

**UNDER THE FATAL ACCIDENTS INQUIRY (SCOTLAND) ACT 1976 v. RICHARD KING and ROLAND
MICHAEL DUFFELL**

UNDER THE FATAL ACCIDENTS AND SUDDEN DEATHS INQUIRY (SCOTLAND) ACT, 1976.

Dundee, 21 February, 2002.

**Determination by Sheriff Richard Alexander Davidson in respect of the deaths of Richard King and
Roland Michael Duffell.**

FORMAL DETERMINATION

In terms of Section 6 of the Fatal Accidents and Sudden Deaths Inquiry (Scotland) Act, 1976, I am required to make a formal determination setting out the following circumstances of the aforementioned deaths, so far as these have been established to my satisfaction, namely:-

- where and when the deaths and any accident resulting in the deaths took place;
- the cause or causes of such deaths and any accident resulting in the deaths;
- the reasonable precautions, if any, whereby the deaths and any accident resulting in the deaths might have been avoided;
- the defects, if any, in any system of working which contributed to the deaths or accident resulting in the deaths; and
- any other facts which are relevant to the circumstances of the deaths.

In fulfilment of the foregoing statutory requirements, I hereby determine:-

- That Richard King, born 28th. February, 1942, died as a result of an explosion and fire in the port aft horizontal brace of the Glomar Arctic IV semi-submersible oil exploration rig while it was berthed at Prince Charles Wharf, Dundee, on 4th. July, 1998 between 21.45 and 21.54, his body being found within said brace by officers from Tayside Fire Brigade subsequently at approximately 00.17.
- That Roland Michael Duffell, born 31st. January, 1958, died as a result of an

explosion and fire in the port aft horizontal brace of the Glomar Arctic IV semi-submersible oil exploration rig while it was berthed at Prince Charles Wharf, Dundee

on 4th. July, 1998 between 21.45 and 21.54, his body being found in the lower ballast chamber of said rig (adjacent to said brace) by officers from Tayside Fire Brigade subsequently at approximately 23.05

- Both men died as a result of the ignition of a flammable mixture of propane and air in said port aft horizontal brace causing an explosion and fire. The cause of death in each case was a combination of heat shock, asphyxiation as a consequence of their airways becoming clogged with soot and carbon monoxide poisoning. A supply of propane had been introduced to the brace in connection with welding operations taking place there. At some point in time prior to the accident, but between 19.00

hours on Friday 3rd. July and 19.00 hours on Saturday 4th. July, molten metal particles from either flame cutting or welding operations being carried out on a horizontal ring stiffener had been allowed to fall on to the propane hose which had been located on the bottom of the brace occasioning a hole in the hose from which propane leaked. At some point in time subsequent to the damage being caused, the damaged section of the propane hose, along with certain other services comprising an air hose and a number of electric cables, some of which had also suffered heat damage, had been wrapped in a piece of welding screen and had had a piece of metal plate placed on top of the welding screen. When Richard King turned on the propane supply at the start of the tea-break period at about 21.00 on Saturday 4th. July, which was the first occasion on which there had been a 'live' supply of propane into the hose since the hose had been damaged, propane under pressure in the hose leaked from the hose at the bottom of the brace, into the blanket and under the metal plate, which caused the propane to escape in a diffuse manner and accumulate at low level along the bottom of the brace (which was a cylinder) during the period of the tea break, which lasted approximately 30 minutes. When Mr. King and Mr. Duffell returned to the brace at the conclusion of the tea break, they appear to have attempted to ignite the propane torch (which would have been used to pre-heat metal surfaces preparatory to welding) and the explosion occurred. Mr. King and Mr. Duffell appear to have been close to each other, within six feet, and also close to the point of explosion which seems likely to have been between them. They may both have been in a kneeling position at the material time. As a consequence of the explosion, Mr. King appears to have been rendered unconscious. Mr. Duffell's body, however, was found near the foot of the ladder leading from the lower ballast chamber of the port aft column of the rig, demonstrating that he survived the accident sufficiently to be able to escape from the brace. When he was found by officers from Tayside Fire Brigade, he had wires, which were electrically live, wrapped round his feet by which he appeared to have been trapped.

- These deaths might have been avoided if the following reasonable precautions had been taken:-

- a competent person or competent persons had prepared proper risk assessments in accordance with the requirements of the then current regulation, namely, Regulation 3 of the Management of Health and Safety at Work Regulations, 1992, for either or both MacGregor Energy Services Limited or Global Marine UK Limited (who were, respectively, the contractors carrying out repairs to the Glomar Arctic IV, and the rig operators) in connection with the works to be carried out in the aft brace of said rig;
- those members of management and staff (as opposed to the workforce) responsible for the planning and execution of the works in the employment of MacGregor Energy Services Limited had been aware of, had read, had understood and had implemented the requirements of the Confined Spaces Regulations, 1997, had properly understood the risks associated with working in a confined space, in particular in relation to the introduction of gases, including two flammable gases, propane and acetylene, under pressure, as well oxygen, under pressure, into a confined space, had properly considered the adequacy of the means of access to and egress from the confined space, had given proper consideration to the adequate instruction and supervision of the persons who were to carry out work in the confined space and had effectively addressed the steps which could have been taken, such as by way of constant gas monitoring, to minimise the risks and had properly considered the need to have a clear plan for dealing with an emergency if such a situation had arisen within the brace, including, without prejudice to the foregoing generality, the provision of fire extinguishers, breathing apparatus escape sets and an adequate means of communication with personnel on the deck of the exploration rig;
- those members of management and staff (as opposed to the workforce) responsible for the planning and the execution of the works in the employment of MacGregor Energy Services Limited had read, understood and implemented "The MacGregor Energy Services Limited Policies and Procedures Manual;"
- those responsible for the selection of those members of management and staff responsible for the planning and the execution of the works in the employment of MacGregor Energy Services Limited had ensured that those so selected were aware of, understood and were adequately trained to undertake, the safety roles and functions attributed to them by the "MacGregor Energy Services Limited Policies and Procedures Manual;"
- general foremen, foremen and chargehands employed by MacGregor Energy Services Limited had had any training or instruction in their roles in relation to safety as set out in the "MacGregor Energy Services Limited Policies and Procedures Manual;"
- the Offshore Installations Manager employed by Global Marine UK Limited had had any understanding of, and had had adequate training in the critical importance of the operation of the Global Marine permit to work system;
- the general foremen employed by MacGregor Energy Services Limited had properly been instructed in the operation of the Global Marine permit to work system in relation to their functions in respect of its operation (on the hypothesis that it was appropriate to delegate this critical function to general foremen);
- certificates and permits issued under the Global Marine permit to work system had been adequately completed and the precautions therein desiderated had been implemented;
- the certificates and permits issued under the system had been displayed at the work sites;

- the tradesmen and labourers working for MacGregor Energy Services Limited in the braces had been properly instructed and trained in relation to their roles under the Global Marine permit to work system;
- the tradesmen and labourers working for MacGregor Energy Services Limited had received proper training and instructions in relation to the risks associated with working in a confined space with flammable gases delivered in rubber hoses, under pressure and, in particular, had been properly instructed and trained to inspect their equipment, including the hoses, at the outset of each shift, to take appropriate steps to protect said hoses from molten metal particles given off by the processes of flame cutting and welding in the brace, had been informed of the dangerous propensities of the gases involved and, in the particular case of propane, that it was approximately 1.5 times denser than air and that therefore, if it were to leak from any hose or equipment, it would be likely to accumulate at low level and linger in any pockets created by the configuration of the workplace; had been informed of the need to ensure that the work place was adequately ventilated having particular regard to the foregoing risks; had been informed of the need to work in such a manner as would avoid conflict between work in two separate locations and to report any dangerous occurrences for investigation by supervisory staff or members of management;
- a competent person or competent persons, as that expression is utilised in the Confined Spaces Regulations, 1997, had been employed and permanently present in each of the braces to supervise the execution of the works;
- equipment for constantly monitoring for the presence of unburnt gases had been provided at all times when work was taking place in the braces and those who were working there had been adequately trained in the use of such equipment;
- management and the workforce of MacGregor Energy Services Limited and those responsible for the operation of the permit to work system employed by Global Marine UK Limited had properly understood and made appropriate provision for the effective operation of the permit to work system and had implemented the precautions as would have been desiderated on a proper consideration of the risks which would have been identified had there been proper consideration of the permit to work system and the documentation relevant to its operation, as by the provision of an effective means of instant communication, to overcome the difficulties associated with the process of remote start, i.e. the state of affairs which necessarily resulted in the gas bottles being located on the main deck, and, in the case of propane, on the ROV deck, one flight above the main deck, with their associated taps and hose regulators being there and the works and the gas using equipment to be used in connection with the works being some 120 feet beneath the location of the gas bottles, to avoid live gas supplies to the brace being turned on by the workers going down to the brace, a journey which, because of the difficulties of access and egress, took a minimum of five minutes going down and significantly longer going up and thus also to avoid the gas supplies to the brace not being able to be turned off until the workers got to the surface;
- rescue equipment, in particular, breathing apparatus escape sets had been provided and worn by those working in the braces and they had been adequately trained in their use;
- proper consideration had been given by those members of the management and staff of MacGregor Energy Services Limited responsible for the planning and execution of these

works to the need to remove torches and hoses from all confined spaces while not in use and to have a system whereby gas taps and regulators on bottles were only operated by qualified tradesmen and were turned off at all times when it was not necessary for there to be a live gas supply to the confined space concerned;

- insofar as method statements were prepared by MacGregor Energy Services Limited for the information of the workforce in relation to the work in the braces, an effective method had been determined for the conveyance of the content of such statements to the workforce and to general foremen, foremen and chargehands and the requirements of the method statements had been implemented and, where necessary, implementation of these requirements had been enforced;
- experienced tradesmen working in the aft brace had used their experience and common sense to avoid circumstances where hoses carrying live supplies of flammable gases in a confined space were at risk of heat damage from molten metal particles from either flame cutting or welding processes;
- experienced tradesmen working in the aft brace had used their experience and common sense to avoid having live supplies of flammable gases into the confined space except when the particular gas or gases actually required to be used;
- experienced tradesmen working in the aft brace had used their experience and common sense and removed all gas using equipment and hoses from the confined space to open air when the equipment was not being used;
- experienced tradesmen working in the aft brace had checked equipment and hoses at the start of each shift for damage and had either taken adequate steps to repair any damage observed or had reported the damage situation to an appropriate level of supervision;
- experienced tradesmen working in the aft brace had checked equipment and hoses after there had been an outbreak of fire in the acetylene hose in the brace on 3rd. July, 1998 and when they became aware that damage to hoses and electrical cables was being caused by molten metal particles from flame cutting and welding operations taking place there, rather than ignoring or concealing hoses and cables which had patently suffered heat damage; and
- Richard King had investigated himself the reason why he could not ignite the propane torch on the evening of 4th. July, 1998, rather than instructing an inexperienced labourer to do so.
- The defects in the system of working which contributed to the death or, in any event,

the accident resulting in the death, were:-

- a lack of knowledge, training and instruction on the part of the management of MacGregor Energy Services Limited, despite the business in which they operate, of the Confined Spaces Regulations, 1997 and the associated Approved Code of Practice;
- a lack of knowledge and understanding on the part of Mrs. Judith Ross, the project safety officer, employed by MacGregor Energy Services Limited, of the nature of the works for which she was preparing a risk assessment, of the risks generated by the works, of the precautions required to eliminate or minimise those risks, of the need for a risk assessment in relation to these works to be specific to the works and the location and other circumstances in which they were being carried out (as opposed to being merely generic) and of the special risks associated with working in a confined space identified by the

Confined Spaces Regulations, 1997 and the associated Approved Code of Practice, all of which led to the production of a grossly inadequate risk assessment;

- a lack of any effective supervision of Mrs. Ross and any system to permit a review of the adequacy of any risk assessment prepared by her;
- a lack of knowledge and understanding on the part of Mr. Colin Johnston, the project manager, employed by MacGregor Energy Services Limited, of his role as defined by his employers' Policies and Procedures Manual in relation to safety, of the process of risk assessment, of the Confined Spaces Regulations, 1997 and the associated Approved Code of Practice and of the critical importance of ensuring the effective operation of the permit to work system chosen for the execution of the works of repair on the Glomar Arctic IV;
- a lack of adequate training by MacGregor Energy Services Limited of both Mrs. Ross and Mr. Johnston in relation to their functions pertaining to the safety of the workforce and others potentially at risk from work being carried out by the company ;
- insofar as Mrs. Ross prepared and Mr. Johnston revised two method statements pertaining to the execution of the works in the brace, each of which were inadequate, their failure properly to instruct the work force in the desiderated requirements and to instruct supervisory staff to ensure that the requirements were implemented;
- the failure by Mrs. Ross and Mr. Johnston and any other member of the management or supervisory staff of MacGregor Energy Services Limited to familiarise themselves with the operation of the Global Marine permit to work system;
- the failure of MacGregor Energy Services Limited, generally, and of Mrs. Ross and Mr. Johnston, in particular, to instruct and adequately train those who were to be working in the braces in the aspects relevant to them of the Global Marine permit to work system, in particular to train and instruct Angus Wylie, nightshift general foreman, and Eric Murphy, dayshift general foreman, on the critical importance of the satisfactory operation of the permit to work system and their role as performing authority thereunder of properly inspecting the worksites in connection with the issue of certificates and permits as appropriate and in their revalidation, in an understanding of what the risks associated with the works were and what precautions would be desirable and as to what their role was in implementing the provision of precautions as desiderated in terms of the certificates and permits issued under the system;
- the failure of Global Marine UK Limited at management level properly to consider the adequacy of Mark Greenhow as an Offshore Installations Manager generally, given his complete lack of understanding of the critical importance of a permit to work system, and for the particular tasks associated with overseeing the repair works to be carried out by MacGregor Energy Services Limited on the Glomar Arctic IV and participating in the operation, in connection with those works, of the Global Marine permit to work system and to provide him with any support in the execution of these tasks;
- the failure of Global Marine UK Limited to train and instruct Anthony Bucknole in the operation of their permit to work system prior to appointing him as a stability technician and deputy OIM on the Glomar Arctic IV;
- the failures of Mark Greenhow and Anthony Bucknole, on behalf of Global Marine UK Limited, properly to operate the permit to work system, to inspect the work sites, to be

aware properly of the nature of the works being carried out, properly to determine what precautions the work should have attracted and to ensure that prior to the commencement of such works, all precautions as should have been properly desiderated were in place and operative and that those who would or might have to utilise them were adequately trained to do so;

- the failure of Global Marine UK Limited and MacGregor Energy Services Limited, at the appropriate management level, to establish a system for adequate communication between the two companies on safety issues arising in the course of the works and for determining who would be responsible for matters such as supervision of the operation of the permit to work system and the implementation of desiderated precautions in terms of the system;
- the failure to provide sufficient and suitable monitoring equipment to detect the presence of unburnt flammable gases in the confined space throughout the execution of the works on the part of either or both of Global Marine UK Limited or MacGregor Energy Services Limited and to train those who would be working there in the use of such equipment;
- the failure by MacGregor Energy Services Limited to instruct those working in the brace only to have live gas supplies to the brace when such supplies were actually being utilised for the works of flame cutting or pre-heating preparatory to welding;
- the failure by MacGregor Energy Services Limited to instruct those working in the brace to check equipment and hoses for leaks and other damage at the start of each shift, and to withdraw hoses and equipment from the braces to open air when not in use;
- the failure by MacGregor Energy Services Limited to make provision whereby gas supplies to the braces could be subject to remote start, and otherwise to provide any adequate means of communication between those working in the brace and either the control room of the rig or their own supervisory staff or anyone else outwith the confined space; and
- the failure by MacGregor Energy Services Limited to provide breathing apparatus escape sets and to instruct those working in the braces in their use and that such items should be worn at all times when in the brace.
- Other facts relevant to the circumstances of the death are:-
- that the workforce employed by MacGregor Energy Services Limited was so employed at short notice and, in at least two cases, men who applied for employment as tradesmen found themselves appointed as foremen or chargehands without prior notice and without any training in their safety responsibilities and functions;
- that the rig's PA system and general alarm system could not be heard in the braces;
- that the Global Marine rig fire-fighting team found itself completely unable to cope with the emergency which arose in the aft brace on 4th. July, 1998 and had had no training for such an emergency;
- that George Cheyne, the Global Marine UK Limited Rig Manager had two days before the accident rejected a request from Tayside Fire Service to permit them to carry out a familiarisation exercise on the rig stating that they had their own firefighting team and the Fire Service would not be required; and

- that it is evident from the extreme difficulties encountered by firefighters from Tayside Fire Service when they entered the port and starboard columns of the rig on either side of the aft horizontal brace both in getting access through hatches, which proved impossible while wearing standard BA equipment on their backs resulting in them having to manhandle air cylinders through the hatches while the recipient firefighter stood on a vertical ladder, in smoke, and in connection with electrical arcing which was taking place in the lower ballast chamber and in the brace, the source of which took the rig electrician some forty minutes to identify and isolate and from the Herculean task, which had to be undertaken by manhandling, of the removal of the two bodies from the points at which they had died, that the means of access and egress used to the worksite in the aft horizontal brace were entirely inadequate and unsafe and took no account whatsoever of how a casualty would be removed.

NOTE

In this Note I set out to explain the reasons behind the conclusions expressed in my formal Determination, and also take the opportunity to comment on some aspects of the evidence which give rise to cause for concern but in respect of which I have found it either impossible on account of a lack of credible and reliable evidence or inappropriate pertaining to issues not falling properly within the scope of this Inquiry, to express any formal conclusions. I intend to set out my Note under the following chapter headings:-

- Preamble
- The Background to the Accident including the Contractual Background
- Preparations for the Work and Deficiencies therein.
- The Permit to Work System and its Operation.
- The Detailed Cause of the Accident.
- Concerns relating to Work in Confined Spaces.
- Risks Associated with the Use of Industrial Gases, particularly Propane.
- Provisions for an Emergency and how they Operated.
- Conclusions and Recommendations.

- **Preamble**

- It is important to recognise at the outset that this is an Inquiry held under and in terms of the provisions of the Fatal Accident and Sudden Deaths Inquiry (Scotland)

Act, 1976, that is to say, it is an Inquiry into the circumstances surrounding the deaths of Richard King and Roland Michael Duffell. It is not, nor could it be, an investigation into the safety record of the oil exploration industry nor the oil rig repair industry in any more general terms. No direct evidence was led about the performance of any companies, operators or employers other than Global Marine (U.K.) Limited, ("GM") and MacGregor Energy Services Limited, ("MESL") other

than incidentally in the context of the employment history of the witnesses to the Inquiry or the recent history of the previous operator of the rig concerned, some of whose employees were still working on the rig during what was a transitional period.

- It is also appropriate that I should re-state, at the outset of this Note, the court's condolences to the family and friends of the late Mr. King and the late Mr. Duffell. It is a matter of regret that, for a variety of reasons, not the least of which was the Scottish Executive's failure to respond within any kind of reasonable timescale to the decision in *Starrs v Ruxton*, 2000 J.C. 208; 1999 SCCR 1052, which caused the demise of temporary sheriffs leaving the permanent sheriffs at any rate in Dundee, the only location about which I can authoritatively speak, in such a state of overwork that accommodating a lengthy and important Inquiry, such as this, proved impossible for a significant period of time. It is a matter of regret that such inaction has added to the burden of the two families concerned. Equally, I regret that, largely on account of the Crown's failure adequately to recognise the amount of time which would be required properly to allow all the evidence germane to this Inquiry to be adduced, that it became further delayed and truncated. That has not assisted my task and the continuing delay must be a cause of continuing distress to the relatives while the circumstances surrounding the deaths of their two menfolk remained unresolved. I regret that I have further contributed to the delay in taking as long as I have to prepare and issue this Determination and Note, but I have found it to be an much more difficult task than initially and over-optimistically estimated and I am grateful to Sheriff Principal R. A. Dunlop, Q.C., for his strenuous efforts to persuade the relevant authorities to make sufficient time available to me to enable me to bring this matter to a conclusion and to the senior staff in the sheriff clerk's office in Dundee for somehow finding time in the court diary.

- The Inquiry concerns itself with the deaths of Richard King and Roland Michael Duffell on the Glomar Arctic IV semi-submersible oil exploration rig ("GA IV") at Prince Charles Wharf in Dundee Harbour where it was undergoing repairs, on 4th. July, 1998. Parties to the Inquiry were the Crown represented by Mrs. Jane Benson, depute procurator fiscal, Dunfermline, the King and Duffell families, represented by Mr. R. Pilkington, Advocate, GA, the operators of GA IV, represented by Mr. J.L.

Mitchell, Q.C., and MESL, the company contracted to carry out the repair works, represented by Mr. R. Thomson, Advocate. The Inquiry commenced on 5th. June, 2000 and, after forty six days of evidence and five days of submissions, finally concluded on 30th. March, 2001. It is right and proper that I should express my gratitude to the four representatives aforementioned for their forbearance, for the tact and diplomacy which they demonstrated throughout the Inquiry and for the very high quality of representation which they provided. Mrs. Benson carried out an immense quantity of exploratory work and devoted a huge amount of time and energy to preparing for the Inquiry as was demonstrated by her comprehensive grasp of all the various issues arising. It was of particular value to me to have Mr. Mitchell present, who freely assisted me with suggestions on how best to conduct aspects of the Inquiry where I was able to draw on his very considerable experience of similar lengthy Inquiries including the Piper Alpha Inquiry. I should also thank Mr. Thomson for his care and attention to the detail surrounding a number of significant, practical aspects of the evidence which is reflected in his written submissions which are of the highest quality. I am grateful to them all for assisting me in the task I have had to undertake.

- I should also briefly express my thanks to Dundee City Council. It rapidly became apparent that the facilities available at Dundee Sheriff Court were inadequate for the housing of the Inquiry. The City Council were good enough to make Committee Room 2 at the City Chambers available to us and it proved to be entirely satisfactory. The assistance of staff at the City Chambers both in dealing with witnesses and productions was greatly appreciated.

- I should also thank Janice Ross, our shorthand writer, who was with us for the duration of the Inquiry and who has promptly and efficiently produced shorthand notes of very high quality given the technical language much in use and that she also had to cope with accents from the length and breadth of the United Kingdom as well as one or two from further afield.
- The Inquiry was also greatly assisted by evidence of very high quality from a significant number of individuals employed by the Health and Safety Executive and the Health and Safety Laboratory at Buxton in Derbyshire. If I single out Mr. Monaghan, who had significant difficulties with his health in the course of the Inquiry about which I was pleased to receive an encouraging report from Mrs. Benson

towards the end of proceedings, and Mr. Summerfield who was obliged to step into his place at short notice, then that is a reflection of the very considerable assistance they each gave the Inquiry.

1.7. Finally, though I shall have more to say about this when I come to deal with certain more specific areas of the evidence, it would be wrong of me not to recognise the efforts of both Tayside Fire Service and Tayside Constabulary in connection with both the Inquiry and, more particularly, the circumstances surrounding the loss of life on GA IV. It was of particular assistance to the conduct of the Inquiry to have the comprehensive set of photographs taken at the earliest opportunity by the Scenes of Crime Officers, in particular Det. Cons. Neil Ritchie, at no little risk to himself, available for our consideration. Other officers are to be congratulated for the assistance they gave in the removal of the bodies of the deceased and dealing as best they could with the process of intimation of the deaths. Most particularly, however, I would want to express the Inquiry's appreciation of the heroic efforts of the Fire Service officers, in particular those who descended into the smoke filled horizontal aft brace of GA IV, despite the very considerable access difficulties which I will in due course describe, despite, amongst other things, evident risk of electrocution, in what, sadly, proved to be a vain attempt to find survivors and who effected the grim and exceptionally difficult task in the circumstances of the recovery of the bodies. Official recognition of their bravery would be well merited, in the event that that has not already occurred. While, unfortunately, I did not have a comprehensive list of the firefighters who entered the brace, included among those who did were Firefighters Iain MacLeod and Gordon Lang, both of whom gave important evidence to the Inquiry and both of whom are among those whose efforts should, in my respectful opinion, be formally recognised.

- The last topic which arises under this head relates to my stated intention to read and

refer in my Note to the Report prepared by the The Hon. Lord Cullen on the Public Inquiry into the Piper Alpha Disaster. Mr. Thomson, in particular, expressed a degree of disquiet about my intention. He may have been concerned at the risk of my elevating the scope of this Inquiry beyond its statutory constraints. In the event that I should do that, it will be inadvertently. My intention in considering Lord Cullen's Report was twofold. In the first place, aspects of the Report were repeatedly referred to in the course of the present Inquiry, particularly by Mrs. Benson and Mr.

Mitchell and, on more than one occasion, by me. In the second place, having been only peripherally involved in the legal aftermath of the Piper Alpha disaster, I was concerned to know whether any of Lord Cullen's recommendations were germane to the failures on the part of both individuals and the two companies concerned in the present accident, particularly in the area of permit to work operation. Suffice it to say, at this stage, that it appears to me appropriate to express disappointment that, in respects which I will in due course identify, two major participants in the North Sea oil industry such as GA and MESL appear to have paid little more than superficial attention to Lord Cullen's Report, in relation to the circumstances leading to an accident some seven and a half years after its publication, given its widespread dissemination and the crucial importance to the safety of offshore workers and installations of its contents. It would be valuable if senior management of both companies were to read Lord Cullen's Report now and act in the light of its recommendations.

- **The Background to the Accident including the Contractual Background.**

2.1

It was instructive to learn from the Piper Alpha report that Global Marine Inc, the ultimate parent company of GM, was no stranger to disaster, having been the operator of a drillship which sank in the South China Sea in October, 1983, with the loss of its entire crew of 81, where they were criticised by the official inquiry into the loss for failing to evacuate the drillship in anticipation of a forthcoming typhoon. One must accordingly regard assertions on their part that they have learned from this present fatal accident with some diffidence. Crown Production 13 sets out the legal organisation chart of the Global Marine Group, from which it appears that the parent company is Global Marine Inc., registered in Delaware, USA, with four principal subsidiaries, the one of interest in the present circumstances being Global Marine Drilling Company, registered in California, USA, which has, in turn, a subsidiary, Global Marine International Drilling Corporation, registered in the Bahamas, which has two relevant subsidiaries, namely Global Marine North Sea Limited, also registered in the Bahamas and GM, registered in Scotland. Global Marine Inc is a publicly traded holding company. Global Marine International Drilling Corporation owns 19 mobile offshore drilling units, including the GA IV. GM is a wholly owned subsidiary of that last named company and is the employer of Aberdeen shore based employees. Global Marine North Sea Limited is an international offshore company incorporated in the Bahamas and is the employer of UK nationals who work offshore outside the territorial waters of the United States and therefore includes the crews of GA IV.

2.2

At the material time, GM had a contract with BP Exploration Operating Company Limited to drill certain wells in the North Sea. GM chartered GA IV from Global Marine International Drilling Company for this purpose. GM was thus the company responsible for the control of GA IV while it was operating in the British sector of the North Sea. Its main function was to drill exploratory wells and then to allow flow from them to establish their commercial viability. The rig had a core crew of about 50 plus some specialists. It had a marine crew, an engineering crew and a drilling crew. GA IV had been purchased from Stena Offshore in March, 1998. The rig had been built in the Far East - South Korea - and it was disclosed in a pre-purchase report that there was a concern about "cracks" in the horizontal cross braces that would require to be attended to as well as other concerns about the condition of the pontoons, the summer break in the operator's (i.e. BP Expro) programme being identified as a time when the defects would require to be addressed. A number of other necessary repairs were identified at the same time. MESL were selected as the contractors to carry out this

work as they had previously undertaken satisfactorily similar work on a similar rig for GM. Liaison took place between MESL and the engineering staff employed by one of the Global Marine associated companies in Houston, Texas, and ultimately it was decided that a number of joints would be totally replaced with a series of specially formed steel plates referred to as "cruciforms" on account of their cross shape. It is explained that each horizontal cross brace was, in effect, a cylindrical steel tube with the cylindrical shape being supported by a series of ring stiffeners located at a number of points on the internal circumference of the brace, through which ring stiffeners passed a series of longitudinal steel beams, running the length of each section of the brace, each horizontal brace being in three sections, port, centre and starboard. The joints to be replaced were certain of the joints where the ring stiffeners and longitudinal beams intersected. Plate 1 shows GA IV at berth at Prince Charles Wharf in Dundee and its general appearance. Plate 2 shows the exterior of the aft horizontal brace. Plates 14 to 17 show the internal appearance of the brace. In plate 14, for example, the photographer is in the port section of the aft brace looking towards the bulkhead which separates the port section from the centre section. The photograph shows three of the ring stiffeners and four of the six longitudinal beams intersecting the ring stiffeners. In Plate 34, Crown Production 99/2, there is a particularly good photograph depicting the cruciform shape of these replacements, the one illustrated being the actual cruciform which Mr. King was in the process of welding into position at the time of the accident.

2.3

The replacement cruciforms were fabricated by MESL at their fabrication shop in Invergordon. It was originally intended that the GA IV would berth at Invergordon for these repairs to be carried out. That was altered at the last minute, due to a delay caused by BP Expro and alternative berthing at Prince Charles Wharf, Dundee, where MESL had another facility, was organised. There is a discrepancy between management of GM and of MESL as to whether there was any fixed period for the execution of the repairs contract. I prefer the evidence of George Cheyne, the GM Rig Manager to that of Colin Johnston, the MESL Project Manager, on this topic that the original intention was that the rig would be returned to service eight days after its arrival in Dundee, though, ultimately, it did not prove to be a matter of great significance, as there was no acceptable evidence from which it could be concluded that the workforce were placed under any pressure to get the work done which generated any effect relevant to the accident. To be fair to Mr. Johnston in this context, it is clear that he had no involvement in the contract negotiations prior to the arrival of the rig in Dundee and once it did arrive, both prior and subsequent to the accident, the scope of the repair work increased dramatically, effectively undermining any pre-arrival assessment of how long the originally scheduled works would have taken.

2.4

When GM acquired the GA IV from Stena Offshore, it was agreed that there would be a transitional period during which the existing Stena crew would be gradually replaced. Mark Greenhow had however been appointed as Offshore Installations Manager ("OIM") on GA IV on 10th. March, 1998 as had Dave Foster. When Mr. Greenhow was onshore off duty, Mr. Foster would be the OIM and vice versa. Mr. Greenhow's first two week stints on GA IV were done shadowing the then Stena OIM and so the first time he took charge of GA IV on his own was 17th. June, 1998. He was aged 35 and had a background in the merchant navy. He had obtained a master mariner's certificate in 1993. Following that, he had worked for about 18 months in Singapore as a warranty surveyor in relation to rigs and other offshore installations and was then employed as a control room operator with GM, shortly thereafter being promoted to stability technician. By September, 1995, he had had his first appointment as an OIM and operated for GM as a relief OIM on several different rigs. After about nine months, he was appointed as OIM on a jack-up rig, Global Adriatic IV, for about a year, and he then held the same position, until March 1998, on the Maersk Finlander, on which GM were required to man a number of key positions including OIM. He therefore had some considerable albeit somewhat disjointed experience of acting as an OIM on a number of different rigs before taking command of the GA IV in June, 1998. He created the impression in the witness box of being an intelligent and thoughtful young man. His total failure to appreciate the significance of the permit to work system and to operate it effectively during the period of the repairs is all the more surprising. When GM took over the rig, it had a Stena crew operating Stena systems. When it headed for Dundee, the crew was still substantially made up of Stena personnel and Stena systems were still being operated. About 10 of the 60 personnel on board were GM employees. There were occasional hints in the evidence of a tension almost inevitable in a situation where, in effect, one workforce is being gradually replaced by another, but nothing in the evidence suggested that any such tension had any impact in relation to the circumstances of the accident, except insofar as it might go some little way to explaining what seemed to me to be the quite significant degree of isolation from

which Mr. Greenhow seemed to be suffering. It was decided to change from the Stena system to the GM system on arrival in Dundee and to use the GM system to control MESL's work of repair on the rig. Mark Greenhow was concerned about the number of contractor's personnel who would be coming on to the rig and expressed these concerns to Graham Harker, GM's Health, Safety and Environmental Superintendent who did not share them. GM had not carried out any risk assessment in relation to the repairs being carried out by the contractors notwithstanding the substantial presence of their own and Stena employees on the rig and their statutory duty to do so. His own previous training in the GM permit to work system had consisted of an induction video, a permit to work video and two or three trips offshore shadowing an OIM, together with access to the documents constituting the permit to work system. He accepted that he had not appreciated the importance of the permit to work system and would not have conveyed the impression to others that it was important. He did nothing to ensure that MESL's personnel knew of and understood the requirements of the GM permit to work system. With the benefit of hindsight, it now seems unwise of GM to have decided to convert from the Stena to the GM system, which no one on the rig seemed to be familiar with, at the time of the repairs, though I can well see, from the point of view of the normal operation of the rig, why that was considered appropriate. More to the point, however, the decision should not have been implemented without GM ensuring that those on the rig who would be required to operate the system understood the system and the critical importance of its effective operation. I have already stated that I had the impression that Mr. Greenhow became isolated, largely through a lack of support. I was unimpressed with Graham Harker, who did not appear to me to have a clear grasp of what his functions as Health, Safety and Environmental Superintendent for GM were supposed to be and who did not appear to me to have provided Mr. Greenhow with any relevant support, nor, so far as I could deduce from the evidence led, did any other more senior manager at GM, including Mr. Cheyne, the Rig Manager.

2.5

There was conflicting evidence before the Inquiry as to whether it had been a term of

the contract between GM and MESL that the method for pre-heating metal to be welded, where the welding specification called for pre-heating, would be by electric heating pads. In particular, reference was made to Crown Production 29, a copy letter dated 4th. June, 1998 from MESL's Charlie Davidson to GM's Technical Manager, Dave Kerr, in which there was reference to "pre-heat provided by transformer source and controlled locally by temple stick crayons." It was accepted that the reference to a transformer could only mean that the intention was to pre-heat the metal surfaces to be welded using electric heating pads. It is explained that, where metals to be welded are particularly thick or are located in a position where the temperatures to which they are exposed are generally speaking low, it is accepted as part of the standard welding procedure that, to avoid cracking of welds, some form of pre-heating of the surfaces to be welded to bring them up to a temperature at which welding can take place should be applied, and that there are two methods of undertaking this, namely, by applying electric heating pads, which operate in the same way as electric blankets, and which require a stepped down current to be supplied for their operation, which in turn would have led, for each necessary pad, to the need to provide an electric circuit from the main deck to the brace, with the risks attendant upon the provision of such a supply of electricity, including overheating from bunching of a number of electrical supply cables and the risk of electric shock from the possible earthing of uninsulated supply cables, or heating of the metal surfaces using a supply of propane applied to the surfaces from a rose head shaped torch. Mr. Mitchell, QC., for GM ultimately accepted that, whatever the provisions of the contract may have been, it would have been evident to anyone applying his mind to the situation that pre-heating in the braces was being done using propane and not electric pads and that if this were a true cause of concern as at least one GM witness, Larry Sparks, an American gentleman who described himself as a troubleshooter, but left me with the impression that his presence was more likely to have the precise opposite effect, asserted, then something should have been done about it at the time. In any event, it was clear from the evidence and, in particular, Crown Production 28, the specialist report by Mr. J.M. Madden, H.M. Principal Electrical Inspector, that there were already concerns on account of the number and lengths of the existing electrical supplies to the braces

without adding to them, and that there were safety concerns militating against the use of electric heating pads of a magnitude at least similar to if not greater than the risks attendant upon the use of propane, had these risks been understood and proper precautions to minimise them had been undertaken, and so I have come to the conclusion that the dispute about which form of pre-heating was to be used is not one of any substance. It was suggested that electric pad pre-heating would have been more expensive and that this was an illustration of MESL cutting corners to save money. The evidence does not support that conclusion nor, looking at the matter broadly, that in the particular circumstances of the aft brace, the use of electric pre-heating via the access and egress route used would have been any safer than the use of propane.

2.6

Various lines of questioning were pursued with various witnesses in the course of the Inquiry about cutting corners to save time and/or money, especially on the part of the management of MESL. While I am critical of the management of MESL for not implementing their own safety procedures and policies on this contract and for failing to ensure that those given the responsibility for this project were adequately trained in issues pertaining to the safety of the workforce, including the performance of a number of statutorily imposed duties, and of those so appointed for failing dismally properly to consider the risks attendant upon the work and therefore to consider what precautions might have been adopted to minimise those risks, and what special training members of the workforce and supervisory staff should have had thereanent, and while I can see that to experienced members of the workforce, the practical consequences of these failures would create the unfortunate impression of a company cutting corners to save time and cost, I believe, having regard to the evidence generally and my estimation of the witnesses holding management positions at MESL, that it was ignorance rather than any deliberately designed policy to save time and money by cutting corners, which led to the failures causative of the accident.

