ltd., as a non executive director upon his retirement from the International Tanker Owners Pollution Federation. Captain Garnett has attended most of the major oil spills on behalf of tanker owners and their insurers in the past 14 years including the Amoco Cadiz in 1978.

The Supervisory Board of MWM, Motoren-Werke Mannheim AG, has appointed **Dr Volker Oberkampf** a full member of the Board of Management to head Commercial Administration. **Werner Kirchgasser** was appointed chairman of the MWM Board, effective August 1.

Texas Eastern Corporation recently announced the appointment of **J D Cody** executive vice-president, to the position of chairman and chief executive of Texas Eastern Gas Pipeline Company.

J Groenendijk has been appointed president of Smit International, effective 1 October, following the retirement from the position of **Rom W Scheffer**.

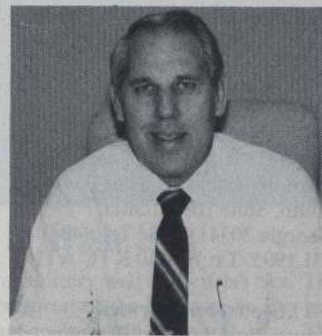
Conoco has announced the transfer to Houston of **Jefferey H Tetlow**, above. Since 1984, Mr Tetlow has been manager of Conoco's UK onshore production division. In his new position, he will be responsible for co-ordinating operational and engineering activities for Conoco Norway.

The Secretary of State for Energy, the Rt Hon Cecil Parkinson MP, has decided that the allocation of Ministerial duties in the Department will be as follows: **The Rt Hon Peter Morrison MP**, Minister of State, will have special responsibility for oil, gas, the offshore supplies industry and energy efficiency; **Mr Michael Spicer MP**, Parliamentary Under Secretary of State, will have special responsibility for coal, electricity, nuclear power and renewable sources of energy.

Terence Chappell has been appointed managing director (designate) of Costain Petrocarbon's nuclear engineering division. Mr Chappell will succeed Philip Hoare, the present managing director on his retirement in 1988.

Richard Barry, presently director, Engineering and Operations for LASMO, has been appointed president and general manager of Hubday Oil (Malacca Strait) Ltd, the joint LASMO/BP oil company in Indonesia.

Dean F Proctor, below, has been named district manager, North Sea Sun Oil Company, Aberdeen District. He replaces **RL George** who has been appointed vice president Sun Exploration and Production International Division.



Nixdorf Computer Ltd has appointed **Chris Isaac** as manager of its oil industry department, part of the Major Accounts and Government Division.

The Board of Robertson Research plc., have announced the appointment of **K Barry Smale-Adams** and **Laurence Gould** as non-executive directors.

The Foster Garton Division of Furmanite Engineering Ltd has appointed a new managing director, **Norman Opie**, as part of it's reorganisation plans.

RS Clare & Co Ltd have announced the following board changes: **Michael P Ridley** has been appointed chairman of both the parent company and a contracting subsidiary Wilson & Scott (Highways) Ltd; **Neville L Biddle** joins the board.

Treasure Petroleum Services Ltd have announced the appointment of **Alastair Lindsay**, below, as acting managing director.

10 August–18 September Edinburgh
A series of five day courses in Petroleum Engineering. *Details:* Heriot-Watt University, Riccarton, Edinburgh EH14 4AS. Tel: 031 449 5111. Tx: 727918.

2–4 September Montreux
1987 ASME COGEN-TURBO. International Symposium and Exposition on Turbo machinery, Combined-Cycle Technologies and Cogeneration. *Details:* 1987 ASME COGEN-TURBO EXPOSITION, ASME International Gas Turbine Institute, 4250 Perimeter Park South, Suite 108 Atlanta, Georgia 30341 USA. Tel: (404) 451 1905. Tx: 707340 KTC ATL.

6–11 September Warwick
Course on Advanced Planning For an Emergency. *Details:* Petroleum Training Federation, Room 326, 162/168 Regent Street, London, W1R 5TB. Tel: 01 439 2632.

8 September Geneva, 9 September Zurich
New York Mercantile Exchange European Seminars on Energy Options. *Details:* NYMEX Information Bureau, c/o Christopher Morgan and Partners, 15 John Adam Street, London WC2N 6LU. Tel: 01 930 7642/1900.

8–11 September Aberdeen
Offshore Europe '87. The biennial offshore and gas exhibition and conference. *Details:* Spearhead Exhibitions Ltd., Rowe House, 55/59 Fife Road, Kingston upon Thames, Surrey KT1 1TA. Tel: 01 549 5831. Tx: 888870.

8–12 September Geneva
International Exhibition of Energy. A five day display of products and services on an international scale. *Details:* Andrew Gillanders, ADG Exhibitions, 11 Lynton Road, Chesham, Bucks. HP5 2BU. Tel: 0494 775444. Tx: 837784.

14–17 September London
Conference on Mobile Offshore Structures. *Details:* Ocean Engineering Centre, City University, Northampton Square, London EC1V 0HB. Tel: 01 253 4399, ext. 3640. Tx: 263896.

15–16 September London
Exergy Analysis and Its Applications. *Details:* Dr TJ Kotas, Exergy Course Director, Department of Mechanical Engineering, Queen Mary College, Mile End Road, London E1 4NS. Tel: 01 980 4811 ext. 4261.

21–25 September Oxford
Short course on Creative International Trading in Crude Oil and Petroleum Products. *Details:* The College of Petroleum Studies, Administrative Offices, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD. Tel: 0865 250521. Tx: 838950 COLPET-G.

21–23 September London
Seventh International conference on the Internal and External Protection of Pipes. *Details:* The Conference Organiser, Pipe Protection, BHRA, The Fluid Engineering Centre, Cranfield, Bedford MK43 0AJ. Tel: 0234 750422. Tx: 825059.

22–23 September London
International Conference on Industrial Flow Measurement, Onshore and Offshore. *Details:* Suzanne Mayhew, IBC Technical Services Ltd, Bath House (Floor 3), 56 Holborn Viaduct, London EC1A 2EX. Tel: 01 236 4080.

28–30 September Bath
Porosity in Carbon Materials — Measurement and Applications. *Details:* The Meetings Office, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX. Tel: 01 235 6111. Tx: 918453 instp g.

28–29 September Glasgow
Third International Symposium on Integrity of Offshore Structures. *Details:* Atilla Incecik, Department of Naval Architecture and Ocean Engineering, The University, Glasgow G12 8QQ. Tel: 041 339 8855. Tx: 777070 UNIGLA.

28 September–1 October Leeds
Course on Safety Aspects of Fire and Explosion Fundamentals. *Details:* Director of Continuing Education, The University, Leeds LS2 9JT. Tel: (0532) 435036.

28 September–9 October Chicago
Course on Base Load LNG. *Details:* Institute of Gas Technology, 3424 South State Street, Chicago, Illinois 60616-3896. Tel: 312/567-3881. Tx: 25 6189.

1–2 October Dallas
Conference on Exploration in the decade ahead: worldwide opportunity. *Details:* Dr Jim Brooks, 10 Langside Drive, Newlands, Glasgow G43 2EE. Tel: 041 632 3068. Or telephone Eric King 01 930 6613.

6 October Norway
Symposium on Subsea Separation and Transport. *Details:* Ketill Borge-Ask, The Norwegian Society of Chartered Engineers, Ingeniorenes Hus, Kronprinses Gate 17, Oslo 2, Norway. Tel: 02 41 87 35.

22–23 October London
8th Annual Oil and Money Conference. *Details:* Susan Lubomirski, Conference Director, International Herald Tribune, 63 Long Acre, London WC2E 9JH. Tel: 01 836 4802. Tx: 262009.

25–30 October Moreton-in-Marsh
Handling Emergencies in the Oil Industry. *Details:* Petroleum Training Federation, Room 326, 162–168 Regent Street, London W1R 5TB. Tel: 01 439 2632.

27–30 October Venice
International Conference on Pollution of the Marine Environment. *Details:* Janet Clover, Conference Associates ACOPS, 27A Medway Street, London SW1P 2BD. Tel: 01 222 9493. Tx: 934346 CONFAS G.

27–29 October Hamburg
Fourth European Symposium on Enhanced Oil Recovery. *Details:* Dr Manfred Albertsen, c/o DGMK, Steinstrasse 7, D-2000 Hamburg 1. Tel: 040 32 64 79. Tx: 211 446 dgmk d.

27–30 October Edinburgh
Institution of Electronic and Radio Engineers to hold a conference on Offshore Search and Rescue Communications and Marine Safety. *Details:* The Conference Secretariat, Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ. Tel: 01 388 3071.

10–12 November Aberdeen
Subtech '87 — a conference on sub sea technology. *Details:* Bob Munton, Spearhead Group, Rowe House, 55/59 Fife Road, Kingston upon Thames, Surrey KT1 1TA. Tel: 01 549 5831. Tx: 928042 SPEARS G.

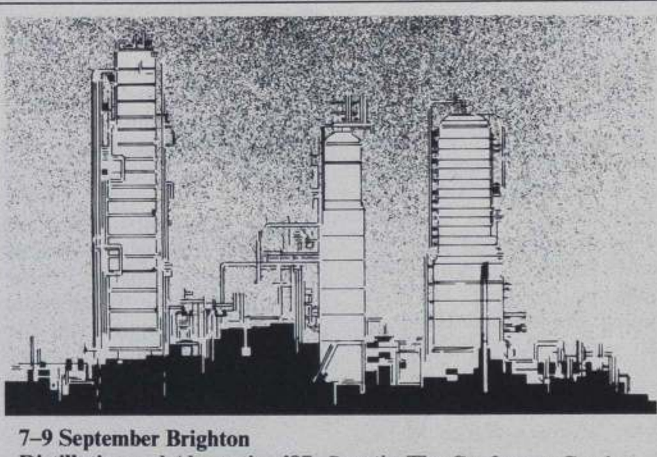
15–20 November Moreton-in-Marsh
Planning for Emergencies. *Details:* Petroleum Training Federation, Room 326, 162-168 Regent Street, London W1R 5TB. Tel: 01 439 2632.

17–19 November London
Second international Conference on Developments in Automated and Robotic Welding. *Details:* The Welding Institute, Abington Hall, Abington, Cambridge CB1 6AL. Tel: 0223 891162. Tx: 81183.

25–26 November Rotterdam
First Rotterdam Oil Symposium. *Details:* Conference Office, Nederlandse Vereniging van ondernemingen in de Energie branche (NVE), PO Box 29822, 2502 The Hague, The Netherlands. Tel: (0)70 546811. Tx: 31440 vng nl.

8–11 December Birmingham
Autotech '87 — automotive exhibition and congress. *Details:* Richard Bull, Press Officer. Tel: 021 780 4171, ext 710.

10 December London
4th Annual Symposium on Microprocessor-Based Protection Systems. *Details:* Rosamund da Gama, Manager Conference Division, The Institute of Measurement and Control, 87 Gower Street, London WC1E 6AA. Tel: 01 387 4949.



7–9 September Brighton
Distillation and Absorption '87. ***Details:*** **The Conference Section, The Institution of Chemical Engineers, 165–171 Railway Terrace, Rugby, Warwickshire CV21 3HQ. Tel: 0788 78214. Tx: 311780.**

BP statistical review

BP's recently published 1987 *Statistical Review of World Energy* shows world oil consumption increased by some 2.5% in 1986 to reach 59.9 mb/d — the highest rate of growth since 1978.

While this is the highest rate of growth for nearly a decade, the growth in overall energy demand has continued to slow despite a sharp decline in prices.

Meanwhile, overall world energy demand was up by only 2.1% in 1986, compared with 2.6% in 1985 and 3.7% the year before that.

In each year this was lower than the rate of world economic growth, showing that the world continues to consume less energy per unit of economic output.

Oil production from OPEC grew by more than 13% during the year, with Saudi Arabia's output climbing by 45%.

In non-OPEC areas the decline in production was concentrated in the US, where output was down three per cent.

In the USSR, the 1985 decline in production was reversed as increased government attention was brought to bear.

Production from the UK sector of the North Sea was virtually unchanged, whilst Norway showed a 9.3% increase.

The latest Statistical Review shows that, at current rates of production, proven oil reserves are sufficient for at least 30 years, natural gas reserves for more than 50 years and coal reserves for more than 200 years. More reserves continue to be discovered.

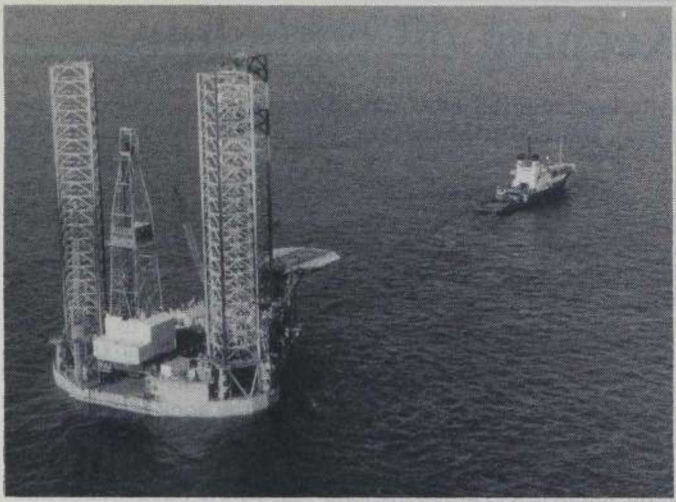
However, the US has less than 10 years of proven oil reserves remaining at current rates of output, compared with more than 80 years in the Middle East.

In 1986, the long-anticipated decline in US oil production was accompanied by a growth in domestic consumption of more than three per cent per annum. The consequent 19% increase in imports, mainly from the Middle East, again raised the question of long-term supply security.

In spite of an excess of gas supplies in the US — the so called 'gas bubble' — consumption of natural gas declined by more than seven per cent in 1986.

In Western Europe consumption of natural gas continued to rise and Japan also continued to increase gas use as a move to diversify away from oil.

In the developing countries demand increased with the development of indigenous gas resources and, in the communist world, consumption was almost double that of a decade ago.



Conoco exploration in Irish Sea

Conoco has begun drilling its first exploratory well in the Irish Sea. The operation, located about 25 miles southwest of the Morecambe Bay gas field, is being managed from the company's Great Yarmouth base. The *Cecil Provine* jack-up rig, seen here being towed into position, has been contracted to carry out the work.

Kittiwake takes off

A £350 million plan to develop the Kittiwake oil field in the central North Sea has been submitted by Shell and Esso to the Department of Energy. If the proposal is approved by the Department, Kittiwake would be the first major new oil field to be announced since January, 1986.

'The striking success of our engineers in devising a plan which gives us the maximum cost-effectiveness has made it possible to develop a relatively small field despite the uncertainty of oil prices,' said Mr Peter Everett, managing director of Shell U.K. Exploration and Production. 'Minimising technical costs has enabled us to proceed with this development and it will be the key to success in planning future fields at a time of continuing uncertainty. Improved cost efficiency has resulted in a reduction in the total cost of the project by 40 per cent.'

Paktank expansion

Paktank, the world's largest independent tank terminal operator, has announced plans to add two new pipelines to its existing system before the end of the year.

The first will be used to transport propylene oxide from the Arco Chemie Nederland Botlek plant to Paktank's own Botlek terminal.

The other new link, which will be constructed in conjunction with Arco's new methyl tertiary butyl ether plant, is expected to come on stream in early 1988.

Letter to the Editor

Sir

I read with interest the article *Passport to freedom* about the Mobility Advice and Vehicle Information Service for disabled people, (*Petroleum Review*, June 1987) I was surprised there was no mention of Motability's ability to help with the financial problems disabled people face in paying for cars and adaptations. For disabled people who receive Mobility Allowance or War Pensioner's Mobility Supplement, Motability's hire and HP schemes provide the means of obtaining suitably adapted cars on the best possible terms. Recently there has been a dramatic increase in the number of disabled people taking advantage of the Motability arrangements. In 1986 we provided nearly 19,000 cars (over 50% up on 1985) or some 1% of total car sales in the UK. A sizeable market, as the article says.

Yours faithfully,

Nigel Haygarth, Charity Director, Motability, 4 Carlton Gardens, London SW1Y 5AB.

In brief

Ethyl Petroleum Additives Ltd has marketed a new range of diesel additives, designed to improve engine performance and economy.

The Hi-Tec 4100 has been designed to control the combustion in the engine, making it take place at the optimum time in the engine's operation cycle, resulting in smoother running, less noise and fewer emissions from the vehicle.

* * *

Petrofina SA of Belgium are negotiating with Neste Oy of Finland with a view to the joint construction of a world-scale steamcracker located in Antwerp.

The proposed unit would produce ethylene, propylene and other products.

If negotiations prove fruitful then a new company would be formed in which Petrofina owned a 65% stake and Neste 35%.

* * *

The Association for Payment Clearing Services has announced the procedure for membership of the company set up to develop a national scheme for Electronic Funds Transfer at the Point of Sale in the UK.

* * *

Phillips Petroleum has renewed its contract with Railfreight for the conveyance of petroleum products.

Keeping oil costs low

Reducing Industrial Oil Costs. John Hall and Graham Hankinson. Gower Technical Press. 118pp. £45.

The publishers imply that the book 'is intended to be a reference manual and an aid to purchasing management'. It has one or two features that contribute towards those ends but it is doubtful whether many people in that section of the industry would willingly pay £45 of their own money for those alone.

