STATE
CORONER
VICTORIA

`LONGFORD'

Inquest into the deaths of Peter Brubeck Wilson and John Francis Lowery and the fire at Longford Gas Plant Number 1

FINDINGS

The deaths of Peter Brubeck Wilson,[1] and John Francis Lowery[2] occurred on the 25th September 1998 both from injuries sustained in a gas explosion at Esso's Longford Number 1 Gas Plant, Longford, Victoria. Following the gas explosion a fire[3] started, which took some days to extinguish.

Summary of the incident

At approximately 12.26pm on 25th September 1998 a vessel (GP905) in Esso's Gas Plant 1 (GP1) at Longford fractured, releasing hydrocarbon vapours and liquid. Subsequently

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1 Coroner's Case Number: 2907/98

2 Coroner's Case Number: 2906/98

3 Fire Inquest Coroner's Case Number 2927/98

explosions and a fire followed in which Peter Wilson and John Lowery, who were employed by Esso, were killed. Eight other employees were injured, some seriously.

The fire, which ignited by an open fired boiler some distance from the main part of the Plant was fed by the escaping gasses, was not fully extinguished until 27 September. The supplies of natural gas to both domestic and industrial users in Victoria were halted for some weeks.

A Royal Commission was established which enquired into the explosion and fire. The Royal Commissioners issued their Report on 28th June 1999. There was also a Supreme Court trial, before a jury, and Esso was convicted on various breaches of the *Occupational Health and Safety Act 1985*. Esso was sentenced by Mr. Justice Cummins on 30th July 2001.

The investigation, inquest hearing and material provided for the finding

Shortly after notification of the deaths, explosion and fire, the Coroner's investigation commenced with the assistance of a number of other agencies; Victoria Police (Arson Squad and Coroner's Assistants Office); WorkCover Authority; Country Fire Authority; Victorian Forensic Science Centre (Fire Investigation Scientists). The investigation for the Coroner was conducted under a pre-existing co-operative arrangement made by these agencies, which is called the *`Fire Investigation Policy and Procedures.'* Also during this phase of the investigation a number of documents and things were seized under Coroner's Authority. After some weeks, all the material collected during this investigation was handed over to the Royal Commission, following an amendment to the *Evidence Act* to enable this transference to occur. After completion of the Royal Commission all evidence collected was returned to the Coroner.

Following completion of the Royal Commission and the Supreme Court trial the Coroner was still required, under the *Coroners Act 1985*, to perform various functions regarding the deaths of Messrs. Wilson and Lowery and the fire at the Longford Plant.

In order to deal with the issues associated with the Longford investigation and complete the matter as efficiently as possible, a Mention Hearing was held at the Coronial Services Centre on 25th June 2002. The interested parties were invited to make submissions on how the inquest into the deaths of Messrs Wilson and Lowery and the fire should proceed, in view of the fact that there had been a number of comprehensive inquiries into the Longford explosion and fire.

After some discussion at the Mention Hearing, the inquest proceeded on the basis that the information already obtained through the Longford Royal Commission Report, the Summary provided for the prosecution of the trial in the Supreme Court and the Judgement of Justice Cummins would be relied on as the basis of the Coroner's finding. The parties were also invited to place written submissions before the Coroner on issues associated with Esso's response to the Longford Royal Commission Report on safety related matters.

Submissions by the parties were received and they have also been considered. A most helpful summary of the findings of the Royal Commission was also prepared by Counsel Assisting,

Ms. Fiona Ellis. This summary was tendered during the Mention Hearing and has been used extensively in the preparation of this Report, as has the Royal Commission Report and the decision of Mr. Justice Cummins.

It is not intended to address in any significant detail the emergency response problems that were evident following the incident. Save to say, these issues are extensively dealt with in the Royal Commission Report. Improvements in emergency management procedures are also appropriately covered in some detail in the submission of the Country Fire Authority to the Coroner in these inquests.

Where an abbreviation or other technical terminology is used in this Report, refer to the Glossary at the end of the finding.

Organisational Issues

Esso Australia Resources Ltd., is a subsidiary of the Exxon Corporation, which is incorporated in the United States. Esso operates the offshore oil wells in Bass Strait and the plants in Longford on behalf of a joint venture with BHP Petroleum (a subsidiary of the former Broken Hill Proprietary Company Ltd). Apparently, BHP (now `bhpbilliton') is not involved in the operation of the plants at Longford. The employees who died and were injured were employed by Esso Australia Pty. Ltd. (Esso Australia Pty. Ltd. is also a subsidiary of Exxon).