2.7

It was argued that it was not for the Inquiry to become involved in what ought to be in a contract between two parties in this type of commercial relationship, nor should the

Inquiry be prescriptive about the involvement of people with safety qualifications in the contracting or estimating processes. On the other hand, it was suggested that it was inadequate and likely to diminish safety provisions if safety costs were simply part of a formulaic on-cost process which might not necessarily reflect the true necessary costs of providing a safe system of work in particular circumstances. It seems to me that this was one of several issues canvassed at some length which were not really within the remit of this Inquiry. I content myself by drawing attention to the provisions of what were Regulations 9 and 10 of the Management of Health and Safety at Work Regulations, 1992 (now Regulations 11 and 12, respectively, of the Management of Health and Safety at Work Regulations, 1999,) which deal with co-operation and co-ordination between two or more employers, on the one hand and with the circumstances of persons working in the premises of other employers on the other where it seems to me that it must be essential at the time of formulation of a contract to carry out works such as those here for the parties to consider jointly how to undertake a risk assessment or risk assessments, as may be necessary, and as to who is going to undertake the various requirements and responsibilities which arise on a consideration of that risk assessment. There was some evidence about the formulation of bridging documents i.e. an attempt to marry up temporarily the system of an employer with the system of a contractor to avoid systems conflict or responsibilities falling between two stools and while I do not consider that there is necessarily a need for a separate formal document dealing with such arrangements, there is in my opinion undoubtedly a need at the time of formulation of the contract to give consideration to who will carry out safety functions and requirements, for the avoidance of doubt in the matter.

- **Preparations for the Work and Deficiencies Therein:**

3.1

It was expected that GA IV would berth at Prince Charles Wharf, Dundee, on 25th. June, 1998 and that the repairs that were then intended would be completed in a period of eight days. Apart from the technical contents of the work to be carried out, it would appear that one of the items raised at a meeting on 17th. June, 1998 was liaison between Judith Ross, the MESL safety officer appointed to the project, and

Graham Harker, the GM Health, Safety and Environmental Superintendent "concerning safety aspects of the rig's visit to Dundee." It was agreed at that meeting that the work would be carried out under the control of the GM permit to work system which would be in place on GA IV prior to its arrival in Dundee. Such liaison was to encompass "PTW, PPE and pontoon working." No reference appears to have been made then or later to the need for risk assessment, nor about the specialities associated with the execution of work involving flammable gases in a confined space nor about what might be given off when heat was applied to the coating previously applied to the metal surfaces in the braces. There was no meeting between Judith Ross and Graham Harker though some information was exchanged between them by correspondence. Neither impressed me as having adequate training or experience for the tasks assigned to them. In any event, Judith Ross proceeded to prepare what she called a risk assessment which forms Crown Productions 3A and 3B. 3A described itself as a Risk Assessment Hazard Checklist which is what it was. It had a list of hazardous agents, of critical activities and of hazardous consequences. The checklist, in the hands of a competent person, would have been a useful starting point. Mrs. Ross in using it failed to recognise as hazardous agents likely to arise in these works "flammable gas/vapour" and "oxygen" both of which were on the checklist, and, under critical activities, failed to recognise, "confined space entry" and, without having seen the means of access and egress, assessed the risk level associated therewith as "low." Under hazardous consequences, she failed to identify the risks from "ignition" and "damage to equipment." She also regarded the risks from "fire/explosion" to be "low" as was the risk from "asphyxiation." In the second part (Crown Production 3B), having identified "electrical energy" as a risk, she provided that "all welding equipment to be checked prior to use" and under "welding/cutting" that "Fire watcher to be present where necessary, fire extinguishers to be on site, cables/hoses to be checked before use," and under "fire" that "If possible, timber decking to be wetted, or wet fire blankets to be used. Fire watchers to be present as necessary. Fire extinguishers to be available." Under "secondary structural damage" she provided "care to be taken when welding, do not damage existing structure during welding, cutting and slinging operations." Under "asphyxiation" she provided, "Hatch

covers to be open where possible, extraction systems to be available and used when necessary."

3.2

Criticism was properly made of the inadequacy of the foregoing as a risk assessment by representatives of the Health & Safety Executive, particularly Mr. Monaghan and Mr. Summerfield, who were concerned generally about the use of a generic risk assessment process as opposed to one specific to the intended works, it being observed that part 1, Crown Production 3A, appeared to refer to the Adriatic 4, a different vessel. While oxygen and flammable gases appear on the checklist, the risks associated with their use did not appear to have been addressed. Ignition of flammable gases in a confined space was a high risk situation. The same was true of the introduction of oxygen to a confined space, especially in the presence of flammable gases. There would be a question of the competency of the workforce for carrying out the work in a confined space which required some specialised knowledge and training. That was not addressed. Confined space entry was apparently not regarded as a significant risk. The risks of ignition, fire and explosion were significant. There was a risk of damage to cables and hoses not only from the hot works but from the environment in which they were being used, having to be run a considerable vertical distance and through hatches and other narrow passages where they were in conflict with the workforce coming and going. There was no mention of gas detection equipment which should have been provided. There was no mention of the intention to operate a permit to work system. There was no reference to communications and emergency procedures. As a risk assessment for the work it purported to address it was "not sufficient."

3.3

Judith Ross had been 26 at the time of the accident. This was her first project as safety officer. She held a diploma in safety management but it was singularly unclear how impressive a qualification this was as it appeared to have been obtained over five weeks of day release from work. The training was not related to any particular industry. She had become employed by MESL in summer, 1995, as a safety assistant. Initially, she had been an administrator but soon she seemed to be deputising for the

then safety officer, doing inductions, attending safety meetings and safety inspections. She had been appointed to the position of safety officer at Christmas, 1997. She had received no specific training from MESL, not even in their own policies and procedures. She was assigned to look after the GA IV contract "a few days prior to its arriving." She seemed to have no understanding of the critical nature of a permit to work system and its effective operation apparently considering her function in this respect to have been met by designating that it would be the general foremen who would be responsible for the operation of the permit system from the MESL point of view, without having any appreciation of what that would entail and what knowledge of or training in the system would be required or received by these general foremen. She did not ask to see the written procedures pertaining to the system or for a sample of any of the forms, certificates or permits. She had no previous experience of rig repair at Dundee. She was aware that work would be carried out in the horizontal braces. She said she did not know that flammable gases would be used in the braces, though that seemed to be inconsistent with her albeit confused understanding of the work of a welder. She did not understand the nature of the work undertaken by a plater and thus the inter-relationship between their work and the work of welders, with the possibility of scope for conflict between the two. She was unable to explain what had become of her desiderated precaution about the provision of fire extinguishers nor could she explain what had been done about the provision of fire watchers. She seemed to think that the general foremen would arrange for precautions to be put in place. Shown Crown Production 26, the MESL Policies and Procedures Manual, she stated that, while this had been prepared prior to her employment with MESL, it was part of her duties to revise and update this. That being so, it was all the more disconcerting that she was so ill acquainted with the contents of the Manual. She accepted that the Manual contained information, guidance and instruction about risk assessment which she had not followed, including discussing the risk assessment with all personnel involved in the job prior to the commencement of the works. She could not recall having read any publication by the Health & Safety Executive on risk assessments. She seemed to have difficulty in grasping the related concepts of frequency and consequence in this context, agreeing

with a suggestion that a risk would only be a high risk if safety precautions were not followed and, correspondingly, that everything would be of low risk provided they were. Despite repeated examination, she appeared incapable of understanding that a risk assessment could not properly be carried out without a clear understanding of the works to be carried out and the location they were to be carried out in. She had not, for example, considered whether there was any place near the work sites where a pocket of dense gas might accumulate, despite apparently being aware that propane was denser than air and would tend to accumulate, were it to leak, at low level. She could not recall reading any safety literature drawing attention to accidents involving explosion or fire while welding or flame cutting equipment was in use. She claimed to have recognised that molten metal particles from cutting or welding might land on and burn rubber hoses, but that "it wasn't in my thoughts as I wrote the risk assessment. I didn't envisage the hoses being directly underneath as they were carrying it out. I would have expected them to be kept back from the work site or routed away from the area." In that passage she appears to be referring to damage to a hose other than the one supplying the gas with which the given individual is working as it still begs the question how a given plater, in particular, protects his own gas supply from molten metal particles. She agreed with hindsight that it would have been reasonable to supply breathing apparatus escape sets and an adequate means of communication between the workers in the brace and the outside world. In relation to the former, she tried to explain her lack of foresight by reference to her knowledge that the rig would have a firefighting team with breathing apparatus on stand by on board the rig, which is, of course, no justification for not supplying breathing apparatus to workers in the brace. She did not offer any explanation for the latter. She had, of course, prepared the risk assessment while the rig was still on its way to Dundee, so she gave herself no opportunity to look at the work sites.

3.4

It was not clear what Mrs. Ross did with the risk assessment having completed it. She said that it was "covered in the induction" and led to the preparation of method statements. She did not, however, make any specific reference to the risk assessment at the inductions. Crown Production 5 was identified by her as a document she used at

induction sessions with new MESL employees and that she did not deviate from its content. Unsurprisingly, there is nothing in that document which would explain how fire extinguishers are to get to the point of being located in the braces, nor about who is to act as a firewatcher and how that task has to be undertaken. In relation to firewatchers, it seemed to be her expectation that someone designated to perform that task would have "a working role just to stand nearby the actual person performing hot works and prevent fire from occurring." Should fire occur, it would be his function to "extinguish" it. Firewatchers should have extinguishers which were available at the stores. But no one was designated as a firewatcher and no one was trained as a firewatcher and no one made sure extinguishers were present in the braces. She appeared to be unaware of the traditional practice of welders and platers to work in pairs, given that the individual who was welding or cutting would have commonly to wear eye protection and would be unable to see anything other than the immediate process being undertaken, so that the other tradesman would watch all that was happening during this process, including where molten metal particles inevitably produced by the process were going and what harm, if any, they were causing, and that such pairs of tradesmen would "spell" each other, alternately taking turns to weld or cut on the one hand and watch welding or cutting on the other. As it happens, therefore, the separate provision of firewatchers was unnecessary, but Mrs. Ross did not appreciate that. The provision of extinguishers, on the other hand, was necessary and no one was instructed to undertake the responsibility of ensuring their presence at work sites in the braces at all times. It seemed that, having prepared the risk assessment, she did nothing positive to have the precautions she decided were appropriate put in place.

3.5

One of the most unfortunate aspects of the performance of the management personnel of MESL (and, for present purposes, I include Mrs. Ross in the expression, "management personnel",) is that it is plain on a reading of Crown Production 26, the MESL Policies and Procedures Manual, that this is basically a well written document into the preparation of which someone has put considerable time and effort. In the present context, had its terms been considered by either of Mrs. Ross or Mr. Johnston,

action might have been taken which would have prevented the accident occurring. I repeat, in fairness to both of them, that neither appear to have received any specific training from MESL on the significance of the Manual nor how it was to be applied by them nor even how their roles were defined by it. As I have already said, however, it was one of Mrs. Ross's functions to revise and update it, so presumably she should have been aware of its contents to enable her to do so. The Manual required that the risk assessment should be discussed with all personnel involved in the job prior to the commencement of the works. That was not done and who knows what doing so might have highlighted. Mrs. Ross could offer no reason for this failure. While I will have more to say later about failures in respect of the permit to work system, Mrs. Ross accepted at this stage that the MESL Manual, at Procedure 10, discussed the procedure to be adopted on the utilisation of a customer's permit to work system and that it required those to be using such a system to be trained in it. It provided that, "The company will provide the necessary information and appropriate training to ensure that appropriate employees, supervisors, contractors and visitors are fully aware of the permits and use and are competent to undertake the tasks and tests prescribed in the permits." She had no explanation as to why this training and information had not been given in relation to the works on the GA IV. The Manual also required that permits to work should be displayed at the work site and work control area "to ensure that all employees are made aware of the permit operational requirements." Mrs. Ross could not explain why that had not been instructed. She accepted that the workforce were not given access to this Manual nor were they told of MESL's safety policy statement. The workforce were not informed by her of their responsibilities in relation to safety in the terms set out in the Manual. She did not give them an introduction to safety legislation, notwithstanding the terms of Procedure 6 of the Manual. She agreed that the purpose of the Manual was to assist in the creation of safe systems of work and that it set out the safety responsibilities of, amongst others, the managing director, the legislative services manager and herself as QA and safety officer. She considered that her job was to make the work site as safe as possible but conceded that she had not done so. She did the job the way she had been taught to do so by her predecessor. With hindsight, she did not consider that her

on the job training had been adequate. She had not asked for further training. She considered that she had not had sufficient time to keep up to date with the legislation. She had done nothing to acquaint supervisors with the roles assigned to them under the Manual. She accepted that she should have had the role of acquainting new supervisory staff of their roles but had not done so. Supervisors should have had training in health and safety, especially the two general foremen, but had not. She was unaware if tool box talks had taken place. She seemed to think that safety responsibilities in terms of the Manual imposed on the local manager, that being the expression used in the Manual which in the present case would mean Mr. Johnston, the project manager, could somehow be delegated to her, failing to appreciate their different functions in relation to the safety of the workforce. She accepted that in Procedure 31 in the Manual, which covered welding, cutting and gouging processes, there was a requirement for regular inspection of the equipment, but no 'competent person' had been identified let alone instructed to do that and she had not instructed supervisors to carry out regular equipment checks. She accepted that there was a procedure in the Manual relating to ventilation which she had failed to implement, and that the arrangements in place for the removal of fumes had been inadequate. She accepted, despite the provisions of the Manual, that there had been no consultation appropriate to the performance of work in confined spaces, another subject to which I will return in due course. There was no planning meeting with the OIM to discuss job safety precautions, alarms and signals and hazards and risks, as the Manual required. She could give no reason for not referring to the Manual in her preparations for the execution of these works beyond saying that it was "not intentional that safety was not given a high priority," a statement that I accept.

3.6

It was not entirely clear exactly what role Mrs. Ross played in assembling the workforce but, in any event, she was well aware that the workforce required to be assembled at short notice and she should have been aware that tradesmen were coming from all over the country to join it. She therefore knew or ought to have recognised that they would be unfamiliar with the site and may or may not be unfamiliar with semi-submersible rigs. She knew or ought to have known that it

would be unlikely that many of them would have worked together before and that, unlike a settled workforce, they would be unfamiliar with each other's trade skills and other abilities and any other relevant idiosyncrasies. It would be the norm, where a new employee was joining any settled workforce, for that employee to be subject to special scrutiny by management until it was clear that that employee was able to do the job competently and was otherwise reliable. That situation cannot pertain where everyone is new to the job. This, in my opinion, places a special series of responsibilities on management and supervisory staff, particularly where there are, as there were here, patently dangerous aspects to the work. I accept that MESL, in common with most other employers in the building and engineering construction industries, have felt obliged to adopt a system of working which involves the employment of temporary workers instead of a permanent workforce, if they are to remain competitive, and no useful purpose would be served by singling them out for criticism when it must be patently obvious to government that this is happening and its effect is to avoid employment legislation most of which has a European basis, as has most of the health and safety at work legislation. It must be obvious to government that there is a much greater risk to the safety and welfare of people at work if they do not form part of a settled workforce and that if it is to continue to be permitted to be the norm that, at least in building and engineering construction, where one patent consequence of this state of affairs now to be seen is a significant skills shortage, they will have to take the training lead in ensuring that people still develop the kinds of trade skills possessed by the workforce which was assembled here, but have a better developed sense of their safety responsibilities both to themselves, to their fellow workers and to all others who might be affected by the way they do their work. A constantly recurring phrase from many of these widely experienced tradesmen was that you had to be "your own safety officer." As both a concept and as a basic truth given the state of these industries with constantly shifting work forces, I would wholly endorse the statement. Unfortunately, as I will come to describe, many of these experienced tradesmen went on to demonstrate how singularly ineptly they were equipped to take on the role, though that was not their opinion. While it might be said that the MacGregor Group of Companies is more

cynical than others about the expendable nature of a given workforce in the sense of parting company with it as soon as a particular task is completed, by having an associated company which is an employment agency, as things presently stand, it must be for government to look urgently at what requires to be done to ensure that skilled tradesmen who are forced to work by way of a series of short term contracts are kept aware of safety legislation and other safety considerations pertinent to the work they do and it seems to me that this can only be done by way of skills certification courses focusing on safety. It was surprising to me, and as was submitted by Mr. Thomson, surprising to the management of MESL, how poorly these experienced tradesmen, many of whom had more than twenty years experience of working not only all over the United Kingdom but many of them had worked all over the world, and who came from all sorts of different backgrounds and a number of different parts of the country, had grasped the dangerous propensities of the equipment and, in particular, the gases that they habitually worked with, and had an equally poor grasp of the need to take particular safety precautions in relation to those dangers. These deficiencies were not understood and certainly not addressed by the management of MESL as they took on this workforce and put it to work in dangerous conditions. That was, in part, caused by their own failures to recognise the dangers but also perhaps by an over-reliance on the apparently high qualities of the workers they had been able to recruit. It does emphasise the need for extremely well motivated and trained supervisory staff and two submissions from Mr. Thomson struck me as having particular merit in this context - firstly, that there would be merit in having a special skills course and certification for the performance of hot works, welding, plating and gouging, in confined spaces, leading to someone having a certificate of competence both to carry out and to supervise such works and secondly, to attract the right kind of people into supervisory roles, there required to be a much greater differential between the pay rates of tradesmen and the pay rates of foremen and general foremen, as well as much improved safety related training and training in communications skills for such supervisors.

3.7

Once the rig had berthed at Prince Charles Wharf, Dundee, Mrs. Ross, in the

company of Mr. Johnston, but not apparently anyone from GM, visited each of the braces. It is, perhaps, instructive to observe that she was obliged to concede in evidence that she did so without having any regard to the terms of any entry certificate or hot works permit so that she could not say whether she or others were complying with the requirements of such permits. However, after her visit, she prepared a method statement, Crown Production 4, another document which was criticised by the Health & Safety Inspectors who gave evidence about its patent inadequacy. Mr. Thomson in his submission suggested that this was the true second stage of the risk assessment process but there is no evidence to suggest that that is how Mrs. Ross considered it. She described the risk assessment as leading to the method statement and therefore the method statement as what workers were expected to do having regard to the risks identified by the earlier process. There was a great deal of evidence at the Inquiry about the two method statements and what was done with them. Crown Production 4 is headed "Method Statement for the Adriatic IV" ie once more the name of the rig is wrong. Its sub-heading is "Working in Horizontal Braces." Its sub-sub-heading is "Permit to Work." It then reads, "No personnel shall enter column bracings until a work permit has been issued. Permit to be read and precautions agreed upon to be adhered to."

This gives rise to a number of difficulties. Firstly it is not clear what was meant by the expression "column bracings" which may explain the diversity of the evidence about where notices, if any, were located. Mrs. Ross was unable to say in evidence what she meant by a column bracing. On the face of it, one goes down the column to get to the bracing. Secondly, it is not clear how personnel would know whether a work permit had been issued in the absence of instructions not to go to the braces unless they had either seen a relevant permit or at least been told by a member of the supervisory staff that one existed. Thirdly, it was not clear how a permit could be read and the precautions in it adhered to unless it was to be exhibited. There was no specific provision made about the exhibition of permits or certificates and the supervisors were not instructed to read them to the workforce and did not do so. Given that most of the precautions which came to be desiderated would require action by the management of either GM or MESL e.g the provision of constant gas monitoring, it is

not clear what employees were supposed to do if they could see that any given precaution did not appear to be in place.

The method statement went on to provide that, "Gas bottles shall be kept on the main deck routing the hoses down the column and into the horizontal bracings. All torches and hoses to be removed from bracing into columns during breaks and gas bottles turned off." Once more this passage gave rise to a great deal of evidence in the course of the Inquiry. In the first place, on account of the non-availability of a crane at the material time, the propane bottle was located and remained so located on the ROV deck, one flight above the main deck. Whether that was significant to the performance of the instruction to turn the propane bottle off and on was not explored.

The hoses were routed down the column, a vertical distance of somewhere between 80 and 100 feet on a route that took them through a minimum of five hatches, to the point of entry into the port section of the aft brace. It was explained that the point of removing torches and hoses from the bracing into columns during breaks was a safety measure to minimise the risk from the ignition of leaking gas. This was criticised on two fronts, firstly because the method statement did not make it clear where about in the column the hoses and torches were to be removed to and secondly because, wherever it might mean, the hoses and torches would still be being left in a confined space. There can be no doubt on the evidence that the best place to leave equipment which has the potential to leak flammable gas is in the fresh air where normally the gas would be naturally dispersed with almost no risk at all. Equally, there can be no doubt that, in the present case, given the restricted means of access to and from the aft brace, the removal of torches and hoses would have presented some difficulty though I am not satisfied that the degree of difficulty was not exaggerated. I accept that there is some relative merit in moving the hoses and torches away from the immediate worksite since the major risk is of ignition and the most likely place for ignition is where naked flames are being used in the processes of heating and cutting but patently there remains a risk of a leakage, followed by ignition, causing an explosion and/or fire in the column with potentially disastrous effects, when there were electrical cables running through the column, temporary electric lighting in the lower chambers of the column, little in the way of effective ventilation and, as can be seen

from the photographs especially those in Crown Production 2, a number of areas where pockets of gas could have accumulated and remained for some time. Also, the route via the column was in regular use by the workforce and other visitors to the brace who could have caused ignition in a variety of ways, not the least of which was the uncontrolled and apparently unobserved smoking which was taking place. For the moment, it was the lack of clarity of the instruction and the thinking behind the instruction which were criticised for not removing the risk where it was possible to remove the risk, but a proper consideration of that risk would lead anyone properly applying his mind to the situation to consider whether a better means of access to the brace could be devised.

"Gas bottles turned off" was another expression which was not as clear as it should have been. All gas cylinders have on/off taps which simply involves turning them which has the effect of opening or shutting a valve on the bottle which permits or does not permit the flow of gas. Equally all the hoses at the gas bottles here had regulators fitted. It is explained that gas is delivered in gas bottles under pressure, in the case of propane at about 20 bar where it is in liquid state. A propane torch works when the pressure of the gas to it is about 3 bar. It is accordingly necessary to fit a pressure regulator valve which restricts the flow of gas under 20 bar pressure from the bottle so that it reaches the point of delivery under 3 bar of pressure. Of course, such a regulator can be turned so that no gas flows. Finally, it is possible, using the simple mechanism of a spanner, to disconnect the hose (with the regulator fitted thereto) from the bottle and thus terminate the supply of gas to the hose from the bottle. The question is, if the object of the exercise is to try to prevent leakage of gas when the supply is not in use, which of these three alternatives best achieves that result. The evidence demonstrates, as I understood it, that it is the last of those three alternatives, but there is perhaps not a great deal between that and closing the regulator. Merely turning off the tap is the poorest alternative as that still leaves gas in the hose at 3 times atmospheric pressure some of which will emerge from the hose, if there is a point of leakage in any event until the gas in the hose equalises with atmospheric pressure. Again the instruction was not as clear as it should have been, though perhaps less critically so, so long as one of the three alternatives was applied.

A great deal of evidence was devoted to what happened to this method statement and to the second statement subsequently produced following a problem with paint fumes. A number of witnesses had vague recollections of seeing it. Mrs. Ross and Mr. Johnston insisted that it was put up at the entrance to the aft brace, wherever else, and, given that there is some support from some of the people working or supervising there, I accept on the balance of probability that that was done. Otherwise, however, Mrs. Ross appears to have considered it appropriate for dissemination of its contents to be made by the general foremen, though she did not instruct them that that should be done and appears to have had little communication with the night shift foreman in any event, and it is clear that no one actually removed hoses and torches from the braces and that no one was disciplined for failure to do so. The question whether gas supplies at the bottles were consistently turned off at break times did not receive a clear answer leading me to the conclusion that performance of the workforce in that respect was inconsistent, but, once more, no one seems to have been disciplined for this failure and, in general terms, no one seems to have properly appreciated the magnitude of the risks from leaking flammable gas. In any event, it was a foreseeable risk not properly addressed by MESL management prior to the commencement of these works.

- **The Permit to Work System and its Operation:**

4.1

It was a matter of agreement between the managements of MESL and GM that the GM permit to work system would apply to the works. As with the MESL Policies and Procedures Manual, one of the more unfortunate aspects of this episode was that the extract produced from the Global Marine Drilling Company Safety Procedures Manual - European Operations, dealing with the permit to work system was a clear and well written document that someone had taken time and trouble to formulate, which would not have taken anyone truly concerned with the effective implementation of the system long to grasp. This was produced as Crown Production 12B. Similarly, the documentation used in connection with the operation of the system, entry certificates, isolation certificates and hot work permits, generally speaking was clear and adequate. Some improvements were suggested in the course

of evidence, to which I shall return, some of which had already been taken on board by GM and the system altered accordingly but it would be wrong to say that the system failed to operate effectively here because in terms of its design and intended method of usage it was inherently defective. As I have already indicated, hindsight suggests it was not a particularly good idea in all the circumstances to introduce the change from the Stena to the GM system coincident with the arrival of the rig in Dundee, but it would be harsh to criticise that decision without the benefit of hindsight. What was regrettable was that Mark Greenhow, despite his not insubstantial experience as an OIM, had no appreciation of the importance of an effective permit to work system and had not familiarised himself with the 23 pages of the Manual which would have made its importance apparent to him and would have informed him how it ought to have been operated. His failure was compounded by the failure of the management of MESL to instruct themselves or any of their workforce in the GM permit to work system and, similarly, to appreciate the importance, in general terms, of an effective permit to work system. On the evidence, I have to conclude that it is unlikely that the accident would have occurred if the permit to work system had been properly applied instead of being treated as an inconvenient formality which is what happened in practice.

4.2

Before examining what went wrong here, since this is perhaps the most important issue to have emerged from Lord Cullen's Report on the Piper Alpha disaster, I make no apology for incorporating some of his observations from the Report which seemed to me not to have been learned at least at the relevant operational level of the two companies here. Lord Cullen said that:-

"A permit to work system is a formal written system which is used to control certain types of work which are potentially dangerous. Within that system, the permit is a formal written means of making sure that potentially dangerous jobs are approached and carried out with the use of appropriate safety procedures. It is an essential part of the procedure to ensure that the work is done safely. Safety in this context means the safety not only of those carrying out the work but also of those who may be affected by the carrying out of that work.....In order to ensure that an effective permit to

work system is achieved in practice it is essential that operating staff work exactly to the written procedure which has been developed by the management of the company.....Contrary to the written procedure, the Performing Authority's copy of the permit was frequently not displayed at the job sitethe lead operator accepted the permit for suspension without first inspecting the job site and satisfying himself that it was in a safe condition.....These examples serve to demonstrate that the operating staff had no commitment to working to the written procedure; and that the procedure was knowingly and flagrantly disregarded.....each of the above departures from the written procedure represented a departure from safe practice.....(the critical) failure can well be understood against the background of the informal and unsafe practices which I have outlined.....In order to have an effective permit to work system it is essential that the persons who are required to operate the system are thoroughly trained in all its aspects. This applies particularly to those who are to act as Designated Authorities and Performing Authorities since the safe execution ofwork is their responsibility.....As regards Occidental personnel who were to act as Designated Authorities it is clear that Mr.....required to pick up the practice from watching others carrying out the function of Designated Authority. This also applied to others on the platform. While training on the job no doubt has its part to play in the full training of personnel in positions of responsibility for safety, I consider that it should not be the sole or primary means of training. It suffers from the crucial weakness of perpetuating or accumulating errors.....It is clear that to a large extent Occidental placed the responsibility of ensuring that contractor's employees were familiar with the permit to work system on the contractors themselves.....Occidental organised no training for contractor's employees in regard to the permit to work system.....I will refer to the safety induction at which the permit to work system was 'explained.'This appeared to be no more than a reference to the existence of a permit to work system.....the training required to ensure an effective permit to work system was operated in practice was not given.....An essential part of any permit to work system is the monitoring and auditing of the operation of the system in practice. By the former I mean checking on a routine basis by platform personnel. By the latter I mean the planned examination of the system at

infrequent intervals by personnel who are not responsible for the operation of the system.....It was (one expert witness's) experience that PTW systems are only as good as the care and competence of the people who operate them. It was therefore essential that all persons who are required to operate the procedures and the tradesmen who work under permits are adequately trained. Specifically, detailed and formalised training should be given to both Designated Authorities and Performing Authorities, and they should be formally assessed prior to their appointment. Records of all PTW training should be maintained....I am convinced that the training should be and can only be provided by the installation operator, as it has to be specific to the operator's PTW procedure. There is also merit in the OIM formally appointing Designated and Performing Authorities, after assessing their general knowledge of the installation and its work practices...."

It is inexcusable and unforgivable that seven and a half years after the publication of the Piper Alpha Report, I should be placed in a position of being able to say that almost all the foregoing observations could be made about the present circumstances and I consider it remarkable, in those circumstances, that no individual has been prosecuted in respect of the failures to ensure here that the Issuing and Performing Authorities were thoroughly trained and thoroughly understood the importance of an effectively operating permit to work system. Those who lost their lives as a consequence of the Piper Alpha disaster did so at least in part on account of the breakdown of the operation of a permit to work system and the time devoted by the Inquiry and by Lord Cullen in the preparation of the Report to the subject of effective permit to work systems should have resulted in the report forming the watershed after which no one pretending to be a significant force in North Sea oil extraction operations or contractors servicing them could claim not to appreciate the importance of having thoroughly trained personnel knowledgeable in the effective operation of permit to work systems in general and the operative system in particular. Instead, the situation in the present case was worse than that which existed on the Piper Alpha platform. Mark Greenhow, who, as OIM, was the designated issuing authority did not know the system, had had no effective training whatsoever in the system despite having been an OIM in various locations for some time and had no appreciation of

the importance of the system. Angus Wylie and Eric Murphy, the two general foremen employed on the night and day shifts respectively for MESL came by default to be the designated Performing Authorities without anyone at either GM or MESL making any effort to ascertain if either of them understood the operation of a permit to work system generally, the rules applicable to this one in particular or the well recognised importance of having such a system operating effectively when potentially dangerous work is being undertaken. They received no training whatsoever in the GM permit to work system.

4.3

It is all the more sad that there were the foregoing training failures when one considers the content of Crown Production 12B, the extract from the GM Safety Procedures Manual germane to the permit to work system. The document clearly defines the purpose of a permit to work system and contains extracts from guidance issued by the Oil Industry Advisory Committee and from the Offshore Installations (Operational Safety, Health and Welfare) Regulations, 1976 relating to the statutory restriction on any hot works in an offshore context without the prior written authorisation of the OIM. It details where various responsibilities lie in terms of the system, including imposing on the Issuing Authority the responsibilities to identify all hazards associated with the job, identify all steps necessary for the safety of the installation, examine the work site and all specified precautions to be taken before work commences to ensure their presence and that they will remain effective throughout the duration of the work, to ensure that the person in charge of the work is aware of the precautions, of any particular safety equipment to be used or worn and any particular procedures to be followed, and that the work site is examined before work starts, before work resumes after any suspension and to ensure that it is in a safe condition when work has been completed. The Performing Authority is to understand the operation of and consequences of non-compliance with the permit to work systems and procedures applicable to the area of work, any necessary additional instruction or training is given to workers to ensure they understand the permit to work systems and procedures in general and the specific precautions applicable to their work, and that the specific precautions are understood and followed at all times.

In addition, the OIM is the only person who can issue hot work permits and must endorse all other permits and one of the main responsibilities specifically entrusted to him is to ensure that the effectiveness of the operation of permit procedures is not impaired by shift hand overs and information is given to incoming shifts about work for which there is a permit and which has not been completed. That, of course, was another of the issues which contributed to the Piper Alpha disaster. Here, at least at worker to worker level, there was no effective shift hand over and it is not clear how effective it was, other than in respect of the formality of revalidation of permits, at supervisor level. The manual goes on to make it clear that hot work permits are required for welding, flame cutting and grinding operations and that their maximum period of validity was 24 hours, with revalidation being required at a shift change. An entry certificate must be issued according to the manual when it is necessary for personnel to enter vessels, tanks, voids, spud cans and structural members. It is made clear that the main purpose of an entry certificate is to certify that the atmospheric conditions in the space to be entered are acceptable and to document the necessary precautions. The entry certificate is for entry only for inspection purposes and an appropriate permit to work must be raised before any task can be undertaken. As we shall see, in the present case, it appears that there was confusion or, at least, a lack of consistency between the entry certificate's requirements and those on the hot works permit, both of which were completed at the same time, it apparently being thought that if precautions were indicated on one then they need not be indicated on the other. This is a perfect illustration of the consequences of the failure to train in the operation of the system. The manual contains at pages 12 - 15 a detailed guide to the completion of permits and certificates. It goes on to provide that, where possible, a copy of the permit shall be displayed at the work site on a dedicated display board or by means of a clear plastic envelope attached to the work location by a tie-wrap. The OIM or his deputy were, according to the manual, to carry out spot checks to ensure compliance. As I say, the system is clear and is encompassed in 23 easily readable and absorbable pages. I do not understand and heard no satisfactory evidence to explain why it was not read and absorb at least by Mark Greenhow and also by a member of management of MESL so that its main contents could be explained to

Angus Wylie and Eric Murphy and its relevant contents could be explained to all who would have to visit the brace while these works were in progress.

4.4

Instead, what happened was that on 27th. June, 1998 at 19.00 i.e. the commencement of the MESL night shift, Mark Greenhow, purporting to act as Issuing Authority, gave to Angus Wylie, purporting to act as Performing Authority, an Entry Certificate No. 5303, (Crown Production 14) and Hot Work Permit No. 22707 (Crown Production 10.) It is not clear from the evidence how either of them actually recognised the need for the certificate and permit, though it is clear that the management of both companies had agreed prior to this date that the GM permit to work system would be utilised in connection with the works. What can be inferred from the fact that both an entry certificate and a hot works permit were issued at the same time is that right from the outset there was a failure to operate the system in accordance with the provisions of the relevant portion of the GM Safety Procedures Manual (Crown Production 12B). It will be recalled that, in terms of that Manual, the purpose of an entry certificate is to facilitate entry for inspection purposes and not to carry out works. By definition, it should therefore be necessary to issue an entry certificate at a point in time prior to the issue of any hot works permit. There is a third certificate, an Isolation Certificate, No. 9256, also dated 27th. June but this time timed at 15.00. It bears to have been requested by Mark Greenhow and to have been performed by Keith Brown, the rig electrician, both of whom have signed the permit accordingly. There is a reference to a Work Permit 16811, but no evidence was led as to what that pertained to. The systems to be isolated are referred to by initials which were not explained to me and it is not clear that this certificate relates in any way to the work in the braces. What is relevant, however, is that Mr. Greenhow considered it appropriate to issue an isolation certificate for an indefinite period. It, being dated 27th. June 1998, is said to be from "15.00" to "Long Term." In accordance with the provisions of the GM Manual, the isolation certificate is presumed to be related to a permit to work, and what is provided is that such a certificate is "to remain in force until it and the Permit to Work is cancelled." As the scheme then was, cold work permits could have a 7 day maximum period of validity and hot work permits had a

24 hours maximum. The reason given for the issue of the isolation certificate is "entry" though entry to what is not specified. If this certificate relates to the Entry Certificate 5303, though that is not clear, at least the two are consistently wrong in that in relation to its period of validity it is to run from 19.00 on 27th. June until "TBA" (to be advised.) According to Mark Greenhow, the isolation certificate was required to prevent "potential drowning."