In the introduction, there are many references to the relatively unstable international price regime since 1973/74 and the importance of making informed policy decisions in the light of current information. Indeed a section of the book is devoted to sources of such information and the Institute of Petroleum receives a favourable mention. There is, however, no mention of the fall in prices in 1986 (over a year before publication) and most of the tables and statistics refer to 1985 with table 5.1 Spot Prices and Appendix 4 (small load surcharges) containing the most recent data, dated early February 1986.

The section likely to be found most useful by its intended readers is Chapter 8 which explains how the cost of holding large stocks can be balanced against the quantity discounts and the potential penalties involved when stocks run out between deliveries.

Much of the section on 'Oil Suppliers and the Terms' would be likely to be such common knowledge to oil purchasing managers and others in the market as to be a waste of space in a book such as this.

Overall, the usefulness of *Reducing Industrial Oil Costs* is probably limited to non-specialists, who only occasionally have to make fuel oil purchasing decisions, and for them it suffers from being somewhat out of date.

Guidelines for petroleum liquids

Storage and Handling of Petroleum Liquids. JR Hughes, revised by NS Swindells. Charles Griffin and Company. 332pp. £29.95.

The increase in amounts of petroleum held in storage by local authorities, combined with the ever-increasing volume of traffic in petroleum, naturally gives rise to considerations of public safety. This book is the third revised edition of a pioneer attempt to set out the technical aspects, practical applications and regulatory standards relating to the storage and handling of petroleum liquids with the emphasis on UK practice.

The new edition takes account of recent technological changes and of the fact that the guidelines and recommendations have become much more international — the US and UK authorities are coordinating their requirements more closely. It is designed for engineers, safety officers, fire officers, municipal administrators and for all responsible for the safe handling of petroleum liquids in storage, marketing and use.

20th edition for yearbook

ANEP 1987, European Petroleum Yearbook — 20th edition, Urban-Verlagm Hamburg. 480pp. DM166.

The lead article in the 20th edition of the European Petroleum Year Book is entitled 'Probable Trends in Western Europe's Oil Refining Industry'. It outlines changes to date and relates them to shifts in demand patterns and market features, using them as a basis for forecasting possible future developments.

Thanks to the new layout chosen for the second section of the book, which comprises four sections in all, the information it contains is much more accessible and easier to use. As in recent editions, Section two contains detailed descriptions of Europe's onshore and offshore oil and gas fields, pipelines and refineries, backed up by new multicoloured maps.

Updated energy, oil and gas statistics are presented in about 200 individual tables on more than 160 pages. They cover energy utilisation, oil and gas production/imports through to consumption/exports of individual products for all the countries in Europe, including Eastern Europe and the USSR.

Section three is a listing of production, processing and distribution companies involved in the European oil and gas industries; and section four includes both a supplier's directory and a buyer's guide to the European markets.

Microbiology of fuels

Proceedings of a Microbiology of Fuels Conference held at the Institute of Petroleum in October 1986. Copies are available from Mrs JJ Etherton, the Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR at a cost of £10 (UK and Europe) and £13 (overseas).

The papers have obviously been chosen with care to outline in a logical manner the future demand for quality of fuels and how these will tend to change with time, dependent upon the crudes refined. The papers then explain how the chemistry of fuels differs and the effect of various additives upon the fuels.

The distribution network changes again highlight how microbial action can differ with different modes of handling.

The final three papers are devoted to the microbiology of fuels, the testing of fuels and strategies for treating heavily affected fuels.

Thus, in a one-day conference and now in one slim volume a whole fertile field of information is available to both the fuels technologist who wishes to know a little more about microbial problems and the microbiologist who needs to know more about fuels and additives.

The proceedings of the day have been covered admirably and will prove invaluable to anyone associated with handling fuels who needs information on microbiological attack and conversely to a microbiologist who needs to expand his knowledge of fuels. This slim volume is a welcome addition.

Safe chemical practices

Guide to Safe Practices in Chemical Laboratories. Royal Society of Chemistry publication. 48pp. £10.

This guide is the successor to the *Code of Practice for Chemical Laboratories* published by the RIC in 1976. While its objective is still the same — to provide general guidance on which specific procedures can be based and to point out relevant statutory requirements — it is different in that it recognises that the design of laboratory facilities and equipment is subject to change, particularly as a result of developments in legislation. The authors have therefore tried to anticipate some of these developments and have made allowances for legislation known to be pending.

Given the fact that small and large organisations can differ considerably in the scale of resources they employ for health and safety advice, the guide is concerned with the principles of laboratory safety rather than the provision of detailed advice on particular activities.

Although directed primarily at those who manage or are employed in chemical laboratories, the guide may be of interest to staff in other laboratories, particularly those working with substances that present toxic, radioactive or biological hazards.

Statistics of Petroleum Bulk Storage owned by Independent Companies in Western Europe

COUNTRY	CAPACITY (m³) 1987	% OF TOTAL	CAPACITY (m³) 1986
Belgium	2,185,200	6.9	2,160,200
Denmark	371,000	1.2	371,000
Eire	28,500	0.1	28,500
France	8,121,900	25.7	6,541,600
West Germany	4,453,000	14.1	4,076,000
Italy	160,000	0.5	160,000
Malta	245,000	0.8	245,000
Netherlands	10,368,600	32.9	10,348,600
Spain	141,048	0.5	120,748
Sweden	699,000	2.2	699,000
Switzerland	346,000	1.1	346,000
United Kingdom	4,426,696	14.0	4,456,166
TOTAL	31,545,944	100.0	29,552,814

Petroleum Review's **1987 survey of independent bulk storage of oil and petrochemicals in Western Europe shows a capacity of 31,545,944 cubic metres, according to information supplied to the Institute of Petroleum. This is an increase of 1,993,130 cubic metres over last year. France again showed the largest increase, with an additional 1,580,300 cubic metres, with West Germany second, up by 377,000 cubic metres. Capacity in the UK fell by 29,470 cubic metres. Details are given in alphabetical order on the following pages. See page 7 for an interview with Nigel Biggs, managing director of the Simon Storage Group, on UK prospects.**

Independent Bulk Storage Detail

AMATEX BV
Head Office: Westerlaan 10. 3016 CK Rotterdam, Netherlands.
Tel: (10) 4649111. Telex: 21435.
A member of Matex Nederland BV. 'Amatex' has one installation in the Netherlands.
Amsterdam: There are 198 tanks with a total capacity of 600.000 cu. metres for storing mineral oils and molasses. Mooring facilities consist of four jetties for seagoing vessels (draught up to 41ft) and seven for barges. Access is by road, rail and sea. There are 15 tanks of 8,500 cu. metres, all with floating roofs. Insulated coiled tanks equipped with steam and warm-water heating are also available. Special services include washing, leading, blending and butanising facilities for gasoline, equipment to standardise and filter molasses and an inert gas supply.

ANTWERP GAS TERMINAL VGN
Land Van Waaslaan z/n, 2748 Beveren-Kallo, Belgium.
Tel: 3/775 2856. Telex: 71119 AGT B.
The terminal is situated on the left bank of the River Schelde behind the Kallo Lock. Four berths are provided, two for ships and two for barges. Vessels up to 75,000 cu. metres can be accommodated. Tankage consists of two fully refrigerated tanks of 50,000 cu. metres each, designed to handle propane and butane and four pressurised spheres of 3,300 cu. metres each, designed to handle propane, propylene, butanes, butadiene, butylenes and VCM.
The terminal can offer a full range of services including receipt and despatch by ship, barge, rail and road tanker, ship to ship transfers and refrigerated to pressurised movements via fired heaters.
The terminal is strategically positioned to give ready access to a large market area via road, rail, canals, rivers and coastal movements.

BARROW STORAGE CO LTD
Head Office: 25 Fitzwilliam Square, Dublin 2, Eire.
Tel: (0001) 763524. Telex: 24387. Fax: 614704.
One installation: Marshmeadows, New Ross, Co. Wexford, Eire. Storage for 16,000 cu. metres of petroleum products, including LPG. The berth on the River Barrow provides for vessels up to 8m draught. Tankage includes 4,500 cu. metres tank which is heated and insulated. Plans are well advanced for further terminals in Dublin.

BTP STORAGE LTD
Hayes Road, Cadishead, Manchester M30 5BX, UK.
Tel: (061) 775 3945. Telex: 669938.
Part of the British Tar Products group of companies. The installation occupies a 20-acre site on the north bank of the Manchester Ship Canal. Total tank capacity of over 100,000 cu. metres with a range of tanks up to 6,000 cu. metres capable of handling most types of petroleum and chemical products. Blending, packaging, drumming, and weighbridge facilities available. Rail sidings for up to 1,000 tonnes. Berth: maximum draught 24.5ft. approximately 8,000 tonnes. Easy access to the M6, M62 motorways.

BRAGTANK AG
Head Office: Westquaistrasse 12, CH 4019 Basle, Switzerland.
Tel: (61) 65 44 22. Telex: 963180.
Bragtank, a member of the Van Ommeren Group, has one installation in Switzerland.
Basle: The terminal has 63 tanks with a total capacity of 346,000 cu. metres. All mineral oils can be stored. There are six jetties for barges. Access is by river, road and rail. Steam and oil heating is provided and there are bunkering facilities for barges.

CHEMICAL STORAGE LIMITED
Head Office: Berkeley Square House, Berkeley Square, London W1X 5LA, UK.
Tel: (01) 499 3422. Telex: 23509.
A subsidiary of Chemitrade Limited. One installation at Martens Road, Northbank Industrial Estate, Cadishead, Manchester M30 5BS. More than 35 tanks with a total capacity of over 10,000 cu. metres in tank sizes ranging from 25 to 1,000 cu. metres for low and high flash point bulk liquids. Some tanks are aluminium, the remainder are mild steel, some being heated and lagged. The installation, which is bonded for hydrocarbons and licensed for methylated spirits, is on the Manchester Ship Canal, immediately adjacent to the berth with five lines. The terminal is only a few miles from the M6 with its excellent motorway connections to all parts of the country. Transport by sea and road (road tankers and drums).

CILA SWEDEN
Brännoljegatan, Skarvikshamnen. S-417 34 Gothenburg, Sweden.
Tel: (31) 54 54 29-33. Telex: 27580. Fax: (31) 545449.
The biggest independent terminal within Scandinavia. Operates 74 tanks ranging from 60 cu. metres to 25,000 cu. metres with a total capacity of over 500,000 cu. metres. The full range of petroleum products is stored, including gasoline, gas oil, fuel oils, lubricating oils and automotive products. Jetty facilities are capable of handling vessels up to 240m in length and up to 40ft draught with additional berths for smaller vessels and barges. The installation is connected to every terminal located in the oil harbour of Gothenburg where the big international oil companies have their own terminals and is also connected

to BP and Shell refineries. Delivery can be made from any tank to road and railway tank wagons, waterborne vessels or drums. Each tank has its own pump and line to loading racks and its own loading point, to avoid any risk of mixing and contamination. Pump capacity up to 1,000 cu. metres per hour. Some tanks from 6,000 cu. metres have a floating roof. All tanks are equipped with a modern system for accurate temperature and level control. Ten pipelines between 6in and 20in diameter from berths to the storage tanks. Also available, blending facilities for gasoline, gas oil and fuel oils.
Possibilities to store in transit.

COMPAGNIE INDUSTRIELLE MARITIME (CIM)

36, Rue de Liège, 75008 Paris.

Tel: Paris (1) 43 87 33 49. Telex: 280330 CIMDGPA. Fax: Paris (1) 43 87 43 08.

Contacts: Mr B Salaun (Adjoint au Directeur Commercial) Direct line: Paris (1) 43 87 43 14. Mr CN Malcolm (CIM UK Representative) Telephone: 0793 30151.

CIM is an independent French Company which owns and operates a modern and highly sophisticated storage, transhipment and break-bulk facility capable of handling crude oils, straight run fuels, distillates and all clean petroleum products. The complex, which is situated in France at **Le Havre** and **Antifer**, has a total capacity of some five million cubic metres. At Antifer, only crude oil tonnage in excess of 250,000 tons DWT is handled with the port being able to handle the world's largest tankers. At Le Havre, the smaller crude oil carriers (under 250,000 tons DWT), straight run fuels, distillates and all other clean petroleum products are handled. The complex is able to handle and store 'heated' cargoes. There is a pipeline link between Antifer and Le Havre allowing cargo to be transferred from Antifer to Le Havre (where it can be backloaded after storage if required). All cargoes stored and handled are in a Customs Bond and CIM prides itself in maintaining their clients confidentiality.

COSMOS TANK BV

Octaanweg 14, 1041 AN Amsterdam, Netherlands.
Tel: (20) 114747. Telex: 13121.
A subsidiary of VTG Vereinigte Tank-lager und Transportmittel GmbH. Operates a terminal with an overall capacity of 600,000 cu. metres for storing all petrochemical liquids and solvents. Tanks range from 250 to 40,000 cu. metres, some coated or insulated and equipped with heating-coils. Blending facilities for gasoline and gasoil and facilities for leading, product-washing and butanising are available. Three jetties for seagoing vessels and eight jetties for barges, together with rail and road tanker filling platforms, ensure efficient storage and transfer.

DEPOTS PETROLIERS DE FOS SA

2.1 Secteur 81-Audience 818, Fos-sur-Mer, France.
Tel: (42) 05 12 13. Telex: 430235.
DPF, an associated company of the Van Ommeren Group, has one installation in France, at Fos-sur-Mer. The terminal has 36 tanks with a total capacity of 652,500 cu. metres. All mineral oils can be stored. There is one jetty for sea-going vessels (draught 45ft) and one for coastal vessels (23ft). Access is by sea, rail, pipeline and road.

ENEMALTA CORPORATION

Petroleum Division, PO Box 6, Hamrun, Malta.
Tel: 871443. Telex: 1735/1219.
Twenty-four tanks with a total capacity of 245,000 cu. metres. Eight tanks ranging in size from 10,000 to 20,000 cu. metres and 16 tanks from 5,000 to 10,000 cu. metres. Reception tank for clean ballast, maximum 4,500 tons. Gas oil, jet/kerosine, low viscosity fuel oil. Three berths for vessels up to 50,000dwt; maximum draught 36ft; maximum length 750ft. Separate pipelines for each product, 12-inch to 18-inch. Simultaneous receipt/loading of products possible. Twenty-four-hour, seven-day service. Centrally situated in the Mediterranean. State-owned. Responsible for all import storage and distribution of petroleum products in Malta.

EUROGAS TERMINALS CV

Head Office/Terminal: Frankrijkweg 4, 4455 TR Nieuwdorp, The Netherlands.
Tel: (0) 1196 12820. Telex: 55684.
A subsidiary of Thyssen Bornemisza (Europe) N.V. Monaco.
The terminal has 130,000 cu. metres capacity for storage of LPG and chemical gases, six spheres of 3,369 cu. metres each, and two refrigerated tanks of 55,500 cu. metres each. There are three jetties for sea-going vessels and barges (draught up to 52ft). Board/board operations for a wide range of gases for vessels/barges are possible. Furthermore, there are facilities for the purging of vessels/barges/trucks/trains with nitrogen including flaring off. There is an open connection to the sea via the Westerschelde and there are good connections to the hinterland by rail, road and water.

FLEET STORAGE CO LTD

Fleet Lane, Woodlesford, Leeds, West Yorkshire LS26 8AD, UK.
Tel: (0532) 824396. Telex: 55495.
Situated adjacent to the Aire and Calder Canal some six miles south of Leeds. Has 15 tanks ranging from 350 to 3,000 cu. metres. Storage available for both high and low flash petroleum products and heated fuel oils. All current tankerage of mild steel construction. Input handled by company's own fleet of rivercraft up to 550 tonnes cargoes from the Humberside area. Road input also available. Delivery to road vehicles by self-service meters rated at 2,000lpm through six loading bays. Vehicle parking, washing, bunkering and steaming facilities also available.

GAMATEX NV

Head Office: Scheldelaan, Kanaaldok B 2, B 2040 Antwerp (Lillo), Belgium.
Tel: (3) 5684511. Telex: 32459.
Gamatex is a 50/50 joint venture between GATX Terminals Corporation and Van Ommeren and has one installation in Belgium.
Antwerp: The terminal offers 123 tanks with a total capacity of 473,000 cu. metres for mineral oils, petrochemical liquids, animal and vegetable oils and fats and LPG. There is one jetty for sea-going vessels (draught 43ft) and two for barges. Access is by sea, rail and road. Tankage is insulated, coiled, coated and aluminium with steam, warm-water and oil heating. Tanks for chemical products are equipped with dedicated pipelines. Prepump, blending, drum filling and nitrogen blanketing are also available.

GEBR BROERE BV

PO Box 150, 3300 AD Dordrecht, Netherlands.
Tel: (78) 182022. Telex: 29024/29393. Fax: (78)179141.
Operates two storage terminals in the Netherlands.
Dordrecht: 200,000 cu. metres capacity for chemical and petroleum products; tank sizes from 150 to 6,600 cu. metres. Tankage is mild steel, some insulated and coated; nitrogen blanketing facilities. Access by road, rail and sea via three deep-sea tanker jetties and four coastal tanker and barge jetties.
Rotterdam-Botlek *(operated by Tank Terminal Rotterdam BV, daughter company)*: 325,000 cu. metres capacity for the storage of chemical and petroleum products; tank sizes from 670 to 15,000 cu. metres. Tankage is mild steel, stainless steel, some insulated and coated; nitrogen blanketing facilities. Two deep-sea jetties for tankers up to 60,000 tons and two jetties for barges and coastal tankers up to 5,000 tons complement the road and rail access facilities.