Establishment of GP1 and associated background issues

GP1 was established in 1969 and was a refrigerated lean oil absorption plant, which uses low temperatures and high pressures. It also uses lean oil to absorb the hydrocarbon components from incoming gas. The end result of this process was rich oil. Using the low pressures and higher temperatures rich oil was also distilled to release methane, which was then returned to the gas stream. The rich oil then became lean oil again.

The equipment and failure (a summary)

The vessel, which failed, was a heat exchanger, GP905. This vessel operated to heat rich oil at the bottom of a Rich Oil Demethaniser (ROD). Near to GP905 was another heat exchanger GP922 that preheated rich oil flowing from the ROD on its way to the Rich Oil Fractionator (ROF). GP922 had developed leaks at its flanges at some time before the incident. Attempts were being made to repair the leaks at the time GP905 failed.

Immediately before the failure the temperature of GP905 was well below operating temperature and may have been as low as minus 48°C. The normal operating temperature was in the vicinity of 100°C. The low temperature was due to the loss of lean oil flow in GP1 (as the pumps, GP1201, were stopped and not restarted for some hours). The hot oil flow through GP905 was the means by which it was heated to its normal operating temperature. The heating of this vessel had ceased for about four hours prior to the eventual rupture.

In spite of the loss of lean oil flow cold rich oil and subsequently cold condensate continued to flow through GP905 causing its temperature to drop.

When the pumps were restarted there was a flow of warm lean oil into GP905. The higher temperature of the oil into the cold re-boiler caused stress in the vessel. This resulted in its brittle fracture at one end.

The rupture of GP905 released a large volume of hydrocarbons in the form of a thick cloud of vapour. The vapour subsequently was ignited by an open flame on a gas fired heater giving rise to explosions and fires. During the process of fracture the large vapour cloud had drifted with the prevailing wind in a south-south westerly direction towards gas fired heaters (having an open flame), which were approximately 170 metres away at the southern boundary of the plant.

It is significant that Mr. Justice Cummins, in sentencing Esso for breaches of the *Occupational Health and Safety Act 1985,* indicated that:

> *`The events of 25 September 1998 were the responsibility of Esso; no one else. Their cause was grievous, foreseeable and avoidable. Their consequence was grievous, tragic and avoidable.'*

Justice Cummins also noted:

> *`employees, including supervisors, of Esso were entirely unaware of the deadly danger lurking at GP905 on the Friday morning, 25th September 1998, particularly around 12 noon. They were loyally attending to a leak in GP922 and evident cold on GP905 and related areas. Only one man knew the dangers, Mr. Vandersteen, a fitter in the maintenance section, saw what was evident to be seen and in evidence said this: "I just said, `Fuck this, I'm out of here.' We jumped on our bikes and we left the area." The explosion occurred immediately thereafter. Mr. Vandersteen was not trained by Esso but was trained by the Navy. It was the Navy, not Esso, who taught him to be aware of such danger'* [4]

How the process worked

Gas is delivered by pipeline from the off-shore wells to the onshore processing facilities at Longford and Longford Island Point. As the raw gas is piped from off-shore it cools and its pressure is lowered causing water and hydrocarbons to condense which then accumulates in the lower part of the pipeline when gas flow rates are low. These aggregations of liquid are known as *`slugs.'* At the gas inlet in the plant there is a *`slugcatcher',* which has the effect of dissipating energy from the slugs as they arrive and stores the liquid prior to processing. The gas then passed through certain processes.

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[4] DPP v Esso Australia Pty. Ltd. [2001] VSC 263.

The inlet gas for GP1 was chilled by means of two heat exchanges GP901 and GP902 to prepare it for the absorption process. Gas entered the lower part of the absorbers carrying with it a quantity of condensate formed during the chilling process. This condensate was heated by means of heat exchangers known as re-boilers (GP903A and B). The condensate was warmed by liquid propane. A small increase in temperature corresponded to a significant increase in the vaporization of the condensate. The temperature of the condensate at the bottom of Absorber B (this Absorber is relevant for the failure) was regulated by a temperature control system known as TRC3B, which by means of automatic valve (this could be manually overridden) controlled the flow or warm propane liquid to GP903B.