However, the GA IV berthed at Prince Charles Wharf on 25th. June and on that same day Sureclean Limited, a specialist company in the field, issued a certificate, the terms of which were never subject to challenge, that they had inspected all three braces and had found them to be gas free. Their client was GM and the certificate is timed at 22.50 on 25th. June. Specifically, that certificate specified a normal oxygen content in the atmosphere of 20.7% and the absence of either explosive or toxic gases. It is clear from the induction records (MESL Prod. 1.2) that the first people to turn up in significant numbers did so on 25th. June and they were scaffolders and labourers, universally referred to as helpers on this job. Five platers and two welders also appeared, though the five described as platers included Mr. Murphy, whose evidence was that he came to Dundee expecting "just to be one of the foremen" but who was rapidly, one may say instantly, elevated by Mr. Johnston, the Project Manager, to the position of general foremen, without either of them understanding the safety functions of a general foreman or the role on this particular contract which someone had assigned to the general foremen of being Performing Authority in terms of the permit system. Another of the five platers was Mr. Stitt, who came as a plater and was similarly elevated by Colin Johnston, to the position of foreman. A third plater to arrive was Gordon Davidson, who, in due course, was elevated to position of foreman. George MacLachlan, a plater, first reported for work on 26th. June at 07.00 and was given an induction. It was his evidence, which I thought on this point was reliable, that he spent his first two days working on the dock-side while the scaffolders built the access stairs from the dock-side to the level of the rig's main deck. He went on to say that it was on 28th. June that David Stitt had first taken him on board the rig and down to the port aft brace, showing him the work to be done. Mr. MacLachlan was then told to assist another plater, Tony Black, in setting up the gear,

i.e. installing the oxy-acetylene supply lines and torches and gas bottles. According to Colin Johnston, the rig had arrived on Thursday, 24th. June, but there was no access until Saturday 26th. June on account of problems with mooring and ballasting. According to Angus Wylie, he was in Dundee by 25th. June and had attended the first induction session, though he is not recorded as having done so, but then he was the only "tradesman" who came to Dundee who was already in the employment of MESL. It was Mark Greenhow's evidence that the entry certificate and the hot works permit were issued on the first occasion that MESL wanted access to the braces i.e. at 19.00 on 27th. June, which would be reasonably consistent with Mr. MacLachlan's evidence about setting up the gear in the course of the morning of 28th. June.

4.5

Both the Entry Certificate, 5303, and the Hot Works Permit, 22707, were defectively completed and were not effectively put into operation. The Entry Certificate is cross-referenced with the Hot Works Permit and it appears that only one of each was issued for the work in the three separate braces, whereas there should have been one permit for each work site. Despite the fact that the Hot Works permit can only be issued for a maximum period of 24 hours, the Entry Certificate was issued for an indefinite period. The reason for entry is said to be "weld," which is not, in terms of the GM Manual, a valid reason for the issue of an entry certificate which normally should be for inspection purposes only. It contains a safety checklist on which all the items are ticked, including "natural fresh air ventilation" and "forced air ventilation required" which may accurately reflect the true position in the braces that there was a certain amount of natural ventilation but that to have a reasonable number of air changes per hour, it would be necessary to supplement that with forced air ventilation using the rig's inherent ventilation system, but, in terms of the list, I infer that these are intended as alternatives. More importantly, the checklist item "Sufficient BA sets available at entrance" was ticked, as was "continuous gas testing required" and "stand by personnel required." Under a separate heading, "Safety Checklist - Stand by Personnel" against a standard entry "establish radio communication with personnel in space" has been entered "OTHER." There are then two declarations. The first reads, "I declare the precautions specified in sections 2 and 3 have been properly carried out

in accordance with company procedure." That is signed by Mr. Wylie who designs himself "Supervisor." The second reads "I confirm the precautions specified in sections 2 and 3 have been properly carried out in accordance with company procedure." That is signed by Mr. Greenhow, who designs himself "OIM." Mr. Wylie times his signature at 19.00 which infers that the items specified on the safety checklist including those to which I have made specific reference somehow instantly manifested themselves. As we know only too well, no BA sets were provided at the entrance and no system for continuous gas testing was established despite these two items being focused in this safety checklist. Had a gas monitor properly calibrated as it should have been to detect the presence of propane been present, as it should have been, and had been properly located at low level close to the propane torch, as any adequately trained operative should have known to do, it would have detected the escape of propane and an alarm would have been sounding when Mr. King and Mr. Duffell returned to the brace. It is inconceivable, if they had been properly trained in how to react to such an alarm, that they would have remained there. They would certainly not have tried to light the propane torch. Had BA escape sets been located in the brace, and had there been an instruction that these were to be worn by those working in the brace, for I think Mr. Thomson is correct when he submits that, unless the set was being worn, it is unlikely in the circumstances that occurred that its mere presence would have saved him, Roland Duffell might have escaped death by utilising one. The completion of these two false declarations, which is the only apt way to describe them, is therefore critical to the fatal outcome of this accident.

Turning to the Hot Works Permit 22707 issued apparently at the same time as the aforesaid Entry Certificate, it again purports to pertain to three work sites whereas a permit should have been issued for each work site. The description of work is "Repairs," a description which is patently inadequate. It has a section headed "Hazard Identification" which includes items such as, "Confined space, remote start, naked flame/arc/spark" and "flammable materials." Of those four, only "naked flame/arc/spark" is ticked. I will come in due course to describe the means of access to the brace, but there was no dispute but that it was a confined space within a confined space or arguably a series of confined spaces. The issue of "remote start" is

one of some significance and I wonder whether either Mr. Greenhow or Mr. Wylie understood the phrase. I intend to deal with the issue further when I am looking specifically at the issues of working in a confined space and the use of flammable gases but for the moment what is important is the appearance of the phrase on the check list and its relevance being ignored. It is not specified whether the risk identified under "naked flame/arc/spark" is any one or more of these but it would, of course, be difficult to have a naked flame, which would be there both in respect of the cutting lance and the propane torch, without having flammable materials, which both acetylene and propane patently are. The only 'special' precautions, i.e. special in the sense of not standard on the "Protective Devices Required" checklist, which comes next, are " (1) Ventilation F.D. on (2) Local F.D." Under protective devices required are listed, amongst others, eye protection, face shield, firewatcher, fire blanket, fire extinguisher, B.A. set and adequate comm. The only items ticked are "Gloves, eye protection" and "face shield." I have already discussed the issue about firewatchers which, on account of the trades practices of welders and platers is not, in my opinion, truly an issue at all but it is clear that, despite the presence of the word on the checklist, there was no discussion about what was intended under the heading or how fire-watching would be undertaken, for Mr. Greenhow did not know about the trades practices. It is interesting to observe the presence of the expression "fire blanket." There was no evidence that I can recall as to what consideration was given at the time of the completion of this or the later hot works permit as to the application of the expression, which is, perhaps, unfortunate given the significant role in this disaster to be played by a piece of welding screen, as I shall come to describe, but no one drew attention in submissions or examination to the presence of this expression on the hot works permit and obviously whoever had drafted the permit envisaged that there would be times when a fire blanket would be required. It was clear from the evidence of a number of the welders in particular that a fire blanket would be used especially offshore to protect surrounding equipment from the sparks and molten chips inevitably given off by the process of welding. Perhaps its presence in the brace is not so surprising or apparent use as remarkable as some submitted, though all that is qualified by Mr. Summerfield's evidence that this particular piece of green material

did not consist with BS specification for fire blanket in terms of its thermal resistance qualities. It is astonishing that it was not apparently considered that fire extinguishers would be required. It is disappointing that it was not considered that BA sets nor adequate means of communication were required but I suppose that follows logically from the failure to identify the work site as a confined space affected by remote start. Curiously, there is no reference on this standard list of protective devices to either gas monitors or to adequate ventilation, though it appears that Mr. Greenhow did, at least, apply his mind to the latter. Under the heading, "Supplementary Certificates Required ?" the reference to an entry certificate has been ticked but the number of the certificate has not been entered. There is no indication of there being an associated isolation certificate. Again, there are two declarations, one each for the Issuing and Performing Authorities, signed respectively by Mr. Greenhow and Mr. Wylie. The first reads, " I have inspected the work site and I declare that it is safe for the work as specified in this permit to proceed from 19.00 to 19.00." The second reads, "I have read and understand the conditions of this permit. All work will be carried out as specified. The issuing authority will be notified if any deviation from these conditions is necessary." Needless to say, Mr. Greenhow had not inspected the work site prior to the issue of the permit. Had he done so, he could hardly have failed to notice that it was a confined space. Despite the terms of the GM Manual restricting the life of a hot works permit to 24 hours, this permit was revalidated at 07.00 on 28th. June, by Mr. Greenhow and Mr. Eric Murphy, the MESL dayshift general foreman, at 19.00 on 28th. June, by Mr. Greenhow and Mr. Wylie, at 07.00 on 29th. June by Mr. Greenhow and Mr. Murphy, at 19.00 on 29th. June by Mr. Greenhow and Mr. Wylie, at 07.00 on 30th. June until 19.00 on 30th. June by Mr. Greenhow and Mr. Murphy, and then from 07.00 on 1st. July until 19.00 though that seems to bear the signature of Mr. Greenhow only and a dash where there should be a signature from the representative of the Performing Authority. This may relate to the temporary cessation of the works on account of the paint fumes problem which I will come to discuss, but the permit does not distinguish between the two bases on which it may come to an end (in other words, neither box has been ticked to inform whether the work has been completed or has been suspended - surprisingly there is no box for the work remains incomplete

and will be continued on the issue of a further valid hot works permit). It is however signed by Mr. Greenhow on 1st. July at 19.00, just above the box which reads "Valid for 24 hours" to the effect that the permit has been cancelled.

A second Hot Works Permit, numbered 22718, was issued, this time with Anthony Bucknole, GM stability technician, as the Issuing Authority but still Mr. Wylie as the performing authority. Mr. Bucknole told the Inquiry that he had joined GM on 22nd. June, 1998 and had joined the crew of GA IV in Dundee on 29th. June. He had not previously worked as a stability technician on any other rig, but had been a control room operator. He had been at sea since he was 17 - he was now 41 - and had acquired a master mariner's certificate in 1994. He had been a merchant seaman until 1984 when he began work on offshore supply vessels. He had been working for TransOcean since 1997 and had experience of their permit to work system. He was told when he arrived at Dundee that he had to issue permits, he thought by one of the other stability technicians. He had had no training in the GM permit to work system, he had not seen nor been directed to the Manual and he did not know from his job description, because he had not at that stage been given one, that the issue of permits was part of his responsibilities. He had never been in a dockside repair situation with any rig and did not know what to expect. There was, as he put it, "a horrendous amount of work going on..". At TransOcean he had in part been responsible for the maintenance of the permit register but he had never issued permits. His past experience was restricted to the occasional issue of permits some time previously when he had been the master of a vessel. Patently, he was insufficiently trained or instructed in the operation of the system. He simply issued the permits as requested by the MESL general foreman. He had never seen the Entry Certificate 5303 until he was shown it at the Inquiry. He did not inspect the work site in connection with the issue of the permit, despite signing a declaration to that effect. He did, however, insert a clearer description of the work sites and of the work than Mr. Greenhow had done and the box marked "confined space" was ticked, as well as "naked flame/arc/spark" under hazard identification, as were "firewatcher" and "fire extinguisher" under protective devices required. The fact that the box "confined space" was now ticked did not appear to have led to any further action for the protection of those who would

have to enter the space, and neither a dedicated fire-watcher nor fire extinguishers were provided. There is some doubt about when this permit was issued, as its date of issue had been changed. I have come to the conclusion that it was on 1st. July at 19.30 as in the declaration, Mr. Bucknole has written that the permit is to run from '19.30 to 19.30 2nd,' he having added '2nd.' in his own hand. However, the first period of revalidation seems to read from "3rd. July 98" Time "19.00" to "3rd July '98" Time "19.00" and that is signed by Mr. Greenhow and Mr. Murphy. It is then revalidated from 19.00 on 3rd. July to 19.00 on 4th. July, the signatories being Mr. Bucknole and Mr. Wylie and then, again, from 07.00 on 4th. July until 19.00 on 4th. July. After 19.00 on 4th. July nothing appears. The permit is neither revalidated nor cancelled and the Health & Safety Executive found no other permit. The accident occurred at about 21.45 on 4th. July when there was no valid hot works permit in existence. The ineptitude of those supposedly operating the permit to work system, in terms of understanding the particular procedure which GM set down and the general importance of effectively operating such a procedure, is sufficiently demonstrated by the foregoing passages for me to need to say little more. Clearly Mr. Bucknole did not know that a permit should be revalidated at each change of shift and, in fairness to him, it seems not only that no one told him that but that he was actively misled by Mr. Wylie who should have known better. As we shall see, it was Mr. Bucknole who had, as he saw it, other more demanding priorities on the evening of 4th. July than the revalidation of the Hot Work Permit. Given his lack of training and insight on the permit to work system, that is unsurprising and he is not to be blamed. On the other hand, those responsible for failing to train him in the system, if he was to operate the system, are.

4.6

Mr. Greenhow explained that, at the material time, there was no GM formal procedure for carrying out risk assessments, whereas there now was. There was, at the time, no one responsible in terms of the company's systems, for carrying out risk assessment. It had been Angus Wylie who had asked him for the certificate and permit issued on 27th. June. He went through both forms with Angus Wylie, but "not in minuscule detail." Both forms are entirely straightforward and comprehensible and

there is no minuscule detail. He considered access could be taken by either column, port or starboard, with the degree of difficulty being the same. However, people went to the port side because there were lights installed in connection with the works. There were no lights on the starboard side. There was natural ventilation in the braces when the hatches were removed notwithstanding that it was 28 metres (almost 92 feet) from the main deck to the braces. A plan was devised to create a draught through the braces by having the starboard supply and the port exhaust fans operating in tandem respectively to push and pull air through each of the braces. Mr. Greenhow did not know if Angus Wylie or anyone else employed by MESL was made aware of this plan. When he ticked BA sets and stand by personnel, he was envisaging a number of escape sets, to match the number of people working in the brace, being present with a stand by man at the entrance to the brace who would be monitoring the operation. That was something that had to be put into place by the contractor, but he did not say that to Mr. Wylie. He accepted that he had not seen to it that these precautions were in place. Since the accident a system had been adopted of having a pre-commencement meeting at which all these responsibilities would be ironed out, though essentially the approach was to leave the provision of equipment to contractors. He had intended that there should be continuous monitoring of the air in the brace. He was aware from his own background that people had died on numerous occasions through entering spaces which were devoid of oxygen. Since he knew the contractors were using new equipment and new hoses, he had not foreseen problems with an escape of the gases being introduced. He did not know that propane was to be used. This was the first time he had completed a certificate with a contractor and was "a little rusty" on the procedures. He could not satisfactorily explain his failure to visit the work site, though he did say that at the time there were so many work sites that it would have been physically impossible for him to visit them all. He could not delegate these tasks "because all the crew were new. They didn't perhaps have an understanding of the permit system and I took too much on myself." He accepted that he should not have allowed work to start without the required precautions in place. In relation to the Hot Works Permit 22707 (Crown Production 10), he agreed that the work and the sites were not sufficiently described. Now, before a hot work permit

could be issued, there would have to be a written risk assessment and there was now a box on the permit to that effect. He had been unaware of the Confined Spaces Regulations, 1997 at the time, but now had a very clear understanding of their requirements. He had not at the time identified "confined space" on the hot works permit because he was issuing an entry certificate. This vividly illustrates the consequences of the failure to train him in the operation of the system. He did not see the action of turning on the gas supply 28 metres above the work site as an illustration of the concept of remote start. He had inserted the need for forced draft ventilation plus the need for local ventilation i.e. a portable fan which, once more, he assumed the contractor would supply. He had discovered when in the aft brace investigating the paint fumes problem, which ought to have been anticipated but apparently was not, that there were no fans there, but he did nothing about it. Given that at least one worker had required medical intervention, that was negligent, though the primary responsibility remained with MESL, the employer. Part of the problem, however, causative of the paint fumes, was the breakdown of the rig fan, EF 11, which was the exhaust fan at the top of the port aft column. As a result, the rig ventilation was 'reconfigured' i.e. instead of blowing and exhausting to port, it was blowing and exhausting to starboard. Unfortunately, no one appeared to have told MESL about the reconfiguration and so their local extraction was to a point where air was being blown into the brace. This well illustrates the quality of the communications between rig operator and contractor. He could not explain why items such as BA sets and communications appeared on the entry certificate and not on the hot works permit. He appeared to me to continue to have difficulty differentiating between the two which was a matter of concern given his post-accident training in the system. He was not aware of any action taken to address this potential for confusion between entry certificates and hot work permits and it is an issue which GM must look at with care urgently to avoid a repetition of the errors which were made here, particularly in relation to continuous gas monitoring which is not one of the standard protective devices listed on their hot works permits as they existed at the time of the accident. Since the accident he had set up a rig safety committee which met at least once during each of his three weeks on. A contractor would be represented on the safety

committee. He could not explain why fire-watcher and fire extinguisher had not been highlighted on the hot works permit. Nor could he explain the failure to cross-reference with the entry certificate, which is, of course, part, at least, of the reason for the immediately aforementioned failure. He thought, in retrospect, that the work scope had been too large for him to manage and he was particularly concerned about repairs to the blister which put the stability of the rig at risk. He had a concern that the MESL employees, who were lax at wearing safety glasses despite repeated requests from him, were "inexperienced," especially when it came to the work in the braces, which begs the question why he did not pay more attention, though his own inexperience was undoubtedly being exposed by this stage. He had come to appreciate that a hot work permit was only intended to remain valid for a 24 hour period. He could not explain why the hot work permits had continued to be used for days. He accepted that the permit should have been suspended when work was suspended on account of the paint fumes problem but that did not appear to have happened either. He accepted that it should have been revalidated before work resumed. Since the accident, the lifetime of a hot works permit had been restricted to 12 hours. A spot check system had been introduced whereby a third party could determine permit compliance. (Such a provision is present in the Manual on Safety Procedures printed prior to the accident, so there is nothing new in that except that it is suggested that the system is now being operated.) The checks he should have carried out were not carried out because of his workload and his inability to delegate because the other senior employees were not GM employees. Since the accident, GM had introduced a universally applied policy of doing permit to work induction by interactive video presentation, for not only all their own employees but all contractor's staff coming on to the rig. Individuals are told not to carry out any work unless they can see that all desiderated precautions are in place. (That seems to me still to beg the question if they would know how to use such precautions.) Bucknole was a GM employee with experience on semi-submersibles so he thought it would be all right to delegate responsibility to him to issue permits. He knew, however, that Bucknole had only been with GM for a few days and that he had had no training on the system. He recognised that Bucknole should have been educated in the system

and should have read the Manual. He admitted that he recalled being approached to revalidate the hot works permit from 19.00 on 4th. July and had redirected whoever had so approached him to Mr. Bucknole. That was likely to have been Mr. Wylie. He recognised now that work should not have been continuing in the brace in the absence of a current permit. He thought that there were 10 to 15 permits in operation in the run up to 4th. July. He accepted, in retrospect, had there not been an accident, that an effective auditing system would have revealed the defects in the permit to work system's operation and it was therefore vital to have such a system operating effectively. He accepted that, by not visiting the work site prior to issuing the hot works permit, he may have created the impression that the permit was not regarded as important. He explained that, apart from his concerns about the blister repairs, the port authority had submitted a claim against him for damaging the quay side and he was preparing a counter-claim for inefficient mooring. He also had some crew members suffering from chicken pox. He was co-ordinating crew changes and employing additional staff. He was active from 06.00 until late at night. The revised system would not work with only one issuing authority unless there were a smaller number of work sites. He accepted, given that one of the principal functions of any permit is to avoid conflicts of work, that only someone in a position to know all that was going on on the rig would be in a position to make that assessment. He accepted that that inevitably meant the OIM would have at least to approve any certificate or permit being issued, if not be the Issuing Authority. Hindsight suggested that he should have had some assistance during this period at Dundee.

4.7

David Stitt appeared to appreciate that no work could start in the braces without a permit having been issued to the working party but his source of appreciation is not clear. His recollection, and this relates to the day shift, is that Eric Murphy would collect the permit and hand it to him. He then claimed to hand it over to the work force. He claimed that this was done on the quay or at the top of the column. He also claimed that there was a permit for every brace. He then decided that he could not be sure about that, having initially stated that as though it were a fact. I did not regard his evidence in the foregoing respects as reliable. Like others, he was now unable to

distinguish clearly between the pre and post accident regimes. No one else spoke about seeing the permits and I am of the opinion that, if they were in the possession of the workers in the braces, then they would have been the source of further discussion. According to Mr. Stitt, there was no general discussion about the operation of the permit system. He had not seen an entry certificate. He did not understand the need for there to have been an entry certificate. Prior to the accident, no one from either GM or MESL had discussed the permit system with him. He had never read any permit prior to the accident and it was unlikely the workers would have. Eric Murphy did not tell the assembled men or him about the contents or requirements of any permits. He was able to say from his own experience that the issuing authority would inspect a work site prior to the issue of a permit with a view to making sure that the work site was safe, and that on a permit there would be a series of precautions ticked which should have been in place. It did not make a lot of sense to me that he should have that level of awareness but should claim not to have read permits which he claimed were given to him, so I do not believe he was given the permits or ever saw them. He did claim that he did not consider that he had any part to play in ensuring that specified precautions were in place. Nor was he instructed to check the operation of any precautions. He assumed that if any precautions were to be taken, then Eric Murphy would have told him.

4.8

Colin Johnston admitted knowing that having a satisfactory and effectively operating permit to work system was one of the primary recommendations of Lord Cullen's Report on the Piper Alpha disaster. He also knew that having an effective auditing system of the permit to work system was an integral part of that recommendation. He acknowledged that, in the present case, the operation of the permit to work system had been subjected to a prohibition notice by the Health & Safety Executive (Crown Production 53.) He agreed that the hot works permit in force in the period immediately prior to the accident bore no cross-reference to the entry certificate 5303. He agreed that there had been a failure to operate the permit to work system properly. He now recognised the need for some sort of joint exercise between operator and contractor prior to the commencement of works and that ongoing communication

required to be improved. He accepted that he had not seen permits to work on display when he visited the braces. The permit was kept by the general foreman as far as he was concerned. He agreed that it was essential for whoever was in charge of the job to know what was in the permit but accepted that who was to see to precautions was not addressed. He believed that it would be a joint responsibility. He was not, despite his position as project manager, getting copies of the permits. He did not consider that a project manager should have to read every permit but offered no solution as to which should and which should not be read. He agreed, with the benefit of hindsight, that there was no point in preparing and issuing the permits the way it was done. Since the accident, MESL had tried to ensure that their employees received induction from the client in their permit to work system failing which MESL would undertake the training. General foremen or foremen remained identified as the normal Performing Authorities and were responsible for permit compliance.

I have to say that I was very far from convinced that, as management spokesperson on this issue for MESL, he had as yet grasped the importance of the adherence to a permit to work system. If the two general foremen used on this job were typical of the *genre*, then I was far from convinced that the system would be effectively operated in the interests of the safety of the workforce. It was plain that he had still not had any effective training in safety and in safe systems of work, including the operation of a permit to work system. Mr. Greenhow considered that, while Mr. Johnston was energetic and enthusiastic about his work, he had a slightly cavalier attitude to safety; it was not high on his agenda. While one could reasonably categorise this comment as the pot calling the kettle black, I was impressed that, as a consequence of this accident, Mr. Greenhow had greatly improved his knowledge of regulations, codes of practice and guidance pertinent to North Sea operations and had personally forced

GM to make a number of changes particularly in relation to safety training. Mr. Johnston, on the other hand, struck me as a somewhat arrogant young man who did not consider that he should bear much in the way of responsibility for this fatal accident and did not appear to have learned much, if anything, from his involvement in it. While he was inadequately trained in his own company's systems, he had been around engineering works long enough to know of some of the risks inherent in the operations and, particularly when he knew that the workforce was being assembled as the works were in progress, he had a responsibility to ensure that the supervisory staff he selected were of high quality and were suitably trained and experienced, as opposed to being among the first to arrive, which, by inference at least in the case of Stitt, appears to have been the basis upon which he

was promoted to foreman plater. In that respect, as in failing to ensure that the workforce received induction in the GM permit to work system, in failing to ensure that his supervisors, Murphy and Wylie, knew what they were doing when they were operating the permit to work system, and in failing himself to have any real appreciation in practice, despite what he said in evidence, of the need for an effective permit to work system, he demonstrated his own lack of responsibility to this workforce and that he could not be regarded as a credible or reliable witness.

4.9

I have already dwelt on the failures of Mrs. Ross, the MESL Safety Officer. Suffice it to say that she accepted that she had not trained the workers in the GM permit to work system. She did not know what experience the workforce had in the operation of permit to work systems, nor of the foremen's experience. She agreed with hindsight that it was unsatisfactory that the foremen did not know and were not told what management expected them to do in relation to the operation of the permit to work system. No effort was made to ascertain the competence of the general foremen to operate the permit to work system. She could not explain why she did not check that permits to work were exhibited at work sites. She had never seen one and so she was not in a position to ensure compliance with their requirements. She agreed that there was no point in having a permit to work system if no one knew how to use it. She admitted not being aware of the content of the MESL Policies and Procedures Manual so far as concerned utilisation of a client's permit to work system despite it being part of her job description to update and revise the Manual. She agreed that it stated that MESL would train the relevant members of its workforce in the client's system. She had done nothing to comply with this requirement. Nor was she aware of the Manual's requirement that permits to work should be displayed at work sites.

4.10

Angus Wylie, the MESL night shift foreman, was a 46 year old who had worked for MESL for about nine years. He had been a foreman for about four or five years, mainly in Invergordon. He had done a lot of oil related work and had been in charge of work in confined spaces. He came to Dundee knowing he was to be the night shift general foreman but apparently knowing nothing about the Confined Spaces Regulations, notwithstanding his previous work experience. He was aware that there was a permit to work system operating on the job but he received no information or training in its operation. He did not consider that he really had any part to play in the

system - he just got the permits. You got the permit at the start of the shift because "that was the rules." Asked, "You are describing it as a formality, you don't really pay much attention to the permit?" he replied, "Up until that point, to be honest, yes." He had not been instructed to get the permits; he had 'just elected' to do so, as if by instinct. He agreed he had been signing as the Performing Authority but regarded the whole thing as a formality. No one had suggested a contrary approach. He did not check that precautions were in place despite having signed a declaration to that effect. It was his opinion that there was no natural ventilation and it was therefore essential to use the rig's system. He accepted that he had done nothing about continuous gas monitoring. He accepted there were no stand by personnel. He said that he was not aware that these issues were being ticked as safety issues in the expectation that some regard would be had to the need for their provision. He did not require the Issuing Authority to inspect the site. He treated the Hot Works permits, Crown Productions 9 and 10 with the same approach. He was involved in revalidation beyond the life of the permits. He allowed work to continue on the evening of 4th. July without there being a permit in existence. While, given the way the system was being operated, that made no practical difference to the occurrence of the accident, the fact remains that, had he been operating the system as it was designed, there would have been no workers in the brace until a new permit had been issued with the appropriate preceding formalities, which might have led either to the discovery of the leak or the damage which led to the leak or at least led to questions being asked about the items wrapped up in the welding screen. He claimed to have put the work permit at the work site but since he only had one, where he put it varied from night to night.

It is difficult for me to comprehend what Mark Greenhow and Angus Wylie thought they were doing as they went through this process. They were dealing with documents that had the words "Safety" "Hazard" "Precautions" and "Protective Devices" screaming at them on the face of the documents. Even without them having had the requisite training each should have had, one would have thought that it might have occurred to each of them independently that these documents, which patently pertained to safety, could not simply be treated as formalities. I am at a loss to understand how Mark Greenhow, with his experience as an OIM, can be in this state

of ignorance. Mr. Wylie was, I thought, refreshingly honest in admitting his state of total ignorance and, with him, it is very much a training issue, for I believe that with him, once he is trained to follow a particular set of instructions, he would follow them to the letter. I am less critical of him, though I still consider that the terms of the documents should have generated some concern, sufficient that he should have consulted someone as to what he was supposed to do. Most critically of all, however, neither had had the requisite training and instruction in the importance of such systems and senior management of both companies must bear responsibility for this state of affairs because, as I have already said, it is unlikely the accident would have occurred if the requirements of the system had been implemented.

4.11

George Cheyne, the GM Rig Manager, i.e. the individual onshore responsible for all aspects of the operation of a particular rig and its crews, told the Inquiry that in the course of the discussions preceding the works on GA IV, to which he had been a party, it had been agreed that the GM permit to work system would apply and that permits would be issued by the OIM on site. There was no further discussion of the subject. "We were under a lot of pressure to turn the works round and there was no time." He said that he was being placed under pressure by Alun Roberts, a person whose name featured from time to time in the evidence whose own evidence on a number of issues would have been interesting, but whom the Crown, in an unfortunate exercise of discretion, chose not to call. He was managing director of GM at the time and is now Vice President of International Operations. Mr. Cheyne acknowledged that the contractor's employees got no training in the permit to work system and that that should have been done. Mark Greenhow should have been familiar with the GM permit to work system having used it previously when OIM on the Maersk Finlander. He accepted that he knew that Mr. Greenhow did not have recent experience of the permit to work system when he was appointed. He gave the impression that the whole business of acquiring and crewing the GA IV had had to be done at short notice and had been extremely difficult. He had not been involved in the selection of the contractor, nor, it would appear, of Mr. Greenhow.

Mr. Cheyne frankly admitted it was his responsibility to ensure that Mr. Greenhow

was effectively trained and instructed to be OIM on the GA IV, and that, given time, he would have done more in that respect, particularly on the vexed subject of permit to work training, but there were time constraints and he had thought that Mr. Greenhow had sufficient experience to handle the job.

Generally, I thought that Mr. Cheyne was an impressive witness, though in one respect I do not consider his evidence to have been credible. He was remorseful and he gave some detail of practices and policies that had changed since the accident. Though he took responsibility for Mr. Greenhow's lack of training, it seemed to me that that should truly have been the responsibility of the person who appointed Mr. Greenhow to the post, but the evidence does not disclose who that was.

4.13

James Miller was a 61 year old technical director of MESL. I regret that I was not impressed with him as a witness. It seemed to me there was an inherent conflict in the way he described MESL as going about its functions which could prejudice safety but he told me that nothing had changed about the way he went about his business on account of the accident. He told the Inquiry that the work on GA IV was typical of the type of work MESL did, repairing or upgrading rigs. He had prepared the original proposal for the replacement work in the braces and had always envisaged that access would be taken via the main deck and the columns. He considered that the cruciforms could have been replaced offshore. He claimed to have been abroad at the time of the submission of a further proposal which suggested electric heating pads as the means of pre-heating surfaces to be welded. He claimed that if he had seen it he would have commented because there would have been too many wires running down the columns. It would also have involved running a high voltage down the columns and that would have been high risk, he considered. He had always intended to use propane. In any event, he considered that working practices set out in an estimate were often changed. At bid stage, even now, risk assessments were not done. Once the job is in and the bid is accepted, he handed over to the construction department. It was for the project manager to carry out the risk assessment. He reviewed them and they were sent to the safety department for comment. There were now strict guidelines on the use of propane, restricting its presence to when a live supply was

actually required.

4.14.

Graham Harker, the GM Safety and Environmental Superintendent, as he was rather grandly entitled, was a 61 year old ex OIM, who had been in his present post since about three months prior to the accident. He had been invited to take on this role by David Kerr, the GM Technical Manager. He had no job description. He did not receive any training for the post. He thought the post would relate to safety matters relating to the offshore operation of a number of exploration rigs, and that his experience as an OIM would therefore equip him for the task. He did not appreciate that he would have any responsibility for overseeing shore based repairs to a rig. He had been sent on one course to do with auditing and there was talk of other courses. The auditing course related to compliance with safety rules. He had, so far, carried out one audit on one rig, not the GA IV. In terms of GM procedures, a rig should have a safety audit three or four times a year. The workings of the permit to work procedure should be checked. He did not believe there was an auditing system operating in June/July, 1998. On being shown Crown Production 12B, the GM Safety Procedures Manual current in June, 1998, he was surprised to find it contained a provision for spot checks of permit to work systems. He had been present at one pre-works visit in relation to the GA IV held in Dundee about 17th. June, 1998. He felt he had been invited there to deal with "marine matters, for instance, how we were going to bring the rig along side and when this would be done having regard to the tides and the currents in the Tay, and what arrangements would be made for a safety boat to be on stand by, not health and safety matters." He did not meet with Mrs. Ross prior to the commencement of the works. She faxed certain documents to him concerning safety matters which, he acknowledged, he just accepted. He was sent to Malta in connection with the acquisition of yet another rig. He did not know what appreciation, if any, the OIM would have of the safety roles being attributed to him. He knew that, prior to its arrival in Dundee, the GA IV had been utilising Stena procedures but the idea was that, by the time it berthed in Dundee, there would have been a changeover to GM procedures. The dissemination of knowledge of the GM procedures was to be done on board the rig, so far as he was concerned. Any training

also would be on the rig but he did not know whether any training had been done and, by definition, whether there was anyone on the rig capable of doing the training. The two systems were similar and, as he put it, "I think the attitude was the OIM will deal with it." He recognised that Mark Greenhow had not been in post for very long. He thought Mr. Greenhow had had some training, including environmental issues and the wearing of personal protective equipment. Mr. Harker reported to Dave Kerr.

Otherwise the department appeared to consist of him and two clerkesses. He had been at the meeting in Dundee where it was decided that the GM permit to work system would apply to the contractor's works, but there was no discussion about training the workforce in its operation and no training was given to the MESL employees prior to 4th. July, 1998. He accepted with hindsight that there was no merit in employing a system if no one knew what the system was. He could not recall whether there had been any discussion with MESL management about how the system would operate in practice. He had not given them a copy of the extract from the Manual and was unaware of anyone else having done so. He had no reason to believe that MESL management were familiar with the system. He eventually conceded that he had read the Piper Alpha Inquiry Report and that that had emphasised the need for effectively operating permit to work systems. He agreed that that was not the situation on GA IV as it berthed at Dundee on 25th. June. He accepted that, at the very least, the MESL workforce should have been trained in the system. He accepted, with hindsight, that he should have been more involved in the planning and preparation for the repair exercise. GM had not carried out a risk assessment and he had not seen MESL's risk assessment. He did not see it as part of his responsibility to do a risk assessment where a rig was coming into dock for repairs. He had not done a spot check while he was in Dundee. He could not recall seeing permits at the work sites.

Mr. Harker was an essentially credible and reliable witness though, in common with quite a number of the witnesses in managerial positions, there were times when answers had to be dragged out of him. What was clear, however, was that he was yet another square peg in a round hole. He had had no proper training, if he had any training at all, in his function as safety manager, if in fact that was part of his job, given GM's failure to comply with yet another statutory provision, in the absence of

him having a job description. While plainly his experience as an OIM was relevant to the safety procedures applicable on rigs, at least in an operational condition, the focus for a safety manager was or should, at any rate, have been quite different. He was weak on risk assessment. He did nothing to ensure that people, including the OIM, were adequately trained on the GM permit to work system and he seemed to be unaware of the Confined Spaces Regulations and their application to the work in the braces. In fairness to him, he had another job to do which involved him being sent to Malta, though how the time scale of that fits with the time scale of GA IV's arrival in Dundee was not fully explored. The impression, I have to say, that I was left with having heard his evidence about the extent of his "department" was that GM, notwithstanding their previous experience of disaster, continued to attach a low priority to safety considerations, in particular, to that of contractor's employees who would be working on one of their installations.

4.15.

David Kerr, the 41 year old GM Health, Safety and Environmental Manager, had held his post since January, 1999, having previously been Technical Manager. As at June, 1998, his remit as technical manager included quality control, health and safety issues and environmental issues. It also encompassed personal and vessel certification and technical and engineering issues. He had been involved in the formulation of the contract with MESL. They were not the cheapest of the four companies invited to tender but they presented the best overall package. GM's past experience of MESL had been positive and that was a significant factor. MESL had estimated a seven day period for the brace repairs and GM knew that they had up to ten days to complete the repairs. The seven day figure had been calculated by Charlie Davidson, who was described as a project manager at MESL. MESL assured GM that they had sufficient people to undertake the work. Mr. Kerr claimed that he asked Mr. Harker "to do the more detailed reviews of MESL's health and safety arrangements. We looked at what systems they had in place, what arrangements they had in place, the general working practices. We looked at whether they had a permit to work system of their own. Graham Harker had conversations with health and safety representatives at MESL. He indicated that they did have systems. He believed that MESL did not have a PTW

system of their own so he had been advised that we should use GMs. Apart from that, he did not raise any concerns that were significant to the project."

The foregoing passage in quotations is a series of bare-faced lies by a man who recognised his own failures but preferred to re-allocate them to others. He did however accept, as he was obliged to, that the contractor's personnel should have been trained in the GM system and did not know why this had not happened, notwithstanding that health and safety issues were within his remit. He would have expected an induction of contractor's personnel including coverage of the permit to work system.

He agreed that he had visited the project but the visit was "driven by quality rather than health and safety issues." He had been in the aft brace. He had not checked any entry certificate or hot work permit. He acknowledged that there was no gas monitoring taking place at the time and admitted that GM had learned a great deal about that subject since the accident. He thought gas monitors "may now add a level of protection," but they required, for their use, "a degree of training." The one thing he acknowledged that had been wrong was to leave matters to the OIM and made it clear that with a project of this significance now, a project manager would be appointed and a full time project safety officer would be assigned, though from my point of view, it was not clear from what resources such a full time safety officer would come, with sufficient background experience to be a project safety officer.

4.16.