JOHANN HALTERMANN GMBH & CO

Head Office: Ferdinandstrasse 55/57, D200 Hamburg 1, West Germany.
Tel: (40) 3338 01. Teletex: 17-402108.
Operates six terminals in Europe.
Hamburg-Wilhemsburg: Total capacity of 150,000 cu. metres, with tanks varying in size from 50 to 5,000 cu. metres, for all petroleum products, solvents and chemicals. Some tanks are heating-coiled and insulated. Drumming and blending facilities available and there is an associated custom processing plant. Access for ships, barges, road and rail tank cars and liner trains; two berths including a 33ft draught jetty.
Berlin: Tanks ranging from 50 to 1,500 cu. metres make up the 20,000 cu. metres capacity for petroleum products, solvents and chemicals. Some tanks are coated. Distribution by road, rail and barge.
Speyer: Total capacity of 100,000 cu. metres, with tanks ranging in size from 250 to 3,000 cu. metres, for all petroleum products, solvents, chemicals and vegetable and edible oils. Some tanks stainless steel and coated; some with heating coils or insulation. Blending facilities and an associated custom processing plant available. Distribution by road, rail, liner train and barge.
Beveren-Kallo/Antwerp Linker Oever (Belgium): All petroleum products, solvents, chemicals and vegetable oils can be stored in this 60,000 cu. metres capacity terminal. Tanks vary in size from 300 to 3,000 cu. metres. Some are stainless steel and coated with heating coils and insulation. Drumming

The Grange Dock Installation

- All Petrochemicals handled
- Capacity: 100,000 water tons
- Tankage: 8 x 500/1000 tons
  35 x 1000/2000 tons
  14 x 2000/2650 tons
- Eight Jetty Lines (two stainless steel)
- Materials handled by Road or Ship
- Ships up to 20,000 tons can be handled
- Office facilities

BULK LIQUID STORAGE IN SCOTLAND

The Ross Chemical & Storage Company Limited

Dock Rd, Grangemouth, Scotland FK3 8UB

Tel: Grangemouth 474774 *Telex: 777750*

Installation at: Grange Dock, Grangemouth, Scotland

Tel: Grangemouth 486111

Telex: 779182

and blending facilities available, as is an associated custom processing plant. Access by road, rail and sea for vessels up to 28ft draught.

Koge (near Copenhagen), Denmark: Tanks ranging in capacity from 20 to 4,000 cu. metres make up this 15,000 cu. metres capacity facility. All petroleum products, solvents and chemicals can be stored. Some tanks heating-coiled and insulated; drumming facilities. Distribution by road, rail and sea, with berths for 12,000dwt tankers.

Malmo (Sweden): This 20,000 cu. metres capacity terminal has tanks ranging in size from 20 to 2,000 cu. metres for all petroleum products, solvents and chemicals. Some tanks are stainless steel, coated, heating-coiled and insulated. Distribution by road, rail and sea.

HANSAMATEX KÖHN & KUYPER (GMBH & CO)

Head Office: Rethedamm 15. D 2102 Hamburg 93, FR Germany.
Tel: (40) 75 19 60. Telex: 2163363.

Hansamatex is a joint venture between Köhn & Kuyper and Van Ommeren and has one installation in West Germany.

Hamburg: The terminal has 321 tanks with a total capacity of 816,000 cu. metres for storing mineral oils, petrochemical liquids, liquid fertilisers, animal and vegetable oils and fats, and molasses. There are four jetties for sea-going vessels and barges (draught up to 44ft), seven berths for barges and coasters. Access is by road, rail and sea. Product lines are partly stainless steel. Tankage is insulated, coiled and coated, provided with steam and oil heating and partly equipped with nitrogen blanketing. Pre-pump facilities, drum filling plant, blending and dyeing facilities for gasoline and fuel oil are also available.

THE INDEPENDENT TANK STORAGE ASSOCIATION (ITSA)

Executive Secretary: H.H. Cail, 24 Chiswick Quay, London W4 3UR, UK.
Tel: (01) 995 3393.

The Association exists to give information and advice to government and other regulatory bodies in connection with the practical, safety and environmental health aspects of the bulk liquid storage business. Membership is open to all companies operating in the UK whose main business is storage of bulk liquids for third parties. A minimum capacity of 50,000 cu. metres is required for full membership. Associate membership is available to those with less than 50,000 cu. metres capacity. All companies with over that amount are currently members of ITSA.

Registered Office: 134–138 Burrough Hill Street, London SE1 1LB, UK.
Tel: 01-407-7070. Telex: 888744.
Fax: 013787842.

INTERNATIONAL BULK LIQUIDS (STORAGE AND TRANSPORT) LTD

110 Lime Street, Hull HU8 7AS, UK.
Tel: (0482) 20736/7. Telex: 592230. Fax: 226162.

132 storage tanks ranging from 50 to 830 cu. metres with a total capacity of 25,000 cu. metres. Specialises in the storage of non-hazardous chemicals, lubricating oil, additives and vegetable oils. The wharves are situated on the Hull river at Hull Forge Wharf and at 50–52 Lime Street, Hull. Facilities for receiving ex-road tankers or containers and good access to main roads leading to the M62. An 80m public weighbridge platform for weighing up to 60 tonnes and a road tanker steam-heating and cleaning service available on site.

INVER HOUSE DISTILLERS LTD

Airdrie ML6 9PL, Lanarkshire, Scotland.
Tel: (02364) 69377. Telex: 778084.

Three tanks, of 2.3m gallons, 0.8m and 0.5m, used for oil storage and fitted with heaters for heavy oil. Electricity supply available. The company stipulates that duration of hire be for approximately three years. Access by road. Airdrie easily reached on the M8 from Edinburgh (35 miles) and Glasgow (15 miles), and on the M80 from Stirling (20 miles) and Fife (16 miles). Weighbridge facilities.

KING'S LYNN STORAGE LTD

Head Office: St. Bartholomew House, 92 Fleet Street, London EC4Y 1DH, UK.
Tel: (01) 353-7331. Telex: 888061.
Terminal at Estuary Road, King's Lynn, Norfolk PE30 2HH, UK.
Tel: (0553) 764382. Telex: 817018.
Part of the Chemolink Group.

The terminal comprises 19 storage tanks in sizes ranging from 270 cu. metres to 1,500 cu. metres, with a total capacity of 16,000 cu. metres. It is served from Bentinck Dock, King's Lynn, where KLS has priority over a berth by agreement with Associated British Ports. The port can accommodate vessels of up to 3,000dwt. Four product lines lead to the terminal, which is approved for the storage of petroleum products and chemicals. Every tank is equipped with segregated pipelines and pumps for the discrete handling of products by road and sea. Three gantries provide 15 loading positions for road tankers. A substantial office building provides space for KLS's customers to install their own staff if necessary. Ample parking space for tankers and for barrels is provided on an adjacent two-acre site.

LANSTAR PETROLEUM LTD

Borough Road, Weaste, Salford M5 2DX, UK.
Tel: (061) 736 8111. Telex: 668620.

Provides storage facilities of 12 tanks, each of 2,000 tonnes, with a total capacity of 24,000 tonnes, for residual and distillate oils. Mild steel tanks, lagged tanks with coil heating and facilities for storing low flash point liquids. Access by road (into standard or specialised petroleum liquid storage); rail (offloading of 1,000-tonne liner trains); and sea (offloading of up to 6,000 tonnes from sea-going tankers).

LONDON AND COASTAL OIL WHARVES LTD

Head Office: Hole Haven Wharf, Haven Road, Canvey Island, Essex SS8 0NR, UK.
Tel: (0268) 682206. Telex: 99104. Fax: 0268 510095.

Canvey Island Terminal: More than 100 tanks ranging from 45 to 20,320 cu. metres. The full range of petroleum products is stored, including fuel oil, lubricating oils and automotive products. Jetty facilities are capable of handling vessels of up to 200m LOA with additional berths for smaller vessels and barges. In addition to having its own jetty, the company has pipeline connections to two jetties owned and operated by Texaco Ltd. Delivery can be made from any tank to road tank wagons, water-borne vessels or drums. The installation is connected to the UK Oil Pipeline system running to North London, London Airport (Heathrow) and Birmingham, and a large part of the company's throughput of gasolines, gas oils, aviation fuels and kerosines is despatched by this pipeline. Chemical storage facilities include stainless steel pipelines, lined, insulated and heated storage tanks, inert gas blanketing and full laboratory service.

Dagenham terminal: This terminal is situated between London and the Dartford Tunnel and is the nearest major public storage terminal to London. Operates more than 140 tanks with total capacity of 136,000 cu. metres. Jetty facilities for vessels up to 200 metres LOA with additional berths for smaller vessels and barges. The modernisation of the company's Dagenham jetty includes new fendering for the berthing of larger vessels. Full range of chemical storage facilities includes stainless steel pipes, lined, insulated and heated tanks, etc. The terminal also handles a wide range of vegetable oils, edible oils and technical oils as well as chemicals and fuel oils. Facilities for bunkering vessels and blending products and filtering. Both terminals have modern workshops, weighbridges, radio and telecommunication equipment, fully computerised stock accounting and easy access to the M25.

Lubricants laundering and solvent recovery: The company has special facilities for treating used lubricants, hydraulic oils, cutting oils, etc, for re-use, with blending and re-spiking of additives as necessary. The plant consists of centrifuges, filters, vacuum distillation unit and additives blending plant. Other treatments include earth, clay or charcoal treatment.

There is also distillation capacity for solvent recovery, together with waste-handling and disposal facilities. Services include recovery of solvents, blending, and disposal of residues.

Chemical analysis services: Includes the testing of petroleum and chemical products to ASTM, IP and BS standards.

MATEX EUROPOORT BV

Head Office: 10 Westerlaan, 3016 CK Rotterdam, Netherlands.
Tel: (10) 464 91 11. Telex: 21435.
A member of Matex Nederland BV.

Rotterdam-Europoort: The terminal has 34 tanks with a total capacity of 740,000 cu. metres for storing mineral oils. Mooring facilities consist of one finger-pier for two VLCC-type vessels (draught 71ft), one jetty for vessels up to 45,000 tons and five berths for barges. Access is by sea and road. All tanks are coiled, 24 have floating roofs and all operations are directed from the fully automated control room. Special services include washing, leading, blending and butanising facilities for leaded and unleaded gasoline. There is a 16ft pipeline to the Rotterdam-Botlek terminal and pipeline connections to adjacent refineries.

NIEUWE MATEX BV

Head Office: 10 Westerlaan, 3016 CK Rotterdam, Netherlands.
Tel: (10) 464 91 11. Telex: 21435.

A member of Matex Nederland BV, operates two terminals.

Rotterdam-Botlek: This terminal has 311 tanks with a total capacity of 936,000 cu. metres for storing mineral oils, petrochemical and chemical liquids. There are six jetties for seagoing vessels (draught up to 41ft) and five for barges. Access is by sea, road and rail. Insulated, coiled, coated and aluminium and stainless steel tanks are available and are equipped with nitrogen-blanketing and vapour-return facilities. Product lines are partly stainless steel. Also available are blending facilities for fuel oil and dyeing and a drumming plant.

Vlaardingen: There are 362 tanks with a total capacity of 400,000 cu. metres. Vegetable and animal oils and fats and molasses are stored. There are three jetties for seagoing vessels, 10 for barges (all draught of 39ft). Access is by road, rail and sea. All tanks are equipped with heating coils and swing-pipes. Drumming facilities, weighing tanks and pre-pump containers for quality inspection are also available.

NOORD NATIE SV

Head Office: Stadswaag 7-8, B-2000 Antwerp, Belgium.
Tel: (3) 2329940. Telex: 31677.

Situated in the port of Antwerp. There are 167 tanks ranging from 30 to 8,000 cu. metres, with a total capacity of 190,000 cu. metres for various bulk liquids including mineral and lubricating oils, vegetable and animal oils and fats, non-dangerous chemicals, molasses and wines. All tanks equipped with heating coils. Two mooring berths for sea-going vessels and a special dock for handling barges. Direct road and railway connections. Three weighing bridges. Mobile pump facility. Drumming and canning installation.

OIL RAIL TERMINALS (LEEDS) LTD

South Accommodation Road, Leeds LS9 0RT, UK.
Tel: (0532) 480574. Telex: 55435.

Head Office: Hayes Road, Cadishead, Manchester M30 5BX. Part of the British Tar Products group of companies. Thirty-two acre site only one mile from the M1 and M621 motorways. Liner trains of up to 1,000 tonnes are received in modern sidings and discharged in two hours. Equipped with high-speed, self-service road vehicle loading bays. Products stored in mild steel tanks ranging from 600 to 6,000 cu. metres, with a total capacity of 21,000 cu. metres. Complete range of low and high flash petroleum products. Blending, drumming and liquid packaging facilities available.

OILTANKING GMBH

Burchardstr. 17, 2000 Hamburg 1, FR Germany.
Tel: (40) 322326. Telex: 2163232. Telefax: 331338.

Storage capacity of approximately three million cu. metres. Operates five seaport terminals, designed for rapid handling, in Amsterdam, Copenhagen, Ghent, Hamburg, Houston. All occupy key positions in the international oil storage business and are backed by a dense network of inland tank terminals. Seaport tank terminals and inland storage facilities can be combined, permitting a wide variety of solutions to individual problems. The Amsterdam terminal in particular plays an important role in the distribution of high and low flash products in North-West Europe and in the UK. Vessels up to 85,000dwt are handled at this terminal and their cargoes redistributed on coasters and barges. Extensive product treatment facilities for the blending, leading and up- and downgrading of gasoline are also available. A member of the Stumm GmbH Group.

West Germany

Hamburg: Forty-one tanks, sizes 2,000 to 19,000 cu. metres. Total capacity 418,000 cu. metres. Low/high flash petroleum products and heavy fuel oil storage. Sea/barge/rail/road. Berth for tankers up to 90,000dwt.

Berlin: Thirty tanks, sizes 1,500 to 25,000 cu. metres. Total capacity 348,000 cu. metres. Low/high flash petroleum products. Barge/rail/road.

Karlsruhe: Tank sizes 600 to 20,000 cu. metres. Total capacity 180,000 cu. metres. Low/high flash petroleum products and LPG storage (Gastanking GmbH). Barge/rail/road.

Bendorf: Twenty-two tanks, sizes 2,000 to 20,000 cu. metres. Total capacity 147,000 cu. metres. Low/high flash petroleum products. Barge/rail/road.

Frankfurt: Tank sizes 100 to 5,000 cu. metres. Total capacity 51,000 cu. metres. Low/high flash petroleum products and chemical storage. Barge/rail/road.

Honau: Eleven tanks, sizes 5,000 to 20,000 cu. metres. Total capacity 115,000 cu. metres. Low/high flash petroleum products. Barge/road/pipeline.

Hamm: Tank sizes 3,000 to 10,000 cu. metres. Total capacity 46,000 cu. metres. Low/flash petroleum products. Road/barge.

Duisburg: Tank sizes 5,000 to 10,000 cu. metres. Total capacity 35,000 cu. metres. Gasoil. Road/barge.

Köln: Tank sizes 800 cu. metres. Total capacity 4,000 cu. metres. Gasoil. Road/barge.

Others: Tank sizes 5,000 to 10,000 cu. metres. Total capacity 50,000 cu. metres. Barge/road.

Belgium (Ghent Tanking)

Ghent: Thirty-eight tanks, sizes 3,000 to 47,250 cu. metres. Total capacity 600,000 cu. metres. Low/high flash petroleum products. Chemical storage/edible oils. Sea/barge/road. Berth for tankers up to 60,000dwt.

The Netherlands

Amsterdam: Forty tanks, sizes 5,000 to 40,000 cu. metres. Total capacity 740,000 cu. metres. Low and high flash petroleum products/heavy fuel oil/crude oil/molasses. Sea/barge. Berth for tankers up to 85,000dwt.

Denmark (Nydol Oiltanking A/S)

Copenhagen: Forty tanks, sizes 1,600 to 16,600 cu. metres. Total capacity 356,000 cu. metres. Low/high flash petroleum products. Sea/barge/road. Berth for tankers up to 40,000dwt.

PHS VAN OMMEREN NV

Head Office: Westerlaan 10, 3016 CK Rotterdam, Netherlands.
Tel: (10) 464 91 11. Telex: 21435.

The Van Ommeren Group is the second largest independent tank storage company in the world with a capacity of over 9.6m cu. metres, 6.4m cu. metres of which is in Europe.

Through its 50 per cent ownership of Chemicals and Oil Storage Management Group, Van Ommeren is associated with Cumbrian Storage, Immingham Storage, Irish Bulk Liquids Storage and Velva Liquids. It also has UK interests through its wholly-owned subsidiary, Thames Matex (for details of these companies, see under Simon Storage Group Ltd.).

In the Netherlands, Belgium, France, Portugal, West Germany and Switzerland, there are six companies in the Van Ommeren Group, some wholly-owned and some associated companies: Bragtank AG, Gamatex NV, Dépôts Pétroliers de Fos, SA, Hansamatex Köhn & Kuyper (GmbH & Co), Quimatex LDA (details of these five companies can be found under their separate headings), and Matex Nederland BV, which manages Amatex BV, Matex Europoort BV, Nieuwe Matex BV (details of these three companies can be found under their separate headings).

Outside Europe the Van Ommeren Group has associated terminals in the USA, Korea, Bangladesh, Pakistan, Singapore and Mexico. Van Ommeren's storage facilities are complemented by the Group's inland tank shipping services which operate in West Germany and Belgium.

PAKTANK INTERNATIONAL BV

PO Box 7300, 3000 HH Rotterdam, The Netherlands.
Tel: (10) 4002911. Telex: 22163. Fax: (10)4139829.