The rich oil leaving the absorbers was dropped in pressure and then flowed to a flash tank or GP1108. The rich oil from GP1108 was taken in two streams to the ROD through a series of heat exchangers. At the bottom of the ROD tower the rich oil was heated by means of a reboiler known as GP905 (this was the vessel that failed). The rich oil from the bottom of the ROD flowed through the heat exchanger GP922 (which was leaking on the day of the accident) on its way to the ROF (Rich Oil Fractionator).

The temperature control system TRC4 controlled the temperature at the bottom of the ROD by regulating the flow of lean oil through GP905 and GP922. The rich oil preheated by GP922 entered the ROF tower at 140°C.

After certain processes, what was now lean oil, was circulated through the re-boilers by pumps (GP1204A, B and C). It then left the ROF and was delivered back to the shell side of GP922.

In lean oil recycle the lean oil from the bottom of the ROF flowed to GP922 and GP905 providing heat to the rich oil in the ROD and to preheat the rich oil on its way to the ROF. The lean oil left GP905 at 77°C and was further cooled by the fin-fan cooler and the cold rich oil passing through the tubes of the heat exchangers. Before the lean oil reached the heat exchangers it was saturated with methane to prevent it absorbing the same when it entered the top of the absorber towers. After leaving the heat exchangers the lean oil went to the Oil Saturator Tank (by pumps GP1202A and B) where any remaining unabsorbed methane was flashed off. Most of the lean oil was chilled using propane (dropping the temperature to -20°C by GP911).

The condensate which had been taken to the Condensate Flash Tank (GP1105A) then passed through a heat exchanger (GP921) where it was heated to 62°C by hot condensate supplied by the Condensate De-ethaniser tower (GP1106A). The hot condensate flowed through the shell side of GP921 and the incoming condensate flowed through the tube side. The heated incoming condensate entered GP1106A flowing to the bottom where it was pumped to a gas fired re-boiler. The methane and ethane driven off left as fuel or were recompressed. The remaining condensate went to the CSP (Crude Stabilisation Plant).[5]

The system of Controls operating in Gas Plant 1 (Longford)

[5] See also summary explanation of the process in the 'Amended Summary of Facts and Hand-up Brief' for the prosecution under the Occupational Health and Safety Act 1985 (Exhibit 2).

The controls operating at Longford Gas Plant 1 were a mixture of pneumatic equipment (introduced in 1969) and a computerized system, parts of which were known as the *`Bailey System'*.

Pneumatic Controls

In relation to the pneumatic equipment, these primary instruments allowed the operator to set the value of the process variable they wished to control by moving a red pointer to the appropriate set-point. A black pointer moved up the left side of the controller to indicate the actual value of the process variable being controlled. Effective control should be demonstrated by the pointers being aligned.

Information was also recorded continuously on paper charts. Alarm panels gave visible and audible alarms should process variable move out of a predetermined range. The audible alarm could be cancelled by pressing a button but the visual alarm would stay illuminated until the controlled variable returned to the normal operating range and the operator manually reset the alarm.

Computerised Controls and the `Bailey' system

The Bailey system provided a more sophisticated control and a higher speed of response than the pneumatic system. The visual alarm would reset automatically when the controlled variable returned to normal operating range. This system also recorded information historically. Further, the Process Information Data Acquisition System (PIDAS) recorded and stored the information in the Bailey system. This information was available off site. Approximately 30% of the instrumentation in GP1 was recorded on the Bailey system.

Other information on GP1, apart from log books of operators and supervisors, was provided by Surveillance Information Database Systems (from operators recording information from local instruments four times per day).

TRC3B controlled the temperature in the bottom of Absorber B. There were also level controls for the condensate in the bottom of Absorber B (LC9B) and for the rich oil in Absorber B (LC8B). The TR9B when active would override LC9B when the temperature of the condensate from Absorber B on its way to the condensate flash tank (GP1105) fell below -3°C. This would reduce the flow of the condensate thus increasing the temperature of the condensate leaving GP919. The consequence was that condensate in the Absorber could build up to a level well above the set point.

A feature of the Bailey system (which was not being used on the day of the incident) was that it would automatically open the control valve FRC7 when condensate transfer (on its way to the rich oil flash tank) was terminated due to excessively low temperatures. Operators were required to close the valve manually once the Absorbers temperature was correctly restored.