Larry Sparks, a 60 year old Manager of Marine Projects, now employed by GM, though in June, 1998 he had been a self-employed consultant, who travelled from his home in California to give evidence to the Inquiry, told the Inquiry that he had been contracted by GM to oversee the repairs project and be satisfied that the repairs were done to the satisfaction of the certifying authority, De Norske Veritas, and to GM's repair specification, and that he had no responsibility, at least in terms of his remit, for safety. He considered that the safety of the workforce would be regulated by the operation of the GM permit to work system. While there are already question marks about his credibility and reliability in other respects, it is instructive, given his statement on the critical nature of the permit to work system, that, though he was

frequently in each of the braces, he did not observe and do something about the absence of hot works permits on display.

4.17.

Aside from the documentation maintained by both GM and MESL on the effective operation of permit to work systems and on the detail of the GM permit to work system, the Crown also produced (Crown Production 73), the Oil Industry Advisory Committee's "Guidance on Permit to Work Systems in the Petroleum Industry." This guidance was said to represent "what is considered to be good practice by members of the committee." The Committee is made up of representatives of the Health & Safety Executive, offshore employers and the relevant trade unions. The edition lodged in process was revised in 1997, having been substantially rewritten in 1991 following the publication of the Piper Alpha Inquiry Report. I will not take up time unnecessarily on its detail. Suffice it to say that this is a particularly well written and constructed piece of guidance literature with the contents of which no one with pretensions of being active in the process of oil exploration or extraction or the support of these processes should be unfamiliar. It does emphasise human failure, usually consequent upon a lack of training, instruction and understanding, as the principal cause of failures to implement permit to work procedures which failures in turn lead to accidents and injuries. It would appear that no one who gave evidence from the management of either GM or MESL had any familiarity with the content of this document, even in the aftermath of the accident. They therefore could not say that they had done anything in response to the circumstances of the accident which accorded with the guidance recognised as best practice by the industry.

4.18.

It is no surprise that, by 8th. July, 1998, as their inquiries into the accident were continuing, Inspectors from the Health & Safety Executive had already concluded that GM should be served with a prohibition notice (Crown Production 53) preventing the continuance of the activities in the braces on the ground that they were being carried out under a permit to work system which was categorised as "unsuitable" because "hot work permits are being issued without monitoring of contractor's compliance, and permits are being revalidated without checks to changes of

circumstances." To put it another way, it was obvious from a very early stage of the investigation that the operation of the permit to work system, focal to the safety of the workers in the brace, was not being operated properly and that work should not be allowed to resume until the HSE were satisfied that it could be operated properly. Bruce Monaghan, one of the first HSE Inspectors on the scene, from the HSE office in Edinburgh, made the point in evidence - one that continues to concern me greatly - that there was confusion between the entry certificate and the first hot work permit in that precautions desiderated on the entry certificate were not replicated on the hot works permit. Gas monitoring should have been a standard precaution on the hot works permit as well as the entry certificate. The hot work permit should have had a maximum life of 24 hours and he could not understand why it had a series of boxes for revalidation. The permits he read required a number of things to be done which were simply not being done and "quite clearly the people we interviewed had very little idea about what was supposed to be happening." Andrew Summerfield, HM Specialist Inspector in Fires and Explosions, who was an outstandingly good witness and whose evidence was given with great care and in a most measured way, remained highly critical of those responsible for the failures in relation to the operation of the permit to work system. In his written report prepared on 7th. October, 1998, by the terms of which he continued to stand, he said, " The permits and control over the work involved in this incident appeared to be seriously deficient in a number of important respects, the most serious being that at the time of the incident, no valid permit to work had been issued for work in progress, the existing permit having expired about three hours before the incident." He went on to say in evidence that the three main functions of any good permit to work system should be control, co-ordination and communication. "Under control, you identify the hazards and the scope of the work to be undertaken and the precautions, giving you a record of the precautions and an aide-memoire to check whether they are in place. Under co-ordination, by defining the scope of the works, the location of the work and ensuring that the work has been properly authorised by the persons responsible for that authorisation and control of the overall environment and that that is seen by the person who is actually going to do the work, you have co-ordination between the two

sides - management and the people actually undertaking the work. Also, by allowing the more senior levels of management to see the overall pattern of the emerging work, you allow the work to be co-ordinated if the system is being properly used so that you do not do different work, or you reduce the risk associated with such work that may affect the work under the permit to avoid dangerous effects. For example, the removal of an isolation may affect someone working in an area he thinks is isolated. In terms of communication, the important aspects of a permit are that, where the work progresses over a number of shifts or for an extended period, inevitably involving different personnel in different roles, it allows the precautions required, the hazards and the various control measures to be communicated at periods like shift changeovers, which are particularly vulnerable times when work is moving from one person to another. It also requires there to be contact between the contractor undertaking the work and the operator of the installation."

Mr. Summerfield went on to make the point that there is a relationship between a permit to work system and risk assessment but made it very clear that the one was not a substitute for the other. Risk assessment must come earlier in the process. The permit system pertained to work in progress and was, if you like, a current aide-memoire to facilitate the implementation of the risk assessment process. It was right that the precautions desiderated on any given permit should owe their derivation to the risk assessment process.

Given that the work sites in the braces of GA IV were what he described as "particularly hazardous working environments" he was highly critical of the inept risk assessment process and the lack of understanding of the two critical elements of risk assessment, frequency and consequence, which the process, such as it was, demonstrated.

The failure in the original hot works permit to recognise the braces as confined spaces was a "seriously deficient hazard assessment." Failure to cross-reference the entry certificate with the hot works permit, particularly the second one, contributed to the failure to have continuous gas monitoring in the braces. Failure to display hot work permits at the site meant no one had a chance to observe and comment on the failure to adhere to precautions. He suggested that a better system than merely ticking boxes

would be one in which the parties to the issue of the permits were obliged to record what precautions had been provided or implemented, as the case might be, and I entirely endorse that suggestion. The GM system envisaged a joint inspection of the work site and little further effort would be involved in making a record of the results of that inspection e.g. '4 BA escape sets in place and being worn; 3 fire extinguishers present and fully charged and recently serviced.....'

He made the point that the GM system as set down on paper and the documents in support of the system were all right, generally accorded with the recommendations of the Offshore Industries Advisory Committee's guidance on best practice and were typical of what was generally in use. He described Mr. Greenhow, having sat and listened to his evidence, as relatively inexperienced, and, generally, from his observations of the numerous defects in the operation of the system, "I conclude from these errors and omissions that the permit to work system was not being properly operated. Both the competence of the individuals issuing the permits and the standard of supervision exercised by those authorising the permits was seriously deficient." I cannot improve on that assessment.

4.19

I have dwelt at considerable length on the evidence relating to the permit to work system and the failures to operate the system and to train and instruct appropriate employees in its operation firstly on account of the importance attached to the effective operation of such systems by Lord Cullen in the Piper Alpha Report for reasons which he well explains therein and which I need not repeat here, secondly for the importance attached to them and the detailed guidance on their satisfactory operation offered by the Oil Industry Advisory Committee in the light of the Piper Alpha Report, thirdly because the critical nature of the effective operation of such systems were recognised by the authors of the carefully prepared safety manuals of both GM and MESL and fourthly because there is little doubt in my mind that, had the permit to work system, whatever else, been operated effectively having regard to the system as documented and the documents used as standard by the system, it is highly unlikely that this double fatality would have occurred. While I accept that the selected system was that of GM, and that the onus was therefore on them to make the

system work properly and monitor and audit it so that it did, the failure to have an effective system remains a joint responsibility to be shared by the respective managements of GM and MESL given the people likely to be affected by these works were in the employment, generally speaking, of one or other or them. Management of both companies at all levels completely failed in their responsibilities to ensure that personnel at the various appropriate levels understood, had read the documentation and were adequately trained in the operation of the systems. Of critical importance was the lack of training of Mr. Greenhow and Mr. Bucknole and of Mr. Johnston, Mr. Wylie and Mr. Murphy. I have to say that nothing I heard in the evidence convinced me that these failures had been adequately addressed. Given the critical nature of these failures and given the background of the Piper Alpha Report's contents and the contents of the Guidance from the Oil Industry Advisory Committee, I asked various witnesses, including the Health and Safety Inspectors, what more could be done to address these failures. I cannot say that I got much in the way of a satisfactory response. That is not a criticism of these witnesses but simply mirrors their own inability to understand how failures of the depth of these can still continue after an occurrence such as the Piper Alpha disaster. In this Inquiry, I cannot address the issue whether such failures are widespread or are confined to the two companies involved here. All I can properly observe is that if such failures are perceived to be widespread, then there is a need for an independent agency to undertake the monitoring and auditing of safety systems, particularly the effective operation of permit to work systems. Clearly, at least having regard to these two companies, there remains a significant process of education in matters of safety to be undertaken and a need to place the safety of the work forces much higher up the list of priorities than has hitherto been the case.

- **The Detailed Cause of the Accident:**

5.1

It seems to me having given a lot of consideration to the matter that the best way to approach the central question of what caused the deaths of Roland Duffell and Richard King is to start from the point at which they died and work backwards. It is a matter of general agreement that both men died substantially as a consequence of a

combination of asphyxiation caused by the inhalation of soot particles and carbon monoxide poisoning. Heat shock may also have had a part to play and there was evidence from another of the first class witnesses to give evidence to the Inquiry, Dr. David Sadler, Consultant Forensic Pathologist, that heat shock, by which is meant the exposure of the body to excessive heat, particularly in circumstances where there has been a sudden outbreak of substantial heat, can kill by causing cardiac arrest, without other factors, though, in the absence of cardiac arrest with no other features, that was hard to define. Both men, sadly, suffered significant burns, some of which may have been after death. In any event, it was Dr. Sadler's opinion, given the location of the burns, that they on their own were unlikely to have proved fatal. The two significant factors were accordingly, in my opinion, carbon monoxide poisoning and asphyxiation by soot particles. The importance to my mind in the circumstances we have here of identifying these two factors as the critical factors is that they would both have been addressed by the men wearing breathing apparatus, had breathing apparatus been made available. I further conclude, on the balance of probability, that it would have been necessary for that breathing apparatus to have been worn for the men to have had the chance of using it successfully to escape from the brace. Given the instantaneous nature of the explosion, instantaneously followed by fire, of which neither man would have any warning beyond the possibility of a smell of gas, it seems to me unlikely that either would be in a position to don such equipment if it were, for example, located at the entrance of the brace. Although one cannot be certain, it looks on the balance of probability as if Richard King was rendered unconscious by the forces unleashed in the explosion. That he did not die instantly is clear from the level of soot staining of his airways and lungs and the level of carbon monoxide poisoning in his bloodstream both indicating that he continued to breathe after the fire began to produce soot and to use up the oxygen in the brace leaving carbon monoxide as one of the principal products of combustion. But it may not have been possible to save him and his only hope, it would appear, would have been if someone could have put breathing apparatus on him and thus excluded the soot and the carbon dioxide from his airways. Given the means of access and egress from the brace, it is difficult to see how that could have been done without the rescuer also

getting into difficulty, and it has been a recurrent question of mine throughout the Inquiry to be told, and I never was told, how a non-ambulant casualty would have been removed from the brace had a non-fatal accident occurred. Mr. Duffell, on the other hand, made it to the foot of the ladder leading from the lower ballast chamber to the upper ballast chamber, notwithstanding the smoke and the heat and the burns he had sustained and notwithstanding that the lighting system would almost certainly have failed and notwithstanding the difficulties of actually getting in and out of the brace area itself, compounded by having to fight his way through cables and hoses and the remnants of the trunking for the ventilation extraction system which were certainly later found to be electrically live and in which one of his feet was found to be entangled, when he was found by the firefighters. That he was able to achieve all that, for it was Dr. Sadler's evidence that he was close to the source of the explosion when it happened and there was a notable similarity in the range of injuries and damage observed which suggested the two men may have been in a kneeling position close to the source at the time, suggests strongly to me that, if he had had an escape set available to him, he might very well have survived and been able to make his way out to safety, although the extent to which his escaped may have been hampered by his becoming entangled in the remnants of the wiring of the elephant trunking remains an imponderable. Both men, but Mr. Duffell especially, were denied that opportunity by the failure of either GM or MESL to provide escape sets and to train them in their use and to require them to be worn while they were working in the brace.

5.2

The explosion and fire occurred as a consequence of the ignition of a flammable mixture of propane and air. There was much discussion about whether the source of ignition could be established. I am entirely satisfied on the balance of probability that on the evidence of Dr. Sadler and from the experts from the Health & Safety Laboratory and the Health & Safety Executive, taken along with the evidence of Douglas Waterston, a helper employed by MESL and James Kennedy, a welder employed by MESL, I can conclude that, at the material time, the two men were trying to ignite the propane torch found lying close to the source of the explosion,

though I cannot determine what they were using to try to ignite the torch. Plate 14 depicts the area concerned. The photographer, Detective Constable Neil Ritchie from Tayside Police, Dundee, is standing with his back to the entrance to the brace about half way along the brace, looking towards the bulkhead which separates this, the port section of the brace, from the central section where the diagonal braces intersect with the horizontal one. In this photograph where the detective officer was working only with the assistance of a flash gun, and therefore the lighting apparent in the photograph is not necessarily consistent with the light available while work was taking place, one can see a large number of relevant matters, not the least of which is the outline in the soot of a body to the right hand side of the photograph on the nearside of the ring stiffener, that being the location where Mr. King's body was found by the firefighters. Secondly, one can see two scaffolding planks rigged across the diameter of the brace, which the evidence demonstrates Mr. King had been using as a working platform. It was suggested that he may have fallen from this platform or been blown off it at the time of the explosion but that cannot be more than speculation. On the planks are two electrically powered grinding tools. There is a canister containing welding rods and three cables and three hoses. The two yellow cables, at either end of the collection, supply electrical power to the electric arc welding set which Mr. King had been using. The welding unit with a rod fitted in it is the red object on the bottom of the brace in the immediate foreground of the picture to the left of the longitudinal steel beam running along the centre of the bottom of the brace. To its immediate right what looks like a small diameter brass or copper pipe can be seen, which is, in fact, part of the propane torch. Lying along the longitudinal beam and crossing over the ring stiffener is a green blanket consisting of welding screen on which a piece of metal plate, likely to have been a portion of metal cut out prior to replacement, has been placed. Of the three hoses lying on top of the planks, the orange coloured one, furthest left of the three, is the propane hose. To its right, and almost in the centre of the photograph is a red hose, which is the acetylene hose. To its right is a blue hose, though it looks black in the photograph, which contains oxygen. As this blue hose climbs from the bottom of the brace up towards the planks, a join can be seen in the hose which consists of a proprietary hose repair kit,

consisting of a small brass pipe section on to which each end of the hose is crimped using compression rings which should make it gas tight. The yellow box near the ring stiffener is the welding generator set. The large hose running from the left foreground of the photograph is a compressed air hose. The white material and associated coils of wire is the remains of the trunking leading to the Nederman fan, which was supposed to function as a ventilation extraction unit, the fan itself being situated on the oily water separator flat, two decks above. The point of the explosion is somewhere between the bottom of this photograph and the nearest ring stiffener depicted in it. Further orientation is assisted on a consideration of plate 15, Crown Production 43/3 which is a photograph taken by the Health & Safety Executive taken close to the entrance of the brace depicting the entire port section.

5.3

It was Mr. Waterston's evidence that, prior to the evening tea break, Mr. King had been trying to ignite the propane torch with a spark gun. Following the accident, no spark gun was found either in the brace or on his person. It would appear, therefore, that that can be eliminated as the source of ignition. Other candidates remain a cigarette end, a match, a cigarette lighter, a spark from the welding machine, a spark from the vacuum extractor used for immediate removal of welding fumes or from use of one of the grinders. The Health and Safety Inspectors who came to the brace observed that the torch valve, which operates in broadly the same way as a tap on a gas cooker, was partly open and they marked the point to which it was open. Mr. Waterston and Mr. Kennedy both gave evidence to the effect that, prior to them all leaving the brace for the tea break, this valve was shut, and I see no reason to doubt them. It is on that basis that I conclude that Mr. King and Mr. Duffell were trying to light the propane torch at the time of ignition of the flammable gas/air mixture and I can therefore exclude any kind of incidental source of ignition, leaving a cigarette end, a match, a cigarette lighter or the welding unit as the likely implements for ignition. Mr. Duffell was a smoker; Mr. King was not. While smoking on the rig was confined to designated areas - the tea hut - no effort was made to control smoking equipment on the brace and it is quite probable that Mr. Duffell who would thus have his smoking requisites with him would have used a match or lighter to attempt to

ignite the gas at the torch. That, it seems to me, would be entirely natural.

Alternatively, Mr. King may have used the welding gun, which would give off a spark which would have ignited the gas but instead it was the explosive mixture which was ignited. Beyond that I cannot go in identifying the source of ignition.

5.3

There was air in the brace. The main provision was by means of forced draft ventilation using the rig's system configured, by this time, there having been a change forced by a breakdown of a fan, which change was never brought to the attention of MESL by GM, as it should have been, from port to starboard. The supply fan was drawing in fresh air from the deck at the top of the port aft column and this emerged from rigid ducting at the oily water separator level. This is best illustrated by Plate 33, which is Crown Production 11, a freehand sketch prepared by Mr. Monaghan, the Health & Safety Inspector, which shows the oily water separator flat, the upper ballast chamber and the lower ballast chamber as well as the brace. At the top of the sketch is a rectangular box described as the "general ventilation supply air discharge duct," i.e. this was the lower end of the ducting from the rig's forced air supply, reflecting the point beyond which people requiring to breathe would not normally venture. That was complemented on the starboard side by an exhaust fan drawing air up from the same level in the starboard column. Leaving aside fumes generated by the work, for the moment, and without getting involved in the technical detail, that arrangement was providing an entirely acceptable breathable environment in the brace with an acceptable number of air changes per hour to justify the description of acceptable ventilation. It was, however, a different matter when welding or flame cutting work generated fumes. For the present purpose, there was an adequate supply of air in the brace to form an explosive mix with propane.

5.4

While there was a slight difference between the experts about the flammable range of propane, I am content to proceed on the evidence from Mr. Summerfield that propane forms a flammable mixture with air when in the concentration range 2 - 10%. In other words where there is a mixture of air and propane where the air constituent is between 90 and 98% you have an explosive mix. Hence the importance of good

ventilation when using propane to avoid any significant concentration of it at all. The other significant factor with propane is its relative density, relative to air that is, of approximately 1.5. This inevitably means that propane released into air will have a tendency to fall to the lowest possible level, if not removed by good ventilation, and, worse still, will have a tendency to gather in pockets. That propensity enhances the chances of it forming an explosive mixture with air in relatively still positions i.e. where there is a limited flow of air. Apart from the witnesses from the Health & Safety Executive who gave evidence about this, the knowledge and understanding of these simple yet highly dangerous propensities was remarkably sparse among people who regularly worked with propane suggesting another area where urgent education is required. In the present case, the source of the propane was a hole in the propane hose. The hole was located 29.8 metres from the propane torch. The total length of the propane hose from the bottle on the ROV deck one floor above the main deck to the torch was measured by the Health and Safety Laboratory personnel under the direction of Mr. Hodges at 103 metres. Mr Hodges described this in his report thus:- "This damaged propane hose had weld spatter burning causing a clearly discernible leak at a distance 29.8 metres from the propane torch. The hose had been taped by duck tape to the shot blast air supply hose and the weld spatter had lodged between the two and burned through the propane hose wall." It might be thought surprising that the hole was 29.8 metres from the torch, especially when Mr. Summerfield measured the length of the port section of the brace at approximately 16 metres long and 2.76 metres in diameter but the evidence demonstrates that the same hose was used in the starboard section having been taken via the centre section and one can see from Plate 15 how hoses in the brace did not run in straight lines. I think Mr. Hodges accepted that the weld spatter, as he described it, might equally be molten particles from the process of flame cutting and Mr. Summerfield may even have favoured the latter having heard evidence which could lead one to conclude that the hole occurred while flame cutting was taking place. The evidence was unclear as to the purpose of the air hose and it may or may not have been associated with shotblasting. What is true is that at some time the air hose and the propane hose had been taped together using duck tape and that, on physical examination of the two hoses, there was

patently a corresponding area of damage on the air hose with the damage on the propane hose, confirming that one of the principal reasons that this damage had occurred was that the taping of the two hoses together had created a wedge shape into which the hot material settled, rather than sliding of the outer circumference of the hose as would normally occur and had thus had an opportunity to burn through the hose wall. Despite 39 witnesses and a number of affidavits and reports, no explanation was offered to the Inquiry for the propane hose to have been taped to the air hose. The correspondence between the damage to the air hose and the propane hose meant that this act of taping the hoses together had undoubtedly taken place prior to the molten metal particles from a hot works process causing the damage. Corroboration of that was provided by the sight of associated heat damage to the duck tape. There are many curiosities about the circumstances of this accident. One not explored in evidence or submissions is how this damage could have been caused other than from above and, if that is so, how, when the welding screen blanket was unravelled, the damage to the hose was to the lower rather than the upper orientation of the hoses, especially given the conclusion inevitable from the melted condition of the duck tape, that the hoses had been taped together prior to the heat damage, unless the orientation had been altered by human intervention, after the damage had been caused.

5.5

Unlike any of the workmen or helpers, chargehands, foremen or supervisors, managers, consultants or OIMs, apparently, the Inspectors from the Health and Safety Inspectorate were immediately suspicious about the contents of the green blanket seen in Plate 14 lying on the longitudinal beam along the centre of the bottom of the brace and traversing the ring stiffener nearest to the scaffolding planks. They were particularly suspicious to find that this blanket had been taped at at least three locations, thus enclosing its contents, as can be seen from plate 18. They could see that a number of cables and hoses went into this arrangement at one end and emerged from the other. They removed the metal plate and found that the area of the external surface of the blanket which had been under the plate was relatively clean and soot free as can be seen on Plate 19. From this and, in any event, from the state it had been

in when photographed by the police, it could be concluded that the metal plate had been put on the blanket before the occurrence of the fire generating the soot.

Intriguingly, also under the plate was a hole in the blanket. The evidence as to how this hole was caused is inconclusive. On the one hand, in the area of the hole, small globules of metal could be seen still adhering to the outer surface of the blanket suggesting the area had been exposed to a stream of molten particles from a hot works process. On the other hand, the hole itself had the appearance of having been cut using something jagged. The former explanation was somewhat undermined as there did not appear to be any corresponding damage in the inner layer of the wrapped blanket nor any evidence of molten particles on the inside of the hole or evidence of anything else which might have caused the hole. It was Mr.

Summerfield's evidence that such a hole would have had to have been created either by a fairly large lump of molten metal or by a significant stream and that, if the hole had been caused after the cables and hoses had been wrapped in the blanket and the blanket taped, and the plate had then been placed on top for extra protection from hot metal particles once it was seen that a hole was still being created in the blanket, then one would have expected to find in the 'inner blanket' some evidence of what had caused the hole. There was none. He was, accordingly, driven to the conclusion that the hole had been caused prior to the hoses and cables being wrapped in the blanket, a conclusion which I in turn have concluded is inescapable. It is an issue to which I shall return shortly. The tape was removed from the blanket and the blanket was very gradually unravelled, being photographed continuously - see

Plate 20, for example. In this photograph, the cables and hoses can be seen in a bunch and the heat damaged duck tape which had joined the propane and air hoses can also be seen in the centre of the photograph. The hole in the blanket can also be seen to the right and, apparently, in line with the damaged duck tape, but it is evident from the amount of blanket which has been unravelled and, in any event, it was the uncontroverted evidence of the inspectors, that there was an undamaged layer of blanket between the hole and the cables and hoses. Within the blanket they found, amongst other things, the propane and air hoses still taped together with duck tape which was substantially undamaged at another point - see Plate 21. However, when

they reverted to the area where the duck tape was damaged, and unravelled the blanket a little further, they could see significant pitting to a yellow 110 volt electrical cable serving the welding unit, which pitting appeared to have been caused to the outer insulated coating of that cable by particles of hot metal which had in a linear series of locations melted the outer coating quite substantially - see plate 22. In this photograph the contiguous nature of the damage to the tape on each of the hoses is also clear. Plate 23 goes on to show the completion of the process of unravelling with each component of the contents of the blanket wrap now being separated. This plate also incidentally portrays the repair to the blue oxygen hose at the right hand side. Plate 24 illustrates what the inspectors found when they rotated the air and propane hoses from the orientation in which they first presented. As can be seen there are corresponding areas of heat damage to both hoses and within the damage section of the propane hose, the hole can be found. Plate 32, which is a photograph of the area in which the leaking hole was found when the hose was subjected to examination by Mr. Hodges and his colleagues at the Health & Safety Laboratory at Buxton, demonstrates only too vividly the damaged condition of the hose. The damaged section of hose was lodged as a production, (Crown Label and that too demonstrated the extent of the damage and its correspondence with the damage on the air hose which was also a production.

5.6

There are already too many imponderables about this case but one of the great ones is why it did not occur to Mr. King or Mr. Kennedy, both of whom were extremely experienced tradesmen, when Mr. King could not get the propane torch to light, in the earlier part of the evening of 4th. July, to look inside the blanket wrap into which they must have been able to see that the propane hose went to see if the answer to the problem lay within. Had they done so, they could scarcely have avoided seeing the damage to the propane hose, and had they seen that, the accident would have been unlikely to occur.

5.7

The intriguing questions then come to be who caused the damage to the propane and air hoses and how and who wrapped up the damage hoses and cables in the blanket

wrap. Let me deal with the second issue first, but before doing that it is important in considering this evidence to be aware of the evidence of both Mr. Hodges and Mr. Summerfield to the effect that the leakage detected in the propane hose was not at such a rate that it would have prevented an effective supply of propane to the burner. In other words, when, on the evening of the accident, Mr. King and Mr. Waterston, in the presence of Mr. Kennedy, were trying to get the propane torch to light, without success, in the absence of any other explanation for the propane supply not reaching the torch, the only explanation can be that the propane supply at the propane bottle was not turned on. In turn, two considerations flow from that. All four representatives submitted that Douglas Waterston was a credible and reliable witness and that I should pay close attention to his evidence, but I find that when I do that, I cannot rely on his evidence about what he did when Mr. King sent him up to investigate the lack of propane. According to his evidence, the on/off tap at the propane bottle was in the "on" position. He then turned the regulator valve handle, which resembles the type of cap commonly found on central heating radiator valves, anti-clockwise, as you would turn a water tap, thinking that was turning it on, until it would turn no more. The spindle appeared to be coming out the way. He did not appreciate that this was having the precise opposite effect, he said, to that intended and he was, in fact, closing the regulator valve. Mr. Hodges, in his evidence, confirmed that this was the position and informed us that from fully open to fully closed involved seven and a half rotations of the valve handle and that turned fully clockwise, the gas supply would fully flow; turned fully anti-clockwise, the gas would cease to flow. In the "as found" position, the regulator valve was two and a quarter turns from the fully on position. The difficulty then with Mr. Waterston's evidence is that, in effect, what he claims he did would have had the effect of turning the propane supply off. One can, of course, only turn off a supply which is on. But the evidence points strongly to the fact that the supply was not on. I will shortly come to the very unsatisfactory evidence of those who were on the day shift of 4th. July but the real evidence suggests that they did not use propane in the course of the shift. We then find that the work in the aft brace on the night shift of 3rd. July appears, substantially, to have been flame cutting and there is no evidence of welding having taken place in the course of that shift. The most

reliable source of evidence about this is the twice daily status reports prepared by Mr. Johnston (MESL Production 2/16) which were prepared and made available to GM at the time. These start at 18.00 on 2nd. July and, in relation to the aft brace, inform us that replacement cruciforms were to be inserted into ring stiffener number 2 at positions 2, 3, 5 and 6 which correspond with the 2, 4, 8 and 10 o'clock positions, looking at the ring stiffener from the entry side of the brace. We can see from the status report that cruciforms 3 and 5 have been cut out, fitted and welded and simply remain to be tested. Otherwise, shotblasting is ongoing. In the starboard side, for which the propane supply would also have been used, cruciform no. 5 has been cut out and replaced and the replacement fitted and 90% welded, and so at that stage it would be likely that the propane supply would be through to the starboard section of the brace. As at 08.00 on 3rd. July, there appears to be no change to the cutting or welding position in the aft brace, which may reflect the fact that shotblasting was ongoing, which would make undertaking other work impossible. By 20.00 on 3rd. July, it appears that shotblasting has been completed and work is 50% complete on cutting out three inserts in the port section. As I understood the evidence, apart from the work of replacing cruciforms, three areas where steel plate was worn and required to be replaced were also identified. The welding of cruciform 5 on the starboard side has also been completed. If the position at 12.00 on 4th. July is then considered, there has been no change in the welding status from 20.00 on 3rd. July, the only change being the cutting out of cruciform 6 i.e. the one at 10.00 o' clock on the clock face, the one we know from the evidence was the one Mr. King was intending to weld in. The words "Recut due to flange misalignment" arise because the new cruciform supplied would not adequately fit the space, and the evidence is that David Stitt and George MacLachlan spent the bulk of their Saturday day shift fabricating a new cruciform which would constitute a better fit. The effect of that was that, at least until late in the day shift, there was no welding to be done in the aft brace and as we shall see, the welder, James Wright, who had sat about doing nothing all day, refused to start welding about 1 1/2 hours before the end of his shift because, he claimed, he would not be able to complete the weld and the night shift man coming on, who would be Mr. King, would just have to start it all over again. So the evidence is that

the last welding in the aft brace prior to the accident took place prior to 20.00 on 3rd. July. Since the damage to the propane hose, in my opinion, was caused later than 20.00 on 3rd. July, I conclude on the balance of probability that the propane supply was not on when the damage was caused, was not on when Mr. Waterston described activity which would have the effect of turning it off and was only turned on when Mr. King turned it on prior to going for his tea break on the evening of 4th. July. The second consideration is that, since Mr. King was trying to light the propane, it is reasonable to infer that he thought the supply was on. Since he was the only welder at the start of the night shift of 4th. July allocated to the aft brace, that would appear to mean, since he would presumably have known if he had turned it on himself, that he descended to the brace either not thinking about it all or assuming that the supply would be on, and, logically, would not have been turned off at the change of shift. It should, of course, have been turned off at the end of the shift, and, as I have already explained, I have concluded that it was in fact off, never having been on since prior to 20.00 on 3rd. July, but Mr. King should have ascertained the position when he came on shift, especially since it appears that he was aware that there was welding to be done and he, in fact, did some welding without pre-heating, which would appear to have been contrary to the welding procedure for the cruciform welds. Mr. King had gone through his induction on 26th. June, but the night shift of 4th. July was the first time he had worked in the aft brace and so I am a little less confident about my conclusion about his failure than in relation to the status of the propane supply, but there can be no doubt that it is the function of the tradesman coming on shift to be aware of the status of the gas supply and in this respect Mr. King appears to have failed. He then compounded that failure by sending an inexperienced labourer to investigate the problem instead of doing it himself. It is perhaps fair to add that in respect of the failure to ascertain the status of the gas supply at the start of the shift, he was not the only experienced tradesman on this job guilty of the same failure.

5.8

It was the evidence of James Wright and Alan Holt, both of whom were welders employed by MESL and John McBain, a helper employed by MESL, that they, in various respects, were responsible for the creation of the green blanket welding

screen wrap. They say that that was done broadly some time about mid-day on 4th. July. Before turning to their evidence, I want to consider the evidence of those who were in the brace subsequent to that time and to what their respective reactions were to this obviously present allegedly unusual arrangement. In his statement to the Health & Safety Inspectors, Hugh MacKay, the night shift welding foreman, who struck me as being an honest and reliable witness, told them that he had seen the green blanket wrapped around the services in the bottom of the brace on the night of the accident. He had not noticed it the previous day. "No one mentioned it. I guessed it had been put there to protect against spark damage. I don't know whether or not the propane hose is routed through the fire blanket." It does not appear, at least at that point in time, that he regarded the bundle as being unusual or for any purpose other than the protection of the services. Detective Constable Neil Ritchie told the Inquiry he moved nothing in the brace; everything was as he found it. "The green blanket was almost underneath the bench running across....There was, it's like a beam running along, right along the middle there's a narrow beam and you could walk along the beam or straddle it." The blanket was "across it." Of course, firefighters had been in the brace and had recovered Mr. King's body from the brace by this time and the possibility of the blanket having been moved by them in the course of that process cannot be excluded, but it is an interesting observation by D.C. Ritchie that the central longitudinal beam made a suitable pathway, for it means that, if the blanket was straddling it, people would have to step over or around the blanket to move along the brace and therefore, like Hugh MacKay, ought to have been aware of its presence. Eric Murphy, the day shift general foreman, said he did not see the arrangement involving the blanket and the steel plate, which would suggest that he was not in the brace from lunch time until the end of the shift on 4th. July. He did say, in response to cross-examination by Mr. Thomson, that a fire blanket might be used while cutting or welding to give a measure of protection and that "they had some down in the braces if they wanted to use it." No one else has made that claim and, as we shall see, Mr. Holt and Mr. Wright claim to have gone to the store and obtained the green blanket from a roll there. Mr. Murphy went on to explain that you might cover services with a blanket, simply by laying it on top of them, which would give some measure of

protection, but you would not wrap them up because you would not know 'if you had put anything on to something.' Elaborating on this, he appeared to be making the point that the blanket was not fireproof, a piece of molten metal could still go through it and then you would not be able to see what harm it had caused. There is certainly some common sense in these observations. Further, he could not understand why anyone would tape the propane hose to an air hose. He had not seen that.

George MacLachlan, a plater with MESL, had been instructed to remove the defective cruciform from the aft brace at about 09.00 on 4th. July and had gone to the brace with David Stitt to do so. There were two welders there, Alan Holt and another man whom he did not know. He cut out the defective cruciform taking about ten minutes to do so. He had then been involved on the dock side in fabricating the replacement cruciform and it was not until about 18.00 that he returned to the brace with the new cruciform. It fitted in. The only other person there was the welder he did not know, and David Stitt who had come with him. The welder tacked in the new cruciform with his welding gear, an electric arc welder. It took him 15 to 20 minutes. He, MacLachlan, had remained there during that period but he had not noticed any green blanket, though it would appear that he must have been close to standing on it when he fitted in the replacement cruciform. He claimed that if he had seen it, he would have asked why hoses were being wrapped up in a fire blanket. "If it was wrapped up, you wouldn't be able to tell whether the hoses had been damaged or not." That had the sound of a conclusion from a post-accident discussion and I regret that I was not convinced that he would have done anything about it if he had seen it and I have some difficulty accepting that he failed to see it. He maintained that David Stitt, the plating foreman, had not said anything about it in his presence. He, Stitt and the welder, who we know to have been James Wright, left the brace when this work was finished. According to his statement at the time to the Health & Safety Inspectors, he had returned to the brace at about 14.00 to 14.30 with the replacement cruciform which was put in position to re-mark. "I then burnt in the new line with the oxy-acetylene cutting gear. The plate was put in position and spot welded. And this work took until the end of the shift at 18.15." So there was flame cutting and welding in the course of the Saturday day shift taking place in the area in which the blanket

was found after the accident. Later in his statement he said, " I think the oxy-acetylene hoses went through the loom with other cables covered with a fire blanket at the first ring underneath the two scaffolding boards." Of course, we know that neither the oxygen nor the acetylene hoses were in the 'loom' as he described it, so it would appear that the content of his statement at the time was not reliable, never mind his evidence now. However, the content of his statement is inconsistent with his assertions not only that he did not see the blanket wrapped round the services but that he would have done something about it if he had, and means, particularly since, without blushing, he accepted that the content of this statement was correct and what he had said earlier therefore was wrong, that he is simply not credible nor reliable on this issue. He denied having anything to do with taping the propane and air hoses together and could not understand why that would be done.

According to David Stitt, he was first in the brace about 11.30 on 4th. July to try to resolve the problem with the defective cruciform. It was between 15.30 and 16.00, he thought, that he and George MacLachlan returned to the brace with the replacement. In the morning Alan Holt was there with another welder, James. In the afternoon, there was a welder and a helper. "We lifted the cruciform into position, George and me, and there was some adjusting had to be done slightly. We trimmed it up with the oxy-acetylene gear and rammed it in, dressed it. George did that, I was standing watching. We had to trim the actual ring stiffener. Once I had seen that that was ready I left about 17.00 to 17.30 to go round the other jobs..." So there was at the very least an element of flame cutting confirmed by this witness as having taken place on the Saturday afternoon. He went on to say that the cruciform was when he left ready to be tacked in but that process had not started prior to his leaving. He seemed to recall the propane hose coiled in the brace and did not think that propane had been used that day. He would not expect it to be used in connection with tack welding. He was aware of the green blanket wrap and knew that it was Alan Holt who had done it. He thought that it was 'just a bit of added protection. If you're working, wrapping stuff up in fire blankets is quite common, if you're working anywhere where there's cables or whatever you wrap the cables up to protect them from when you're welding or burning near hand, you know.' He could not, however, think of any reason why the

propane and air hoses were taped together.