The world's largest independent tank storage company, providing bulk storage and related facilities to the chemical and oil industries. Over 7m cu. metres of tank storage capacity at terminals in Western Europe and further capacity in the Caribbean, the USA, Tunisia and Singapore.

The Netherlands

Botlek (Rotterdam): 1,531,000 cu. metres capacity; access by sea, road, rail and pipelines; 39ft 6in draught sea berths; storage for crude oils and petroleum products, chemicals and specialised liquids.

Europak (Rotterdam): 1,973,000 cu. metres; sea, pipelines; 68ft; crude oils and petroleum products. Able to receive vessels up to 72ft via the Maasvlakte terminal.

Laurenshaven (Rotterdam): 926,000 cu. metres; river, pipelines; petroleum products.

NOM/Pernis (Rotterdam): 333,000 cu. metres; sea, road, rail; 37ft 6in; petroleum products, molasses, molten sulphur, aromatics. Also storage of chemicals.

Waalhaven—Pier 2 (Rotterdam): 18,000 cu. metres; sea; 18ft, industrial waste acids.

Maasvlakte Oil Terminal CV (Rotterdam): 360,000 cu. metres; sea, pipelines; 72ft; crude oils.

Sweden

Goteberg: 48,000 cu. metres; sea, road, rail; 36ft; petroleum products, chemicals, lubricating oils, molasses, latex.

Sodertalje: 108,000 cu. metres; sea, road, rail; 32ft; petroleum products, asphalt, chemicals,

vegetable and animal oils and fats.
Malmo: 23,000 cu. metres; sea, road, rail; 36ft; asphalt, petroleum products, chemicals.
West Germany
Neuss: 58,000 cu. metres; river, road, rail; petroleum products, chemicals.
Tollerort and Hohe Schaar (Hamburg) and Kiel: See under VTG-PAKTANK HAMBURG GMBH.

PANOCEAN STORAGE & TRANSPORT LTD
Head Office: Chester House, Chertsey Road, Woking, Surrey GU21 5BJ, UK.
Tel: (04862) 26241. Telex: 859343.
Provides storage and transportation services for handling and distribution of liquid products in bulk.
Operates bulk liquid storage installations in Belgium, Holland and UK, and the USA, with a total capacity of some 1.48m cu. metres, handling chemicals, petroleum fuels, lubricating oils, latex and vegetable and animal oils. Has its own access by sea, road and rail as well as ancillary service possibilities in supplying nitrogen, large-scale drumming and canning.
Belgium
Eurotank (Antwerp): 469,000 cu. metres capacity. Tanks range in size from 100 to 50,000 cu. metres; stainless steel, aluminium, heated, coated and insulated. Facilities for blending and drumming together with dry cargo warehouse space.
Hemiksem (Antwerp): 128,000 cu. metres capacity. Tanks range in size from 33 to 5,500 cu. metres; stainless steel, aluminium, heated, coated and insulated. Facilities for blending, drumming and canning together with dry cargo warehouse space.
Netherlands
Botlek (Rotterdam): 206,600 cu. metres capacity. Tanks range in size from 365 to 10,000 cu. metres. Specialised tankage includes various categories of coated and insulated tanks with both mild steel and stainless steel heating coils.
Pernis (Rotterdam): 350,000 cu. metres capacity. Tanks range in size from 15 to 7,300 cu. metres. Specialised tankage includes aluminium, heated and coated tanks. Facilities for drumming, blending and clarifying.
United Kingdom
Birkenhead (Merseyside): 40,500 cu. metres capacity. Tanks range in size from 50 to 2,000 cu. metres; heated, coated and insulated. Facilities for blending and drumming.
Eastham (Merseyside): 74,500 cu. metres capacity. Tanks range in size from 50 to 3,500 cu. metres. Specialised tankage includes coated and temperature controlled tanks.

LA PETROLIFERA ITALO RUMENA SPA
Head Office: 40136 Bologna, Viale Aldini 190, Italy.
Tel: (51) 331567. Telex: 511549.
Terminal: Porto Corsini—Ravenna: Total storage capacity of about 100,000 cu. metres for petroleum products. Tanks between 500 and 15,000 cu. metres for low and high flash products. Storage and handling facilities for lubricants. Total storage capacity of about 60,000 cu. metres for chemical products. Tanks between 250 and 5,000 cu. metres for high and low flash products. Some tanks of stainless steel, some rubber or specially coated; nitrogen blanketing facilities; modern hot water system for accurate temperature control. Each tank has its own pump and line to loading racks and its own loading point, to avoid any risk of mixing or contamination. Two vessel berths, both of which can accommodate vessels up to 190m (623ft) in length and up to 8.5m (28ft) draught. Twenty-five pipelines, between 6ins and 12ins diameter (some insulated and of stainless steel) from berths to the storage tanks. Vessels can discharge several products simultaneously. Draught to be increased to 34ft during 1988.

P.L. TRANSTORE LTD
Riverside House, East Street, Birkenhead, Wirral, Merseyside L41 1BY, UK.
Tel: (051) 647 4111. Telex: 629574.
One installation in the Birkenhead Dock system. Fifty tanks ranging in size from 38 to 914 tonnes, with a total capacity of 14,000 tonnes. Facilities for blending and drumming supplemented by own laboratory and public weighbridge. Diesel and lubricating oils, non-hazardous chemicals, waxes, animal and vegetable oils and fats. Mild steel, lagged, vertical cylindrical tanks with conical tops and steam coil heating. Access by road and ship. Tankcar washbay for all products. Operates a fleet of stainless steel, general purpose road tankcars, fully fitted with pumps and compressors.

POWELL DUFFRYN TERMINALS LTD
UK Head Office: Powell Duffryn House, London Road, Bracknell, Berks RG12 2AQ.
Tel: (0344) 53101. Telex: 858906. Fax: 0344 50599.
Operates three terminals in the UK, one in France and one in Spain.
Barry, South Wales: High and low flash tankage, including pressure vessels, for petroleum and chemical products, with a total capacity of 206,600 cu. metres. Tank sizes from 60 to 14,400 cu. metres; mild steel—many lined, lagged and coiled, using stainless steel fittings where required. Eight jetties with a minimum depth of 9.8 metres (32ft), served by over 30 pipelines in stainless or mild steel, lagged and traced as required. Blending and drumming; weighbridge; road and rail facilities. This location is ideal for supplying the industrial areas of South Wales, the South of England, the Midlands and the North-West.
Ipswich, Suffolk: High and low flash storage; tanks from 100 to 10,000 cu. metres with a total capacity of 89,000 cu. metres for petroleum and chemical products. Mild steel tanks, lined, lagged and coiled. Three tanker berths with a minimum depth of 7.9m (26ft), using both stainless and mild steel pipelines; blending; road facilities.
Purfleet, Essex: Two jetties: the main seven-berth private jetty with a minimum depth of 10.6m (35ft) can accept vessels of up to 50,000dwt or a maximum length of 800ft; a smaller chemical jetty upstream. High and low flash tankage for petroleum and chemical products, with a total capacity of 420,000 cu. metres. Tank sizes from 50 to 15,000 cu. metres; stainless or mild steel; many lined, lagged and coiled, using stainless steel fitments when required. Fourteen stainless and mild steel main pipelines; many are lagged and traced for temperature control. Full train-loads on 100-tonne rail cars and all types of road tankers; weighbridge; blending and drumming.
All three terminals have steam or hot water heating, many with their own power pack for precise temperature control. Special driers for hydroscopic chemicals and refrigeration used as necessary. All have modern communications facilities.
France
Compagnie Française Powell Duffryn, SA: 35 Avenue de l'Europe, 78143 Velizy-Villacoublay, Cedex, France.
Tel: (1) 39469611. Telex: 696738. Fax (1) 39566711.
60,300 cu. metres of tankage at Nantes. Mild steel tanks, lagged and coiled. Mild steel lines. Deep water, road and rail facilities. Customs.
Spain
Proquimica SA (for details, see under this company's own heading)

PROQUIMICA SA
Head Office: Calle Orense 20, Madrid 28020, Spain
Tel: (1) 4560605. Telex: 43250.
An independent company, associated with Powell Duffryn Terminals, with an installation in the port of Barcelona for the storage and handling of chemical, petrochemical and edible products.
Barcelona: 53,500 cu. metres for high and low flash, corrosive and other special liquid products in bulk. Tanks ranging from 46 to 3,000 cu. metres. Two berths (12 metres draught) operating 24 hours a day. Heating, blanketing, heat traced pipes, stainless steel tanks and pipes, coated tanks, bleeding, drumming facilities (55 drums per hour). Access by sea and road, rail in project, ship to ship facilities. Authorised to store gases. Logistic and technical advice. Operating now as a transhipment/distribution centre for South-West Europe and Mediterranean coastal traffic.

QUIMATEX LDA
Avenida Infante Santo 23-1 Esq. 1300 Lisbon, Portugal.
Tel: 676075. Telex: 43917 Q MATEX.
The tank terminal, located in the Port of Lisbon, has a total capacity of 65,000 cu. metres for storing ammonia, fuel oil and chemicals. Maximum draught at the jetty is approximately 32ft at high tide.

THE ROSS CHEMICAL & STORAGE CO LTD
Dock Road, Grangemouth FK3 8UB, Scotland.
Tel: (0324) 474774. Telex: 777750.
Grange Dock, Grangemouth: Sixty tanks ranging from 800 to 2,650 cu. metres, with a total capacity of 100,000 cu. metres, for fuel oil, motor spirit, petrochemicals and edible oils. Served by a common-user oil jetty with mild and stainless steel jetty lines. The jetty is capable of handling ships up to 20,000dwt. Distribution by road. Office facilities and land available for expansion.

PAKTANK- tankstorage

SIMON STORAGE GROUP LTD

TR House, 134-138 Borough High Street, London SE1 1LB, UK.
Tel: (01) 407 7070. Telex: 888744 SIMSTO G. Fax: 01 378 7842.
The Simon Storage Group manages the bulk storage facilities owned by Simon Engineering plc., and the UK facilities owned by Van Ommeren. All enquiries regarding the companies listed below should be addressed to the Simon Storage Group.

Chemicals & Oil Storage Management Limited (COSM):
This is a holding company owned 50/50 by Simon Engineering and Van Ommeren and comprises Cumbrian Storage Limited, Immingham Storage Company Limited, Irish Bulk Liquid Storage Limited and Velva Liquids Limited. Below are details of these companies and also of Seal Sands Storage Ltd., which is wholly owned by Simon Engineering plc., and Thames Matex, wholly owned by Van Ommeren.

Cumbrian Storage Limited:
Prince of Wales Dock, Workington, Cumbria.
Tel: (0900) 5503. Telex: 64331 CSTORR G.
A COSM member. 33,500 cu. metres for petroleum products, liquid sulphur and chemicals storage. Transport by road, rail and sea. Ships Agency: Workington—can handle 10,000 dwt vessels and provides excellent port facilities for deliveries to or from North West England and Southern Scotland.

Immingham Storage Company Limited:
Immingham Docks, Nr. Grimsby, South Humberside.
Tel: (0469) 72615. Telex: 52291 ISCOL G.
Part of the COSM Group. Operates three installations: two at Immingham Dock (East and West) and one at Killingholme. More than 300 tanks with a total capacity of 0.9 million cu. metres, making it the largest independent bulk storage terminal in the UK. Included in this figure are pressure storage for gases, stainless steel, lined, lagged and steam heated tanks. More than 60 jetty lines including six stainless steel provide for excellent segregation of grades. Use is made of three jetties: Eastern, Western and one at Killingholme. The terminal is connected to the Humber refineries and chemical plants by pipelines. The jetties have 35ft draught and can accommodate up to 35,000dwt tankers, coasters or barges. Transport by road, rail, sea and pipeline. The company has land available for expansion to meet customer's special requirements at both Immingham and Killingholme.

Irish Bulk Liquid Storage Limited:
Foynes Harbour, Foynes, Co. Limerick, Eire.
Tel: 010 353 69 65505. Telex: 26882 IBLS EI.
A member of the COSM Group. One installation. 12,500 cu. metres for petroleum and chemical products on the River Shannon. The jetty can accommodate 20,000-ton tankers and facilities are included for the loading to road tank wagons and the supply of products to barges at the jetty. Land available for expansion of the terminal.

Velva Liquids Limited:
Northumberland Dock, North Shields, Tyne & Wear NE29 6DY.
Tel: (0632) 571894. Telex: 53180 Velva G.
A member of the COSM Group. Operates a terminal on the Tyne for the bulk storage, blending and handling of a wide range of petroleum products, chemicals and other bulk liquid products. Total capacity 52,000 cu. metres. Fifty mild steel tanks, ranging in capacity from 300 to 8,600 cu. metres for chemicals, gasolines and oils. Blending facilities. Many tanks are coiled. Ethanol bonded storage available. Some tanks are coated with epoxy or phenolic resin-based paints. Additional land is available for further development and construction to suit particular client requirements. Access by sea and road. Three berths at North Shields provides for vessels up to 10 metres draught. There is rapid access to major road networks for road tankers. Licences to handle chemical wastes.

Seal Sands Storage Limited:
Seal Sands, Middlesbrough, Cleveland TS2 1UB.
Tel: (0642) 546775. Telex: 58218 SSTOR G.
Wholly owned by Simon Engineering plc. Over 100 tanks with a total capacity of 196,400 cu. metres for petroleum products, chemicals including molten sulphur, VCM and propylene and a wide range of edible or specialist products. Two jetties, one taking vessels up to 30,000dwt. The terminal is connected to local chemical plants by pipeline. Transport by road, rail and sea. Block trains handled.

Thames Matex:
Oliver Road, West Thurrock, Grays, Essex RM16 1EH.
Tel: (0708) 86 3261. Telex: 25207 G.
Wholly owned by Van Ommeren. An excellent and modern installation on London's orbital motorway (M25), providing storage for a full range of petroleum products and a wide range of chemicals. Jetties can accommodate up to 50,000dwt vessels. Comprehensive road loading facilities ensure rapid turnround times for loading vehicles. There are 348,000 cu. metres of storage in 120 tanks, a substantial number of which have floating decks. One hundred and five road loading points, many linked to on-line computer facilities. Rail facilities include handling capability for block trains and own shunting loc. Reloading to barges and coasters at up to 500 per hour. Fully computerised stock accounting with direct links to customers equipment by arrangement. Plans exist for further expansion.

SOGESPA

Société Générale de Stockage du Port d'Antifer, 36 rue de Liège, 75008 Paris, France.
Tel: 43873349. Telex: 280330.
Two crude oil terminals in Antifer with an overall capacity of 955,000 cu. metres. Six tanks of 150,000 cu. metres each, and two of 22,500 cu. metres each. Access by sea and pipeline. Seaberths with draughts of 98ft and 82ft respectively. Facilities for discharging ULCC-type vessels up to 550,000 MT and for transhipments.

SOGESTROL

Head Office: Route de la Chimie, 76700 Gonfreville l'Orcher, France.
Tel: (35) 265525. Telex: 190582.
Two terminals, with a total capacity of 320,000 cu. metres, located in the industrial area of Le Havre Port, near chemical and petrochemical plants, and reserved exclusively for chemicals and petrochemicals and all dangerous liquids. Tanks are insulated, coated, heated, refrigerated, of mild and stainless steel, with traced insulated lines. Nitrogen facilities into each tank. Tanks from 5,000 cu. metres have a floating roof. Access by road, rail, sea, river. Connections with certain local plants.

Terminal No.1: 147 tanks from 50 to 15,000 cu. metres, with a total capacity of 222,070 cu. metres. Three jetties, draught of 38ft. for 50,000 ton ships, length 250 metres. Reception from and delivery to ships, barges, road containers, rail cars and drums. Drumming and pipelines to local industries.

Terminal No.2: 38 tanks from 630 to 4,900 cu. metres, with a total capacity of 91,800 cu. metres. One jetty, draught of 27ft. for 9,000 ton ships. Reception from and delivery to ships, barges, road containers, rail cars and drums. Drumming station connected to tanks; facility to drum directly to road containers and rail cars.

SOTRASOL

36 rue de Liège, 75008 Paris, France.
Tel: 45.22.22.70. Telex: 280330.

Tarnos (Port de Bayonne): 100,000 cu. metres capacity for chemical liquids, crude oil, liquid fertilisers, animal and vegetable oils and fats. Seventeen tanks from 640 to 15,000 cu. metres, some stainless steel, some with heating coils or insulation. Nitrogen blanketing facilities. Access by road, rail and sea (two jetties with draught up to 28ft).

Le Havre: One hundred tanks from 30 to 5,000 cu. metres, with a total capacity of 100,000 cu. metres for mineral oils, chemical products with a flash point of over 100°C, liquid fertilisers, molasses, natural and synthetic latex and vegetable and animal oils and fats. Tanks are partly stainless steel, some heated and insulated. Access is by road, rail and sea (three berths, maximum draught 38ft). Planned extension; 1,500 cu. metres.

STOCKNORD SA

ZIP de Mardyck, Dunkirk, France.
Tel: (28) 253102. Telex: 130065.
Associated with Paktank Europa. A total capacity of 230,000 cu. metres, including 35,000 cu. metres for liquefied gases, 16,000 cu. metres for pressurised gases and 7,500 cu. metres for butadiene. Stainless steel tankage for chemicals. Insulating and coating facilities. Three jetties to accommodate vessels up to 100,000, 10,000 and 6,000 tonnes dw respectively. Excellent road and rail access facilities.

TANKFREIGHT LTD

Copthall Bridge House, 1 East Parade, Harrogate HG1 5LN, UK.
Telephone: 0423-506181. Telex: 57608. Fax: 0423 522360
Tankfarms at Felixstowe and on Humberside offer over 130,000cu metres bulk storage capacity equipped to handle a comprehensive range of liquid, edible, chemical and petroleum products.