Organisation Supervision and Management

The actual organisational structure

There were a number of managers and supervisors responsible for the safe operation of Esso's Longford Plant. They were Mr. Olsen (Chairman & Managing Director); Sikkel (Exploration and Production manager – ultimately responsible for productions at the Longford Plant); Coleman (Production Manager – responsible for all on-shore and off-shore operations. Responded to Massey); Keen (Plant Surveillance Supervisor); Sutherland (maintenance and reliability supervisor); Shinners (Production Technology Manager – responsible for the overall Risk and Management System); Harrison (Longford Plant Manager – responsible for overseeing all phases of Esso's operations at Longford); Shepard (production co-ordinator, gas and LPG – answerable to the operations superintendent).

On site on 25th September

On the day of the incident Mr Peter Wilson, was the maintenance superintendent. In the absence of the Longford plant manager, he was the most senior member on site. Lowery was the acting mechanical supervisor.

Earlier structural changes potentially affecting the incident

Two relevant structural changes to operations management had occurred prior to the incident. These changes had some effect on the outcome. They were:

1. Engineers, previously stationed at Longford, were relocated from the country town of Sale (near Longford) to Melbourne, which is about two hours drive from the site. The role of the engineers was surveillance (monitoring the process to ensure that operations undertaken within safe operating limits) and the implementation of projects. Esso (Mr. Coleman) gave evidence at the Royal Commission that this relocation was not relevant to events and that PIDAS had provided engineering personnel with current and historical information. In any event, according to Coleman, Harrison (Plant Manager) was an engineer.

   The Royal Commission concluded that *`this change appears to have had a lasting impact on operational practices at the Longford Plant. The physical isolation of engineers from the plant deprived operations personnel of engineering expertise and knowledge which previously they gained through interaction and involvement with engineers on site. Moreover, the engineers themselves no longer gained an intimate knowledge of plant activities. The ability to telephone engineers if necessary, or to speak with them during site visits, did not provide the same opportunities for informal exchanges between the two groups (engineers and operations personnel), which are often the means of transfer of vital information.'* There was no risk assessment undertaken by Esso prior to relocation of the engineers. The Royal Commission was of the view that there were no experienced engineers at Longford on the day of the incident and that expert knowledge from engineers *`of plant operating parameters, of the metallurgical limits of equipment and*

vessels in GP1 and of the consequences of cold temperatures resulting from loss of lean oil circulation in the ROD/ROF area' was absent.[6]

2. The responsibilities of operators and supervisors were redefined. Operators assumed a greater responsibility for the operations of the plant electing to become control panel operators or machinery operators. Consequently the number of supervisors was reduced and they were no longer expected to be in the plants on a continuous basis. In this area the Royal Commission was also critical, although the Commissioners had some difficulty in evaluating the link to the eventual failure. They said that the structural changes *`were clearly intended to alter operating and supervisory practices'* and thus required *`management of change risk assessment and evaluation.'* This type of assessment prior to the change *`may have exposed important and relevant weaknesses in the level of operator knowledge, in training programmes, in communication systems, in operating procedures and in other aspects of Esso's management system.'* [7]

The lead up to the incident and how it occurred

Introduction - lead up

The following is a summary of the lead up to the incident.

The night before the day shift of 25 September there was a strong flow of liquids into the *`slugcatchers*.' The lighter components of these liquids were fed back to GP1 gas inlet via the KVR compressors and referred to as KVR gas. The volume of KVR gas flowing to the absorbers was higher than usual resulting in a feed that was rich in heavy hydrocarbons. This resulted in a large quantity of condensate as the gas passed through GP901 and GP902. The condensate would have been separated into the bottom section of the absorbers.

There was a build up of condensate in Absorber B. The volume of condensate was large enough and cold enough to cause TC9B to override LC9B and significantly reduce the flow of condensate through GP919. This resulted in a build up of condensate in Absorber B.

The level of condensate in Absorber B rose to a point where it was not possible to measure it by the available instrumentation. Probably, the condensate entered the rich oil stream causing that stream to flash more than usual on its way to the rich oil flash tank (GP1108) and to drop in temperature. There was a rise in the level of the Oil Saturator Tank (OST) (GP1110) that was caused by additional liquid coming from the pipe from the top of the ROD tower.