Cross examined by Mr. Mitchell, he agreed that it was not normal for a fire blanket round services to be taped, agreeing that that would prevent you from seeing what was happening in the bundle. His position was that he had seen Mr. Holt wrap the services in this blanket - he thought on the day of the accident and while they were 'busy putting in the cruciform - there was a few sparks going about but." As we shall see, this evidence is not consistent with anyone else's about the presence of Alan Holt in the brace in the afternoon and about Holt wrapping the blanket round the services at that time but in many respects it makes more sense for someone to wrap at a time when he can see that damage is occurring or, at least, may be occurring than at a stage when it is not. But although there are discrepancies about the time, all the other witnesses involved in the replacement of the defective cruciform agree that the replacement was not ready until the afternoon and that Holt had left the brace to work elsewhere by that time so I regret that I cannot regard the foregoing passage as reliable no matter how much it might otherwise fit the facts.

James Kennedy was sent to the brace for the first time on the night shift of 4th. July. He claimed not to have liked the conditions there one bit and regarded them as dangerous but he did nothing active about it. He confirmed that Richard King was welding but that he did not have any propane supply to keep the surfaces to be welded hot. It was his position that Mr. King had said to the helper, Mr. Waterston, "go and switch the propane on upstairs," and the helper had said he would do it at tea time. Mr. Kennedy was very clear that Mr. King was getting nothing out of the propane hose. He agreed that there was no reason why propane and air hoses should be taped together. He had seen a fire blanket which he said was burnt. He said it had white film over it which meant that it had been bombarded with welding or burning particles which might reflect the work done in the course of the Saturday afternoon to incorporate the newly fabricated replacement cruciform. It was an old fire blanket, not a new one. The blanket was wrapped round cables. The blanket should have been loosely wrapped round the services. The more layers, the better heat would be absorbed. Cross-examined by Mr. Mitchell, he said that he had seen Mr. King try to light the propane torch with his welding gear. He had picked up the torch, after Mr.

King gave up, and made sure that it was off. He, Kennedy, did not know where the propane bottle was. When they all went up for tea, he was the last. He did not know if anyone had done anything about the propane bottle. I have reservations about Mr. Kennedy's evidence. He told the Inquiry in terms that he was here to speak 'for the boys that died' and that affected his balance. He became at times extremely aggressive and defensive, not only of himself but of the actions of Richard King, trying to suggest that it would normally be the helper's task to deal with gas supplies. He thus substantially destroyed his credibility and reliability which was a pity for, with his experience and boldness, one or two of his observations might otherwise have merited further consideration. His precise evidence about what was said to Waterston is not consistent with Waterston's evidence and I prefer Waterston's evidence on this point. There would have been no point in sending Waterston to the gas bottle when Mr. King was going up himself anyway and Waterston account of what happened in the tea-hut, to which I shall shortly come, is not consistent with any suggestion that he was going at the start of the tea-break to deal with the propane problem. While I doubt the accuracy of his evidence on the point, it is instructive that Mr. Kennedy apparently saw nothing wrong with Mr. King instructing the labourer, Mr. Waterston, to go and turn on the propane supply and, if it were true, it would be a further indication that Mr. King failed to check the status of the supply at the commencement of the shift, but, as I say, I doubt its accuracy. However, I accept Mr. Kennedy's evidence that Mr. King was trying to light the propane torch in vain with his welding gear and that there was no propane in the hose. He is another witness who was unsurprised at the presence of the green blanket and the apparent purpose of protection for which it was being used but, though he claimed not to have seen that the blanket was taped, did not like the idea of such a protective cover being taped. Douglas Waterston told the Inquiry that he had been working as a helper in the brace on the night shift of 4th. July with Mr. King. They were trying to get the propane hose to light. When Mr. King tried to ignite it, it would not. There did not appear to be any gas coming out. He had to go up to the deck - the terms of his response suggesting he was instructed so to do - to check the hose and the bottle and make sure they were still connected and there were no kinks in the hose. Once more, if Mr. King had

followed normal practice, he would have known at the start of the shift whether the hose was connected at the regulator valve and that the gas supply was otherwise on and would not have needed Waterston to check that. He said that he checked both taps and that they were in the fully 'on' position. He used the expression "out on to full on," which again may reflect his misunderstanding of the true 'On' position of the regulator valve. He could not have turned the propane on at the start of the shift because he did not know where the bottle was until he was sent to find out why there was no supply. He said that he had turned both valves to the fully open position. In relation to the regulator valve he said in terms that he had turned it anti-clockwise. If all he in fact did was simply check that both valves were in what he thought was the fully on position, that would explain the earlier absence of propane in the brace. What he said he did would not. He went on to say that on his return to the brace, the propane torch was still not working. He went back to the surface and gave the propane bottle a shake. There was liquid gas in the bottle. He said that when he turned the regulator the first time, he did not hear any hissing sound, which made him then think about the possibility that the gas bottle was empty. He said that back in the brace, while he had not tried to light the propane torch, he had held it up to his face and nothing happened when he depressed the trigger of the torch. Despite all this, Mr. King had done some welding. He, Mr. King, Mr. Duffell and Mr. Kennedy had all gone up for tea break about 21.00. They all went up together. Mr. King went off to check the propane bottle. He came into the canteen about five minutes after the witness had got there and said "Some cunt has turned the valve in the wrong direction." Mr. Waterston assumed from what Mr. King said that Mr. King had fixed it. He assumed the reference must be to the regulator valve as he could not see how he could have gone wrong with the 'On/Off' tap. As discussed, what he said he did would have had the effect of turning the gas supply off. Mr. Waterston had then had the good fortune to be told by Mr. MacKay to stay behind and clean up the tea hut, otherwise it is unlikely the Inquiry would have had the benefit of his evidence. When the alarm went off and it became clear there was a problem in the aft brace, he had gone back to the propane bottle and turned it off using the 'On/Off' tap. That tap had been in the 'On' position. He did not touch the regulator. In his statement to the

Health & Safety Inspectors following the accident, he had said, " on the way up to the canteen Richie (Mr. King) had gone to check the propane bottle himself. Shortly afterwards in the canteen Richie arrived and explained one of the valves on the propane was in the wrong position. He said the metal valve on top of the propane gas cylinder had been open but the black plastic regulator valve was not in the right position to allow the gas to flow. From this conversation I assumed he had left the bottle switched on." Curiously, given all that was going on and some of the detail he was able to provide, he could not recall seeing the fire blanket. The lack of propane did not appear to cause anyone to think there might be damage to the hose, beyond the possibility of kinking. He had not seen bottles turned on and off habitually at shift changeovers. It was his opinion that if propane had been leaking into the brace from the hose during the early part of the shift, even if confined to floor level, he would have smelt it.

Gordon Davidson, who had become the chargehand plater, had worked on external works on the rig with Roland Duffell for a couple of nights and had considered him to be a competent plater who gave "no troubles on the safety side." He had not noticed the fire blanket in the aft brace on Saturday evening though he had been there at the start of the shift. It was normal, so far as he was concerned, to use a fire blanket to protect cables and hoses from burning, but not normal to tape up the blanket. Had he noticed that, he would have asked about it. He had been in the tea-hut at evening tea break time and had heard Richard King say something about a valve on the gear. He had been working in the forward brace and returned there after the tea break and knew nothing about the accident until a labourer came and told them to stop work. Colin Johnston had been in the aft brace about 1 1/2 hours before the accident but said he had not seen the green blanket arrangement. He was shown it by the Health & Safety Executive as they were on the point of unwrapping it but was not present when it was unwrapped. When he was in the brace, he had spoken to Richard King and knew that he was setting up to weld. He seemed to recall the propane hose and torch being there. Platers were setting up to cut out in the starboard section. One of the platers was Roland Duffell. The job had been marked out for them by the day shift. Shown Crown Label 5 he agreed that this was a welding blanket which looked like it

would have been relatively new when used in the brace.

Mark Greenhow had not been in the aft brace on the Saturday and had not seen the green blanket.

James Reid, another plater employed by MESL had been working with Roland Duffell on the night shift of 4th. July. He was sure that Richard King was welding in the port section as they set up in the starboard section. They began to mark off their job and then Mr. Duffell started cutting. After about ten minutes, he ran out of oxygen. The place was beginning to fill up with fumes so they decided to go to tea break and change the oxygen bottle. When he came through to the port section Mr. King and Mr. Kennedy were there. He remembered there was an asbestos blanket, as he described it, but could not remember it being wrapped round anything. He would not have wrapped the blanket round in the manner shown in the photographs shown to him " as you would not be able to see if a spark had made contact with a cable or a hose." He knew of no reason for taping an air hose to a propane hose. When he had come out of the brace, he had gone and turned off the bottles, though he admitted he had not removed torches and hoses from the brace. He knew that there could be a gas leak 'too small to see but big enough for gas to be leaking.' When they went up they could not find an adjustable spanner, so they went for their tea. After tea break, he pursued engineers to try to borrow a spanner to change the oxygen and Roland Duffell went back to the job. He then heard there was a fire and had gone and turned off the oxygen and acetylene bottles.

Hugh MacKay said that Richard King told him, in the port aft brace, that he had been up at the bottle and had had the labourer up at the bottle. MacKay had done nothing about it because King was 'such an experienced guy.' He had been in the brace 5 to 10 minutes and was concerned about the ventilation. He had seen a fire blanket but he could not remember where. He could see merit in using it to protect cables but not the propane hose for you would not see if a spark had landed on it. He could not believe that any welder would conceal the damage to the propane hose in a fire blanket because 'they would know what would happen.' He had instructed Douglas Waterston to clean up the tea hut at the end of the break. He agreed that he had told the Health & Safety Inspectors at the time that he had seen the green blanket

at the start of his shift wrapped round the services in the bottom of the brace and guessed it had been put there to protect against spark damage. Shown the photographs of damage to the propane hose, this decent man seemed genuinely shocked at what he was seeing. Anyone who had wrapped up the propane hose in that condition had created 'a very high risk which would have been evident to any welder or plater.'

Angus Wylie was not in the aft brace on the evening of 4th. July prior to the accident. Shown the photographs he was appalled, again it seemed to me quite genuinely, that anyone could have left the propane hose in that condition. He recognised that a fire blanket would not comprehensively protect against molten particles. The risk to the services would have been substantially minimised by moving them to the other side of the central longitudinal beam. He agreed that anyone wrapping the hoses and cables in the blanket could hardly fail to notice the damage.

As can be seen, there really is no witness who, on merely looking casually at the fire blanket apparently being used for protective purposes, would have thought there was any cause for concern or any pressing need to investigate further, though most were appalled at the actual condition of the propane hose and would never have wrapped it up in that condition. They could not see how it could have been wrapped up without those who were wrapping it being aware of its damaged condition. Neither can I. They were at a loss to understand why anyone would tape a propane hose to an air hose.

5.9

I now turn to the evidence given to the Inquiry by Alan Holt. Holt was a 45 year old welder from the Manchester area who had 26 years experience in light and heavy fabrication work, including shop work and site erection throughout the United Kingdom and, for periods, in The Netherlands, Denmark, Nigeria and Angola. He had worked offshore in the North Sea and for British Gas in Morecambe Bay. He had also worked at St. Fergus for Total. Between 1968 and 1994, he listed 32 different employers. On paper, he appeared to be an extremely experienced welder. He was, however, also, a liar.

He had started work with MESL about a week before the accident. He had previously worked for them in the Netherlands. He telephoned the company from time to time

when he was looking for work and, at the material time, was offered short term employment either at Invergordon or Dundee. He had worked previously in confined spaces, but never internally down the column of a rig. He had been through the R.G.I.T. offshore safety survival course, which includes training in the use of breathing apparatus. At Dundee, he initially worked on the stairwell for access to the rig and then he was involved in setting up the gear for the work in the braces i.e. he took down welding leads and the propane hose. He also claimed to have set up what he called "the burning leads" but that is inconsistent with the evidence of Eric Murphy - though I do not regard him as reliable either. He thought he had done this on the first Sunday. He had also put the propane bottle into position. It was one level up from the main deck where the oxygen and acetylene bottles were located. He described the propane hose as "light brown." He claimed that the bottle end of the propane supply i.e. the end of the hose with the regulator valve attached, would be "connected up" at the start of each shift and would be "taken off" at the end. The gas bottles were generally stacked on the heli-deck and the propane bottle had ended up where it was by virtue of the fact that, when installation was taking place, there was no crane operator available to lower the propane bottle down to the main deck from the heli-deck above. The propane would not be disconnected at break times. If you went off for a break, you would need to pre-heat the metal surfaces before you could resume welding and that is what the propane was required for. The cables from the welding set to the arc welder were black. There were two arc welders in the brace and corresponding leads. The job in the braces was to weld new cross-sections into place. It was either the foreman, Derek, or Colin Johnston who had shown him what to do. He had only worked in the aft brace. He had worked there on the Monday and the Tuesday and had then been out of there because of the paint fumes problem. At all times there were a lot of fumes from the welding and flame cutting processes and they took 15 to 20 minutes after the cessation of hot work to disperse. He had made a statement under section 20 of the Health & Safety at Work etc., 1974 in which he named his foreman as Dave Stitt, and in which he said that on Saturday, 4th. July, he had worked in the brace until about 12.30p.m. when he went to another job. In the port section of the aft brace with him had been two other people, apart

from Stitt, from time to time, who he named as J. Wright, a welder and D. Waterston Jnr., a helper. There was no work to do prior to the time he left. The other two were there when he left. The plan was that Wright would weld a plate in, in the course of the afternoon. The oxygen and acetylene lines were taped up at the same level as the temporary lighting. Otherwise, the services were in a bundle at the bottom of the brace. There were electrical cables, welding cables and an air line. He claimed not to be aware of the propane line (though he had installed it). There was a platform consisting of two battens under which there was a green fire blanket to protect the services, which he had put there in the course of the morning. He had added a thick metal plate crossways "for added protection." D. Waterston, Jnr. had helped him. "I was satisfied this would protect the services from hot globules of metal that would fall later when the electric welding was done above." He said that, perhaps a day or two before, "George was using the oxy-acetylene cutting torch and he, (Holt), had heard a hiss from what turned out to be the oxygen hose." He, Holt, had kinked the hose while George got a repair kit and mended the hose. He imagined that a propane hose could be repaired in the same way "but I have never had occasion to do this in my working experience." He remembered being told when he came in on the Saturday morning that there had been "a couple of fires" in section one of the brace during the Friday night shift. When he went down to the brace, he saw some hose repair kit tubes lying beside the two planks. He considered that when he left the propane hose was coiled up at the entrance to the brace - that simply cannot be true for it was in the blanket wrap. He claimed that the "practice" (which can only have evolved over about four days) was to turn the propane off at the torch and then turn off at the bottle on the upper deck when going for breaks. That statement was made on 9th. July, 1998. On 13th. July, Holt told the Inspectors he wanted to make a further statement. He claimed that on 4th. July, when he left at 12.30, he had not gone to the propane to check it was off. He had gone to the canteen on shore and had asked J. Wright to remind him to check it after dinner. Then, "I went back to the bottle about 1.00p.m. and attempted to close the cylinder valve with a gloved hand. It seemed to be shut and so I walked away but then thought it might have been slipping in the glove. I then went back to the cylinder, removed my glove and attempted to close the

valve, but it did not turn for it was closed."

He said in evidence that he had used propane "from time to time" during the four days or so prior to the accident when he had worked in the aft brace, only for a few minutes at a time, whereas it would take a day to weld in each new cruciform. He seemed to distinguish between tea breaks when the propane bottle at deck level would not be turned off and dinner breaks when it would. He claimed to have a discussion with Colin Johnston about the terms of the method statement insofar as it required the removal of the hoses and torches from the brace, the result of which, he claimed, was that he had been told not to bother doing that but just to disconnect at the bottle. I do not believe this discussion took place, at least not in these terms. He thought he would have used propane on the Friday 3rd. July dayshift for a total of about ten minutes. He was aware that a gas leak could cause a fire or explosion if ignited by an ignition source. He thought that propane "lies low" i.e. he had some understanding of its density relative to air. He understood in broad terms the need for an explosive mix with air but he did not know what the flammable range was. He accepted that both cutting torches and arc welding equipment would be sources of ignition. The firewatcher in the brace on the Saturday morning was a young lad about twenty with blondish short curly hair. After doing nothing for a while, he claimed he decided to start tidying up and was going about picking up bits and pieces of rubbish, face masks was the one thing he particularly recalled, from the floor. "I then noticed a 110 volt cable, that there were marks on it from burning." The outer surface of the cable had been damaged. He thought it had been caused by "the cutting gear." They then went for a tea break after which he and James Wright went to the store and got a length of fire blanket. It was brand new and he had cut it from a roll. This was taken back down to the brace. It was about eight or nine feet long. " We slid the fire blanket under the cables and the young lad lifted it while we wrapped it around three or four times." He claimed not to know where the propane hose was. The purpose, he said, was to protect from welding sparks damaging the cables. Once the crucifix was in position they would be welding overhead and that would be the first act of overhead welding. He claimed then to have taped the "burning leads" i.e. the oxygen and acetylene hoses, to an overhead pipe. He thought he had used masking tape for that purpose. He

had also taped the ends of the blanket with masking tape. He thought the bundle in the fire blanket was "down the centre." (p.291) Shown Crown Production 2/QQQQ, (plate 14) he considered that that showed the blanket where he had left it. The plate was the last thing he put on and he did this for extra protection, "Sparks won't go through a plate." There was no hot work done between him wrapping the services in the blanket and placing the plate on top. He was equivocal about whether he had looked for damage to the other cables and hoses he had wrapped in the blanket. His evidence about where the propane hose and torch were was verging on prevarication. While he agreed the position of the blanket, shown Crown production 43/13, he claimed that that was not where he left the metal plate. He claimed to have left it on "the round bracing" i.e. the ring stiffener. Of the hole in the blanket under the plate he said, "It looks like it's been burnt." He maintained that it was not like that when he wrapped the services in it - it was brand new. He could not explain how it could have occurred. He reckoned the air line was for an air arc gouger and could offer no explanation as to why the propane hose should be attached to it for he considered that you would never be using propane and an air arc gouger at the same time. He described the propane hose as "red." He denied taping the hoses together. He claimed that the propane hose "was a lot darker than normal." He "could not accept" that it had been in the bundle he had wrapped up. He thought the damage to the yellow cable as shown on the photograph demonstrated "deeper penetration" than he recalled seeing. He said if he had seen damage like that he would have changed the cable. He accepted that it was possible he had missed seeing the air and propane hoses taped together. He reckoned that there must have been "about 100 feet" of propane hose in the brace. The oxygen and acetylene hoses were taped together "but that's standard." He did not think he had done that but he might have forgotten. It then emerged that he was colour blind on green, red and brown and so had, at least, trouble distinguishing between an acetylene hose and a propane hose. Shown Crown Productions 43/18 and 43/20 (plate 24), he considered that he was seeing in the latter photograph damage caused by "burning spatter" because it covered such a large area. He agreed that it would be strange at least and probably dangerous to tape over such damage. It should have been cut and re-connected. He claimed that he would not have wrapped up such

a damaged hose, if he had seen the damage. George the plater had burnt a pinhole in an oxygen hose earlier in the week and he, Holt, had heard the gas hissing out of it and had run his hand along the hose until he had felt the jet of oxygen emerging. As a temporary measure, while George went to deck level to turn off the supply, he, Holt, had wrapped some tape round it, but it had then been subjected to a proper repair using a kit. What that means is that he is aware of platers damaging hoses at an earlier point with minimal signs of damage on the hose. The propane line did not have a pressure gauge on it. He denied trying to repair the propane hose by applying tape to it. He maintained he had not seen damage like that shown in plate 24, Crown production 43/20, when he had wrapped up the various hoses and cables in the blanket.

He then gave an extraordinary account of what he had done when he left the brace at 12.30. Initially, he claimed to have gone to the propane bottle and switched it off. Then he admitted that he had not gone to the bottle until after dinner, claiming Jimmy Wright had reminded him. Considering the "practice" hitherto seems to have been to leave the supply live, or at least not to know whether it was live or not, and further considering that Jimmy Wright expected to be welding at some point in the afternoon, all this seemed strange to me. Anyway, when he got there, he was wearing his welding gloves for he was going to another job. "I turned it to switch it off and it felt like it was slipping in my hands, but when I switched it I only turned it half to crank it open. Some people wind the bottle right up to the very top and like lock it open, but I just turn it half a turn which is sufficient I think. So when I went over I switched it off, put me hand on it and it felt like it slipped. I thought it's just slipped in me hand so I walked away and I got to the top of the stairs, I thought I'm not sure that's definitely off, so I went back to the bottle and took me glove off and it was switched off, because somebody else might have undone it, they might have cranked it fully up and locked it at the top. When I got hold of it without me gloves and that felt like it was slipping, but it might have been jammed open so I turned it by hand and it was off." This is an extremely strange piece of evidence even allowing for any difficulty the shorthand writer may have had with this man's thick Mancunian accent. The regulator valve is much like a tap except that to operate it i.e. make the gas flow you

turn it the opposite way. I do not recall any evidence from the staff of HSL that it was malfunctioning. There is no mechanism any more than there is on a tap for "locking" it in any position - you simply turn it to a position and, like any other effectively working valve, it maintains that position - so Holt's use of language is strange. It is equally strange to walk away from something in a state of uncertainty and then go back. If because he was wearing thick gloves he was unsure whether the regulator was turning or not he should, as he eventually says he did, have taken his gloves off and confirmed the position. This was the content of his supplementary statement to the HSE inspectors and is therefore immediately suspect and it all smacks of a cover up. But of what ? It is near certain that the propane was never on that day - so why make a fuss about it ? Why not just say 'I forgot but when I eventually went to check I found it had never been on in the first place.' It is all very unsatisfactory. When you read his evidence at this point, it demonstrates a very clear tendency not to answer the question that he has been asked, but to give an evasive answer to an associated question. This is not the approach of a person with nothing to hide.

He admitted that Jimmy Wright and the firewatcher were smoking in the brace. He knew that a person caught smoking would be dismissed immediately. He thought acetylene was heavier than air. He had seen Colin Johnston in the brace two or three times but the lady safety officer only once. He maintained that he was telling the truth when giving his statements to the HSE inspectors. He was unable to explain his failure to tell them about Colin Johnston's alleged oral variation of the instruction in the method statement about the removal of torches and hoses from the brace.

In the course of his cross-examination by Mr. Pilkington, he revealed that he knew that James Wright was in the United States at the time he was giving evidence. "I seen him when I went to Aberdeen a couple of weeks ago and he was going to America for about three months I think, around two or three weeks ago.....He's a friend of a welder I know in Aberdeen."

When Mr. Pilkington showed him Crown Production 93/19, things took, it seemed to me, an even stranger twist, because Holt then claimed it was not this that he had been turning but the On/Off switch at the bottle. I do not think that there is a clear photograph of the propane bottle but the evidence I have heard leads me to believe

that the arrangement is substantially the same as that which applies to the acetylene or oxygen bottles which can be seen in Crown Production 99/35, (Plate 35) where it can be seen that the regulator is connected to a brass fitting which, at one end goes into the gas bottle and at the other end goes into the supply hose and, strictly, its purpose is to regulate the pressure at which the gas is delivered to the user at the end of the hose, but if that valve is fully turned off then that closes off any supply of gas. In addition, on the top of each bottle, a tap can be seen, which is the On/Off tap. With that turned off, no gas should emerge from the bottle irrespective of the position of the regulator and it appeared that now, in cross, Holt was claiming that it was the On/Off valve he turned. He said - and there is some logic to it - "I would not interfere with the regulator on the basis that it would have been set at the beginning at the required pressure for the job," except that he should know the required pressure for the job and how to set the regulator.

Cross-examined by Mr. Mitchell, he admitted that when he had met James Wright, who was a friend of a friend, about three or four weeks ago, the Inquiry had been discussed including the fact that he, Holt, was to give evidence. Wright had said he was not coming to give evidence. Holt thought, correctly, that Wright had not given a statement to the HSE Inspectors. He also admitted being aware through the trade of other incidents in the past where welders had been injured as a consequence of explosions caused by gas leaks during periods when work was not taking place. He accepted that he had been given instructions in the method statement directed towards that risk with which he had not complied. He suggested that the use of propane for pre-heating was not a common usage and that, offshore, heating was always done using electric heating bands. Pre-heating was only required if the plate to be welded was particularly thick and the temperature was really cold. He could not explain why he did not know whether he had checked the propane first thing in the morning given that he apparently expected to start welding in a new cruciform which would require pre-heating. There was no smell of gas in the course of the morning in the brace. If what he says is correct, I suppose it does not exclude the possibility that the regulator was on at least to some extent when Waterston went up to try to solve the problem and that what he did was turn the gas on at the On/Off tap and then turn it off at the

regulator and that would resolve my main concern about Mr. Waterston's reliability. He said that in his recent meeting with Wright, Wright had, in effect, reminded him of their awareness of a fire in the brace on the preceding night-shift. Wright had said, "There must have been a fire because the statement that were taped to the wall got burned off."

Cross-examined by Mr. Thomson, the witness recollected that he had used propane in the third, starboard, section in the course of 3rd. July. That is consistent with Mr. Johnston's status reports contrasting 08.00 and 20.00 on 3rd. July.

He accepted that he had told the HSE Inspectors that there was 'no procedure' for the removal of torches and hoses from the brace, which was inconsistent with his evidence about his conversation with Mr. Johnston which he claimed led to a variation in the procedure which he had omitted to mention to the Inspectors. He denied the suggestion that there had been no such discussion with Colin Johnston, but I do not believe him and prefer Mr. Johnston's evidence on this issue. Shown Crown Label 6, the so-called fire blanket, he identified particles of tape adhering to it as similar to what he had used to wrap it up. He thought he might have used a hacksaw blade to cut the blanket from the roll which, he thought, would explain its frayed appearance. Ultimately, he appeared to concede that Label 6 did not look like a new blanket while continuing to maintain that what he had used to wrap the hoses and cables was new from the store.

In the course of re-examination by Mrs. Benson, Holt said that he had not seen Mr. Wright immediately after the accident i.e. he, Wright, had disappeared from the scene. "He probably thought it wasn't a safe environment to be working in, he must have had enough, like."

I find it hard to know what reliance if any to put on Mr. Holt's evidence. He was evasive, self-contradictory and some aspects of his evidence simply defied belief. In particular, even from the outset, his statements to the HSE Inspectors were inconsistent and contradictory. I found it hard to believe that he was unaware of the whereabouts of the propane hose, given his familiarity with propane and his evidence that he had set it up and his ability to tell me that there was about 100 feet of propane hose in the brace. It is hard to believe someone who maintains the need to assess

carefully the damage to a hose before deciding whether to repair or replace but apparently does nothing on hearing that there has been a fire in the course of the preceding shift leading to repairs having to be effected, who sees damage to an electric cable and who decides to protect services by wrapping them in a so-called fire blanket, but who does not check for and see the damage to the adjacent propane hose which is almost incapable of being missed. The brief description of his meeting and discussion with Mr. Wright in the recent past seemed to me to be sinister, especially when coupled with Mr. Wright's disappearance immediately after the accident, never to return, apparently, at least until that meeting. I find it hard to believe that the evidence about getting a new blanket from the store is false, despite Mr. Thomson's understandably strenuous submissions to that effect, for there seems no reason to make that up, but the absence of any acceptable explanation for the hole in this otherwise new blanket casts doubt on the witness's entire explanation of what went on in the brace on Saturday 4th. July.

There is clear evidence that George MacLachlan did quite a substantial amount of cutting on the Saturday afternoon, apparently after Holt had gone, to fit in the remodelled cruciform, including having to trim the existing metal surfaces, which would give rise to a significant amount of molten particles from this cutting exercise, a state of affairs about which, surprisingly, little, if anything, was said in submissions, everyone apparently assuming that the damage was done on the Friday night shift. However, if Mr. MacLachlan's activity on the Saturday afternoon had caused the hole in the blanket, one would have expected particles of the slag to be found in the underlying layers of the blanket and there is no evidence of that. One cannot exclude the possibility that the blanket was only there in a single layer at that time over the services - that cutting slag caused the hole in that single layer, and went on to cause the damage to the air and propane hoses - there is certainly some support in the evidence of David Stitt for the suggestion that the wrapping of the services in the blanket was contemporaneous with the cutting to accommodate the remodelled cruciform - but all the evidence suggests that Mr. Holt was no longer in the brace by then so how would he know about the wrapping of the blanket and the placing of the metal offcut on top of it unless he had been involved in that process. I regret that the

result of these imponderables is that I cannot place much reliance on anything this man said but, if, as he claims, he wrapped up the blanket and put a plate on top of the arrangement, then he wrapped up a propane hose which already had a hole in it, the damage to which hose was eminently visible at least in the circumstances in which he described handling the hoses and cables, and which any tradesman exercising reasonable care would have known to be dangerous and in need of immediate repair. If he did what he claims he did, then he created the circumstances in which the propane would leak from the hose at low level and make its way in a diffuse pattern through the blanket, which would also muffle the sound of escaping gas, and collect, given its greater density than air, at the bottom of the brace where it subsequently ignited, all, of course, once it had been turned on by Mr King. Holt has, on his account of what he did, a high degree of culpability in respect of the accident and the deaths of Mr. King and Mr. Duffell.

Before leaving his evidence, there is one final curiosity I have to deal with. Holt named the helper working with him and Wright as "D. Waterston Junior." He said that in his HSE statement and maintained that in evidence initially before the Inquiry though was more doubtful when it was put to him that the helper was John McBain. John McBain, as we shall see, claims to have helped Holt wrap the blanket. I think, once again, Holt is simply wrong about who the helper was.

5.10.

Turning, then, to the evidence of James Wright, a 38 year old Glaswegian welder, he told the Inquiry that he had done an apprenticeship at Scott Lithgow in Greenock and that in his career since then he had done ship repair, worked in the petro-chemical industry and had done both fabrication work onshore and had worked as a welder offshore. He had telephoned MESL looking for work and had been asked to report to Dundee on Tuesday prior to the accident, 30th. June. He had been working day shift. He had a 'run of the mill twenty minute induction from some woman.' He was not aware of the work on the rig until he got on to the rig and met his chargehand. In particular, he did not know in advance that there would be working in confined spaces. He had only worked in the aft brace. He did not seem to be aware that there was a permit to work system in operation. That seemed to be based on his

experience to the effect that if there was such a system operating then the permit would have been on display at the work site - a not unreasonable expectation. He had experience of working in confined spaces but he had never been in one like this before and the means of access and egress were difficult. He had never worked with this length of hose before. He had not used gas in a confined space before. A lot of the work he had done did not require pre-heating. He had not seen damage to the propane hose. Had he done so, he claimed, he would have gone to the foreman and insisted that the damage be repaired. He had been given no instruction about the use of propane in a confined space. He was part of a team of two and the practice was that one welded while the other did fire-watching. He did not remember if there was a fire extinguisher in the brace but there was no breathing apparatus and no means of communication with the outside world. He 'did not believe' there was gas monitoring. The starboard leg was never pointed out as an escape route though he did recall someone with a torch arriving from that direction. He initially thought, however, that you could walk from one end of the brace to the other and he had forgotten about the existence of the bulkheads until shown a photograph depicting them. Even then, he seemed unconvinced. He denied smoking in the brace, but I do not believe him. He denied seeing anyone else smoking or being aware of the presence of smoking materials. Again, I do not believe him. The ventilation was poor and he was unaware of the presence of a 'screamer.' There could have been more extractors or they could have cut holes in the brace. It was 'a terrible job' and he wanted out of it and complained to the foreman about a lack of rotation of welders into the braces. He was told, "If you don't like it, there's the gate," by Eric Murphy. He would have left but for the state of his financial position after a holiday. He had raised with "Derek," his chargehand, the question of cutting holes in the brace to improve access and ventilation but that was refused. He had seen that done at Invergordon about eighteen months prior to this episode. Derek told him they were not going to interfere with the integrity of the brace. Normally electric heating pads would have been used for heating metal surfaces to be welded in a confined space. He was, however, unaware that propane was denser than air and would tend to fall and accumulate at low levels. He had been paired up with Alan Holt and all the shifts he

worked he worked with him. Holt was more experienced than he was. He would switch off the propane at night. "And at any other time we left the job, tea breaks, cup of tea." He was surprised to learn that Holt's evidence was that he had not done that. He was not aware, he claimed, of any instruction to remove hoses and torches from the braces. There was no point in that; you would have to take them to the surface. He did not remember Colin Johnston coming to the job. Derek the chargehand and Paddy the welding inspector were the only two non-tradesmen who came regularly to the brace. The helper with them was a young man aged about 18 or 19 with blonde hair, he thought. He had little experience. On Saturday 4th. July he and Holt were told there was a job ready for them, by Derek, so he thought Holt would have gone and turned the propane on. He would, if he got a whiff of propane, test torches at glands for leakage by applying saliva and looking for bubbles. He believed the propane hose and torch were 'lying in a corner' when they went down on the Saturday morning. They could not weld the ill-fitting cruciform and were told at tea break time that the platers would have to build a new cruciform and that they, the welders, were just to hang around. He noticed damage to his welding procedure sheets and the associated tape and told Derek that he thought there had been a fire in the brace on the night shift. "When the platers are burning the sparks can go fifteen feet." He denied seeing damage to any electric cable. He could not remember if they had checked any of the equipment for damage in the light of his assessment of the recent occurrence of fire. He recalled getting the blanket. The wrapping only took five minutes. There could not have been a leak in the propane hose in the section wrapped when it was wrapped for they had had, he said, the propane on for a couple of hours by that point and he would have smelled the escape of gas for they were sitting around, and the area where the blanket was was right underneath him. He accepted that that depended upon his assumption that Holt had turned the propane on. He had not used propane to pre-heat to tack weld the new cruciform when it eventually was ready about a couple of hours before the end of the shift. He said he could not be bothered climbing all that way for five minutes. The tack welds would have been removed anyway. About 17.30, he was told to put heat on the job and start welding. He refused on the basis that constant heat either from pre-heating or the welding process would be required or the weld would

crack and he could not conceivably complete the weld before the end of the shift. He said that when Derek came back down at that point, Holt was with him and that thereafter, he and Holt simply sat there until the end of the shift. He considered that it would be 'a positive nuisance' that the propane hose was taped to an air hose. He could see no purpose in that and did not think it had been like that when he arrived on Saturday morning. This is a strange piece of evidence if the damage to the propane and air hoses and the tape joining them together had occurred on the Friday night as everyone was inclined to assume, since it is an inescapable conclusion that the air and propane hoses were taped together when the damage occurred in the notch created by virtue of them having been taped together. He accepted on a consideration of the photographs of the damage to the propane hose that anyone who picked up the hose should have seen that damage and that Alan Holt should have seen it and been concerned about it. "Nobody in their right mind would cover up and conceal that damage."

Having heard about the accident, he did not go back to work but spent four days in the hotel, drinking. He then went to MESL's offices and told them he was not coming back. "The way I looked at it, if I had started the job when the foreman asked me to do it, the same thing could have happened to me, so it was close." While it would be an irony to think that Mr. Wright had saved himself by virtue of his own indolence, for he effected throughout his evidence to being indolent in the extreme, I found his explanation unconvincing and consider that both it and his affectation of indolence were a cover for something more sinister about his state of knowledge of what occurred though I regret I have been unable to reach a conclusion on precisely what. I suspect he knows how and when the damage was caused and how it came to be concealed in the blanket. At one point, he came out with the outburst, in response to entirely appropriate cross-examination by Mr. Thomson, "Why don't you just come out with it and say we're trying to pin it on you ? Why don't you just come out and say that ? That's what it sounds like to me." A cynic might well think that that was an effort to divert the very conclusion that he, Wright, recognised as being inevitable. While 'it cannot be pinned' on him, he clearly knows much more about what happened than he chose to tell the Inquiry.

Shown Crown label 6, the blanket, he recalled that it had been cut with a saw blade or a knife. He agreed there must have been several layers of blanket round the services that were wrapped up.