Felixstowe Tankstore
F.T.D. House, The Dock, Felixstowe, Suffolk IP11 8RY, UK.
Telephone: 0394 286112. Telex: 98341.
A total capacity of 105,500cu metres, com-

THE SECOND OIL LOSS CONTROL CONFERENCE

Wednesday, 7 October, 1987

to be held at
The Cavendish Conference Centre, London

PROGRAMME

09.30 **Opening Address**

Dr R. G. Reynolds, Director, Manufacturing, Supply and Trading, Shell UK Oil, and Vice-President, Institute of Petroleum.

09.45 **CRUDE OIL LOSS ANALYSIS**

An analysis of differences between Bill of Lading and Outturn quantities as supplied by major oil companies, to establish a pattern of loss distribution

Captain D. Smith, Shell International Marine

10.15 Discussion

10.40 **THE DETERMINATION OF DENSITY AND ITS ERRORS**

Sources of error in the sampling of liquids and the subsequent determination of density are considered, along with the concepts of wet and dry density

H. and D. Fitzgerald, Moore, Barrett & Redwood.

11.10 Coffee

11.25 **SHORE TANK MEASUREMENT**

Evaluation of the effects of hydrostatic head on tank calibration and the use of hydrostatic pressure as a means of measuring density

F. Kelly, Shell Research Ltd.

11.55 **PREVIEW OF CARGO MEASUREMENTS AND INSPECTION GUIDELINES**

Preview of Institute of Petroleum Codes of Practice for cargo measurement and inspection

R. D. Cowin, Esso UK.

12.25 Discussion

12.50 Lunch

14.15 **GASOLINE VAPOUR RECOVERY SYSTEMS — ORGANIC VAPOUR EMISSIONS**

Environmental regulations applicable to vapour emissions from gasoline vapour recovery systems — technical and economic considerations

H. D. Richards, Shell International.

14.30 **EXPERIENCES WITH COMMERCIAL VAPOUR RECOVERY SYSTEMS**

Overview of vapour recovery applications in gasoline marketing operations, followed by four short papers on user experiences with various types of commercial vapour recovery units

Vapour recovery developments in Europe
P. G. Edgington, BP Oil International.

Carbon adsorption units
H. D. Richards, Shell International.

Cool Sorption liquid absorption and Kappa Gi condensation units
D. T. Coker, Esso Petroleum Co.

BOC liquid nitrogen condensation unit
A. H. Hall, Mobil Oil Co.

15.15 Discussion

15.30 Tea

15.45 **COMPUTER AIDED LOSS INVESTIGATION AND MONITORING**

The application of statistical analysis of historical data to reveal source and magnitude of measurement errors

J. Miles and P. A. M. Jelffs, Moore Barrett & Redwood.

16.30 Discussion

16.45 Chairman's Closing Remarks

Registration Fees will be **£95 (PLUS 15% VAT)** for IP individual members, and nominated representatives of collective members, and **£120 (PLUS 15% VAT)** for non-members.

The Proceedings of the Conference, to include all papers **and discussion,** will be published by John Wiley and Sons Ltd. early in 1988. Delegates attending will receive a 25% discount off the selling price.

For a copy of the registration form, please contact **Caroline Little,** The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK. Telephone: 01-636 1004. Telex: 264380. Fax: 01-255 1472.

prising 172 mild and stainless steel tanks from 50–5000cu metres for all categories of high and low flash bulk liquids including petroleum products and chemicals. Two berths for tankers up to nine metres draught. Stainless and mild steel jetty pipelines. High speed petroleum road loading facilities. Drum filling, blending, steam cleaning and quality control services.

Humber Tankstore
Scunthorpe, South Humberside DN15 8SY
Contact telephone no. 0394 286112. Telex: 98341.
A total capacity of over 30,000cu metres comprising 35 mild steel tanks, some insulated and coiled from 30–2,500m^3 at Gunness, Grove and Althorpe Wharves on the River Trent, near Scunthorpe. Storage for a variety of high and low flash bulk liquids including petroleum products and chemicals. Four berths, for barges/coasters up to 5.5m draught. Mild steel jetty pipelines. Drum filling and blending facilities. Sites for planned expansion, including stainless steel tanks.

TEES STORAGE CO LTD

Erimus House, Queen's Square, Middlesbrough, Cleveland TS2 1QX, UK.
Tel: (0642) 230 000. Telex: 58477.
Jointly owned by Gebr. Broere BV and Unitank Storage Co. Operates two terminals in the UK.
Middlesbrough: Fifty-six tanks from 50 to 6,500 cu. metres, with a total capacity of 80,000 cu. metres. Mild steel coated and stainless for petroleum and chemicals. Road, rail and sea. Jetty facilities at South Wharf for ships up to 7,500dwt. Ten dock lines (six stainless steel). Based at the Middlesbrough terminal is a 1,500 tonne chemical tank-barge for inter-river transfers and overside cargo.
Seal Sands: Eighty-two tanks from 55 to 8,500 cu. metres, with a total capacity of 140,000 cu. metres. Mild steel coated and stainless for petroleum and chemicals. One sphere of 6,650 cu. metres for Vinyl Chloride Monomer. Road, sea and pipelines to neighbouring plants. Provision for rail. Drumming facilities. Two jetties for ships up to 40,000dwt. Maximum length 760ft; maximum draught 36ft. Fourteen docklines (eight stainless).

TERMINALES PORTUARIAS SA

Head Office: Port of Barcelona, Muelle de Inflamables, Barcelona 4, Spain.
Tel: (3) 3350500. Telex: 54061.
Installations in the ports of Barcelona, Tarragona, Bilbao and Valencia for the storage of chemical and petrochemical products and vegetable oils. A joint venture between GATX Terminals Corporation and Petrofrance.
Barcelona Terminal: 46,765 cu. metres capacity in 86 tanks ranging in size from 50 to 1,200 cu. metres. Two berths with 40ft (12.19 metres) draught. Services include drumming, liquid and dry goods storage (1,080 sq. metres of dry storage), bonded storage, heating, refrigeration, gas blanketing, and coated and stainless steel tanks. Surface access via Barcelona Expressway system.
Bilbao Terminal: 7,449 cu. metres capacity in 27 tanks ranging in size from 50 to 630 cu. metres. One berth with 22ft (6.7 metres) draught. Services include drumming, heated and coated tanks, gas blanketing. Surface access via E50 Coastal Highway.
Valencia Terminal: 8,634 cu. metres capacity in 34 tanks ranging in size from 50 to 630 cu. metres. Two berths with 30ft (9.14 metres) draught. Services include drumming, heated and coated tanks, gas blanketing. Surface access via E101 Valencia-Madrid Highway and E26 Coastal Highway.
Tarragona Terminal: Capacity of 24,700 cu. metres in 27 tanks of 650 and 1,300 cu. metres. Two berths with 45ft (14 metres) draught. Services include heated, coated and stainless steel tanks, gas blanketing. Surface access via local major arteries.

UNITANK STORAGE COMPANY

Nicholson House, Nicholson's Walk, High Street, Maidenhead, Berks SL6 1LQ, UK.
Tel: (0628) 36111. Telex: 847862.
Operates eight terminals in the UK. Associated with Tees Storage, Middlesbrough, and Seal Sands; Unitank Terminal Service, Philadelphia; United Molasses; Pacific Molasses; Wymondham Oil Storage.
Avonmouth, Bristol: Fifty-six tanks with a total capacity of 142,600 cu. metres, from 311 to 6,900 cu. metres in size, for high and low flash petroleum products, chemicals, molasses and oils and fats. Dock facilities comprise seven berths at the Royal Edward Dock (depth 32ft, maximum length 690ft, maximum beam 95ft), five piggable docklines (three 10in lines, one 24in line for molasses and one 8in s/s line) and 18 dedicated m/s lines. Distribution is through self-service road loading capable of handling 550 gallons per minute. Wensat pipeline connection. Access to British Rail network. Easy access to M4 and M5.
Belfast: Thirty-seven tanks with a total capacity of 35,290 cu. metres from 95 to 3,100 cu. metres in size for high and low flash petroleum products, chemicals, latex and oils and fats. There is one jetty on the Musgrave Channel (depth 30ft. maximum length 600ft, maximum beam 100ft), two 8in s/s docklines and separate lines for fuel oil, latex and tallow. All lines are piggable. Distribution is through self-service road loading capable of handling 550 gallons per minute. Easy access to M1 and M2.
Bromsgrove, Worcestershire: Rail-fed terminal. Nineteen tanks ranging in size from 35 to 1,350 cu. metres with a total capacity of 16,000 cu. metres, for high flash petroleum products. Capable of handling 1,400-tonne block trains. Distribution through self-service road loading facilities. Easy access to M5 and M6.
Eastham, Merseyside: Seventy-nine tanks with a total capacity of 276,700 cu. metres from 50 to 10,800 cu. metres in size in mild and stainless steel and aluminium, for high and low flash petroleum products and chemicals. Dock facilities consist of three berths in the QEII Dock (depth 33ft, maximum length 670ft, maximum beam 90ft) with seven piggable docklines (two 6in s/s lines, one 10in s/s line, one 10in m/s line, two 12in and one 14in). Distribution is through self-service road loading capable of handling 550 gallons per minute and rail sidings capable of loading and discharging 1,000-ton block trains. Easy access to M53, M56 and M6.
Grays, Essex: Fifty-two tanks with a total capacity of 311,000 cu. metres from 1,700 to 20,800 cu. metres in size, for high and low flash petroleum products and some chemicals. There are two jetties (Wouldham Nos. 1 and 2, depth 37ft at low water, maximum length 750ft, beam unrestricted) with five piggable docklines—three 10in, one 12in and one 14in. Road distribution is through self-service road loading. Rail sidings capable of loading 1,000-ton block trains. Easy access to M25.
Runcorn, Cheshire: Four tanks with a total capacity of 40,000 product tons for heated liquid sulphur. Dock facilities comprise one jetty on the Manchester Ship Canal. Distribution is through road loading on two automatic weighbridges. Easy access to M53, M56 and M6.
Leith, Scotland: Thirty tanks with a total capacity of 67,900 cu. metres, from 55 to 13,400 cu. metres in size for high and low flash petroleum products and chemicals. Dock facilities comprise one berth (depth 31ft, maximum length 650ft, maximum beam 100ft) with three mild and two stainless steel docklines. All lines are piggable. Distribution is through self-service road loading and rail. Access to M8, M9 and M90.
Wymondham, Norfolk: Eight tanks with a total capacity of 39,200 cu. metres from 4,100 to 5,200 cu. metres in size. High and low flash petroleum products on a co-mingled, through-putting basis. Distribution through fully automated road loading gantries at 55 GPM. Easy access to A11.

VTG-PAKTANK HAMBURG GMBH

Monckebergstrasse 18, 2000 Hamburg 1, West Germany.
Tel: (40) 322843. Telex: 2163506.
Hohe Schaar (Hamburg): 427,000 cu. metres; sea, road, rail; 48ft; crude oils, petroleum products, chemicals.
Tollerort (Hamburg): 32,000 cu. metres; sea, road, rail; 29ft; petroleum products, chemicals, lubricating oils, latex, vegetable and animal oils and fats.
Kiel: 33,000 cu. metres; sea, road; 30ft; petroleum products. Bunker station.

VTG VEREINIGTE TANKLAGER UND TRANSPORTMITTEL GMBH

Head Office: Neue Rabenstrasse 21, 2000 Hamburg 36, West Germany.
Tel: (40) 44191-0. Telex: 2170080 vt d.
VTG, a member of the PREUSSAG Group, is one of the largest independent tank storage companies in Europe. VTG operates large modern tank installations at seaports and inland with a total capacity of around 2.5m cu. metres. Storage facilities are complemented by 22,000 rail tank wagons, special purpose wagons and tank containers for the transport of petroleum products, chemicals, gases and bulk goods. An Inland Tank Shipping Service operates on all major European waterways. The VTG offshore service provides high-powered supply ships and helicopters to service drilling rigs and construction platforms where oil and gas are being extracted offshore.
Berlin: 225,000 cu. metres, 94 tanks ranging from 10 to 20,000 cu. metres for all petroleum products, solvents and petrochemicals; access for barges, road and rail tank cars and liner trains.
Duisburg: 240,000 cu. metres, 155 tanks vary-

ing in size from 15 to 9,000 cu. metres. Insulated, coiled, coated and aluminium tanks are available and equipped with dedicated pipelines, heating, blending, nitrogen blanketing, vapour-return and dry air ventilation facilities. Petroleum products, chemical and petrochemical liquids, liquefied gases and solvents. Distribution by road, rail, barge, pipeline.

Ebrach: 5,000 cu. metres for storing petroleum products.

Hanover: 340,000 cu. metres. 28 tanks ranging from 500 to 70,000 cu. metres for crude oil, petroleum products, chemicals and solvents. Access for road and rail tank cars, liner trains and barges; crude oil pipeline.

Munich: 155,000 cu. metres, 41 tanks ranging from 50 to 47,000 cu. metres for storing petroleum products, chemical and petrochemical liquids and solvents. Blending facilities for gasoline are available. Access as above.

Regensburg: 66,000 cu. metres, 54 tanks varying in size from 100 to 9,000 cu. metres. All petroleum products, chemical and petrochemical liquids and solvents. Heating, blending and mixing facilities. Distribution by road, rail and barge.

Operation of the BP terminals:

Köln: 101,000 cu. metres, 31 tanks ranging from 25 to 25,000 cu. metres for storing petroleum products, chemicals and solvents. Access by road, rail, barge and pipeline (RMR).

Mainz-Gustavsburg: 256,000 cu. metres, 33 tanks ranging from eight to 40,000 cu. metres for all petroleum products, solvents and petrochemicals. Access by barge, road, rail tank cars, liner trains and pipeline (RMR).

Stuttgart: 35,000 cu. metres, 29 tanks from 25 to 5,500 cu. metres for all petroleum products, solvents and petrochemicals. Distribution by road, rail, barge.

Amsterdam: COMOS TANK BV

Hamburg: VTG-PAKTANK HAMBURG GMBH

Further details of these two companies are given under their separate headings.

ZEEGAS

Marcus Gerardstraat 1, 8380 Zeebrugge, Belgium.

Address and telephone no. in UK as for King's Lynn Storage Ltd. Part of the Chemolink Group.

6,400 cu. metres of gas storage capacity in two spheres and 24 underground bullets, for the storage of LPG, chemical gases and VCM. C3 gases can be handled directly to and from sea, road and rail. Two jetties for ships up to 12,000 cu. metres. Seven rail/road loading and unloading points. Rail weighbridge. Two-storey office building, plus laboratory, workshops etc.

ZEETANK NV

New Yorklaan 12, 8380 Zeebrugge, Belgium.
Tel: (050) 544611. Telex: 81304.

Operates a 145,600 cu. metres capacity terminal at Zeebrugge, with individual tanks varying in capacity from 1,000 to 24,000 cu. metres. High-flash white oils, high flash black oils and low flash clean products can be handled. Road and rail loading facilities, with connections to UK ferries. Berths for coasters, barges and seagoing vessels up to 40ft draught. ●

Losses in the shipment of crude oil: Recent developments in analysis and quantification

by David Tomi, BE, PhD, CEng, MIChem E, MIMarE, and Ivan Vince, BSc, MSc, PhD, FInst E,
CWA Consultants Ltd

***The Second Oil Loss Conference* to be held in October this year will review progress since 1984. The paper that follows by David Tomi and Ivan Vince on evaporative loss of crude oil from tankers is a precursor to the subjects that will be presented. It is hoped that an opportunity will occur during the conference to discuss its findings and implications for the future**

Abstract

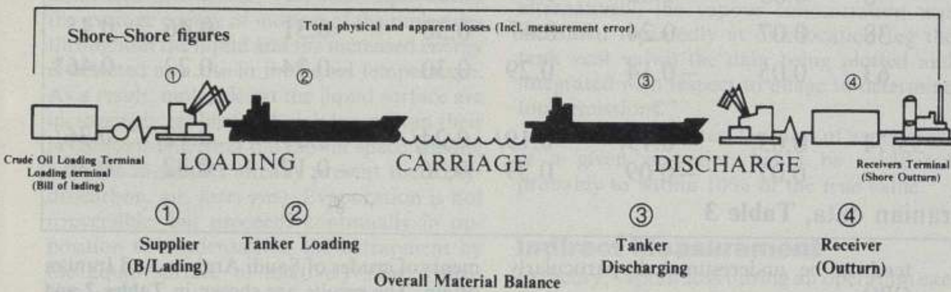
The underlying problem in the reconciliation of oil measurements for the purpose of loss control is the identification and quantification of real losses as opposed to apparent losses due to measurement error. An overall material balance provides a useful framework for analysis.

The results of a recent pilot study of oil loss statistics, derived from conventional voyage files for liftings of Middle East crude parcels during 1984/86, are presented.

The factors which govern evaporative loss are identified and discussed. The magnitude of crude evaporative losses during loaded passage is considered from fundamental principles. Predicted transit losses are relatively small and lie within the 95% confidence limits derived from the pilot study.

There are grounds to suggest that evaporative losses of light ends during COW can produce a net penalty in NSV outturn. The quantification of additional vapour loss induced by COW and the control of venting during COW requires further attention.

Figure 1: Analysis of Measured Outturn Loss



Reconciliation ① − ④ = (① − ②) + (② − ③) + (③ − ④)

by measurement $B - R = (-SSL - OBQ) + (A/L - B/D) + (SSD + ROB)$

by loss factor $B - R = \triangle P + (ROB - OBQ) + (SSD + SSL)$

Notes SSL ship/shore difference, loadport. $\triangle$P passage difference. SSD ship/shore difference, disport.