As a consequence of this rise in the level of the OST, LRC2 closed the valve regulating the flow from the GP1201 pumps. This reduction in flow would have caused LFSD8 to shut down the GP1201 pumps which in turn would have meant that the level of the OST fell rapidly. The level steadied out when the switch operated to shut down GP1201. Lean oil circulation would have stopped when the GP1201 pump shut down.

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[6] Longford Royal Commission Report, p.209.

[7] Longford Royal Commission Report, p.210.

The inflow of gas continued, as did the production of condensate. Within 5 minutes of the loss of lean oil flow it is likely that the flow would have become pure condensate.

The Royal Commissioners indicated that had *`the GP1201 and GP1202 pumps been restarted within reasonable time'* after shut down it is likely that *`the subsequent failure of GP905 would have been averted.'*[8] Low flow shut down could have been bypassed, however both of the *`relevant shift operators were not aware of how'* this could be achieved.

The absence of any lean oil flow to the heat exchangers meant that that the condensate flowing through the rich oil system was not warmed before it reached ROD, GP905 and GP922 with simulated temperatures of as low as -48°C. The Commissioners concluded that this *`cold flow caused an upset on entering the ROF'* and because *`GP922 became cold its flanges became distorted causing leakage at each end.'*[9]

Also there was a failure to effectively manipulate the bypass around the temperature control valve (TRC3B having been malfunctioning at least 10 days prior). At this stage the condensate temperatures were *`consistently below the set-point of -10°C reaching -25°C at one stage.'*[10] At 11.00am a decision was made to shutdown GP1.

After the shut down, there was a decision to attempt to warm GP922 by recommencing the flow of warm oil, hoping to solve the problem of the leaks. When the pumps were restarted the warm lean oil flowing from GP1204 created a thermal shock and brittle fracture of the re-boiler when the oil reached the now significantly cold vessel, GP905.[11]

There was a history of TRC3B valve[12] failures and problems from about March 1998 (there was a work order dated 18th March and a recent *`Temporary Defeats Board' notice board note indicating TRC3B U/S. Running on bypass valve'* and *`Valve seized up coupla days!'* This fact was apparently not known by either Mr. Ray Wilson or the ROD/ROF operator Watts. A number of issues of miscommunications, omissions and inconsistent versions as to what was said at handover are discussed by the Royal Commissioners. Crucial facts that were not known to individuals making relevant decisions at relevant times (e.g. Ward ordered Rawson to close the TRC3B bypass unaware that the condensate at the base of Absorber B was so high as to be off-scale).[13]

Leak from GP922 and the Loss of Lean Oil Circulation - a chronology

The following chronology briefly documents the leak from GP922 and the loss of Lean Oil Circulation as a lead up to the incident:

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[8] Longford Royal Commission Report, p.45.

[9] Longford Royal Commission Report, pp.45-46

[10] Longford Royal Commission Report, p.46

[11] Longford Royal Commission Report, p.47

[12] This was the control system designed to regulate the temperature of condensate in the bottom of Absorber B.

[13] Longford Royal Commission Report, pp.48-49

1. At 7.30am area operator Mr. Rawson closed the bypass on TRC3B on Ward's instructions. Within half an hour the temperature in Absorber B had fallen from -18°C to -26°C. At about 8.22am Ward instructed Rawson to open the valve which he did to about 20% of its capacity.

2. At 8.30am Mr. Rawson noticed a leak at the western end of GP922. There are different accounts as to who was informed of what and when (Ward, Visser and Rawson).[14]

3. At 8.29am (in response to an alarm) Mr. Ward radioed and told Rawson that GP1201 lean oil booster pumps had shut down. He asked Rawson to restart them. Rawson unsuccessfully attempted to do this. A check revealed a low level in the Oil Saturator Tank (GP1110) and, that as a consequence GP1202, had shut down as well. Rawson unsuccessfully attempted to restart all three using the starter buttons.

4. Mr. Rawson attended both GP1203A and B in response to being again contacted by Ward at 8.34am. On return to GP1201 and GP1202 he noticed icing on GP905, GP922, on the ROD outlet to GP905 and GP904 and on other pumps.

5. At 9.05am Mr. Ward told Rawson that he had restarted GP1202. Ward was unable to answer Rawson as to what the level the oil was in the ROD and there was no indication of the level in the control room. Rawson told Ward that he would inspect the level visually. However, he could not do this using a sight glass.