Asked if he had ever talked to Mr. Holt about the accident after it had occurred, his initial response was, "No' really, no." However, he then went on to describe Mr. Holt coming to his house in Aberdeen as he came onshore immediately prior to Holt's coming to give evidence to the Inquiry. This was in June, 2000. "We did talk about it, yes. I was going to America and he came to my house the night before and stayed the night at Aberdeen then he went to here (i.e. the Inquiry) in the morning." Asked what was discussed, his answers had to be dragged out of him, but he eventually conceded that it included wondering about what happened, wondering why he, Wright, had not been called as a witness, the burning of the weld procedure sheets, the use made of the blanket, ending with "we went through the whole day basically." He denied that this was a discussion to get their story straight but that that is exactly what it was, given the timing, was an inescapable conclusion. He accepted that the hole in the blanket under the plate must have been made before the plate was put there. Neither he nor Holt had done anything to cause that hole in the blanket before the hoses and cables were wrapped in the blanket. He accepted that if the gas was on then they would have smelt propane while wrapping the services. He further reckoned that, if the gas had been on, there would have been an explosion when he tack welded. The hoses could have been slung overhead which would have prevented this accident. There was an argument for having the gas supply live only when necessary for use. That could have been achieved by radio contact between the brace and someone at the bottles. He agreed that he should have been fully trained in the risks associated with the use of propane. At one stage, he seemed unsure in what colour of gas bottle the propane would be supplied. He suggested that welding cable could come in yellow, red, orange or black and, if that is so, then there would be a benefit to standardising the colour. He had been tacking in the new cruciform for about 20 to 30 minutes. While Mr. Wright was a more intelligent and more streetwise witness than Mr. Holt, he remained unconvincing. Some of the inconsistencies in his evidence may have been produced by a hint of conscience about his involvement in what had occurred

but that hint of conscience was insufficient to compel him to tell the Inquiry all he knew of the circumstances. Like his colleague, Holt, he was unable to offer any convincing explanation for the hole in the blanket found under the plate, against a background of a new blanket used to wrap the services with the plate immediately being placed on top. At least he did not try to defend the indefensible of not seeing the damage to the propane hose while wrapping it and contented himself with placing himself sufficiently far away from the process to be able to devolve responsibility. Ultimately, he proved to be a most unsatisfactory witness, with no good, honest explanation for his removing himself from the work place or for his subsequent discussion with Holt immediately prior to the Inquiry, both of which acts place his credibility in severe doubt. As I have said, he knows more about what happened than he was prepared to tell the Inquiry.

5.11

The final witness on this aspect of the Inquiry was John McBain. Unfortunately, he was yet another witness in whom I could place little reliance. His approach to the evidence sought to be elicited from him was to say that he could not remember anything which might have been of significance. He was a 23 year old Dundonian labourer, whose father worked in MESL's fabrication shop. He had worked for a few weeks for MESL once before. He claimed that his job was to watch for fires and to get things for the tradesmen. He had had a 20 to 30 minute induction given by a male. He claimed to have taken a fire extinguisher to the brace but was unable to remember what colour it was and appeared to be incapable of distinguishing among various types of fire extinguisher. In any event, he could not say what had become of the fire extinguisher. He was the only witness to suggest that there was ever a fire extinguisher in the brace. He had worked in one of the braces - always the same one

- but he could not remember which. Like a number of witnesses, he had a lot of trouble distinguishing between the pre and post accident provision of precautionary measures but seemed to recall that before the accident there were no radios in the brace, nor breathing apparatus and no gas monitors. He denied smoking in the brace. He claimed at first that the practice was to turn gas bottles off and back on at the beginning and end of breaks but then said that he had only done it once and that he

had never seen the welders or platers do it. "I didn't know how to turn it off at first and one of the welders had taught me which way, you turn them two opposite ways I think....." Access was difficult and ventilation was poor. It was hot in the brace compounded by the process of getting in and out also making you hot. He had had nothing to do with ventilation equipment. Fumes from the burning processes just hung about.

On the day of the accident, he had worked on the dayshift. He thought he was working with a plater called Alan and a welder called Jimmy. He thought it had been the Saturday on which they had sat about for most of the shift without actually doing anything but he was not sure about that. He knew George MacLachlan but did not recall him being in the brace that day. He agreed with the leading question suggesting that he might have been involved in wrapping some cables and hoses in a fire blanket. He had no recollection of taping up any such blanket. He had made a statement to the HSE Inspectors a couple of days after the accident in which he had told them the truth. It turned out to have been made six days after the accident - see Crown production 88. In it he described "Alan" as a welder. In the statement he had said that Alan wanted to wrap up some cables in the bottom of the brace and that he, Alan, had got some fire blanket and he and the witness had wrapped the blanket around the cables beneath a couple of wooden battens. He remembered two yellow wires - "One of them was a bit burnt." He did not know how that had occurred. He did not know if the bundle contained the propane hose but it did contain "a big, black, rubbery tube." He believed that he was doing this to avoid the items being burnt later while welding was taking place. He said that he had put tape round the bundle and that Alan had got a heavy metal plate and put this on top crossways for further protection. After the lunch break he had done some cleaning and then "the welding had started up. Jimmy was doing it and another young welder came in and started doing it and Jimmy looked on. The other young welder could have been George MacLachlan." Mr. MacLachlan is, of course, a plater but he did do work in there that afternoon - the lion's share, but his work would necessarily precede anything being done by Jimmy the welder, so the witness is wrong even in his HSE statement about these matters. He said that the work went on until nearly 7.0'clock when he left with the others. He had

not turned any gas bottle off or on. There was no removal of any hoses from the space at the end of the shift. He thought the purpose of the blanket was to prevent the services from getting "further burnt." "Alan just told me that there was some burnt wires and to get them wrapped up," he told the Inquiry before having second thoughts about that. He had never repaired a gas hose or seen any being repaired. He did not recall there being a hole in the fire blanket. Asked about the propane and air hoses being taped together, he said "I can't remember if it was me or Alan." Then he decided that he thought it might have been Alan. Then he said that he did not recall the hoses being taped together. Shown photographs of the damage, he said he had not seen such damage but was at a loss to explain how he had seen damage to the yellow cable but not to the red hose. Cross examined by Mr. Mitchell, he initially agreed with the suggestion that they knew that they were wrapping damaged hoses and maintained that he had just done that guided by the two more experienced men, Alan and Jimmy. When he left at the end of the shift, the cables and hoses remained inside the blanket. Cross-examined by Mr. Thomson, he appeared to accept at least as a probability that he had seen the damage to the two hoses but did nothing about it because Alan did nothing about it. He had not heard the sound of escaping gas nor smelt gas.

As I said at the outset, unfortunately I do not feel able to rely on this witness's evidence and therefore reach no further conclusion on its content beyond saying that Holt and Wright know more about what happened than they told the Inquiry and that on Holt's own admissions, a high degree of culpability attaches to him. I am in no doubt that it was he and McBain, in the presence of Wright, who wrapped the damaged services in the blanket.

5.12

That still leaves unanswered the vexed question of who caused the damage to the propane hose from which the propane leaked and caused the fatal ignition. I am satisfied that it cannot have happened prior to the commencement of the night shift of 3rd July for it is demonstrated by Mr. Johnston's status reports that welding was done in the starboard section during the day shift of 3rd July and I see no reason to disbelieve Alan Holt when he says he did that and used propane in connection with

doing so. On the night shift of 3rd. July, there were platers, one of whom was Mr. Duffell, working on ring stiffener No. 2 in the port section cutting out the defective cruciform at the 10.00 o'clock position. Obviously hot work was done. We have heard evidence that that night both the oxygen and acetylene hoses were 'holed' at different times and required to be repaired and that the acetylene hose caught fire. Douglas Waterston is the best source of evidence about this. There was no welding in the port section during this shift. As we also know, Holt and Wright went down on the morning of Saturday, 4th. July to weld in the replacement cruciform but were unable to do so because it was a poor fit and they spent most of the day doing nothing while a further cruciform was manufactured on the quay side. However, the defective cruciform had to be cut out, and the probability is that George MacLachlan cut it out using the cutting torch. When he and David Stitt returned in the afternoon with the newly fabricated cruciform, they had to do some trimming and had to burn out the line to get this one to fit and that work seems to have taken a couple of hours. There is no evidence of any damage occurring during that exercise - one might think curiously. Then, James Wright did some tack welding. Finally Richard King did some welding in the early evening of the night shift, albeit without being able to use propane to pre-heat.

On the Friday night, Mr. Waterston had been working in the starboard section of the aft brace with a welder called Simpson, who was not called to give evidence to the Inquiry. He said that on two occasions, what he called "weld spatter" got on to the hoses. It burst one hose the first time and set fire to another hose the second time. This was in the port section of the aft brace. There were two platers there and another person who was either a plater or a welder. He thought Simpson, his welder, had been working in the starboard section. The damage was caused not by welding but by burning the old plates out. One of the platers was called "Rolly" one of the men who died. The witness had heard a crack while he was about the middle of the port section of the brace and by the time he had turned around, one of the men had grabbed the hose and pinched it to close off the gas supply. He could not say who this had been. He was sent to the stores to get a repair kit He thought he might have turned the bottle off at the On/Off tap but his recollection was unclear. He surmised that the hose

which had cracked would be the oxygen hose, but he was uncertain. The hoses concerned were tied together. That hose was repaired. He had not checked other hoses or cables for damage and had not seen anyone else do that. Shortly thereafter he had been back at the same spot in the centre of the brace "when I heard a louder bang this time and when I turned round I seen the jet of flame coming out of one of the hoses. It was the acetylene hose." One of the platers - he thought Roland Duffell but he was not certain - was beating the flame out with his gloved hand. "I ran past him heading for the exit when I seen this. By the time I turned, stopped at the exit and turned round, the fire was out." The jet was two feet. It took a couple of seconds to get it out. There was no fire extinguisher. He was sent for another repair kit so he got two or three this time. He had not reported the occurrence. There was no discussion about reporting the occurrence. He thought it must be a common occurrence, so lightly had the tradesmen treated it. The hoses were then moved over to the other side of the brace away from the area where the molten debris from burning was landing. When in the course of the Inquiry he was shown the damage to the propane hose, he remarked that it looked very similar to the damage he had seen to the piece of the acetylene hose which had been replaced. However, the lack of propane flow on the Saturday night did not appear to cause anyone to think that the propane hose might have been damaged.

Incidentally, I am not forgetting the evidence of Alan Holt and George MacLachlan about the latter causing and the former dealing with a hole in the oxygen hose earlier in the week, which appears to demonstrate just how easy it was to cause such damage, but I discount that occurrence as relevant to the damage to the propane hose because of the subsequent use made of propane.

James Reid, a plater from Dundee, told the Inquiry that he had been working with Roland Duffell in the aft brace on the Saturday evening and that Mr. Duffell had told him about the hoses going up the previous night and had shown him how to kink the acetylene hose should it happen again. He said that anything that burnt off would go to the middle of the brace where the hoses were. It did not seem to occur to either of them to move the hoses.

Apart from the evidence of the experts, who felt unable to say for certain whether the

damage to the hose had been caused by weld spatter or molten debris from flame cutting, but that it was caused by molten metal particles, there is no other direct evidence of damage to hoses and therefore no direct evidence of damage occurring to the propane hose. That it should have been damaged in the course of one or other of these incidents on the Friday night appeared attractive to all parties to the Inquiry as it fitted with the damage necessarily preceding the wrapping in the blanket but, if the propane hose was not live, as I conclude was the situation, then there was nothing to attract attention to damage occurring to it at the time and the damage could have occurred at any time while hot work was proceeding on the Friday night, for hot work continued after the repairs were effected, until the cruciform was cut out. Equally it could have occurred on the Saturday morning when George MacLachlan was cutting out the defective cruciform which had been tacked in, which suggests a welder had been at work at some time on the Friday night shift too, who might also have caused the damage. If Holt and Wright are to be believed, the hose was wrapped before lunch break on the Saturday. Given its condition when found, coupled with the evidence of McBain, the obvious conclusion would be that it was damaged before it was wrapped; hence the attraction of the proposition that that occurred at the same time as damage to either the oxygen or acetylene hoses. However, that still leaves the mystery of the hole under the metal plate and I cannot exclude the possibility that that occurred while George MacLachlan was trimming the parent metal on the Saturday afternoon, in the presence of Wright and Holt, that they saw hot metal particles falling on to these services, including the propane hose, and that they then proceeded to wrap them up, as McBain said in his evidence, aware that they were in a damaged condition. The bottom line here is that I do not consider that I can reach any positive conclusion as to when the damage occurred beyond saying that it must have occurred prior to the departure of the Saturday day shift from the aft brace and therefore prior to the arrival of the night shift. I do think on the balance of probability that the damage was caused by the use of a flame cutting lance rather than an electric arc welder and by the molten metal particles produced by the flame cutting process. I regret that I cannot be any more precise about the precise circumstances leading to the ignition and the fatal explosion and fire than that.

- **Problems Associated with Working in a Confined Space.**

6.1

The most important issue here is why the two companies, but I have to say the employers, MESL, in particular, and the individual employees were all so unaware of the Confined Spaces Regulations, 1997 and the associated Approved Code of Practice. Even before that, one has to ask oneself, given that Regulations pertaining to shipbuilding and ship repair have since the early 1960s made provisions about work in confined spaces why, irrespective of an ignorance of the current Regulations, there was also such a depth of ignorance of the risks of working in such a confined space, which, once more, highlights the inadequacy of the risk assessment process.

6.2

To focus the issue, and perhaps to understand better my extreme dissatisfaction in the circumstances with the performance of the management of MESL generally and, at project level, the performance of Colin Johnston and of Judith Ross, it is necessary to understand the means of access and egress to and from the confined space that was the aft brace of the GA IV which they apparently considered adequate to facilitate the execution of these works. Plate 5, Crown Production 1/HH, shows the first flight of stairs down from main deck level on the way down the column once a person heading down the column has entered the watertight doors at the top of the column. There is no great difficulty with this first stage. Plate 6, Crown Production 1/MM depicts the second flight of stairs down from the first floor below main deck level to the second floor below main deck level and, again, as can be seen, this flight is adequate and unobstructed. At this point, however, things become a little more tricky. Plate 7 depicts, from the top and with the camera in the watertight manhole, the first half of the vertical ladder, leading down to the oily water separator flat. There is a platform at the foot of this ladder, as can be seen. In plate 8, Crown Production 1/KKK, to the left bottom corner of the photograph can be seen the bottom of the second half of the vertical ladder down from the second deck below main deck to the floor of the oily water separator flat and, in the middle of the photograph one can see the manhole giving entrance to the vertical ladder leading from there to the floor of the upper ballast chamber. Plate 9, Crown Production 2/OOO depicts the ladder giving access

from the oily water separator flat to the upper ballast chamber with the photographer being in the upper ballast chamber. Plate 10, Crown Production 2/RRR, depicts in the top right hand corner, the top of the hatch giving access to yet another vertical ladder leading to the lower ballast chamber. Plate 11, Crown Production 2/ZZZ shows the short vertical ladder, viewed from above, giving access from the upper to the lower ballast chamber. Plate 12, Crown Production 2/III shows the entrance from the lower ballast chamber into the brace. The obstruction caused by the tangle of cables and hoses is self-evident subject only to the comment that this is the immediate post-accident state of play and that the elephant trunking for the extraction fan has been reduced to a series of distorted wire loops. Plate 13, Crown Production 2/MMMM, depicts the last two obstacles prior to attaining entry to the brace, through two bulkheads. As I hope can be seen from the foregoing, the journey from the main deck to the brace demanded a significant degree of skill and stamina, especially if carrying equipment or waste materials and was patently not to be undertaken by the faint hearted or the unfit. More to the point, as we shall see, it was a route which was entirely unacceptable as a means of escape and I have to say that that seems to me to be so obvious as to defy comprehension that anyone exercising proper judgment could have considered it suitable as a means of entry and exit not only for men working in this confined space in not well controlled numbers but also for their supporting services. In combination with the introduction of flammable gases to the brace it was, literally, a death-trap.

6.3

The corporate minds of MESL and GM ought to have been focused on the many things that could have been done either to avoid the risk altogether or, at least, to minimise the risk, if anyone had read the Confined Spaces Regulations and the, generally speaking, well and clearly written Approved Code of Practice associated with the Regulations. The Regulations, printed along with the Approved Code of Practice, are available from HSE Books presumably at HMSO. In any event, the document is available on the Internet at the Health & Safety Executive web site, wherever else, and can be downloaded for the cost of the paper. I heard no evidence about steps taken to draw the attention of industries likely to be affected by the

commencement of the Regulations but I am concerned that no one appeared to have had any inkling about them prior to the accident, given the publication date of 31st July, 1997 and the commencement date of 28th January, 1998 and there may be a need for more to be done to draw the attention of such relevant industries to the promulgation of Regulations and Codes of Practice which affect them. I appreciate that the Approved Code of Practice has been prepared with input from both sides of industry but I remain unclear and have to express concern about the process of dissemination, particularly when knowledge and application of the content of the Regulations and the Approved Code of Practice would almost certainly have avoided this accident.

6.4

I do not want to take up further time with an exploration of the circumstances which led to a stoppage of work on account of fumes being given off by paint work coating on the inner surfaces of the steel to be cut out and where welding was to take place beyond making the following observations:-

- It is a further demonstration of the inept planning of these works that it apparently did not occur to anyone that the surfaces of the inside of the brace would be likely to be coated with some kind of protective paint which might give off fumes which might be dangerous (as it turned out they were) when heat was applied to them;
- The occurrence provided an opportunity for MESL and GM to look at the whole situation in the braces including the nature of the works taking place, the risks associated therewith, the implementation of the precautions desiderated by the risk assessment, albeit it was defective, by the first method statement which was supposed to be operative then and by the entry certificate and hot work permits, and to determine whether the permit system was functioning properly and whether there was an effective system of communication in relation to such difficulties between MESL and GM; it was an opportunity which was completely missed; in particular, Mark Greenhow, the GM OIM completed a Self Critical Analysis of Incident form (Crown Production 22) in which he identified poor ventilation as the principal cause of the situation, but did not share this analysis with MESL and did nothing to improve the state of the ventilation, not even informing MESL that the rig ventilation system had been reconfigured so that the direction of the air flow was now the opposite of what it had been; and
- It should have provided an opportunity for the MESL Project Manager, Colin Johnston, the MESL Safety Officer, Judith Ross, and the GM OIM, Mark Greenhow, to examine and reflect upon the operation of the permit to work system and to ask themselves where the precautions desiderated by its paperwork were and, in particular, why, given an episode in which potentially toxic fumes had been emitted, there was no gas monitoring equipment in

the brace, there was no breathing apparatus in the form of escape sets in the brace and there were no fire extinguishers in the brace, whatever else.

6.5

The only gas test ever carried out in the aft horizontal brace germane to these events was carried out by an operative from Sureclean Limited on 25th. June, 1998, who certified at 22.50 on that date that the aft brace contained a breathable atmosphere with the appropriate oxygen content and that there were neither toxic nor flammable gases present. This, of course, was prior to the commencement of the hot works in the brace introducing flammable gases to it and before any heat was applied to any paint work introducing toxic gases. Colin Johnston, the MESL Project Manager, claimed to have been misled by this certificate into thinking that constant monitoring was taking place. It is difficult to see how he could have been so misled. In any event, he should have been taking positive action to ensure the effective presence throughout the works of appropriate gas monitoring devices in the braces and that suitable trained personnel who knew how and where to use them were present. The terms of the entry certificate issued by Mark Greenhow on 27th. June, 1998, Crown Production 14, further imposed on him an obligation to ensure that there was effective constant gas monitoring taking place in the braces. He did nothing to carry out that obligation or see to it that anyone else was doing so.

6.6

The Crown lodged, as Crown Production 69, the HSE document, "Safe Work on Confined Spaces" which is the combination of the Regulations and the Approved Code of Practice ("ACOP"). In the preamble it is made clear that the ACOP has a special legal status akin to that of the Highway Code. The document refers to the provisions of Section 17 of the Health & Safety at Work etc. Act, 1974 which set out that special status. The Regulations and ACOP came into force on 28th. January, 1998. There is a wide ranging definition of a combined space which would certainly apply to the aft horizontal brace of the GA IV though I observe that the Regulations do not apply offshore. Para.1 of the Regulations also defines a "specified risk" as being one of "serious injury to any person at work arising from a fire or explosion," and, without prejudice to that, "the loss of consciousness of any person at work

arising from an increase in body temperature; the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen." I observe that one does not need to read further to understand the potential importance of these Regulations to the instant case.

6.7

ACOP provides a working definition for a confined space as having two defining features, firstly, an area which is substantially enclosed and secondly an area where there is a reasonably foreseeable risk of serious injury from hazardous substances or conditions within the space or nearby. It specifically provides, at Para. 9, "The hazards that the Confined Spaces Regulations address arise through the combination of the confined nature of the place of work and the possible presence of substances and conditions which, taken together, could increase the risk to the safety or health of people. Remember that a hazard can be introduced to a substantially enclosed space that would otherwise be safe." ACOP then goes on to identify "the most likely hazards" starting with "flammable substances and oxygen enrichment." It states, "A risk of fire or explosion can arise from the presence of flammable substances. There can also be a risk of fire and explosion from an excess of oxygen in the atmosphere, for example, caused by a leak from an oxygen cylinder forming part of welding equipment. There is also a risk of explosion from the ignition of airborne flammable contaminants. A fire or explosion can be caused by leaks from adjoining plant or processes that have not been effectively isolated." ACOP goes on to identify "fume and vapour" from "work inside the confined space, for example, welding, flame cutting..." as possibly being toxic or a cause of oxygen deficiency. Regulation 3 of the Regulations requires employers to comply with the provisions of the Regulations and to ensure compliance, so far as is reasonably practicable, "by persons other than his employees insofar as the provisions relate to matters which are within their control." Regulation 4(1) requires that the first step, in the process of risk assessment which must precede the commencement of works and the significant parts of which should be recorded in writing, should be the identification of measures whereby the execution of works in a confined space can be wholly avoided. While I accept that it was necessary ultimately for the integrity of the rig that the flame cutting and welding

operations for the removal and replacement of the cruciforms had to take place inside the brace, which would always be a confined space, I do not accept that it was necessary that access and egress to and from that space should have been through five other confined spaces when a straightforward alternative, cutting access directly into the brace from the outside, was available. There is a little unclear evidence that a passing thought was given by someone to this possibility prior to the commencement of the works but that was not clearly recorded and, in my opinion, at least on an application of the spirit of the Regulations, on a reading of Paragraph 4, it would have been appreciated that there was a need to give a great deal more consideration to the means of access and egress and think effectively about what could be done. That was Mr. Summerfield's conclusion and I agree with him and it would appear that some of the tradesmen, including ironically enough, James Wright, raised the issue of direct access to the braces with their supervisors without that attracting any response from management. I take the point that minds were concentrated following the accident in a way that they were not prior to the accident but that misses the point that if MESL and GM had fulfilled their obligations in terms of the Regulations prior to the commencement of the works, instead of just getting on with them, they would at least have made proper enquiry into the possibility of taking access directly from the outside into the braces. Mr. Thomson submitted that all the work to do so involved extra time and expense. That, of course, makes the point that those negotiating the contract should be aware of the responsibilities falling upon an employer to make a proper risk assessment but it begs the question how much time overall would have been saved by a much more straightforward and direct means of access, albeit not without difficulties given it would involve building scaffolding over water, and that some welding in the confined space would still have been necessary, and a much improved working environment. In any event it was clear from all those who gave evidence about being in the braces after the accident once direct access holes had been cut in the braces that the ventilation problems had disappeared as had the problems of caused by the unsuitability of the former means of access and egress.

5.7

The Regulations go on to provide that, if it is not reasonably practicable to prevent

work in a confined space the employer or the self-employed will need to assess the risks connected with entering or working in the space. Risks to others who may be affected by these works also have to be considered. Assessment upon which a safe system of work is to be based must be carried out by those competent to do so. It was striking about the present case that none of the three principal individuals on the ground, Colin Johnston, the project manager, Judith Ross, the safety officer who prepared the risk assessment, such as it was, and Mark Greenhow, the GM OIM, were competent in the sense of the Regulations to carry out the respective responsibilities imposed upon them by the Regulations, substantially on account of a lack of training which produced a lack of appreciation of them and, in the case of Colin Johnston, a lack of empathy with the need to prioritise safety of the workforce. The ACOP at Para 22(b) sets out what is required to make a person competent, namely experience of and familiarity with the relevant processes, plant and equipment so that they understand the risks involved and can devise necessary precautions to meet the requirements of the Regulations. Sadly, Judith Ross, who was left to carry out the risk assessment process, appeared not to appreciate that there were any special risks associated with the introduction of flammable gases into a confined space which says all that needs to be said about her competence and suitability to undertake this risk assessment, a state of affairs that would have been obvious to any competent person, in the sense of the Regulations, who had reviewed her risk assessment, the only person to actually do that being Colin Johnston, who was focused on getting the job done and not on getting it done safely.

6.8

ACOP goes on to focus upon a number of particular issues relevant to the present circumstances, namely:-

- risks associated with the use of temporary workers;
- risk associated with a changing work scope on a construction site;
- the propensities of the gases introduced to the confined space;
- the need to monitor for the presence of unburnt flammable gases as well as for the risk of oxygen deficiency or enrichment or the presence of toxic gases;
- the need for adequate ventilation, especially of isolated pockets;

- the need for proper assessment of the arrangements for emergency rescue;
- the need to modify the confined space either to avoid or improve the means of entry;
- the need for easy access to the confined space, taking account of the requirements of emergencies;
- the need for adequate, effective, trained supervision of the work by competent persons;
- the need for tradesmen carrying out the work to be competent persons;
- the need for the provision of respiratory protective equipment;
- the need to make adequate provision for fire prevention and fighting; and
- the need for a system of instant communication between those in the brace and those outside the brace which would permit a remote start system to be used for the gases so that live supplies into the brace would only be permitted when the gases were actually required for hot work processes in the course of being carried out, and also to enable instant communication in the event of an emergency.

Had the management of both companies, but, again, principally, the responsibility must rest with MESL as the employers of the two deceased men, applied their minds to the foregoing lists of risks and precautions, rather than merely considering how to get the work done, the present tragedy ought to have been avoided. In the present case, there was no avoiding the flame cutting and welding operations in the braces and so at least oxygen and acetylene would always have been required, as well as an electrical supply for at least both welding and lighting, but both common sense and the Regulations and ACOP point in the direction of the shortest possible means of entry to the confined space. It should not have taken the deaths of two men to make GM and MESL consider opening up holes in the braces, an exercise which, in the overall scheme of things, appeared to have been relatively simple and not inordinately time consuming. MESL would have given further consideration to the risks arising from the inevitable conflict between welding and flame cutting works where, as here, one or other of the types of hot work was producing a quantity of molten metal particles falling upon the services either for that work or for the other type of hot work. Both companies might have appreciated the importance of making the permit to work system operate properly and to responding to the need for the precautions identified, particularly gas monitoring, which remains their joint single most important failure in the circumstances here. Both companies might have appreciated the need to have properly trained employees supervising and carrying out the works,

employees who were aware of the Confined Spaces Regulations and understood the risks and the need for precautions to be provided and adhered to, instead of employees who recognised that they were burning holes in hoses supplying flammable gases but who either did nothing about that, except effect temporary repairs, or, worse, cover up the damage with a blanket. They would perhaps have appreciated the merit in having effective communications with those working in the braces, not just for emergency purposes but also so that an effective remote start operation for the gases could have been utilised. It is striking that, while pre-heating is an essential component of the welding operation to prevent cracking, it is only required until such time as the metal surfaces to receive the weld are heated to a sufficient temperature to allow welding to start, whereafter the welding process itself generates sufficient heat to avoid cracking provided it is continuous. Therefore the supply of propane is only required for those relatively short periods of pre-heating. To leave a live supply of propane twenty four hours a day into a confined space when the requirements for its use were so minimal is gross negligence, in my opinion. Similar considerations apply to the supplies of oxygen and acetylene. While their use for flame cutting would be more substantial, it was certainly not continuous, and supplies should have been cut off from the braces when they were not in use to minimise the well known risks associated with the leaking of unburnt flammable gases and oxygen enrichment. In addition, if anyone had thought about the risks of leakage of unburnt propane, then they would have either known or ascertained that its relative density is 1.5 that of air and that, inevitably, it would have a tendency to collect low down and there was therefore a need to consider adequate ventilation. I shall deal further with this under the next heading.

6.9

The two method statements prepared by MESL, Crown productions 4 and 6, demonstrate that someone at MESL had some understanding of the risks associated with the leakage of gases in a confined space, albeit it has to be said that the understanding appears to have been limited. Had the provisions of Para 62 of ACOP been considered, it would have been evident to those framing those method statements that there was a need to have equipment checks at the start of each shift

i.e. tradesmen should have been instructed and constantly reminded to examine all hoses and tools for leaks or other damage and to report such leakage or damage to their supervisors before commencing work. ACOP would also have reminded of the need to remove tools and hoses from the confined space at the end of every work period to avoid such a leak. Para.63 goes further in this respect, though I have reservations in the light of the circumstances of this occurrence, whether it goes far enough. Para 63 provides, " The use of pipes and hoses for conveying oxygen or flammable gases into a confined space should be controlled to minimise the risks. It is important that at the end of every working period, other than short interruptions, the supply valves for pipes and hoses are securely closed before the pipes and hoses are withdrawn from the confined space to a place that is well ventilated. Where pipes and hoses cannot be removed, they should be disconnected from the gas supply at a point outside the confined space and their contents vented." If by "controlled" what is intended is (a) that hoses should be of the shortest length practicable and (b) someone independent of the workers should look at the route being utilised for the hoses and be satisfied that that route does not expose the hose to the risk of damage, then that is sufficient, but perhaps these two considerations, and others if there are others, should be specified. I am concerned about the use of the words, "other than short interruptions." What may be a short interruption to one person may be a fatal 30 minute tea break period, as here, to another. I respectfully suggest to those responsible for the draftsmanship of the Code, which, generally, I have found to be clear and helpful to my understanding of the risks and precautions, that there is a need here for a change of emphasis, to focus on the provision of effective remote starting so that gas supplies to a confined space are only live when the gas requires to be on. That is the most effective way of eliminating the risk of leakage of unburnt gas in a confined space. That, of course, would be without prejudice to the disconnection of supply hoses at every significant break in working and the removal, where practicable, of the hoses and cutting or burning equipment from the confined space. There was also some confusing, at least to me, evidence before the Inquiry about venting. It was correctly observed by Mr. Thomson that gas to some degree will remain in a given hose, once its pressure has equalised with atmospheric pressure,

unless the hose is purged with another, preferably inert, gas. The point ACOP seeks to make is that any emission of unburnt gas from a hose or tool should only be permitted in a well ventilated location, preferably in open air. I appreciate that in the present case, given the means of access used, that it could be argued that "pipes and hoses cannot be removed." I do not agree that that was the situation here and the hoses and tools should have been removed to the main deck when not in use.

6.10

The most telling factor against the means of access used however is also focused upon by ACOP at Para 64 and 65 and in subsequent provisions specifically relating to emergencies and rescue. Para. 64 emphasises the need for access to the confined space to be such that persons can "quickly escape in an emergency." This is elaborated upon in Para 65 which provides:-

" The size of openings to confined spaces needs to be adequate. Openings affording safe access to confined spaces, and through divisions, partitions or obstructions within such spaces, need to be sufficiently large and free from obstruction to allow the passage of persons wearing the necessary protective clothing and equipment, and to allow adequate access for rescue purposes."

As we shall see, the openings were insufficient, especially, as I understood the evidence, the hatches into the oily water separator flat and from it into the upper ballast chamber, to permit firefighters wearing standard Fire Service BA sets to get through without having to take them off. This of itself demonstrates the inadequacy of the means of access and egress to a confined space where flammable gases are being introduced and it may be that there is a requirement either to amend the Confined Spaces Regulations or at least to draft something into the ACOP to deal with this specific issue. Commonly it will ultimately be the Fire Service who will be called upon to effect rescues from confined spaces. They are trained in the use of particular equipment and its merit is that it gives them a reasonable time to search an area where there is no breathable air supply beyond what they have on their backs. The whole purpose of that is defeated if they cannot get into the space while wearing that equipment.

6.11

It is of course a specific requirement of the Regulations, in Regulation 5, that "suitable and sufficient" arrangements for the rescue of persons in the event of an emergency have been prepared. Once more, had minds been applied to this consideration prior to the commencement of the works, the inadequacy of the means of access would have become obvious, in my opinion. The Regulation requires those who elect to put employees and others into confined spaces to carry out work not only to think about emergencies, something that simply did not happen in the present case, but also to plan for them and to have available, prior to the commencement of the works, such arrangements and equipment as may be necessary to effect rescue from the confined space. No one could describe to me how they would have effected the rescue from the brace of anyone who had rendered themselves non-ambulant. It would have been very difficult for someone with something as commonplace as a sprained wrist to get out of that brace, not at least without exacerbating the injury. The associated paragraphs of ACOP draw attention to the need to consider rescue and resuscitation equipment, means of raising the alarm, a means for safeguarding the rescuers - and we should not lose sight of the fact that the GM firefighting team put themselves at some risk when they entered the smoke filled area of the upper ballast chamber - and training in the use of the equipment concerned. The appropriate rescue equipment should be identified in the risk assessment process and should be in place prior to the commencement of the works. A means of communication which is effective is also of primary importance. Fire extinguishers and their placement at appropriate locations are vital. Consideration of whether to continue with forced ventilation in the event of a fire or fumes problem is also important. One area not canvassed but it seemed to me at least of some potential importance again given the problems encountered by the Fire Service in this case is the maintenance of a log of who is in the confined space. There was here an uncertainty how many men were present, and it could easily have been four but for the intervention of fate, in the brace and that uncertainty would have been removed by the maintenance of a simple entry control log. The importance of practice drills is emphasised by Para. 98 and, again, if a practice evacuation drill had taken place, that might have demonstrated the unsatisfactory nature of the means of access to and egress from the braces. Para. 100

discusses the use of BA escape sets. Para. 109 discusses atmospheric monitoring equipment and special ventilating equipment.

6.12.

Paras 113 - 116 of the ACOP discuss training issues and this is a matter which has come up over and over again in the course of my reading of the evidence and productions and in the submissions made to me by all parties to the Inquiry. It was Mr. Thomson who suggested that special certification of competence to work in confined spaces was a suggestion worthy of consideration and I agree. The foregoing paragraphs talk, quite properly, about the training requiring to be specific to the task but in ship and rig building, modification and repair, there is always likely to be some work in confined spaces which will involve welding and flame cutting as fatigued or otherwise redundant metal is replaced. There must therefore be merit in a scheme for certification of confined space competent welders and platers. I would urge the Health & Safety Commission, together with both sides of industry, in the light of what I have had to say earlier about the level of ignorance of the risks and the available precautions demonstrated by the tradesmen in the present case, to devise a scheme for such certification and then to consider whether welding and plating and other related hot work processes should only be permitted in terms of amendment to the Regulations in confined spaces when carried out by certificated tradesmen or, at least, under their supervision. I do not want to be prescriptive about the contents of such training but plainly it should cover the risks associated with the equipment used in welding and flame cutting, the terms of the Regulations and ACOP, the merits and demerits of work under a permit to work system and a knowledge of rescue and other emergency equipment and procedures germane to rescue of persons from confined spaces. In particular, training should be given on the effective use and location of gas monitoring equipment.