1.0 Introduction

The commitment of the Oil Industry to monitor, reconcile and control oil losses was hardened irreversibly by the now historical increase in crude oil prices. Further stimulus was given by the introduction of tougher anti-pollution regulations. Despite the recent easing of supply-side economic conditions, the disciplines of oil loss control, as established over the last decade, continue to be deveoped. At the first Conference convened by the Institute of Petroleum on *Oil Loss Control*[1] there was a strong consensus that oil companies and other interested parties should sustain and increase their investment in oil loss control programmes. Consequently, further attention has been given to improving the accuracy of measurement systems, particularly the detection and measurement of water in crude. Improved codes of practice for oil inspection, measurement and reconciliation have been formulated by a work committee of the Institute of Petroleum. Most recently, the first steps have been taken towards establishing a pooled loss data base for the benefit of the Industry taken as a whole.[2] Technologically, considerable advances have been made but nevertheless the control of losses in the shipment of crude presents special difficulties in comparison with the cargo handling of refined petroleum products.

It is misleading to consider 'crude' in terms of one common material. The current listing of world crude analyses compiled by the Oil and Gas Journal numbers almost 200 crudes produced from established fields. Inspection of the assay data[3] demonstrates that handling properties of crudes (for example Reid vapour pressure (RVP), viscosity, density, pour point) exhibit variations over an enormous range. Furthermore, subject to the pre-conditions of shipment, including stabilisation, dewatering and residence time in storage for final settling, export crudes also exhibit wide variation in sediment and water content (S&W) at the point of supply. The practice of blending or spiking crudes and the impact of ambient conditions are additional, important factors to be taken into consideration.

The underlying problem in the reconciliation of oil measurements for the purpose of loss control is the identification and quantification of real losses as opposed to apparent losses due to measurement error. Whereas real losses inevitably occur, to a greater or lesser extent, at each point of transfer and during carriage, in practice such losses (eg evaporation, increase in clingage) are not susceptible to direct measurement. Unlike retention of residues onboard, which are subject to washing and recovery as slops, in accordance with the load on top procedure, evaporative losses are generally unrecoverable, but occur continuously, to a greater or lesser extent, during loading, carriage and discharge.

A system for data collection and analysis is required and it is recommended that this takes the form of an overall material balance. A useful framework for analysis in the case of a simple voyage is shown in **Figure 1**. Losses occur over each stage of the shipment during loading, carriage and discharge and these must be reconciled in terms of the measurements made. The tanker provides the common link between the shipper and receiver and presents a well defined cargo handling system and sequence of operations for analysis in terms of loss factors.

2.0 Pilot study statistics

By way of illustration, it is of interest to examine the results of a pilot study recently conducted by CWA concerning oil loss statistics relating to typical liftings of Middle East crudes, predominantly over the period 1984/86, as can readily be extracted from routine voyage files. The data base comprises 158 separate voyages, almost entirely from Saudi Arabian and Iranian origin with shipment by VLCC. The pilot study considered only overall results so that in cases of multi-grade/multi-disport voyages the outturn results were summed.

The global results of the data base of the pilot study are shown in **Table 1**. Losses are normalised and expressed as a percentage of the Bill of Lading. Simple statistics are presented for various loss factors including outlier values, standard deviation, mean and the 95% confidence limits about the mean.[4, 5] The following points are noted with reference to **Table 1.**

a The mean NSV loss (0.59) is almost double the mean TCV loss (0.31) and this is due to the commensurate increase in S&W (0.28) as measured at the disport in relation to the point of supply. The mean S&W received is 0.31 which represents a 10 fold increase over the mean S&W figure supplied by Shippers. This result underlines the major area of concern towards undetected S&W at many export terminals, a factor which leads to significant paper shortages.

b The mean passage difference, derived from comparison of ship's loaded figures over passage, is computed as 0.11; although the confidence limits are fairly wide, 0.04%–0.18%. These results, as discussed

Table 1 Analysis of Data, Global

	S&W Supp	SSL	Pass Diff	%COW	ROB	ROB–OBQ	SSD	S&W Rec	S&W Diff	Outturn TCV	Loss NSV
Count	158	158	158	158	158	158	158	158	158	158	158
Max	0.38	1.58	1.51	100	1.18	0.59	2.93	1.77	0.17	2.75	3.10
Min	0.00	−1.12	−1.62	0	0.00	−1.90	−1.32	0.00	−1.77	−1.81	−0.70
Std dev	0.05	0.35	0.44	42	0.14	0.29	0.56	0.32	0.32	0.53	0.50
Mean	0.03	0.05	0.11	59	0.09	−0.10	0.35	0.31	−0.28	0.31	0.59
95% CL of Mean	0.02/ 0.04	0.00/ 0.10	0.04/ 0.18	52/66	0.07/ 0.11	−0.15/ −0.05	0.26/ 0.44	0.26/ 0.36	−0.33/ −0.23	0.23/ 0.39	0.51/ 0.67

Note: TCV = Total Calculated Volume
NSV = Net standard Volume

Table 2 Analysis of Saudi Arabia Data

	S&W Supp	SSL	Pass Diff	%COW	ROB	ROB–OBQ	SSD	S&W Rec	S&W Diff	Outturn TCV	Loss NSV
Count	82	82	82	82	82	82	82	82	82	82	82
Max	0.38	0.78	1.51	100	0.38	0.13	2.20	1.77	0.17	2.00	2.33
Min	0.00	−1.12	−1.62	0	0.00	−1.42	−1.04	0.00	−1.67	−0.97	−0.54
Std dev	0.06	0.33	0.45	38	0.07	0.24	0.47	0.30	0.31	0.46	0.45
Mean	0.06*	0.04	0.10	63	0.05	−0.14	0.29	0.30	−0.24	0.22	0.46*
95% CL of Mean	0.05/ 0.07	−0.03/ 0.11	0.00/ 0.20	55/71	0.03/ 0.07	−0.19/ −0.09	0.19/ 0.39	0.24/ 0.36	−0.31/ −0.17	0.12/ 0.32	0.36/ 0.56

*Highly significant with reference to Iranian data, **Table 3**

in section 3.0 are in line with estimates for ocean loss by evaporation reported in the technical literature. We note, however, the wide scatter in results including high negative values which certainly cannot be explained by evaporative loss and are suggestive of measurement errors in ship's figures.

c The difference between ROB and OBQ is negative, indicative of good stripping, although the mean recorded ROB, 0.09, is considered low. It is noteworthy that ROB and OBQ measurements are subject to large measurement error and, in practice, tend to be underestimated, particularly OBQ.

d As far as the decomposition of the TCV outturn loss is concerned, the dominant loss factor is the higher ship/shore difference at discharge in comparison with ship/shore difference at loading.

At the disport, additional evaporative loss occurs, particularly with COW and there is also the question of clingage and line hold up. The residual, unexplained loss is linked to the relative accuracy of shore measurements.

The global data have been partitioned to compare and contrast losses arising in shipments of crudes of Saudi Arabian and Iranian origin. The results are shown in **Tables 2 and 3** respectively. Inspection suggests obvious differences between respective loss factors and this is confirmed statistically for a number of results. We tested the hypothesis that the mean NSV for Saudi liftings (0.46 from a sample of 82 with a deviation of 0.45) was equal to that found for Iranian liftings (0.76 from a sample of 64 with a deviation of 0.52). The tests showed that we can reject the hypothesis with 99% confidence. In other words, the higher mean NSV loss for the Iranian liftings compared with that for Saudi liftings is highly significant.

Table 3 Analysis of Iranian Data

	S&W Supp	SSL	Pass Diff	%COW	ROB	ROB–OBQ	SSD	S&W Rec	S&W Diff	Outturn TCV	Loss NSV
Count	64	64	64	64	64	64	64	64	64	64	64
Max	0.00	1.58	1.51	100	0.61	0.58	2.93	1.77	0.00	2.75	3.10
Min	0.00	−0.58	−0.94	0	0.00	−1.09	−1.32	0.00	−1.77	−0.87	−0.38
Std dev	0.00	0.33	0.39	44	0.11	0.22	0.63	0.34	0.34	0.53	0.52
Mean	0.00*	0.05	0.14	64	0.10	−0.05	0.37	0.35	−0.35	0.42	0.76*
95% CL of Mean	0.00/ 0.00	−0.03/ 0.13	0.04/ 0.24	53/75	0.07/ 0.13	−0.10/ 0.00	0.22/ 0.52	0.27/ 0.43	−0.43/ −0.27	0.29/ 0.55	0.63/ 0.89

*Highly significant compared with Saudi data, **Table 2**

The mean S&W supply, as reported for Saudi liftings (0.06) were significantly higher than that in the Iranian sample, since, in the latter case, this component was invariably reported as zero. In both cases, however, there is a marked increase in the S&W measured on receipt, 0.30 and 0.35 for Saudi and Iranian liftings respectively which suggests that for each source the S&W supplied is understated to the same order of magnitude.

On the sample data, the mean passage loss factors are not significantly different, the 95% confidence limits being 0–0.2 and 0.04–0.24 for Saudi and Iranian liftings as shown in Tables 2 and 3 respectively. With this background in mind, consideration is given to the analysis and quantification of evaporative loss from first principles. The question of COW induced vapour loss is taken up at the end of this paper.

3.0 Evaporative Loss

Background

Evaporative loss during the handling and transport of crude oil occurs as a result of a series of phenomena which are fairly simple to describe physically, although complex to formulate accurately.

Heat is transferred from the environment into and throughout the liquid bulk by radiation and convection. This heat input raises the average energy of motion of the molecules throughout the liquid and the increased energy is detected as a rise in the liquid temperature. As a result, molecules at the liquid surface are increasingly enabled to break loose from their neighbours and enter the vapour space, mixing with the molecules already present there (hydrocarbon, air, inert gas). Evaporation is not irreversible, but proceeds continually in opposition to condensation, the entrapment by the liquid surface of relatively slow hydrocarbon molecules impinging on it from the vapour.

The way in which vapour is lost permanently from the vapour space into the atmosphere varies according to tanker operation. The reader is referred to Uhlin[6] for a clear diagrammatic account. Very briefly, loading results in gross displacement of the tank atmosphere. During loaded passage, daily cycles of warming and cooling cause pressure fluctuations within the vapour space, which, if severe enough, result in 'breathing' losses through the pressure-vacuum (PV) valves. After discharge the cargo tanks contain an atmosphere rich in hydrocarbon vapour, which is usually vented in the course of normal operations which are performed during ballast passage (ballasting, tank washing, gas freeing etc).

Review

The published literature contains very few reports of the monitoring of evaporative loss during normal crude tanker operations.

Reported studies fall mainly into two groups: detailed reports on one or two voyages, and superficial reports on a larger number of voyages. The API study[9] provides useful results for crude losses during small scale transfer operations at US terminals but these are of limited application and the study specifically excludes VLCC and COW operations.

In view of the very large number of variables affecting evaporative loss, it is perhaps not surprising that estimates based on such limited field measurements combined with intuitive 'guesstimates', should vary by more than an order of magnitude.

Whereas the extent of data to be extracted from the limited number of voyage monitoring studies is insufficient for predictive purposes, it is worthwhile to review the accuracy of reported measurements.

Direct Measurement

It appears that direct measurements of vapour loss have been restricted to transfer operations during loading, discharge and ballasting.

In several trials[6, 8–10, 14] portable instruments were used to measure hydrocarbon concentration in situ. The common principle of operation of these instruments is the measurement of the rate of heat loss from a heated filament subjected to the gas mixture. Since thermal conductivity varies somewhat among the light hydrocarbons of interest, the instrument was calibrated in the laboratory, using either gas chromatography (GC) or non-dispersive infra-red (NDIR) techniques, after the vapour composition had been determined, usually by GC.

Vertical concentration profiles were obtained throughout loading and discharging, or alternatively, the vapour concentration was measured repeatedly at one location (eg the tank vent valve) the data being plotted and integrated with respect to ullage to determine total emissions.

By these procedures, the mass of vapour lost in a given operation could be calculated probably to within 10% of the true value.

Indirect Measurement

In theory, vapour loss during an operation can be calculated from liquid composition before and after the operation. Reference 7 describes three diagnostics, namely:

- ***a*** Change in gas chromatograms of liquid samples
- ***b*** Change in RVP
- ***c*** Change in density

Method ***a*** is criticised[7] on the grounds that, since GC is incapable of representing the heaviest fractions of crude oil accurately, quantitative comparisons cannot be made. This objection could, however, be overcome by ignoring the heaviest fractions. The loss of light components could be monitored, in our opinion quantitatively, against a combination of well characterised peaks in the C10–C16 region, where evaporation would be minimal.

Practical limitations of sampling procedures render change in RVP method ***b*** an inconvenient parameter for monitoring evaporative loss, since a fractional loss of the most volatile components can reduce RVP dramatically.

Provided water content is meticulously accounted for, change in liquid density method ***c*** has been recommended as probably the best indirect measurement method. Inkley and Purvey[14] taking precautions to minimise loss of light ends during sampling, carried out density determinations using calibrated hydrometers corrected for meniscus thickness and standardised the density values using an experimentally determined expansion coefficient. A limited number of direct measurements were found in reasonably good agreement with results obtained as described above.

The intrinsic difficulty of obtaining representative crude oil samples seems to us to cast doubt on the validity of inferring the extent of vapour loss from changes in liquid properties. Conversely, a random sample, even if representative of the bulk cargo, would not indicate the state or extent of any depleted crude near the liquid surface.

Breathing Losses

Unfortunately, no direct measurements of breathing losses in transit were attempted in any work reviewed here. Estimates for breathing losses were based on tank repressurisation data alone[6, 11] and should therefore be viewed cautiously.

Results of Reported Monitoring Trials

The most thorough and broadly based of the surveys[9] is summarised below. Estimation procedures are developed for:

Loading gasoline into tankers and barges
Loading of crude oil into tankers
Ballasting of crude oil tankers

Emission factors have been developed at three levels of increasing detail and accuracy:

- ***a*** *Typical overall emission factors* can be used to estimate emissions in the absence of specific information about vessel and cargo.
- ***b*** *Category specific emission factors* are more precise, taking into account vessel's previous cargo, arrival ullage and compartment treatment during ballast voyage.
- *c* *Correlations for estimating emissions from loading and ballasting of crude oil tankers.* These correlations require as input, additional to (b) above, RVP and cargo arrival temperature.

The test programme involved measurements during all seasons of the year and in many regions of the US, usually during routine operations.

The data base for crude oil loading comprised tests of 67 compartments during 16 loading operations of six different crudes (RVP = 0.2–7.0 psi) at temperatures between 68°F and 120°F. The data base for ballasting was of a somewhat larger size and spread. Confidence intervals were obtained for crude oil ballasting but not for loading.

Hydrocarbon concentrations were measured at deck level using an on-line instrument calibrated by laboratory GC or NDIR. The concentrations were integrated with respect to ullage throughout the operation. Molecular weight of vapour was measured using GC.

No details of temperature measurement either in liquid or vapour phase are given, but are presumably available in the relevant API documentation file.

Typical evaporative loss estimates for non-lightered and lightered crude oil tankers were 0.03 (range 0.01–0.08) and 0.05 (range 0.01–0.12) vol % respectively.

Loss during discharge accounted for 75%–95% of total evaporative loss.

Laboratory Simulations

No tanker monitoring programme of reasonable size could hope to examine the separate influence of all relevant factors upon evaporative loss, far less draw statistically meaningful conclusions concerning them. It is surprising, therefore, that the literature contains no report of a systematic laboratory study in which many factors are varied individually. The results of such a study could be extrapolated, using well-established scaling procedures, to help predict evaporative losses onboard tankers.

In the context of crude oil spills, evaporation experiments[8] on five crudes have yielded weathering data in good agreement with a simple thermodynamic model.

Another study[8] carried out in the research laboratories of a major oil company, produced a most unexpected result: the rate of evaporation of a crude can depend on its viscosity even more than on its volatility (measured as RVP). A likely explanation is that evaporation impoverishes the liquid surface layer with respect to volatile hydrocarbons, and replenishment of this layer requires convective mixing within the liquid bulk, a process that is highly sensitive to changes in viscosity.

Discussion of factors affecting Evaporative Loss

Fundamentals

Evaporative loss, as outlined above, is mediated by a sequence of heat and mass transfer processes, in both the liquid and vapour phase within a vessel's tank. The driving force for heat transfer is **temperature gradient**, while that for mass transfer is **concentration gradient**. It is well known that wet clothes will dry more quickly on a hot day (enhanced heat transfer) or on a dry day (enhanced mass transfer — additionally, wind aids drying by continually replacing moist air near the liquid surface with dry air). In addition to the driving forces, account must also be taken of the **time** and **surface area** available for the transfer processes: given enough time, an entire lake loses all its water unless replenished; and increasing a liquid's surface area by spraying it is the basis of many industrial drying processes.

The factors governing evaporative loss in crude shipments are enumerated below and all are related to one or more of the underlying determinants, namely temperature and concentration gradients, time and surface area. However, evaporation onboard an oil tanker does not in principle imply an unrecoverable loss, unless the vapour is vented to the atmosphere. The pressure generated within the vapour space is therefore also an important consideration, particularly in transit. A primary purpose of PV valves is, after all, to prevent vapour emissions despite daily cycles of evaporation and condensation within the ullage space of cargo tanks.