6.13

Finally, it would be wrong to leave the issue of problems of work in confined spaces without looking at what the tradesmen did or did not do in the present case that was wrong and not, at least in my opinion, in accordance with common sense. At least so far as concerns the aft brace, it was in my opinion a bad idea to supply all the services

via the port aft column, if the columns were to be used as the means of access. There seems to have been no insurmountable reason why the starboard column could not have been used as the route for services to the starboard section of the brace. This would have avoided the obvious risk associated with the services for the starboard brace running through the port brace underneath hot works. Alternately, only one trade should have worked in any given brace - and I mean brace and not section of brace - at any one time. But the tradesmen should have realised the risk to the services and either taken steps themselves to move them out of the way of where they were working or, if they were unable to devise an effective and practicable way of achieving that, to have complained to management about the risk. George MacLachlan burnt a hole in the oxygen hose several days before the accident and this was noted and dealt with by Alan Holt, but neither of them reported the incident. The platers working on the Friday nightshift, one of whom was Roland Duffell, burnt holes in the oxygen and acetylene hoses in the course of that shift, setting the acetylene on fire, but that was not reported to management. Despite these occurrences the propane hose, at least, was left on the floor in the middle of the brace without protection until Mr. Holt's intervention in the circumstances already dealt with at length. The tradesmen did nothing to protect themselves from the obvious risks associated with igniting acetylene and enriching the atmosphere with oxygen. In addition, it must have been obvious to them that there were no fire extinguishers in the brace. Why did they not demand them ? Why did they continue to work in circumstances where they were unable to communicate any emergency to the outside world ? Why did they instruct inexperienced labourers to engage in the control of gas supplies ? Why did they not check the state of their equipment at the start of shifts ? Why did they not take the time and trouble to remove hoses and torches from the braces during periods when they were not working ? Why did they not consistently shut off or, better still, disconnect gas supplies at the bottles at all break and shift change times ? Is it correct, as Mr. Thomson suggested, that they were just lazy ? That suggestion does not sit well when one considers the curricula vitae submitted by the tradesmen which suggest a very wide range of experience and a willingness to go and look for work wherever it is to be found. Is it a fear of reprisal if they speak out

about adverse conditions ? While I cannot conclude on the evidence that MESL deliberately cut corners or set out on a deliberate policy of not considering the welfare of their employees as being of any consequence, because of the lack of training or aptitude of the management or supervisory staff, the tradesmen could have been forgiven for thinking that the provision of a safe system of work had not attracted a high priority and that, as temporary contracts are bound in any event to induce a fear of lack of continuity, they had perhaps better just get on with it, do their work and say nothing. I cannot believe that the conditions which existed in the brace would have been tolerated by employees in many factories with a regular settled workforce and, if temporary work forces doing dangerous work are to be the order of the day as a matter of economics, then they require independent protection either from an enhanced and effectively resourced and proactive Health and Safety Inspectorate, whose inspectors would require to prioritise the building and construction industries, or the sanctions for breaches of the law require to be directed against individuals at all levels. Otherwise the approach to safety as a low priority will persist and more men and women will die as a consequence of the failure to take simple steps to protect themselves or to have those steps taken by employers. It is instructive that, after the accident, gas monitoring equipment, breathing apparatus and radios that worked in the braces were supplied as was training of the workforce in their use and in the permit to work system. Whether that only happened to have the HSE prohibition notices lifted must remain a matter for speculation only. In any event, whatever the reason may have been, most of the experienced tradesmen who gave evidence, and who told me as they did repeatedly of the need to be your own safety officer, either did or failed to do things that they ought to have done in accordance with common sense, some of which at least would have improved the prospects of the accident not occurring. I regret that this criticism has to extend to both Mr. King and Mr. Duffell, to the former for not finding out himself why the propane supply was not operative and , instead, delegating that task, in effect, to an inexperienced labourer, and not thinking, as he should have, that one explanation for it was a leak in the hose, and the latter for being involved in a process where hoses were burnt without the hoses being moved, without any effort being made to see what other harm that might

have caused and without reporting these plainly reportable incidents to management for them to address.

- **Problems Associated with the use of Flammable Gases, especially Propane.**

7.1

A number of issues arise under this head all generally speaking arising from the surprise of discovering that the majority of the experienced tradesmen who gave evidence to the Inquiry appeared to have a poor understanding of the propensities of the gases they were accustomed to working with and the associated risks. One issue arises particularly from the thorough forensic examination of the items found at the accident site by HSE Inspectors carried out by the Health & Safety Laboratory at Buxton, particularly by the team under the leadership of Mr. Hodges.

7.2

The first issue, and I deal with the issues as they arise, rather than in any particular order of importance, is smoking in the brace. No witness suggested that it was not known that smoking was prohibited on the rig except in designated areas. Of course, inveterate smokers will try to smoke wherever they think they can get away with it. This is why, as was discussed in evidence, most refineries operate a system where the smoking materials of anyone seeking entry to the premises are removed at the gate-house. I do not, however, suggest that either MESL or GM, in terms of their procedure, did anything inappropriate here, for the instruction prohibiting smoking was clearly well understood. As in most other aspects of the execution of the work, the fact that smoking in the braces and in the lower ballast chamber was allowed to happen illustrates the poor quality of the supervisory staff. I cannot exclude a cigarette, a match or the flame of a cigarette lighter as the source of ignition for the explosion in the present case, although I have concluded that the source of ignition was related to an attempt to light the propane burner. The fact of the matter is that the experienced tradesmen appeared to think that, because there inevitably were other sources of ignition present in the brace, they need not be concerned about the risk of ignition from smoking. That begs the question who knows which ignition will start a fire but, more particularly, it demonstrates a lack of understanding of the flammability of hydro-carbon gases such as propane and acetylene despite their common industrial

usage. It particularly demonstrates a lack of understanding of the risk of ignition of unburnt gas and, particularly in the case of propane, that, because it is 1.5 times heavier than air, it will tend to fall to the ground and linger, especially in pockets of buildings and constructions, unless and until it is dispersed. Such pockets at ground level are, of course, just the very sort of venue where a careless cigarette smoker may discard a match or still burning cigarette end, either of which may be hot enough to cause ignition. There is, accordingly, or so it would appear, an urgent need for dissemination of knowledge of that risk. Plate 16 shows the entry to the port section of the brace, where the first part of the "floor" is a "C" shaped flange, beneath which there is a void, ideal for propane to gather in and not disperse, which area can be seen to be littered with cigarette ends. This photograph was taken no later than 6th. July, 1998 and therefore depicts the state of play at the time of the accident.

7.3

Crown Production 99/31, amongst other photographs, shows the services exiting the port section and entering the centre section of the aft brace, on their way to provide services to the starboard section. We know from the evidence generally, and it is not in dispute, that all services to the brace were run down the aft port column. This created a situation where those working in the port section of the brace were inevitably working above the services being run to the starboard section. It does not appear to have occurred to anyone prior to the commencement of the works that this was potentially dangerous. I was surprised to learn in the course of the evidence how easy it appeared to be to burn through a gas carrying hose and it appears to me that there is a general issue which requires consideration by the Health & Safety Executive and both sides of industry as to the sufficiency of the thermal resistance qualities of the gas carrying hoses. I appreciate that there was evidence that, generally speaking, if particles of molten metal meet the insulated outer surface of such hoses, they should simply slide off under the influence of gravity, but that begs the question whether, especially when working in a cylinder as here, after they have slid off, they cannot slide underneath the hoses and burn through them before losing sufficient heat to do so. It was a negligent system of work to have the services to the starboard section located underneath hot work in the port section and MESL are responsible for

that, but the question remains whether the section of any gas carrying hose near to the point of use is always vulnerable to being burnt through by molten metal particles especially from flame cutting and whether anything can be done to improve the thermal resistance qualities of at least the portion of the hose nearest the lance or torch, as the case may be, to minimise the risk of burning through, without losing the flexibility, in every sense of that word, of the delivery of gases in such hoses. I appreciate from a consideration of Crown Production 70, that the hoses are the subject of BS EN 559, and there is no evidence that the hoses in the present case did not meet that standard, but they did not meet their alleged design function of being resistant to molten metal particles. I understood from Mr. Summerfield's evidence that the thermal durability test involved the application to the outer coating of the hoses of a piece of wire heated to 800oC for a period of 15 seconds thus simulating a hot particle falling on the hose. Given the repeated occurrence of damage to the hoses in the circumstances considered by the Inquiry, I have to express doubt about the sufficiency of that test, since it appears more realistic to assume that such hoses will have to endure a shower of molten particles, rather than the odd isolated one.

7.3

More particularly, there is a problem where a notch is created between either two hoses or a hose and other items in the vicinity e.g. welding cable. Of all the stupid things that were done in the lead up to this accident, and there were many, the single act which led to the inevitability of the accident was the tying together of the propane and air hoses in the port section of the brace. The person who did that has not been identified. The person who did that created a situation wherein, as those two hoses lay on the floor of the cylinder which constitutes the brace, because they had been tied together, at the point of their junction, they formed a notch. Molten metal landing on these hoses could not slide beyond the point in the notch where the two hoses were joined so there it lay burning both hoses and, in particular, creating a hole in the propane hose. It is my conclusion that there was no live supply of gas in the propane hose at the time and therefore this was not noticed, but Mr. Hodges did not exclude the possibility that the burn may not have created the hole instantly but merely weakened the surface of the hose sufficiently so that a hole would materialise

the next time it was moved. In any event it was the creation of the notch which led to the creation of the hole and, apart from the firefighters, the most compelling evidence given at the Inquiry was Mr. Hodges's demonstration of the correspondence between the damage to the propane hose and the damage to the air hose demonstrating to me beyond doubt that these two hoses had been tied together prior to the damage occurring and that it had been that act of tying together that created the conditions in which the damage could occur. No one could offer any explanation why these two hoses should have been tied together and, therefore, on one view, this precise mechanism for the accident was not foreseeable. What is certainly now foreseeable is the occurrence of a similar accident, not so much involving propane, but involving the much more potentially dangerous mix of oxygen and acetylene. A flame cutting lance is normally "powered" by the combination of oxygen and acetylene. It is, strictly, the acetylene which burns and it is designed to burn at such a heat that the metal to which it is applied combines chemically with the oxygen to form an oxide which is then, in effect, blown away by the force of the flame and so the two gases need to be supplied together. That description also demonstrates the inevitability while such a process is taking place of the not very controllable redistribution of particles of molten metal. It is commonplace, according to the evidence, for the two hoses to be tied together throughout their lengths for convenience and ease of use. Worse still, according to Mr. Sparks, whose experience in the oil construction industry was world wide, in the United States, oxygen and acetylene hoses are manufactured together as, in effect, a single item. Unfortunately we did not fully explore exactly what that meant in terms of the precise relationship between the two hoses, but certainly where informal tying together takes place and unless some design is incorporated into the manufacture of twin hoses to allow debris to escape, then the same situation of the creation of a notch in which molten material may be trapped arises as occurred here. The effects here were disastrous but if a similar event permitted burning through both oxygen and acetylene hoses when there was no live supply and oxygen and acetylene together subsequently leaked into a confined space, the effects would be likely to be catastrophic. Again, there is an urgent need for dissemination of this information to all users of industrial gases and particularly in the

case of users of oxy-acetylene gear and there is a need for urgent consideration as to whether there is a need to amend Regulations and/or ACOP in the context of confined spaces, or the need for wider regulation of all use of industrial gases to prohibit use of gas hoses which, either by design or by arrangement create a notch in which molten material can become wedged and can burn through the hoses. In any event, the widest possible publicity about this risk should be given as a matter of urgency.

7.4

Crown Production 70 was HS(G) 139, a guidance pamphlet issued by HSE entitled, "The Safe Use of Compressed Gases in Welding, Flame Cutting and Allied Processes." I regret I have to say that of all the documents that I have had to read in connection with the Inquiry, this was the one which I found the least comprehensible by some distance. The difficulties I experienced were exacerbated by the inept photocopying of the document by the Crown. While the foregoing conclusion may be no more than a demonstration of my own inadequacies in this field, I am bold enough to think that I may not be the only one who would find this material difficult to comprehend and, as a consequence, less than compelling reading. It does inform that acetylene has an odour similar to garlic and that it is slightly lighter than air. It has a lower flammable limit of 2.5% by volume in air but no clearly defined upper limit. Unlike other fuel gases used in welding, it is potentially unstable. In either liquid state or as a gas under pressure it may decompose violently in the absence of oxygen or air. It further states that propane or liquid petroleum gas (LPG), both are the same thing, is a colourless gas with a stenching agent added. It is considerably heavier than air, its relative density at 20oC being 1.55. Its vapour pressure is 8.53 bar absolute at 21.1oC and it is normally supplied in liquid state in containers under pressure. Oxygen was described as being a colourless and normally odourless and non-flammable gas. It was remarkable how many of the tradesmen described oxygen as flammable and had no appreciation of the chemistry of the flame cutting lance. Combustion is hazardous in an air/oxygen combination in excess of 21% oxygen. Materials such as clothing, metal and plastics which would not burn in air will burn in an oxygen enriched atmosphere and oil or grease may react explosively. Air containing more than 25% oxygen in a confined space may prove fatal. The guidance note contains information

about precautions to prevent fires and explosions including the topics of routing and positioning hoses in a safe manner, safe cylinder handling techniques, training, instruction and supervision to ensure correct operating procedures, appropriate fire precautions and appropriate regular maintenance checks. It explains that the function of a regulator is to control the pressure of gas under supply pressure down to the pressure required to operate the tool in question and that these are not protective devices. It further explains the merit of fitting pressure gauges, in a statement of the obvious, to measure the pressure at which the gas is being delivered and so a user can see that there is or is not gas pressure in the hose. Unfortunately, the subject of pressure gauges only arose peripherally in the course of the Inquiry and all I can properly say is that it is my impression that there is much to be said for their presence, arguably both at the gas bottle and at the delivery end of the hose, particularly if the hose is of any length. Patently, the presence of such gauges on the propane hose here would have demonstrated whether there was any gas under pressure at either end of the hose and if there was a difference in the two pressures. The guidance note goes on to inform of the risk of burning, especially from clothing fires, the need for repairs to hoses only to be effected by competent persons, the need to protect combustible materials from contact with flame, heat, molten slag or sparks advising the use of metal sheeting, mineral fibre boards or blankets. Given what occurred here, perhaps again some more thought requires to be given about the use of blankets and even boards. What is important is that users appreciate that they are not foolproof and there will remain a need to examine hoses, especially those in vulnerable areas, really every time hot work is carried out, to ensure that they remain undamaged. Wrapping services in a blanket so that their condition is concealed is not a good idea.

7.5

It appears from Crown production 70, that it is part of BS EN 559 that acetylene and all other fuel gases except LPG should be supplied in red hoses, LPG should be in orange hoses and oxygen should be in a blue hose with black hoses for what are described as non-compatible gases, the example given being compressed air. The committee responsible for the standard will be far more familiar with the wider picture than I could possibly be merely from the evidence which emerged from this

Inquiry but I was again struck by how few of the tradesmen knew in what colour of hose propane/LPG would be expected to be delivered and others appeared incapable of distinguishing between the orange of the propane and the red of the acetylene hoses. The proximity of those two colours did seem to me to be a legitimate cause for concern and I would respectfully urge the standards committee to reconsider the colours and markings of such hoses. The colours used for acetylene and propane, in my opinion, are too close together in the spectrum for there to be a clear distinction made between the two especially in poorly lit confined spaces. In any event, in these days when luminosity is recognised as having merit when it comes to making sure that things that matter can be clearly seen, I respectfully suggest that both of these flammable gases should be delivered in luminous tubes, marked at regular intervals with the identity of the gas or group of gases involved, and the words "Contains flammable materials," whatever else.

7.6

Crown Production 71 was the British Compressed Gases Association ("BCGA") Code of Practice CP 7 "The Safe Use of Oxy-Fuel Gas Equipment (Individual Portable or Mobile Cylinder Supply). Despite the length of its title, I found this document much easier to read and follow than its HSE equivalent. It is a Code designed, it states, for use by the technically competent and it makes the point that it is no substitute for the exercise of technically competent judgment. It also stresses the importance of the skill and competence of operators, supervisors and management. It informs that propane will ignite from a spark or contact with hot metal, amongst other things. It says in terms, "This gas must be considered as a potential fire and explosion hazard." It applies the same epithet to acetylene and makes the further point that, with it being lighter than air, it may collect at high points e.g. in roof spaces. It further states that, "Mechanical shock to the cylinder or overheating when under high pressure may cause decomposition giving rise to high temperatures and possible detonation even in the absence of oxygen." It makes the point that it is essential that hoses be in good condition and "shall be protected from heat, mechanical damage, traffic, sparks, slag and oil and grease." It also warns that fire extinguishing equipment should be readily to hand. It warns that where work is being carried out in

a confined space, constant and thorough ventilation should be ensured. Equipment should not be left in a confined space after the actual work has been completed or at times when work has ceased for more than a few minutes. Had the management or safety department of MESL read this document or the HSE equivalent referred to in the foregoing sub-paragraph they would have been better informed of the risks and precautions associated with the use of such gases, especially in a confined space and therefore more able to prepare an effective risk assessment and to minimise the risks by putting appropriate precautions into place.

7.7

I want to consider the contents of Crown production 74, HSE Contract Research Report No. 78/1995 - An Investigation into the Passage of Unburnt Gas through Welding Gaps during the Use of Oxy-Propane Pre-heating Torches. Little if any reference was made to this document in the course of the Inquiry but for a number of reasons I consider that its contents are of some significance and so, in the circumstances, I make no apology for referring to it. Such reference must however be subject to the further caveat that it strictly relates to the use of oxy-propane torches as opposed to a propane only torch as used here. The principal concern of the investigators was to ascertain if there was a risk during pre-heating of unburnt gas passing through gaps in welding and collecting in any cavity at the back of the surfaces to be welded with the risk of an ignition when welding commenced and the conclusion was that, in certain circumstances, such a risk did exist. That research, while of general importance to welders, is not immediately relevant to the present circumstances. What is of direct relevance is that the research proceeded on the hypothesis that there are only two ways to pre-heat metal surfaces preparatory to welding, namely using a fuel torch or using an electric blanket. When gas is used, the report concluded, the preferred fuel is propane. The research covered about 60 companies half of which used oxy-propane pre-heating torches. The companies were engaged in medium to heavy industry. 20 companies were visited. Most of the managements of these companies were aware of accidents which had happened with these torches including a fatal accident. The researchers, nonetheless, found a considerable number of nozzles in use across the companies visited which were in a

significantly damaged condition. Only one company maintained a written schedule for maintenance of the equipment on a regular basis; otherwise the condition of the equipment was left to the operator's discretion. Some 'high calibre' companies were found to have equipment in very poor condition. None of the companies carried out any in-house training on the proper use and maintenance of the equipment. Most operatives said that, on starting work, they were simply asked if they knew how to use the equipment and if they said they did, then they were left to get on with it. It was not unusual to see gas burning at the rear of the nozzle because of damage to the screw threads leading to an escape of propane. Operators did not appear to appreciate that propane sinks and that therefore to light the torch it should be held downwards. Operators were seen to try to light torches held in all sorts of directions encountering various degrees of difficulty while doing so. They appeared to be oblivious to the fact that, in the course of these attempts, they were permitting substantial quantities of unburnt flammable gas to escape to atmosphere. The standard regulator gives no indication of the rate of gas flow. The researchers commented that such torches should not be lit in confined spaces.

In their conclusions, the researchers expressed concern about the lack of operator training in how correctly to use the torch and, in particular, to set the flame. They were concerned to inculcate in operators an understanding of a need to ventilate areas into which unburnt gas might escape, preferring ventilation by blowing to sucking. They suggested the use of gas detectors. They suggested a need for operators to understand how flammable gases could form an explosive mix in air and how that could occur some time after the use of the torch had ceased provided that there was a source of ignition present.

I was inevitably struck by the extent to which the recommendations of the researchers coincided with the concerns which I developed as did all the legal representatives engaged in the conduct of the Inquiry about the lack of understanding on the part of the experienced tradesmen of the dangers associated with the use of the equipment they used almost every day in the course of their working lives. I endorse the suggestion made particularly by Mr. Thomson in his submissions and to which I have already referred for some sort of safety certification for welders and platers, perhaps

generally, but certainly in connection with confined space working. This research document appeared to me to lend significant support to that submission.

7.8

Reading the foregoing research report also focused in my mind the following issues in relation to improving safety in connection with the use of gas:-

- that there is a need for the incorporation somewhere into the delivery system, preferably at a point where the operative can see it of an indication of the pressure of gas in the hose;
- that there is a need to resolve the risks occasioned by remote start;
- that only trained operatives holding appropriate certificates of competence should be allowed to handle valves of gas bottles and be involved in the connection and disconnection of hoses from bottles; and
- that, as a matter of generality, there should only be a live supply of gas at the supply end of the gas hose when it is required for use.

Much of the foregoing results from the evidence of Mr. Waterston. Generally speaking, everyone regarded him as a credible and reliable witness and I have already suggested an explanation for the one issue which was causing me concerns about his reliability. The bottom line, as I have already said, was that, in his state of training, or, rather, lack of it, he should not have been instructed by Richard King to investigate the failure of the propane supply to the torch. Anyone doing that investigation, however, would not have been assisted by a consideration of the indications on the regulator valve as to the position in relation to the presence or otherwise of gas. As has already been discussed, the regulator would be confusing to a layman because it appears to function like a tap while in fact operating in precisely the opposite way i.e. closing the gas flow valve when turned anti-clockwise rather than opening it. Mr. Waterston, being a person of sound common sense, would not have made that mistake if he had been able to look at a gauge which informed him that he was diminishing to the point of termination the gas supply rather than opening it up. It cannot be beyond the wit of man to incorporate into a regulator valve a pressure gauge indicating at what pressure gas is flowing. Apart from assisting with an understanding of whether gas was flowing or not, it would allow operatives to set the gas pressure at a pressure appropriate to the tool being used in accordance with the tool manufacturer's recommendations. Once again, this is a matter for urgent

consideration by those responsible for regulations and codes of practice.

One of the boxes on the GM hot works permit was "Remote start." Generally, people did not know what this meant, including those who were supposed to be operating the permit system, but, given the frequency with which equipment designed for use with gas leaks, it is a matter of the utmost significance. In the present case, the brace was some 120 feet below the main deck where the oxygen and acetylene bottles were located, with the propane bottle being yet one further deck up. It took a minimum of five minutes to descend to the brace and longer to ascend. Even if operatives had strictly followed the instructions of turning off gas supplies at all breaks, which they did not, the five minute periods or longer would elapse from the time, for example, when they turned on the gas supply at the bottle on the main deck to the time when they got to the brace. If one or more of the items of equipment in the brace was leaking - and we know from Mr. Hodges's evidence that the propane torch and the oxy-acetylene lance found in the brace were both leaking - then at the very least during those periods of ascent and descent, unburnt gas was leaking from that equipment into the atmosphere in the brace, possibly collecting at a low or high point depending on the physical qualities of the gas, and possibly forming an explosive mixture with air, given the relatively low starting points to the flammable range for both propane and acetylene. This potential risk could have been overcome by the process of remote start i.e. matters are arranged so that the gas supply at the bottle is not turned on until the operatives arrive in the brace and want to use the gas. This would have required a person dedicated to the task of turning gas supplies on and off at deck level and an efficient means of communication between those in the brace and that person. No thought was given to an efficient or, in fact, any means of communication between those in the brace and those outwith the brace for any purpose and, though the words "remote start" were on the hot works permit, and were explained in the GM Safety Procedures Manual (Crown Production 12b), as with other matters, no one applied their minds to the usefulness of using this approach to minimise the risk of the ignition of unburnt flammable gases.

Of course, for this system to work satisfactorily, those operating it would require to have the appropriate experience and to receive the appropriate training in the use of

the communications equipment. It would have been inappropriate for a labourer, such as Mr. Waterston, to have been allocated this task. It would have to be done at the bottle end of the supply line by someone with the ability and experience to turn off supplies, turn on supplies, disconnect gas bottles from lines of supply, connect gas bottles to lines of supply and replenish bottled gas supplies when necessary.

The operation of such a system would ease the introduction of one further step which appears to me to be paramount to avoid further accidents of this type, though remote start is not the only way to deal with the problem and ultimately the responsibility would have to rest with the tradesman using the gas concerned. It became evident in the course of the Inquiry that propane was only required for very short periods to carry out pre-heating prior to welding. Even with oxygen and acetylene, while the cutting lance was in more regular use, it was by no means in constant use and its usage tended to be in what might be described as a block of action rather than in a series of short bursts. Platers would, for example have to spend a considerable amount of time marking up the job to be done. During that stage of the works, they had no requirement for the cutting lance and therefore no requirement for live supplies in the brace of oxygen and acetylene. A remote start arrangement would have readily permitted the much safer state of affairs wherein the gas supplies to the brace would only have been live when required. The position is even more striking with propane which might be required in a five minute burst at the outset of welding or on the resumption of welding following a break. A live supply of propane was not otherwise required. In the whole circumstances of this case, it seems to me that remote start, as I have described it, must be the way to deal with the situation, but even in its absence, it would have been preferable if the tradesman had had to go and switch the propane supply on when he needed it and then switch it off when he did not. Given that the whole point of pre-heating is to warm up the surfaces to be welded prior to the commencement of welding, patently a remote start arrangement is much to be preferred. There appears to me to be a very strong argument for an amendment to the Confined Spaces Regulations to the effect that all gas supplies to a confined space are to be subject to the principle of remote start and that the remote starter is to be a competent person and, further, that both he and the tradesman using the gas will

have a responsibility to ensure that all gas supplies are turned off at the bottle unless the equipment requiring the gas supply is in active use. I urgently request those responsible for review of the operation of the Regulations and the ACOP to give consideration to the implementation of this suggestion which, it seems to me, would go a very long way to enhancing the safety of those who have to work with flammable gases in confined spaces and which, had it been in operation on 4th. July, 1998, would have been likely to have prevented this accident, for the 30 minute build up of unburnt gases which I have concluded must have preceded the explosion simply could not have occurred.

7.8

To emphasise the point about adequately informed and trained welders and platers being required for the safe operation of the equipment, I revert to the evidence of John Hodges. Despite the fact that the items were new and were reported by him as being in good condition on examination, he found the propane hose to be leaking at the burner gland, which could have been easily rectified by the tightening of a nut and at the nozzle stem compression fitting where, once again, the leak could have been rectified with tightening using a spanner. Both these faults should have been observed in the course of a daily maintenance check by the user and remedied by the user.

7.9

It is also worth recording the evidence of Mr. Summerfield of what Mr. King and Mr. Duffell were faced with in the brace so that all concerned can be clear about the consequences of their contributions to this disaster. He said, "An explosion is the sudden conversion of potential chemical or mechanical energy in a fuel oxidant mix to kinetic energy. This is accomplished by movement of gases, it is a gas mediated event, resulting in those gases having a physical effect on their surroundings. That is either moving things, bending things or shattering things. In this case the type of explosion that I consider we are looking at is in the class of combustion explosions. In this type of explosion you have a point of ignition within a flammable cloud of fuel and air. The immediate effect of that ignition is to do two things, raise the temperature of the gases within the combustion reaction and also to increase the physical volume of gas taking place from combustion. In the case of propane this is a

relatively small effect. This then causes the generation of a flame front and the displacement caused by the heating and explosion creates the pressure wave at the surface or just in front of the flame front. It could be visualised in the perfect academic world as a fireball radiating from a point. However, turbulence happens and this entrains some of the pre-compressed fuel/air mix into the combustion phase of the expanding fireball causing it to accelerate and produce a larger pressure wave."

He then went on to describe the difference between detonation and deflagration. Put simply, if there had been a detonation here, he would not have expected to find much evidence. It was his conclusion that there had therefore been no detonation but a deflagration. The effects of a deflagration were wide ranging, but normally damage was categorised as being of high order or low order. This was low order damage. Relatively light objects were moved short distances. The flame front would have lasted for a second or less. The furthest damage from the ignition was in the upper ballast chamber. The flame would have travelled there from the point of ignition in the port section of the brace in about one second or less. The flame front would impart energy to everything combustible in its path. Hence there were signs of heat damage to goggles, light bulbs, a bundle of rags etc., but it was damage of a limited nature. The effect of the heat on the PVC coating of the ventilation trunking would have been to produce a lot of black smoke. Small areas of fire might have continued for some time, but the main event would have been very short. As part of the process, the oxygen in the brace has been consumed in the combustion reaction producing carbon dioxide. Once the oxygen has been depleted by carbon dioxide incomplete combustion then occurs which produces carbon monoxide. The physical evidence in the brace demonstrates that the explosion occurred between the first and third ring stiffeners in the port section with a layer of hot gas and smoke rapidly developing near roof level. The point of explosion appeared to have been relatively low and that would be consistent with the area of the greatest quantity of leaking propane. The fire had spread from the area of work at the planks, into the lower ballast chamber and up into the upper ballast chamber where minor burning had occurred. The main fuels would appear to have been plastic materials in the ventilation ducting and in cable insulation and paint deposits. These types of materials were known to produce large

quantities of dense smoke. The heavy soot deposits found are consistent with a period of burning where combustion was oxygen limited, which would lead to the production of carbon monoxide. The findings of the consultant pathologist supported these conclusions. The fire was not sustained for long or at a high temperature in the absence of any evidence of heat damage to the metal surfaces and its predominant effect appears to have been to fill the brace and the ballast chambers with an oxygen deficient atmosphere containing high levels of carbon monoxide and dense black smoke.

7.10

HSE had reported to them about three incidents a year involving holes in gas supply pipes. Given that in one small area of this job, four holes in gas supply pipes were caused in less than a week, clearly the preponderance of these incidents are not reported. That is a pity as it might have encouraged earlier action to remedy some of the issues I have striven to highlight.

- **The Response to the Emergency:**

8.1

A smoke alarm, the head of which was located in the oily water separator flat in the port aft column, went off at 21.54 according to the GA IV's computer print-out. It is a matter of speculation how long before that the explosion and fire had occurred but before that alarm went off, while a number of witnesses spoke to hearing a bang and one spoke of a shudder, no one realised that something had gone far wrong in the aft horizontal brace. The probability is that both men were dead before the smoke alarm went off. Had there been effective radio communication with the brace, or a system of stand-by personnel, both as desiderated by the precautions list on the hot works permit, one could have expected that there would have been instant intimation of the event, at least. Whether that would have assisted in attempts at rescue is, however, doubtful.

8.2

The response of the control room operator on GA IV to the smoke alarm going off was to send someone to investigate. Mr. Smith, the storeman, did so and reported back, apparently at 22.00, that there was smoke in the column. Six minutes seems a

long time before that report was made but that is what is logged. At that point a 999 call was made and the rig's own fire-fighting team were mustered. At 22.06 the general alarm was sounded and the Fire Service arrived at the quay side. It was not, however, until 22.09 that the rig's own fire-fighting team got into breathing apparatus and entered the lower portion of the brace. Six minutes later they came back out, apparently unable to cope with the smoke induced disorientation. So much for Mr. Cheyne's assertion of their capabilities. I do not mean in any way to demean the efforts of the rig fire-fighting team but am obliged to record these stark facts to demonstrate their inadequacy at least for this task. The bottom line, it seems to me, is that this is a further illustration of the stupidity of the access and egress route to the work site. As we shall see, professional firefighters had a great deal of difficulty coping with the circumstances into which they were obliged to go, at no little personal risk. I do not doubt that the attempt made by the amateur firefighters was also at some personal risk to members of the team but they were simply not trained nor equipped for what confronted them.

8.3

Station Officer John Sinclair was in charge of Blue Watch at Kingsway East Fire Station in Dundee on the evening of 4th. July. In response to a call timed at 22.00, three appliances from the fire station turned out to Prince Charles Wharf arriving at 22.04. When they arrived there, there was no one on the quay side, consistent with the general alarm not being sounded until 22.06. The information available to the Fire Service at that stage was "Smoke from fire alarm operating at oil rig." They did not know that smoke was coming from a work site where workman may well have been trapped. The occupant of the security office contacted the rig and discovered that there was a fire on board involving personnel. Mr. Sinclair then requested the attendance of the ambulance service and senior fire officers. He went on board with his crews. They found a number of people milling about and were eventually taken to the top of the port aft column. The person directing them thought that there were three people missing but was unsure. He asked if members of the rig firefighting team could help lead his men to the area of the fire and was told that they were short of air. The advice offered was to follow the cables. The people on the rig were unable to tell

him whether their mains water supply was operative so he organised a water supply from the quay side. Once that was established, and that took some time, officers wearing standard fire service BA kit attempted to make an entry. Two teams of two firefighters were sent in. The teams reported difficulty getting the hose down and getting access through a hatch between the oily water separator flat and the upper ballast chamber where they had had to remove and carry their air cylinders to get through. The witness was concerned about the safety of his men. He asked for a plan of the rig but the document supplied did not demonstrate the area concerned nor the means of access to it. Another BA team tried to effect entry via the starboard leg but also experienced difficulties with access, including similar problems with hatchways and finding themselves in the dark in amongst unidentified pipework. Firefighter MacLeod reported finding a casualty and that there were no signs of life. The witness could hear the warning whistles on the air supplies these men had sounding at the time and told them to come out. He reckoned they had not got to the casualty because of all these various difficulties until about 35 minutes after they had taken entry to the smoke filled portion of the column. The next team down found that the first casualty was entangled in the remains of wire hoops for the trunking for the ventilation system

- the Nederman fan. The temporary lighting system had collapsed and some of its wires were among these wire hoops rendering them electrically live. At least one firefighter received a mild shock. It took a considerable time to get the electrical supply to these lights isolated. The first casualty had to be manhandled to the surface. No one had told the witness what the workmen were doing down there and he did not know that there were supplies of gas to the brace. After the electrical problem was solved, a further team located the second casualty inside the brace itself and again they established that there were no signs of life. To get to him firefighters had to negotiate a gap where a covering had been removed which was open to the river. A pulley system had to be rigged up to get the bodies out and they were removed from the rig by crane. While it is unlikely that anything could have been done after the event to save Mr. King or Mr. Duffell it is quite apparent from the foregoing that neither GM or MESL had given any thought to a plan for an emergency and that the response to the occurrence was, to put it as charitably as I can, confused.

8.4

The task of searching for casualties and recovering them had eventually involved about 50 firefighters. Two of them, Iain MacLeod and Gordon Lang, gave evidence to the Inquiry. Mr. MacLeod had four years experience as a firefighter. He was aged 27. He was one of the two man BA team first to enter the port aft column of the GA IV on the night of the accident. He was instructed to go "into air" at deck level. They took a 45 ml. fire hose with them. They were told that there were three persons missing. The first problem was at a hatch at the foot of the second of the two flights of stairs leading down from the main deck. This led to a vertical ladder with what he described as a "back scratcher system" i.e. there were a series of horizontal hoops surrounding the ladder to break any fall from it. There was a change of direction of this ladder system halfway down. They then encountered a second hatch in the floor where they had to take off their BA sets to get through. They each had to carry their air cylinder above them as they descended a vertical ladder, in smoke, to maintain their air supply. Mr. MacLeod described the struggle to put the air cylinder back on to his back with one hand while clinging to the vertical ladder with the other. Below this level there was no lighting and they had to work in the dark. Each firefighter had a torch fitted to his BA set which gave some light. Mr. MacLeod's colleague had gone down the vertical ladder from the upper to the lower ballast chamber first, while he fed the hose through. Mr. MacLeod had then descended that ladder and, as he turned at the bottom, he had become aware of the presence of the first casualty, Mr. Duffell. He noticed finger marks on the wall. There was wire wrapped round the casualty's leg which appeared to be the remains of the elephant trunking for a ventilation ducting. The finger marks on the wall were made in the soot now lining the surfaces in the chamber. No firefighter had been past this point at this stage and so it was a reasonable inference that these marks had been made by the casualty. There were no signs of life. By carefully manoeuvring his leg, they were able to free the casualty from the wire hoops. The wiring was arcing suggesting some kind of live electrical current. A lot of sparks were given off as the wire touched the metal surfaces of the chamber. They managed to move the casualty to the base of the ladder but, at that point, their low pressure whistles began to sound and they were obliged to evacuate.

They returned to the surface and reported to Station Officer Sinclair. About 30 minutes later, Firefighter MacLeod and his colleague once more entered the column in air. Other firefighters were manoeuvring the casualty they had found gradually up the column but only with great difficulty, by manhandling. They went on to the entrance to the brace. The electrical arcing was continuing. Mr. MacLeod found a hatchway which appeared to be open to the river sufficient in size for him or anyone else to have fallen through. At that point, they were instructed to evacuate, on account of the arcing problem remaining unresolved. Mr. MacLeod had gone back down a third time, by which time BA equipment was no longer necessary, when he had assisted the police photographers to find their route down and to identify to them issues of significance, including where he had located Mr. Duffell's body, where he had seen the finger marks and where the electrical arcing had been taking place. Mr. MacLeod told the Inquiry that he had never encountered anything like this in his service or service training with the Fire Service. He did not know what he would have done if he had found signs of life with the casualty. Efforts to move him as his own air supply began to run out would have compromised his own safety. I considered him to be a very impressive witness and a very courageous young man.

8.5

The same can be said of Gordon Lang, a 31 year old firefighter from MacAlpine Road Fire Station in Dundee, who had located Mr. King. He had ten years service as a firefighter. He had initially been involved in the process of running out hoses but was asked to become part of a "BA pool" and he went in as part of a two man team with Firefighter Derek Milne. He had helped running a hose down the starboard leg but the BA team who had preceded them via the starboard leg found they could not get access to the incident and were coming out. Before they went into the port leg, colleagues had found the first casualty and so they had some information about what to expect and what some of the hazards on the route were. "It was a case of going down and seeing what we could find. The route down was difficult. It was probably the worst conditions you could have. It was very difficult wearing a BA set down ladders and through hatches and very enclosed spaces. One of the hatches was very tight but there was a leading firefighter there to help us get through." He went on to

explain that his colleague was a larger man than he was and there was one area through which he simply could not go. They also encountered the tangle of wires and arcing. When it was eventually discovered that the lighting system was causing the arcing, then the place was in darkness. Firefighter Lang had had a thermal image camera with him and with it and the torch attached to his BA set, he found Mr. King in the brace as his air supply warning whistle was beginning to sound. There were no signs of life. The casualty was face down with his head towards the entrance to the brace. His hair was singed. His hand was hanging on to the thick hose which started out of the green material on the floor as though he had grabbed at it while falling, perhaps from the planks that appeared to have been used as a work platform. "If he had not been dead, but seriously injured, I could not have moved him on my own and we would have had a dilemma about the air situation." He had later returned and assisted colleagues with the removal of the casualty which had to be done by manhandling. Where access was via the series of vertical ladders, that was an exceptionally difficult process.