Cargo characteristics

Vapour Pressure: The volatility, or tendency to evaporate, of a liquid at a given temperature is closely related to its vapour pressure at that temperature. The vapour pressure, also known as the true vapour pressure (TVP) in distinction to the RVP (see below) is the pressure exerted by vapour in equilibrium with the generating liquid in a closed container.

Clearly, TVP is of fundamental importance in predicting evaporative loss. Unfortunately, in the case of liquid mixtures, TVP is not a unique characteristic of the mixture properties alone, but depends also on the size of the container. It can readily be shown, using elementary molecular theory (Raoult's and Dalton's Laws) that the TVP of a mixture of liquids will decrease with increasing vapour-to-liquid volume ratio.

To illustrate this point, consider a sealed liquid mixture containing 10 moles of a highly volatile component, TVP = 30 psia at ambient temperature and 90 moles of non-volatile liquid. By Raoult's Law, the mixture TVP = 3 psi. Now let the mixture be poured into a container of $3m^3$ volume. A quick calculation shows that there is insufficient volatile component to maintain 3 psi even if it were all in the vapour phase. The mixture TVP would fall to nearly zero in a container of $30m^3$, even though most of the mixture was still liquid.

Temperature: A 5°C rise in the mean temperature of a tank of crude oil is accompanied by a TVP increase of the order of 20%, the precise value depending on the nature of the cargo, the actual temperature and the vapour/liquid ratio.

Reid Vapour Pressure (RVP): The RVP apparatus provides a standard environment (temperature, vapour/liquid ratio) for the determination of mixture vapour pressures. Nomograms are available for the approximate conversion of both crude oil and petroleum product RVPs to TVPs at varying temperatures. The point has repeatedly been made that nomograms and formulae in common use under-predict TVP in a loaded tank, when vapour/liquid volume ratio is two orders of magnitude lower than that in the RVP apparatus.

Composition: Two crudes with the same RVP initially can suffer depletion to very different degrees, depending on the precise composition of the light ends. Thus, a crude whose light ends consist of a relatively small quantity of highly volatile components will evaporate to a lesser extent in the course of custody transfer operations than one whose light components, while somewhat less volatile, form a much larger proportion of the crude.

Viscosity: The effect of oil viscosity on evaporation rate has already been mentioned. In a weathering test[8] in open top containers at 77°F, a highly viscous crude (600 centiStokes) was found to evaporate 10–20 times more slowly than a more mobile crude (7.5 cSt) despite having a higher RVP (14.1 vs 11.9 psi).

Effect of Vessel Factors

Size: Heat and mass transfer rates are strongly influenced by the length scale of convection currents, which in turn are a function of the container size. Additionally, simple geometry dictates that the surface available for heat transfer and evaporation is less per unit volume in the shipment of larger inventories. For these reasons, experience with evaporative loss on barges and small tankers has led to overprediction onboard VLCC's[9, 10].

Tankers vs OBOs: It is beyond the scope of this article to examine in detail the effect of design factors that can have a bearing on evaporative loss. As an obvious example, the OBO structure is more vulnerable to overpressurisation; consequently OBOs have PV valves adjusted to lower settings than tankers (usually less than 1 psig vs 2–3 psig). Gross movement of liquid in an OBO is generally more vigorous than in a tanker, owing to the larger free surface. Finally, OBOs have relatively large hatches, the seals of which, with weathering, are prone to a loss in gas-tightness. For all these reasons, OBOs are likely to experience relatively greater evaporative losses than tankers, particularly during loaded passage.

Condition and Settings on PV Valves: The higher the pressure setting on a PV valve (and, conversely, the lower the vacuum setting) the smaller will be the breathing losses. If the temperature-generated diurnal pressure variations are lower in amplitude than the difference between the low and high PV valve settings, there should, theoretically, be no breathing loss at all. On the other hand, jammed or leaking valves give rise to continuous breathing and substantial losses in transit.

Carriage in Centre vs Wing Tanks: Centre tanks are better insulated from the environment than wing tanks. Depending on the initial cargo temperature, this effect could increase or decrease evaporative loss.

Inert Gas (IG): On vessels fitted with IG, judicious timing and control of tank pressurisation can help to minimise venting to the atmosphere. There is a certain amount of confusion concerning the effect of IG on evaporative loss and a number of misconceptions appear to have been reported in recent publications. The partial pressure of hydrocarbons in the ullage space is solely determined by the temperature at the vapour/liquid interface and the composition of the surface layer of the liquid. These factors apart, the hydrocarbon concentration of the ullage space will be identical whether the gaseous diluent is air or IG. IG provides the means of greater control of breathing losses but can lead to unnecessary venting if tanks are pressed up above the minimum requirement at night.

Condition of Painted Surfaces: Atmospheric heat transfer into the cargo bulk is almost exclusively via radiation. Hence a reflective deck is the best protection against excessive diurnal temperature cycling and consequent venting.

Rate of Loading: Very rapid loading increases turbulence in the early stages, and thus the liquid surface area available for evaporation. As a result, the penetration of saturated vapour into the ullage volume is more rapid. Delays in loading, especially in the early stages, increase loss, since they allow increasing saturation of the vapour space. Since hydrocarbon vapour is considerably denser than air, the vapour generated during loading tends to form a saturated layer on top of the liquid surface, from which it spreads upwards mainly through molecular diffusion, a relatively slow process. Few quantitative measurements are available in the technical literature. Uhlin[6] gives an estimate of 0.03% for evaporative loss during loading, a figure which is also supported by a BP study[11]

Routing of Ullage Vapours during Loading: It is not always essential for the vapour contents of every tank loaded to be vented to atmosphere. Further, if the vapour is displaced instead into an empty tank, it will tend to suppress vapour generation when that tank is loaded (by lowering the concentration gradient).

Ullage Volumes: Slack tanks will suffer larger breathing losses in terms of volume than full ones; however, the hydrocarbon content of the vented gases will be considerably lower in the case of slack tanks. For a given set of cargo characteristics and environmental conditions, there is probably an optimum ullage for minimising evaporative loss. This question has not, to our knowledge, been investigated.

Voyage Duration: In-transit losses are roughly proportional to the number of breathing episodes, detectable as repressurisations on vessels fitted with IG systems. Since these episodes are driven by diurnal temperature cycles, total evaporative loss should be proportional to voyage duration, ambient conditions remaining constant.

Tank Gauging: Manual ullaging, sampling and temperature measurement result in substantial vapour losses, both at loadport and disport.

Environmental Factors

Season and Latitude: The main environmental influence on evaporative loss is solar radiation. Both the peak intensity and the daily duration of sunlight are strongly influenced by season and latitude; the relationships can be expressed approximately by mathematical formulae and are tabulated[12].

Sea Conditions: Heavy seas cause a vessel to roll and pitch, agitating the cargo. Evolution of vapour is encouraged by increased surface area, by replenishment of the surface layer of liquid with light hydrocarbon from the bulk, and, in the case of slack tanks, by dispersion of the saturated vapour blanket lying just above the liquid surface. Under extreme conditions, even liquid can be ejected from full tanks.

Theoretical Analysis of Breathing Losses

Introduction

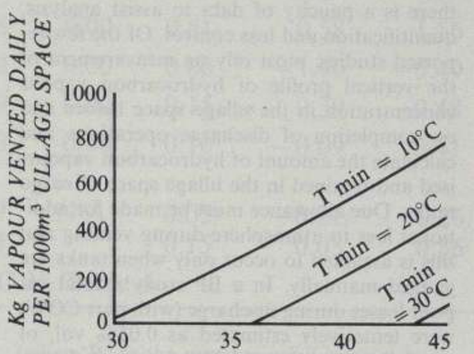
The precise mathematical treatment of evaporative losses is beyond present capabilities, for two main reasons:

a The underlying processes of heat and mass transfer are not at equilibrium and, during loading and discharge, are not even at steady state. As a result, the complexity of calculations is increased by several orders of magnitude, and the accuracy of answers very much reduced.

b A large number of factors influence evaporative loss, some of which are not amenable to precise quantitative modelling (eg the effects of COW), and some which are difficult to measure in practice, eg average heat absorption properties of vessel's deck, thus precluding the testing and validation of predictive mathematical models.

The comments made above should not be mistaken to imply that theory is of marginal relevance to the problem of evaporative loss. On the contrary, consideration of heat and mass transfer phenomena from first principles allows identification and ranking of relevant factors, and points to cost effective improvements in design and operation of vessels

Figure 2: Breathing loss during carriage at sea as a function of daily temperature extremes in the ullage space



Note RVP = 8 psi PV valve settings (+2, −1) psig

to minimise evaporative losses; for example, the introduction of reflective paint on vessels' decks.

The above reservations apply with less force to in-transit 'breathing' losses; as described below, CWA have developed a theoretical model which, with the aid of computer simulation, predicts these losses semi-quantitatively. The formulation is summarised in the Appendix.

Consider a full tank on a tanker, holding several thousand m³ of crude oil with an ullage volume of perhaps 1000 m³. Depending on season and latitude, the deck above the tank may be subjected during the day to intense thermal radiation. A proportion of this radiation is rapidly transmitted into the ullage space, warming the gaseous contents. Given time to equilibrate, the liquid cargo would act as a massive heat sink, damping down any temperature rise within the vapour phase; however, time for equilibration is not available. Heat transfer from vapour to liquid bulk can take place only by natural convection in a most unfavourable configuration: downwards from a horizontal surface. This is far slower than the (mostly) radiant heat transfer from the environment to the ullage vapours. Additionally, warming of the liquid surface layers induces net evaporation with extraction of latent heat, thus reducing the temperature gradient within the liquid and further retarding thermal equilibration between liquid and vapour. Note that the above description holds also for the process at night, with the direction of heat flow reversed. Passage through a hot, sunny climate can therefore lead to marked diurnal temperature cycling in the ullage space above a crude oil cargo.

The ullage space is filled with cargo vapour and inert gas (IG) the proportion depending on the true vapour pressure (TVP) of the cargo at the vapour temperature, and on the total pressure (see below). A temperature change causes a change in the partial pressure of each constitutent of the ullage spaces. However, this effect is mediated somewhat differently for cargo vapour and IG. Heating the vapour induces net evaporation from the liquid surface, as mentioned above, and thus an increased vapour concentration in the ullage volume. The extent of this increase may be quantified using empirical data (eg those summarised in the appended API nomograph) but the imprecise relationship between RVP and TVP should be borne in mind. In the case of IG (or air) an absolute temperature increase will result in a proportional pressure increase (Charles' Law) without any change in concentration (no change in mass).

Breathing losses occur if the temperature-driven pressure cycles exceed in amplitude the difference between the high pressure and vacuum settings on the PV valves, leading to venting of vapours during the day and IG repressurisation during the night.

Results

With reference to the Appendix, the results of the predictive model for breathing losses at sea are presented in **figures 2, 3 and 4**. These plot breathing loss (normalised as kg vapour per 1000 m³ of ullage space) as a function of the vapour temperature as affected by the extent of the temperature swing (**Figure 2**), the PV valve setting (**Figure 3**) and RVP (**Figure 4**). Generally PV valve settings and RVP are known and hence the main unknown is the extent of temperature swing within the ullage volume for a given cycling in ambient temperature. To our knowledge, ullage temperature variations during transit have not been reported.

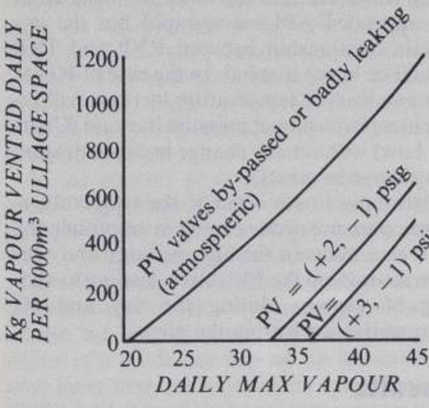
Assuming perfect mixing in temperature swings of up to 20°C (for example from a minimum of 20°C to a maximum of 40°C each day) fairly volatile crude is predicted to lose of the order of 250 kg per 1000 m³ ullage of vapour daily. Thus for a VLCC with ten tanks, each of ullage volume equal to 1000 m³, over a one month voyage the intransit evaporative loss is predicted as 75 MT or 0.075% of 100,000 MT cargo. **Figure 4** shows that intransit losses increase appreciably with increasing RVP. A summary of typical results is given in Table 6. **Figure 3** demonstrates that careful maintenance of PV valves and deck seals is vital. Leaking PV valves could lead to a trebling of intransit vapour loss due to continuous breathing.

It is of interest to compare the predictions of our model with the formula provided by the *API Bulletin 2518, June 1962, Evaporation Loss from Fixed Roof Tanks* (although this work has been centred mainly on gasoline tanks). Note also that shore tanks are maintained at ambient pressure or very nearly, so that the API results should be compared with leaky PV valve curves (**Figure 3**).

a We find a stronger dependence of vapour loss on vapour pressure than the API formula.

b Having assumed perfect mixing of vapour and IG, our model predicts breathing loss to be proportional to the ullage space. Thus, if a tank were twice as long or twice as wide or twice as deep, it should lose twice as much vapour daily. The API dependence is less than linear for each of the three dimensions and additionally is weaker for the vertical dimension than the horizontal, thus loss is proportional roughly to the square root of the height of

Figure 3: Effects of PV settings on breathing losses during carriage at sea



DAILY MAX VAPOUR TEMPERATURE IN ULLAGE SPACE (°C)

Note MIN DAILY T = 20°C, RVP = 8 psi

ullage space, all other things being equal. This makes sense if we assume considerable layering within the shore tank as it is being worked daily so that the top layers are far from saturated in vapour. There could also be substantial temperature layering, so that the uppermost layers contain less vapour mass per unit volume.

c The API study considers ambient temperature whereas the CWA model uses the vapour space temperature; hence direct comparison is dubious. The temperature dependence is slightly greater than linear in our model while in the API model loss depends on the square root of the temperature variation. Owing to the heat sink effect of the liquid cargo, thermal radiation will have a progressively smaller effect in terms of increasing vapour space temperature, the hotter this becomes. It seems therefore that the two models are in broad agreement with regard to temperature dependence of vapour losses.

It is interesting to observe that breathing losses in shore tanks for given climatic conditions should be greater than for ships tanks for three reasons:

- Negligible pressure tolerances within the vapour space.
- Much greater surface area for heat transfer in the case of shore tanks.
- In the case of inland installations, daily temperature swings are likely to be greater as well.

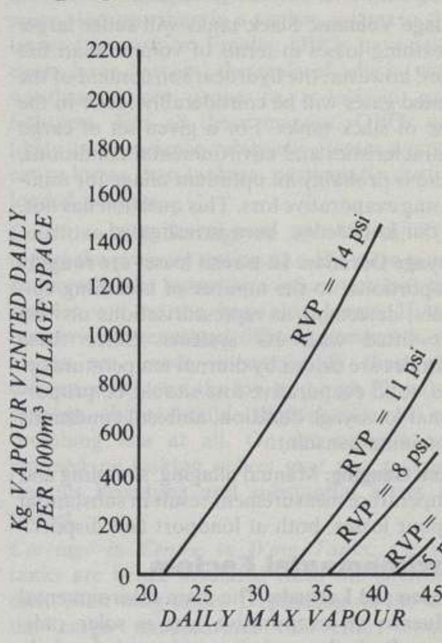
To summarise, in-transit losses by evaporation for crude shipments generally should be confined to low and relatively insignificant quantities. For high RVP crudes, particular attention should be paid to the control of atmospheric venting during loading and to ensure that PV valves are maintained in good working condition. Losses are lessened further by judicious control of the introduction of IG during the night cooling cycle to ensure that tanks are not unduly re-pressurised above atmospheric, thereby minimising the probability of venting during daytime heating of the ullage space.

Impact of COW

The review of the technical literature confirms the generally acknowledged view that highest losses of crude occur during discharge operations and that additional vapour evolution occurs during COW. In either case, however, there is a paucity of data to assist analysis, quantification and loss control. Of the few reported studies, most rely on measurement of the vertical profile of hydrocarbon vapour concentration in the ullage space before and on completion of discharge operations and calculate the amount of hydrocarbon vapourised and retained in the ullage space of cargo tanks. Due allowance must be made for additional loss to atmosphere during venting and this is assumed to occur only when tanks are gauged manually. In a BP study[11] total vapour losses during discharge (with part COW) were tentatively estimated as 0.05% vol, of which it was estimated 25% was lost due to atmospheric venting when tanks were manually gauged. Later work, based on density measurements, by Inkley and Purvey[14] reported total overall evaporative losses for Kuwait crude shipped to Rotterdam, as around 0.4% vol, concluding that with improved equipment and procedures, total vapour losses should reduce to 0.1–0.15%, although a further breakdown was not provided. Uhlin[6] reports on ullage space measurements made on a 250,000 dwt VLCC, before and after discharge, with 100% COW and gives the total evaporative loss during discharge as 141 MT, 0.08% vol, although in this case, losses by atmospheric venting during gauging are reported to be relatively insignificant (13 MT). Broad guidelines are quoted within the Industry; for example the 'rule of thumb' of a major oil company is that vapour induced losses due to COW are estimated as 1% of the crude oil throughput to the guns. For a VLCC, a typical configuration of wash guns is 2 guns per centre tank; 4 guns per wing tank. Assuming a maximum COW flow per gun as 170 tph and 2 hours wash cycle per tank, 100% COW on a VLCC comprising 4 centre cargo tanks and 5 pairs of wing tanks, is estimated to produce a vapour loss of 160 MT.

From a fundamental point of view, the factors which govern vapour concentration and composition in the ullage space are the properties of the crude itself, the temperature and pressure of the system and the vapour-liquid ratio during COW operations. In practice, much depends on the configuration of the equipment and the operating procedures actually carried out, including the incidence and control of venting via PV valves during the course of COW, a potent factor, which, it appears, has not been subject to technical audit.

Figure 4: Breathing loss during carriage at sea as a function of RVP and peak temperatures in ullage spaces



DAILY MAX VAPOUR TEMPERATURE IN ULLAGE SPACE (°C)

Note PV SETTING (+2, −1) psig

(DAILY MIN. TEMP. IN ULLAGE SPACE = 20°C)

Tables 4 and 5 from the CWA pilot study (section 2.0) summarise results for voyages with 100% and 0% COW, respectively. The NSV loss is significantly greater with 100% COW. This finding is reinforced by a

Table 6 Evaporative Loss in Transit. Typical Predicted Results from Figures 2–4

Crude inventory	**200,000 MT**
Ullage volume	**10,000 m³**
PV valve settings	**+2, −1 psig**

Crude RVP (psi)	Mean daily ullage temp swing (°C)	Cargo loss over 20 day passage (MT)	(%vol)
8	15	0	0
8	25	104	.07
11	15	34	.02
11	25	180	.13

Table 4 Analysis of 100% COW Data

	S&W Supp	SSL	Pass Diff	% COW	ROB	ROB–OBQ	SSD	S&W Rec	S&W Diff	Outturn TCV	Loss NSV
Count	64	64	64	64	64	64	64	64	64	64	64
Max	0.20	0.78	1.51	100	0.34	0.18	2.93	1.77	0.17	2.75	3.10
Min	0.00	−0.61	−1.62	100	0.00	−1.09	−1.32	0.00	−1.77	−0.64	−0.38
Std dev	0.05	0.30	0.48	0	0.07	0.19	0.66	0.38	0.39	0.57	0.56
Mean	0.04	0.00	0.10	100	0.07	−0.10	0.35	0.38	−0.34	0.35	0.69*
95% CL of Mean	0.03/ 0.05	−0.07/ 0.07	0.02/ 0.22	N/A	0.05/ 0.09	−0.15/ 0.05	0.19/ 0.51	0.29/ 0.47	−0.44/ −0.24	0.21/ 0.49	0.55/ 0.83

*Significant compared with 0% COW, **Table 5**

Table 5 Analysis of 0% COW Data

	S&W Supp	SSL	Pass Diff	%COW	ROB	ROB–OBQ	SSD	S&W Rec	S&W Diff	Outturn TCV	Loss NSV
Count	40	40	40	40	40	40	40	40	40	40	40
Max	0.12	1.58	1.28	0.00	0.61	0.58	1.56	1.14	0.05	1.13	1.79
Min	0.00	−0.61	−0.94	0.00	0.00	−1.90	−0.49	0.00	−1.14	−1.81	−0.70
Std dev	0.04	0.40	0.39	0.00	0.15	0.39	0.48	0.32	0.33	0.53	0.47
Mean	0.02	0.11	0.03	0.00	0.10	−0.09	0.41	0.27	−0.25	0.24	0.49*
95% CL of Mean	0.01/ 0.03	−0.01/ 0.23	0.09/ 0.15	N/A	0.05/ 0.15	−0.21/ 0.03	0.26/ 0.56	0.17/ 0.37	−0.35/ −0.15	0.08/ 0.40	0.34/ 0.64

*Significant compared with 100% COW, **Table 4**

significant positive correlation between NSV loss and percentage COW, and furthermore by a similar correlation between SSD and percentage COW. It is concluded that more attention needs to be given to the net impact of COW, in particular to the extent of loss of light ends in exchange for the reduction in clingage and sediments and the higher outturn of heavier components. It might well prove feasible at major import terminals, to eliminate this valuable source of loss, by recovering the vapour emitted during tank ballasting, given that the light ends are similar in composition to LPG components and that the vapour recovery and condensation technology is well established.

APPENDIX

Breathing losses of crude oil in transit

A number of assumptions are necessarily made.

a The ullage space contains air/IG at uniform temperature saturated with cargo vapour at all times. The liquid surface layers, as distinct from the bulk, are thus implicitly at the vapour temperature.

b The ideal gas laws apply and air/IG is insoluble in the cargo.

c The cargo RVP remains constant throughout the voyage, ie light ends are not appreciably depleted.

Calculations

Critical Temperature for Venting

Let the cycle begin at minimum diurnal ullage temperature, T_{min}(K). The corresponding cargo true vapour pressure Pv_{min} is obtained from the following formula, fitted to the standard API nomograph:

$$Pv(psi) = A \exp(BT) \qquad (1)$$

where A and B constants depending on the crude RVP

The initial air/IG pressure Pa_{min} is found by difference:

$$Pa_{min} = 14.7 - P^- - Pv_{min}$$

where P^- is the absolute value of the PV valve vacuum setting (psig).

The critical temperature Tc(K) is found by iteration, such that:

$$Pv_{Tc} + Pa_{Tc} = 14.7 + P^+$$

(where P^+ is the pressure relief setting) ie

$$A\exp(BT_c) + Pa_{min} \times T_c/T_{min} = 14.7 + P^+ = P_c$$

If the daily peak ullage temperature T_{max} exceeds the critical temperature T_c, venting will occur. In the case of leaking PV valves venting will occur no matter how small the temperature swings, in other words, $T_c = T_{min}$.

Venting Rate

Consider the effect of an infinitesimal temperature increment dT on the ullage contents initially at $T > T_c$.

The notional increment in cargo vapour pressure in response to the temperature increment is given by:

$$dPv = d(A\exp(BT)) = AB\exp(BT)dT (= BPv dT)$$

while the notional air/IG pressure increment is:

$$dP_A = P_A dT/T = (Pc - Pv)\, dT/T$$

hence the total pressure increment

$$dP = dPv + dP_A = (BPv + (Pc - Pv)/T)\, dT \qquad (2)$$

Consider now this notional increment in pressure over and above Pc is relieved by venting of cargo vapour and air/IG in proportion to their partial pressures. The cargo pressure thus lost = PvdP/Pc.

But now the vapour pressure is below equilibrium. The lost cargo vapour must be immediately replenished by evaporation from the bulk liquid — and once more, there is an impermissible overpressure which must be relieved, and so on ad infinitum. The nth term of this series of vapour losses is clearly:

$$(Pv/Pc)^n dP$$

The series is thus seen to be a geometric progression, which is readily summed:

$$\sum_{n=1}^{\infty} (Pv/Pc)^n\, dP = \frac{PvdP/Pc}{1 - Pv/Pc}$$

which represents a cargo mass loss

$$dm = \frac{Pv}{Pc} \times \frac{dP}{14.7} \times \frac{273.15}{T} \times \frac{UW}{0.0224} = (830\ UW/Pc)\ (PvdP/T)$$

where U = ullage volume in m^3

W = mean molar weight of cargo vapour

The expression is readily integrated numerically after substituting from (1) and (2) for Pv and dPv:

$$\text{Daily cargo mass loss} = \int_{T=T_c}^{T=T_{max}} dm$$

The results obtained have been cross checked and confirmed using a more involved mass balance formulation.

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New Fellow

Dr KL Goyal, Deputy General Manager, in charge of Reservoir & Production Division, Institute of Petroleum Exploration, Oil & Natural Gas Commission, Dehra Dun, India, has been transferred from Membership to Fellowship of the Institute of Petroleum. He obtained PhDs in Reservoir Engineering and Petroleum Engineering and has spent 26 years in the fields of exploration, training and reservoir and production research and development. He has also more recently been involved in research, development and applications of non-conventional energy sources and is responsible for R & D co-ordination with universities and other laboratories. Dr Goyal has been the author or co-author of numerous papers presented at international conferences such as the World Petroleum Congress and the World Energy Conference.

New Collective Members

Dover International BV is a Netherlands-based company and is the European affiliate of Dover Corp OPW Division Cincinnati, Ohio. Dover manufacture a range of oil marketing equipment, including bulk terminal loading arms, vapour recovery fittings, service station nozzles and accessories. Dover-I.S.T. Hamburg's line-pigging system is currently being used in the luboil and process industries in the UK and other EEC countries.

International Marine Survey Bureau Limited, based in Humberside, are cargo surveyors and consultants to the oil and chemical industry, with experience in the quality and quantity inspection and testing of bulk cargoes. In-depth reporting is carried out on behalf of their clients who include oil companies, ship owners and traders. The company's analytical facilities include computer-linked gas chromatography for full product analysis.

Foxboro Great Britain Limited markets products and services to accomplish the intelligent automation of the industrial process. The company is a wholly-owned subsidiary of The Foxboro Company of Massachusetts, USA and the Redhill, Surrey site provides the headquarters for Foxboro's operations in Europe, North Africa and India. Foxboro solutions draw upon their range of more than 1,000 products, including electronic and pneumatic instruments through to totally integrated management systems. They are in operation throughout the petroleum industry in both offshore and onshore installations. Foxboro serve their customers from 17 plants in eight countries and approximately 100 sales and service centres throughout the world.

Past President

At the IP AGM in June, it was agreed that Dr Jack Birks would continue as IP Past President for the time being, until a President-Elect is appointed to succeed Dr Jungels as President in 1988.

Obituary

We report with regret the death of **Mr Richard Llewelyn Wilson**, formerly of Lancaster Close, London. He was 87. Mr Wilson had been a member of the Institute for 61 years and spent the early part of his career working for Unirea S.A.R. de Petrol, Ploesti, Romania. Within a month of his joining the IP in 1926, an IP Branch was established in Ploesti and it survived until 1939.

New members elected by Council

Members

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Paez, Benjamin G, ICCET, 48 Prince's Gardens, London SW7 1LU.

HM The Queen's Birthday Honours List

Leo Murdock received an MBE for services to the oil industry in June. He recently retired as Fuels Product Quality Adviser for Esso and until then was the last remaining founder member of IP Panel ST-B-11, serving as its secretary for much of its 25 year life.

Liquefied Petroleum Gas

Volume 1, Second Edition

The Institute of Petroleum Model Code of Safe Practice has for many years made a significant contribution to oil industry operations and their record of safety. This revised edition of Part 9 of the Code is being produced in two volumes and supersedes the edition published in 1967, the technical recommendations of which have both been amplified and brought up to date. Cognisance is also taken of the tremendous developments which have occurred in the sphere of refrigerated storage.

Volume 1 covers:

a General information applicable to LPG

b Pressure storage at refineries, bulk distribution plants and also industrial consumer premises, where such storage is large

c Refrigerated LPG

It provides a general guide to safe practice in storing and handling of LPG and it gives recommendations for safe practice rather than rigid rules. It is intended that this approach should enable the use of new methods, techniques and materials which may be developed in the future and which meet the requirements for safe practice given in this Code.

A major change from the approach adopted in the 1967 Code concerns the criteria for establishing safe location for plant and equipment which is based upon consequence analysis related to likely incident scenarios.

The location and spacing of LPG storage vessels and other equipment with respect to boundaries and other critical areas within the plant are based upon radiation flux levels being kept below recommended maxima. Suitable calculation methods are set out in the code for determining heat flux from pool fires and flares.

The Code should be regarded as complementary to the statutory requirements pertaining to LPG in many countries. It is hoped that the adoption of this Code will help to reduce the risk of accidents.

Volume 2 is in course of preparation and will cover smaller pressure storage, cylinders and transport by road and rail.

Specifications and Qualification Procedures

Aviation fuel filter monitors with absorbent type elements

This publication, which has been prepared by The Institute of Petroleum Aviation Liaison Sub-Committee, is designed to provide the industry with comprehensive specifications and qualification test procedures for filter monitors with absorbent type elements suitable for use in aviation jet fuel handling systems. The specifications do not cover trigger type monitor elements.

Copies of this publication are available ONLY from The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK at a cost of: £9.00 (UK and Europe) and £11.00 (Overseas). **Orders will only be despatched if accompanied by the correct remittance.**

Petroleum Retailing: Europe and the UK

A petroleum retailing conference in May promises to become a major annual event. The retailing sector of the economy is going through a period of rapid change and nowhere more so than in the field of petroleum. As was the case in 1986, there are many aspects of the papers which were presented which are likely to be of interest to a wider readership than those who were able to attend the conference as delegates. The papers presented at **Petroleum Retailing: Europe and the UK** on 20/21 May 1987 were:

An outlook on the role and future of oil in the European Community and the consequences on retailing activities
JMC Bishop, Principal Administrator, Directorate General for Energy, Commission of the European Communities

International aspects of retail developments of today
AE Gustafsson, Strategic Business Adviser in the Retail Business Development Unit, BP Oil International

The retail market — a continuing quest for profitability
JJF Timmerman, Head of Retail Development, Shell International Petroleum

Debit cards — why did it take so long?
W Hislop, General Manager's Assistant, Barclaycard

The role of a major petrol retailer — retailing is detailing
GW Fisher, General Manager, Retail, Mobil Oil Co. Ltd

The retailer today
CKB Petter, Director, Petrol Retailers' Association

Driver-controlled deliveries
MEJ Blount, Market Development Engineer, Micrelec plc

Development of Convenience Stores
JR Hunt, Director of Oil and Licence, Circle K

24 hours unattended self-service — the Belgian experience
PG Plumridge, Architect, Retail Department, Petrofina (UK) Ltd

Changes in distribution
PG Edgington, Marketing Distribution, BP Oil International

Marketing of Unleaded Petrol in Europe
L Liebaert, Retail Co-ordinator, Kuwait Petroleum International

Copies of this publication are available *ONLY* from The Institute of Petroleum, 61 Cavendish Street, London W1M 8AR, UK at a cost of: £22.00 (UK and Europe); £25.00 (Overseas). **Orders will only be despatched if accompanied by the correct remittance.**

UKPIA statement

continued from page 30

Standard or accepted code of practice governing their design and manufacture, several research laboratories have carried out investigations to identify the causes of these operational problems.

The main conclusion from these studies has been that the discoloration and deposits are caused by photo-oxidation of the fuel during storage in the tank. This is a light-induced oxidation process resulting from prolonged exposure of the fuel to daylight. *All* distillate fuels produced to British Standard 2869 requirements are prone to such oxidation, but it is not usually a problem as fuels are normally manufactured, distributed and stored in the dark.

Correct materials

With the introduction of tanks made out of translucent plastics, the fuel can now be subjected to light for long periods of time, for example, throughout the summer, and it is this prolonged exposure to light that has caused the fuel to degrade. It is therefore the recommendation of the oil industry that plastic tanks sold for oil storage should be made of an opaque material. Laboratory trials have shown that if UV radiation and visible light sources are excluded, it is possible to store oil fuels in polyethylene containers for at least a year with the fuel remaining within specification and fit for use. Thus, the satisfactory storage of petroleum products in plastic tanks can be achieved provided the correct materials of construction are used and that proper standards of housekeeping and tank cleanliness are applied.

One additional question addressed during the laboratory investigations was the possibility of a reaction between the fuel and plastic being the cause of the observed deposits, but no evidence has been found to substantiate this. However, the correct choice of plastic materials for use with petroleum fuels is vitally important and guarantees on the suitability of any particular grade or quality of polyethylene can only be provided by the tank or raw material supplier.

Need for a standard

For the future there is a need for an accepted standard and/or code of practice for the design, manufacture and installation of plastic tanks which takes into account the natural characteristics of the fuel being stored. Discussions on this subject have already commenced between representatives of the tank manufacturers, the UK Petroleum Industry Association, the Health and Safety Executive and the Fire Brigade's Inspectorate, but it will be some time yet before a suitable code can be produced. In the meantime, the UK Petroleum Industry Association advises that if consideration is being given to the installation of plastic tanks, then guarantees should be obtained from the tank manufacturer that the tank is suitable for the intended application. It is also advised that to ensure proper safety standards during normal usage, the recommendations from the manufacturers regarding the installation of the tank and the control of static electricity are strictly adhered to.

Many translucent tanks have been in service for a number of years and have given trouble-free operation, but if problems are encountered it is advised that contact be made with the supplier or manufacturer to determine the most appropriate course of action to be taken. Most manufacturers are now supplying dark coloured, opaque fuel storage tanks which exclude light from the tank contents.

UK Petroleum Industry Association represents oil companies involved in the supply, refining and distribution of oil in the UK. Its office is at 9 Kingsway, London WC2B 6XH. **Contact for Enquiries: Dr Ian Berwick or Tony Fox on (01) 240 0289**

Deliveries into Consumption

UK deliveries into inland consumption of major petroleum products

Tonnes

Products	*March 1986*	*March 1987*	*Jan–Mar 1986*†	*Jan–Mar 1987**	*% change*
Naphtha/LDF	243,520	300,080	1,015,640	957,520	− 5.7
ATF—Kerosine	397,390	401,930	1,114,320	1,155,470	+ 3.7
Motor Spirit	1,739,540	1,835,910	4,870,270	5,037,490	+ 3.4
Burning Oil	205,960	212,400	698,630	698,840	—
Derv Fuel	696,200	737,750	1,895,300	1,990,840	+ 5.0
Gas/Diesel Oil	975,990	906,750	3,044,180	2,710,250	−11.0
Fuel Oil	1,302,800	741,390	3,278,280	2,689,130	−18.0
Lubricating Oil	65,600	72,660	191,070	202,090	+ 5.8
Other Products	517,550	578,800	1,325,080	1,491,530	+12.6
Total above	6,144,550	5,787,670	17,432,770	16,933,160	− 2.9
Refinery Consumption	439,440	409,690	1,302,020	1,279,950	− 1.7
Total all products	6,583,990	6,197,360	18,734,790	18,213,110	− 2.8

†Revised *Preliminary