8.5

It is patently clear that these brave firefighters and their colleagues, while remaining professional and acting in accordance with their training, put themselves at considerable personal risk but nonetheless did not hesitate to do what they could to explore for signs of life and to remove the bodies of the unfortunate victims. It was some time into the incident before the officer most immediately in charge, Station Officer Sinclair, whose actions also deserve commendation, learned that flammable gases had been in use in the braces. By that time the supplies had been turned off. The firefighters were, nonetheless, at some risk, had there been gas lingering in pockets, from a further fire or explosion ignited by the electrical arcing that was taking place. Those who considered the means of access and egress to and from the brace to be an adequate and appropriate means to get to and from the site of these works involving flammable gases and electrical supplies will hopefully have learned something from reading this section of my Note. There is an issue, however, to be addressed about whether anyone should require to enter into a confined space the entrance to which is of such small dimensions that entry to it cannot be taken by a firefighter wearing

standard BA kit. The smallest hatchway here was measured by Mr. Summerfield as having a diameter of 470 millimetres.

8.6

There were no fire extinguishers in the brace. No form of emergency lighting had been installed. There was no effective means of raising the alarm. There were no photo-luminescent signs pointing the way to any exit. There was no stand by man As Mr. Summerfield put it, "There was evidence of a lack of foresight and planning with regard to this work. For example, the lack of markings of the alternative escape route from the horizontal brace, the lack of fire extinguishers for the workers in the space to use, the absence of BA saver sets, the absence of proper two-way radio or other communication, the absence of a sentry in position at the entrance to the confined space etc. Fire resulting from hot works such as welding is foreseeable, it is therefore essential to make specific emergency plans to deal with the outbreak of fire and the rescue of casualties from confined spaces, particularly where these are part of the rig not normally occupied." In this case, no one stood back and looked at the risks which the system of work necessarily entailed, especially not in the context of the formation of a plan specific to the works in the event of an emergency occurring. There was no such plan. There should have been and the management of MESL should have ensured that one was prepared. It was negligence on their part to have failed to do so.

8.6

The final issue of fact I have to consider relates to the attempt by the fire service to obtain access to the rig for familiarisation purposes. This relates to the evidence given by Garry Brown, a 35 year old leading firefighter from Kingsway East Fire Station in Dundee about an episode which occurred two days before the incident. He had been undertaking a fire inspection in Dundee Harbour and had observed the presence of the rig. He thought he would use his initiative and see if he could arrange for a familiarisation inspection of the rig. This was standard procedure if any ships or rigs were expected to be in the harbour for any length of time, though it appears to have operated entirely informally and very much at the instigation of the Fire Service. One can readily see the sense in such a process. Mr. Brown went to the quay side at Prince

Charles Wharf and was directed to Mrs. Ross. She explained, quite properly, that she was the contractor's safety officer and, while she had no difficulty with what the fire officer was proposing, he would require authority from the rig operator. It is instructive of the position of the OIM that the telephone number she gave the fire officer was that of Mr. Cheyne, who was on board the rig at the material time. Mr. Brown spoke to Mr. Cheyne and explained the purpose of his call. The response was that the rig had its own fire-fighting crew and the Fire Service would not be needed. Mr. Brown explained that the fire service had a statutory responsibility to respond to a fire in their area but Mr. Cheyne merely repeated that they would not be required. The conversation became, at the very least, somewhat terse at this juncture, and Mr. Brown left it saying that he hoped the services of the Fire Service would not be required. Mr. Cheyne tried to explain this by saying in evidence that he had misunderstood the position to be that the fire service wanted to carry out this exercise there and then, while he was in the middle of a meeting, and claimed that he had asked Mr. Brown to make an appointment, but he agreed that the conversation became terse. I prefer Mr. Brown's version and do not believe Mr. Cheyne, particularly in the light of the evidence of Mrs. Ross, who was quite clear about Mr. Brown's intentions and Mr. Greenhow who was critical of Mr. Cheyne's attitude. It is unlikely that the exercise would have taken place prior to the incident and therefore its not taking place does not affect the outcome of the incident, but the incident demonstrates the merit in having such an exercise. Mr. Greenhow gave evidence to the effect that, when a GM rig was putting into port, it was now part of the process that they contacted the local fire service to set up a familiarisation exercise to avoid a recurrence. Mr. Cheyne's attitude viewed with hindsight was unfortunate but he is not the first nor will he be the last commercial manager to be irritated by the untimely and unexpected arrival of "officialdom." The point, it seems to me, is that if this is a good idea, as it undoubtedly is, with the benefit of the hindsight of this exercise, then it should not be left to be carried out on the informal basis that it was. Of course the Fire Service have no statutory right of entry to a vessel so the compulsion to submit to such an exercise must come from the port authority, but it seems a sensible measure to adopt and apply universally. Mr. Brown said that the position now was that if the

operator of a vessel refused them permission to board for familiarisation, then the Fire Service drew this to the attention of the port authority who would apparently then insist on access being given. The issue is thus pragmatically resolved, but perhaps consideration should be given to the Fire Service having a statutory right of access to a vessel or rig either in port in the normal course of events or in dock under going a process of repair or upgrade.

9. Conclusions and Recommendations:

9.1

I was struck by Mr. Mitchell's perceptive submission that the real question I had to address was why so many people involved in the background to this accident had behaved in the way they did. There is much truth in that submission. What I want to do in this final session, is to look briefly at the conclusions offered by others, particularly the Health & Safety Executive, to record my own conclusions and to summarise the recommendations that I see as having potentially a more general application but which have arisen out of the process of eliciting evidence in this Inquiry in the hope that others will contemplate what requires to be done by way of regulation, advice or education to prevent a recurrence.

9.2

Mr. Monaghan focused on proper and effective risk assessment as the most important failure and, correspondingly, lesson to be learned from this tragedy. He considered that if that process had been carried out properly, that would have led inexorably to the conclusion that the proposed means of access and egress were unsuitable and many of the problems would have been minimised, if not completely overcome, by creating direct access to the braces. He also focused on the grossly inadequate performance of those operating the permit to work system and was glad to learn of the changes GM had introduced to the paperwork as being a step in the right direction.

Mr. Greenhow, reflecting on what had gone wrong, focused on effective and meaningful auditing of procedures as the way to get people to do what they were supposed to do properly. He also saw training for all levels of staff as a major issue particularly in communicating the attitude that it was undesirable for people to work

in unsafe conditions and that they should not feel in any way inhibited from drawing attention to such conditions or working practices. He was now ensuring that that formed part of the induction process for anyone coming on to his rig.

Mr. Summerfield accentuated the problems arising from the failure to recognise the issues associated with remote start. With arrangements in place for that, the gas supplies to the braces need only have been live when positively required, thus reducing the opportunity for leakage, particularly unobserved leakage. He was concerned at the lack of monitoring of the atmosphere in the brace and the ineffective operation of the permit to work system generally. There was a lack of planning in the safety aspects of the task, particularly with respect to fire precautions, communication and means of escape. There was no effective monitoring of the permit to work system. The risk assessment process was wholly inadequate. There was no "competent person" involved with the work in the confined spaces as that phrase is defined by the Confined Spaces Regulations. There was a lack of communication and co-ordination and planning between the rig operator and the contractor. The lack of training of all involved in the permit to work system was a critical failure. A proper approach to all these issues would have led to proper consideration of the suitability of the means of access and, in all probability, a completely different approach being taken to the work.

9.3

I now offer my own conclusions, as follows:-

- that Mr. King and Mr. Duffell died on 4th. July, 1998 at about 21.54, in the port section of the aft horizontal brace of the GA IV while it was moored, undergoing repairs, at MESL's yard at Prince Charles Wharf, Dundee;
- their deaths were caused by a combination of heat shock, asphyxiation by inhaling soot particles and carbon monoxide poisoning, following the ignition of a flammable mixture of propane and air, the propane having leaked from a propane supply hose in the brace, the propane supply being for use in connection with the pre-heating of metal surfaces to be welded in the course of replacement of cracked metal joints, known as cruciforms, which supply hose had been damaged, the damage including a pinhole through which the gas was leaking;
- the damage to the propane hose which caused it to leak occurred at some time between 19.00 on 3rd. July, 1998 and 19.00 on 4th. July, 1998 and was caused by molten metal particles from either flame cutting or welding processes, more probably the former, taking place in the brace, some of which particles fell into a notch created on account of the

propane hose having been taped at two points to a compressed air hose, the notch being formed where the two hoses were contiguous, as a consequence of which contiguousness, the metal particles were trapped and burnt into the coatings of both hoses, whereas in the absence of such contiguousness, the particles would be expected to slide off the outer surfaces of such hoses without causing significant damage; the first live supply of propane to the hose after it had been damaged was so supplied when Mr. King turned on the propane gas bottle at the commencement of the tea break period at about 21.00 on 4th. July, 1998;

- Alan Holt and John McBain, in the presence of James Wright, all employees of MESL who were working in the port aft horizontal brace in the course of their employment on the day shift of 4th. July, 1998, wrapped the already damaged propane hose along with the air hose and a number of electrical cables, including those for the electric arc welding equipment, in a piece of green welding screen at about 12.00 noon on 4th. July; the welding screen was taped in three places; it was claimed that this was done in response to observing damage to the outer surface of an electrical cable for the arc welder, to avoid further damage; it is difficult to understand, given the contiguousness of the damaged cable to the damaged propane hose, how these men could have failed to observe the damage to the propane hose in the course of wrapping it; examination of the propane hose reveals that, if it were lying in a particular 180o orientation, then it would appear to the casual observer to look undamaged, but the minute it is rotated, on an examination of the other 180o orientation, the damage is obvious; a piece of metal plate which had been cut out from a damaged section of the inner surface of the brace was placed on top of the welding screen with its wrapped contents; after the incident, despite the claims by Holt, Wright and McBain that the welding screen had been newly cut by them from a roll in the store and that the plate had immediately been put on top of the wrap, a hole was found in the uppermost surface of the welding screen underneath the plate; while there are the vestiges of globules of molten metal in the area of this hole, the presence of which are hard to understand in the absence of the removal of the plate, the hole itself has the appearance of having been cut roughly with a not particularly sharp instrument; there is no satisfactory evidence as to how this hole was created; the whole circumstances cast substantial doubt on the credibility and reliability of Holt, Wright and McBain which, taken along with other evidence from which collusion between Holt and Wright can be inferred, carries the very strong inference that Holt and Wright know considerably more about the precise circumstances surrounding these events than they revealed to the Inquiry;
- the effect of wrapping the damaged propane hose in the welding screen and putting the piece of metal plate on top of it was twofold - firstly, it concealed the damage to the hose from casual observation and secondly, when the propane supply was turned on and began to emerge from the pinhole, instead of emerging in a jet probably with an audible hiss, it emerged into the welding screen under the plate at the bottom of the brace, escaping in a slow, diffuse manner through the weave of the screen, remaining, given the relative density of propane to air being 1.55, at the bottom of the brace where, in the absence of effective ventilation directed at the bottom of the brace, it did not disperse, but collected, forming an flammable mix with the air in the brace;
- no explanation emerged as to why anyone would have taped the propane and compressed air hoses together but it was the act of taping them together that created the notch into which the molten particles fell and were thus trapped, transferring their heat to the outer surfaces of both hoses, causing corresponding damage to both hoses and, in particular,

causing the hole in the propane hose; on the other hand, oxygen and acetylene hoses used with oxy-acetylene cutting lances are commonly tied or otherwise joined together, there being evidence that in some countries, the United States in particular, that they were actually manufactured as twin hoses, which joining replicates the condition in which molten metal particles could become trapped in the notch created by the two hoses being joined together, with the significant risk of burning through both causing the risk of an acetylene in air flammable mixture igniting in an oxygen enriched atmosphere, with potentially catastrophic consequences;

- the thermal resistance qualities of the hoses used in the brace for the conveyance of propane, oxygen and acetylene, notwithstanding that they were manufactured to a standard which accorded with the requirements of BS EN 559, were inadequate for use in the hostile working environment of the brace and, in my opinion, for use in any confined space;
- both Mr. King and Mr. Duffell were, at the material time, employees of MESL working on a semi-submersible oil exploration rig, the operators of which were GM; both MESL and GM accordingly owed them duties of care both statutory and at common law;
- MESL failed in its duties to these men under the Confined Spaces Regulations, 1997; GM failed in its duties to its own employees under these regulations, the relevant duties being imposed on employers; the management of both companies admitted ignorance both of the Regulations and the associated Approved Code of Practice; given that Regulation 4 requires that no person at work shall enter a confined space to carry out work for any purpose unless it is not reasonably practicable to achieve that purpose without such entry and that, without prejudice to the foregoing, no person at work shall enter or carry out any work in or leave a confined space otherwise than in accordance with a system of work, which, in relation to any relevant specified risks, renders that work safe and without risks to health and that Regulation 5, without prejudice to the foregoing, requires that no person at work shall enter or carry out work in a confined space, unless there has been prepared in respect of that confined space suitable and sufficient arrangements for the rescue of persons in the event of an emergency, whether or not arising out of a specified risk, with special emphasis being placed on the reduction of the risks to would be rescuers, together with the provision and maintenance of resuscitation equipment, and that Regulation 1 defines the expression, "specified risk" as, *inter alia*, a serious injury to any person at work arising from a fire or explosion or the loss of consciousness or asphyxiation arising from gas, fume, vapour or the lack of oxygen, and given the detailed provisions of the Approved Code of Practice which deals with relevant issues such as what a confined space is, the hazards to be expected in a confined space including the risk of fire or explosion from the presence of flammable substances or an excess of oxygen in the atmosphere from leaking equipment, from toxic gas, fume or vapour, from oxygen deficiency and from the presence of excessive heat, the duty on an employer to carry out a confined space working risk assessment prior to the commencement of the works, such assessment to be by a competent person, with a special need to consider the position of temporary workers who would be unfamiliar with the location at which the work was taking place, the risks associated with oxygen enrichment and deficiency, the risks associated with the physical dimensions of an enclosed space, possible sources of ignition and emergency rescue arrangements, the need to consider what measures can be taken to enable the work to be done without the need to enter the confined space, including modifying the confined space, where it is not reasonably practicable to avoid taking entry, to devise a safe system of work in the confined space

having regard to a number of considerations including the need to have the system of work supervised by a competent person, the need to train personnel adequately to enable them to work safely in a confined space, the need to establish an adequate communications system between those in the confined space and those outside, the need to test and monitor the atmosphere in the confined space, the need for good ventilation which addressed the particular propensities of any gases either to be expected or to be introduced into the confined space, the need for the provision and training in the use of respiratory equipment, the need to control the use of gas hoses and equipment in a confined space with emphasis on the removal of such equipment to fresh air and the disconnection of supplies when not in use, the need to provide a safe, quick, unobstructed and ready means of access and egress, including making sure that at no point is the means of access and egress less than 575mm diameter, the minimum recommended requirement for persons wearing breathing apparatus, the need to take adequate steps to prevent fire in the confined space, the need to provide emergency lighting and to protect lighting used in a potentially flammable atmosphere, the need to minimise the risk from static electricity, the need to prohibit smoking, the need to have emergency arrangements and equipment in place prior to the commencement of works, the merit in reducing the system of working to writing, the need to consider the effective operation of a permit to work system in connection with the work in the confined space and the need to consider the suitability of persons selected to work in the confined space, the need to consider and put in place appropriate emergency arrangements including rescue and resuscitation equipment, means of raising the alarm, means of effecting rescue, means of safeguarding rescuers, consultation with the public emergency services, where appropriate, and training both for those required to work in a confined space and potential rescuers, the failure by MESL to be aware of, to consider and to implement as appropriate the relevant provisions of the Regulations and the Associated Code of Practice was a major contribution to the deaths of Mr. King and Mr. Duffell; had GM carried out the consideration they should have carried out in relation to the application of the Regulations and Approved Code of Practice to their own employees, given that their employees designated as Issuing Authority under the permit to work system ought to have been in the confined space to carry out obligations under the permit to work system, then they too should have been aware of, should have considered and should have implemented the relevant provisions of the regulations and Approved Code of Practice, which would have been bound to, at least to some extent, enhance the safety of MESL employees, such as Mr. King and Mr. Duffell, in relation to the work they were instructed to carry out in the port aft horizontal brace;

- GM did not carry out any risk assessment in relation to the repairs works which were to be carried out on the GA IV by MESL, despite having a full crew on board and other employees attending from time to time on the rig, despite their duty to their employees in terms of the then current Regulations, Regulation 3 of the Management of Health & Safety at Work Regulations, 1992, which came into force on 1st. January, 1993; in so failing they were in breach of their statutory duty to their employees, especially those who they required to take access to the port aft horizontal brace during the period of these works; further, they failed to comply with the requirements of Regulation 9 thereof which imposes certain duties of co-operation where two or more employers share a workplace, even on a temporary basis; they also failed to adhere to the requirements of Regulation 10, which imposes certain duties on employers to provide comprehensible information on risks to the employers of workmen on their "premises" when they failed to ensure that their own employees, and, in particular,

Mr. Greenhow and Mr. Bucknole, were adequately trained in matters in relation to safety at work and, in particular, the safe and effective operation of the GM permit to work system; further they failed in relation to the duties imposed upon them by Regulation 11 in entrusting to Mr. Greenhow and Mr. Bucknole the duties associated with being Issuing Authority under the GM permit to work system without adequately training them to carry out those duties;

- insofar as MESL carried out a risk assessment, they delegated the task to Mrs. Judith Ross, a safety officer in their employment, who had only a limited understanding of the nature of the works to be carried out in the braces on GA IV and who was unfamiliar with the location of the works and the means of access and egress thereto; her knowledge and understanding of the process of risk assessment and of safety legislation generally was hopelessly inadequate and she had not received adequate training and was insufficiently experienced to have the task of project safety officer for the works on the GA IV delegated to her, as ought to have been obvious to the senior management of MESL;
- insofar as she specified some precautions as a consequence of her attempt at a risk assessment, neither she nor anyone else at MESL did anything to put the specified precautions into operation;
- Colin Johnston, the MESL Project Manager, did not know or did not, at any rate, understand and implement his role in relation to the health and safety of the workers engaged to carry out the works on GA IV; he was focused on the execution of the works rather than their safe execution; he did not have any training which would have properly equipped him to carry out the role ascribed to him in relation to the health and safety of the workforce by the MESL Corporate Integrated Management Systems Manual (Crown Production 26); he did not carry out any adequate review of the risk assessment prepared by Mrs. Ross nor had he been adequately trained to do so nor instructed to do so;
- a proper risk assessment should have identified hazards associated with the work to be performed in the aft horizontal brace of GA IV, risks associated with the performance of the work and methods of working and precautions which could have been taken either to remove or, at any rate, to minimise the risks involved in the work; a consideration by MESL or GM of the Regulations and the associated Approved Code of Practice would have enlightened them to the need to take reasonable steps to familiarise themselves with the hazards and risks in their work, of the special considerations pertinent to dynamic activities on a work site, of the need to review risk assessment at a level of management higher than that at which the assessment is prepared, that Acts and Regulations specific to the risk are identified and complied with, that the assessment addressed what actually happened at the work site, and that the risk assessment be reduced to writing; had either company carried out a proper risk assessment, at least some of the risks associated with the execution of hot work processes in a confined space a long way from fresh air using flammable gases and oxygen would have been recognised and addressed with appropriate precautions; the failure of MESL as employers of Mr. King and Mr. Duffell to carry out an adequate risk assessment was a major contributory factor to the accident and their ensuing deaths; had GM carried out a proper risk assessment, for their own employees, it is difficult to see that that would have had no impact on the protection of the MESL employees and may have avoided the accident;

- had a proper risk assessment taken place, taking proper account of the Confined Spaces Regulations, 1997 and the associated Approved Code of Practice, and being conducted by a competent person, then the risks associated with the proposed use of flammable gases in the braces should have been identified and properly considered, leading to a recognition of the inadequacies of the proposed means of access and egress to and from the aft horizontal brace, particularly in the context of formulating a contingency plan to deal with emergencies and rescue of personnel in the event of any emergency arising while work was being carried out in the aft horizontal brace;
- such a proper risk assessment should also have identified the need to avoid conflict between two work scopes in the same brace; the need for effective communication between those in the brace and those outside; the need to establish an effective remote start operation so that live supplies of gases were restricted to times of actual usage; the need for adequate ventilation arrangements which would effectively remove fumes from the hot work processes and, without prejudice to the foregoing generality, took account of the propensities of the gases introduced in connection with the works, one of which was lighter than air and so would rise if it leaked and would form pockets of gas at high levels and another of which would fall if it leaked and, as it did, would form pockets at low levels, and provided the means to disperse such gases if they were to leak; the need to provide gas monitoring equipment and a competent person to operate it; the need to provide fire-fighting and rescue equipment in the brace, in particular, an adequate supply of fire extinguishers and a BA escape set for each person in the brace at any given point in time, together with the workers being adequately trained in their use and, in relation to the BA sets, with instructions that these were to be worn whenever hot works were to take place, prior to the works commencing; the need to instruct the workers to inspect all tools and hoses especially for leaks at the commencement of each shift, to disconnect all gas bottles at the conclusion of each shift and only to re-connect when a live supply of the particular gas would be required and that tools and hoses should be removed to fresh air and vented at the conclusion of each shift;
- the managements of MESL and GM at the stage of planning for these works determined that the GM permit to work system would be utilised to regulate their conduct, but gave no further thought as to how that would be achieved in practice notwithstanding that the management of GM were aware that the bulk of the crew of GA IV were employees of Stena Offshore who had been operating that company's permit to work system and that, given the OIM was to be designated as the Issuing Authority, how he could cope with the role of monitoring and approval of the adequacy of precautions at the number of expected work sites all over the rig; in particular, they gave no thought as to how employees of MESL at any level would be made aware of the main features of the system nor did they consider how familiar either Mr. Greenhow or Mr. Bucknole were, the latter having only just joined GM as an employee, in the detail of the system in particular or the importance of the effective operation of a permit to work system in general; MESL gave no thought as to how their employees were to be made aware of the operation of the system or their part in it and, in particular, failed to make key employees, Colin Johnston, Judith Ross, and the two general foremen who were to be designated as Performing Authorities, Angus Wylie and Eric Murphy, aware of the respective parts they were expected to play in the operation of the permit to work system nor how they should go about operating the system;

- permit to work systems should only be operable by persons acting in the roles of Issuing Authority or Performing Authority where those persons have been fully instructed and trained in the details of the operation of the system and have demonstrated, in the context of a test assessment, a clear understanding of the operation of the system and the importance to safety of the effective operation of the system;
- in the present case, the completion of the permits and the certificates by Mark Greenhow, Anthony Bucknole, Angus Wylie and Eric Murphy and the performance of obligations, especially in relation to the examination of the work site and the provision of desiderated precautions, expected of Issuing Authority and Performing Authority, was hopelessly inadequate, principally as a result of none of these people being adequately trained in the system nor understanding the importance of its effective operation from the safety standpoint; had they been adequately trained and instructed and had they understood the critical importance of the effective operation of the permit to work system, then they should have identified the risks associated with the use of flammable gases in a confined space and should have identified precautions which would have minimised those risks, such as "remote start," and "flammable materials," should have understood the relationship and the need for cross-referencing among entry and isolation certificates and hot work permits, should have identified on the hot work permits precautions such as "BA set," and "adequate comm.," should have identified on an inspection of the site the absence of precautions such as fire extinguishers, BA sets, means of communication, an effective remote start system for the operation of the flammable gases, and, most importantly of all, gas monitoring equipment, and should at least have applied their minds to the adequacy of the means of access and egress and the ventilation system; the failure by both companies to ensure that those who were delegated with the key tasks in relation to the operation of the GM permit to work system were competent to operate it was a major contributing factor to the deaths of Mr. King and Mr. Duffell;
- it would be an improvement in the operation of permit to work systems in general, and this one in particular if, instead of making use of a series of boxes to tick to indicate the requirements in relation to precautions, the issuing authority was required to specify what precautions were required and what precautions were in place, for example, by specifying the number of fire extinguishers which had been put in place and specifying their locations; it would be better if permits were not revalidated but, instead, new permits were issued at the commencement of each new shift, with a designated handover procedure being set out so that issuing and performing authorities all liaised with each other as to the state of works and what permits had been in existence during the outgoing shift and were required for the incoming shift;
- that it is unfortunate in these days where articles can readily be made luminous that supplies of flammable gases are supplied in hoses, conform to BS EN 559, which, in the case of acetylene are red and in the case of propane are orange, which in a poorly lit confined space would be barely distinguishable, and are not marked at regular intervals along their lengths with an identification of their gaseous contents and the words "Danger - Flammable Gas" or similar;
- that neither method statement prepared by MESL once Mrs. Ross had had an opportunity to examine the work site significantly improved on the inefficacy of the risk assessment she had earlier carried out in that neither explained how "personnel" were to obtain access to a permit to read it and to adhere to the agreed precautions, that no consideration was given

to the obvious conflict between workmen and services both utilising the same route to the brace, notwithstanding the number of hoses and cables including the 12" diameter elephant trunking for the local ventilation extraction system operated by the Nederman fan, in the remains of which Mr. Duffell appeared to have become trapped while trying to escape, nor did they adequately explain where hoses and torches were to be removed to during breaks; there was no specification as to who was to monitor the effectiveness of the ventilation system, and no one did, at least not as a matter of routine; insofar as it might have been of some consequence in preventing the accident which occurred to enforce the removal of hoses and torches from the work sites and to turn gas bottles off at breaks, these instructions were not adequately conveyed to the work force nor were they ever enforced by any supervisor or by any member of management;

- that it should have been obvious to experienced tradesmen working in the aft horizontal brace that services and, in particular, hoses, were at risk from the hot works being carried out in the braces, in particular from the dispersal of molten metal particles from flame cutting and welding processes, and that they should have themselves taken steps to minimise the risks associated with heat damage being caused to these services either by effectively protecting them from those risks with use of suitable fire boards or similar forms of protection or by moving the services out of the way of the stream of molten particles either by raising them above the area of operation or sufficiently to the side of the operation; in the event that they were unable to protect or remove the services from heat damage by the flow of molten particles they should have drawn the attention of their supervisors to the risks associated therewith and declined to work further until the risks were effectively addressed;
- that it should have been obvious to experienced tradesmen that it would have been consistent with their duty to take reasonable care for their own safety and that of their fellow employees to avoid having live supplies of gas into the brace other than at times when the gas was actually required for pre-heating or cutting and that, accordingly, they should not have maintained a system where there were live supplies of flammable gases, especially propane the need for which was only occasional, into the brace at all times;
- that experienced tradesmen should have been aware of the risks associated with leakage of flammable gases especially in a confined space and should have known of the need to remove equipment from the confined space to open air after use and to control carefully the closure of gas bottles including the regular disconnection of the supply hoses from the gas bottles so that the hoses could be vented;
- that experienced tradesmen should have been aware of the need to check at the commencement of each shift the condition of the equipment, especially the hoses, throughout their lengths, for signs of damage and should have taken adequate steps either to repair any such damage or to bring their supervisor's attention to such damage; in particular, the tradesmen working in the aft brace who were aware of damage having been caused on two separate occasions to the oxygen hose and on one associated occasion to the acetylene hose, should have had the sense to check for damage to all hoses on a regular basis;
- experienced tradesmen working in the aft horizontal brace should have known better than to conceal or allow to remain concealed any part of any hose, since such concealment would prevent them being able to inspect the hoses for damage;

- experienced tradesmen should have known better than to entrust to inexperienced and untrained labourers any tasks associated with the operation of gas supplies to the braces and in particular should not have permitted labourers to interfere with any supply valve or regulator, to be involved in the connection or disconnection of gas supplies or to check the condition of hoses or equipment, especially when there appeared to be an obstruction in the supply of gas; Richard King, in particular, should have investigated himself why the propane supply was not operating properly; had he done so, it might have occurred to him that there might have been a leak and he might have investigated the contents of the welding screen.
- there was a failure at senior management level of GM and MESL to make proper arrangements to communicate with each other about issues relating to the safety of the MESL workforce and others, including the GM crew members, whose safety might have been prejudiced by the execution of the works, and, in particular, to work out in advance who would be responsible for putting in place any precaution desiderated by those undertaking the operation of the GM permit to work system;
- no hot works involving the use of flammable gases should be permitted to take place in a confined space in the absence of suitable and sufficient atmospheric monitoring equipment and personnel trained in its use;
- no hot works involving the use of flammable gases should be permitted to take place in a confined space in the absence of a sufficient number of BA escape sets and all persons working in confined spaces should be fully trained and instructed in the use of such sets including the times and circumstances in which they should be worn as a precautionary measure;
- no one should be permitted to carry out hot works in a confined space, nor to supervise the execution of works in a confined space, without having first obtained a suitable certificate to the effect that they have been competently trained in all aspects of the safe conduct of such works in confined spaces; government should instruct that a system of for such certification be devised and put into operation at the earliest possible moment;
- if companies such as MESL and their competitors are to be allowed to continue to avoid employment legislation on the ground of economic necessity if they are to remain competitive and are thus to be allowed to continue to employ temporary workers in accordance with the inconsistent supply of work to them, given that it is recognised in the HSE literature and is, in any event, a matter of common sense that a temporary workforce is at much greater risk from hazards in any work place than a permanent workforce, and companies employing temporary workers have no incentive to train them in matters of safety beyond their immediate needs, then government must take the lead in not only making provision for training for such workers in all relevant aspects of their health and safety but must also, either through HSE or some other similar organisation, make provision for the regular independent inspection on a proactive basis of places where such temporary workers are required to work to ensure that safety legislation is being adhered to and that all involved in such works are competent and sufficiently instructed to carry out the particular tasks assigned to them in a manner safe to themselves and to their fellow workers;

- companies such as MESL should be encouraged to ensure the quality of the supervisory staff it employs by selecting them from full time employees, so far as possible, and by paying them at a sufficiently higher rate than tradesmen so that they are encouraged to do the job properly and to take opportunities to enhance their supervisory skills by being encouraged regularly to attend relevant courses on both safety and man-management and communications skills;
- no supply of oxygen or flammable gas to any confined space should be permitted in the absence of a pressure gauge being fitted to the supply line, preferably adjacent to, or even encompassed within, the regulator valve; it would be useful if tools for use with flammable gases under pressure also incorporated pressure valves from which the gas pressure at the tool could be observed;
- in this particular case, there was a failure to identify and erect appropriate signs identifying the starboard column as an emergency exit for those working in the aft horizontal brace;

(xxxvii) ships or rigs coming into a repairer's yard or quay should be the subject of a familiarisation exercise by the local fire service as a requirement of them being allowed to berth;

(xxxviii) the fact that neither company appeared to have any knowledge of the Confined Spaces Regulations is a cause for concern about the dissemination of knowledge about the introduction of such Regulations and their associated Approved Codes of Practice;

(xxxix) there is some cause for concern about the use of the expression "other than short interruptions" in Para. 63 of the Confined Spaces Regulations ACOP, given the circumstances of the present case and the scope for doubt as to what constitutes a short interruption; the emphasis should be on there being live gas supplies to a confined space only when an active live supply is required;

(xl) while I appreciate that there is reference in Paras 93-98 of ACOP about the dimensions of manholes and similar means of access, and that dimensions of such means of access are also subject to British Standards specifications, I consider that the circumstances of the present case demonstrate a need for legislation on the minimum dimensions for points of entry into confined spaces;

(xli) the description of the rescue efforts made by the professional firefighters, including the various difficulties they encountered, and the time taken to reach the casualties, all demonstrates graphically the inadequacies of the means of access to and egress from the brace for the men who had to work there;

9.4

In the light of my foregoing conclusions, I now offer the following

recommendations:-

- there are a number of matters which I would like to see considered as a matter of urgency by the committee responsible for British Standards in relation to flame cutting and welding equipment and hoses carrying both oxygen and flammable gases, namely;-
- the elimination of circumstances wherein the creation of a notch between two hoses can trap molten metal particles, to eliminate the risk of those trapped particles burning their way through the outer surfaces of the hoses causing either an immediate fire, or oxygen enrichment or, worst of all, a leakage of unburnt gases into atmosphere with potentially explosive effect on ignition - patently there is a particular risk with oxy-acetylene equipment, especially if use is made of oxygen and acetylene hoses which are manufactured in such a way as to be permanently joined together;
- the adequacy of the thermal resistance qualities of the hoses used for the conveyance of oxygen and flammable gases;
- the adequacy, in the circumstances disclosed in the evidence, of the test for the thermal resistance qualities of such hoses;
- what steps can be taken for the easier identification and distinction between propane and acetylene hoses given the proximity in the colour spectrum of their present outer coating colours, especially given the availability now of luminous colours; also what markings about the flammable nature of the contents of the hoses should be marked on the outer coatings; and
- whether and how best pressure gauges can be incorporated as standard into equipment used in connection with welding, flame cutting, grinding and allied processes;
- Consideration requires to be given as to whether there is a need for further regulation, whether by amendment of the Confined Spaces Regulations, 1997, or otherwise, or, at any rate, by amendment of the Approved Code of Practice, to take account of the following:-
 - whether persons should be permitted to enter or carry out work in a confined space without an adequate means of instant communications with a responsible person outwith the confined space first being established;
 - whether persons should be permitted to enter or carry out work in a confined space where flammable gases and/or oxygen is present without a safe and sufficient means of regulating the supply of all such gases to the confined space by a remote start system operated outwith the confined space so that supplies of any particular gas or gases to the confined space are only live when the gas is required for flame cutting, pre-heating or other related processes, and the supplies are not otherwise live;
 - whether persons should be permitted to enter or carry out work in a confined space where flammable or toxic gases and/or oxygen are or may be present without the presence of suitable and sufficient atmospheric monitoring equipment and a person sufficiently trained in its use so that the presence of any unsafe condition, including

oxygen deficiency or enrichment or the presence of toxic or unburnt flammable gases, can be detected;

- whether persons should be permitted to enter or carry out work in a confined space where flammable or toxic gases and/or oxygen are or may be present without the presence of a suitable and sufficient supply of fire extinguishers;
- whether persons should be permitted to enter or carry out work in a confined space where flammable or toxic gases and/or oxygen are or may be present without the presence of an adequate supply of emergency respiratory equipment of the type known as BA escape sets, in the use of which such persons as enter the confined space should be adequately trained;
- whether, at least so far as concerns planned works, as opposed to those which may arise on an emergency basis, no work involving any hot process such as flame cutting, welding or grinding should take place in a confined space without the works being controlled by an effective and properly operated permit to work system;
- whether, prior to any person being permitted to act as either an Issuing Authority or Performing Authority under a permit to work system, that person should be required to pass a written test of competence in the particular system and in the importance generally of permit to work systems; and
- whether at all times when a permit to work system is in operation a copy of the permit should be exhibited at the site of the work being carried out under it;
- Those who operate permit to work systems should consider:-
 - the adequacy of their cross-referencing systems;
 - whether when it comes to deciding upon appropriate precautions, instead of using a "tick box" approach, there should be a requirement to specify what each precaution should consist of e.g there should be 3 fire extinguishers each of the dry foam type located within the confines of the confined space;
 - whether there are any circumstances in which revalidation should be permitted; and
 - whether communication of information from manager to manager, supervisor to supervisor and tradesman to tradesman at shift changeovers is adequate or requires to be formalised.
- Whether, more generally, there is a need for the relevant authorities to consider:-
 - whether only tradesmen holding appropriate certificates of competence should be allowed to -
 - carry out hot works (welding, flame cutting, grinding and allied processes) at all or, at any rate, in a confined space;
 - be permitted to install equipment for such processes;
 - be permitted to maintain and repair equipment for such processes

- be the only persons permitted to carry out any function in relation to the operation of any portable gas bottle or cylinder and the connection or disconnection of hoses or other equipment thereto;
- supervise the performance of hot works in a confined space; and
- prepare a risk assessment for the performance of hot works in a confined space;
- how to address the problem of the safety of temporary workers especially in the building and construction industries where the work site is constantly changing and the absence of a settled workforce with some prospect of continuity of employment contributes to the present lack of safety among such workers;
- how to improve the quality of supervision, with particular regard to safety, of temporary workers; and
- whether there is a need for statutory provision to enable local fire services to have access for familiarisation exercises to ships or other marine installations in dock, whether for repair, upgrading or otherwise, for a period in excess of seven days.

I hope all of the foregoing will serve to encourage urgent consideration of revisals necessary at the various levels I have striven to identify to prevent further unnecessary loss of life.