6. Mr. Ward then asked Visser for manpower but did not tell him of problems with the pumps (GP1201 and GP1202).

7. At 9.20am it appeared that GP502B had shut down. Mr. Rawson asked Ward whether there was enough level in the Crude De-Ethaniser tower to start the pumps feeding the GP502 boilers. Ward told Rawson that the level had dropped and that the lighting of the pumps would have to wait until the level returned.

8. At about 9.28am Mr. Rawson (after another discussion with Ward) said that he managed to start one of the GP1201 pumps and the GP1202 pump. However, charts show no indication that GP1201 was running but that there were two attempts to start GP1202.

9. Mr. Rawson was unable, using a sight glass, to determine the level of rich oil in Absorber B. Visser gave permission for Rawson to open the LC9B bypass valve. Later Visser opened the valve two more turns.

10. Mr. Rawson noticed smoke billowing from GP1202. Both he and Visser tried pressing the stop button but it did not shut down. Visser went to the switch building and tripped the breaker which stopped the pump.

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[14] See discussion Longford Royal Commission Report, p.50 et seq. Longford Royal Commission Report, pp.45-46

The Shutdown of GP1 and the Subsequent Restart of the Lean Oil Pumps - a chronology

The shutdown of GP1 and restart of the Lean Oil pumps is dealt with in point form. This shutdown and restart, chronologically leads to the rupture, explosion and fire:

1. Mr. Visser spoke to Kristeff, an electrical engineer about the GP1202 pump. Rawson informed Visser that the leak from GP922 was getting worse and both then observed that both ends of the vessel were leaking. Visser decided to shut down GP1.

2. Mr. Visser sought Kennedy's assistance and told Peter Wilson (the deceased) what was going on. Wilson telephoned Harrison to inform him of the leak and Harrison told him to ring Coleman in Melbourne. A message was left for Coleman, as he was not there.

3. At 11.35am Mr. Ward told Rawson to close the bypass on the level control valve at LC9B.

4. Sometime after 12.16pm production co-ordinator, Mr. Shepard saw ice on GP905 and, in order to reduce the flow of lean oil, asked Ward to close TRC4 so as to open valve 1 (at 12.20pm). Apparently Mr. Ward misheard the instruction, thinking Shepard said PRC4, and consequently made no adjustment to TRC4. Shepard said he realised that *`if the temperature got too low there was a danger that an impact could cause a brittle fracture.'*[15]

5. At about 12.25pm Mr. Shepard *`instructed Ward to "go for maximum output" on TRC4'* The Commissioners say that it *`was at or around this time that Shepard operated the HS4 switch. His motivation in doing so, was to try and get the TRC4 Valve 1 to open to minimise lean oil circulation through GP905. It would appear, however, that he was not sure what the outcome of operating of the switch would be.'* The Commissioners stated in *`all probability, it was only a moment or two after operating the HS4 switch that Shepard looked at TRC4 Valve 1 and observed the steam rising as the valve began to open.*' It was about this time that GP905 ruptured.[16]

Technical analysis of the failure

The Commissioners dealt with a range of technical issues that resulted in the eventual failure. In this document it is not intended to examine any of these issues in great detail, only to provide a summary of the principal conclusions.

One of the technical issues was the ***`Carryover from the ROD.'*** The Commissioners concluded that, in the absence of reliable chart recordings,:

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[15] Longford Royal Commission Report, p.59.

[16] Longford Royal Commission Report, pp.59-60.

`the precise cause of the high flowrate from the top of the ROD remains unclear. Nevertheless, on the balance of probabilities it appears that the ROD did carry over liquid (or condensable vapour) possibly due to the internal flooding. Liquid carryover occurred from sometime before 7.03am until after 8.19am when the GP1202 pumps stopped, depriving GP905 and the ROD of the heat required for vaporisation.'[17]

On the issue of the ***`GP1201 Pumps Shutdown'*** the Commissioners were of the view that of the possible alternate explanation the preferred one *`is that the LRC2 control valve did remain partly open despite the signal that it was at 0%.'* [18]

Another technical issue was the ***`Heat Exchanger GP922 Leak.'*** The Commissioners said that the coincidence of the leak of GP922 and the shutdown of the GP1201 pumps suggests that they either had the same cause or were initiated by the same event. They opined that:

`the initial leak of GP922 at the western flange was probably due to the change in thermal gradient when TRC4 bypassed the exchanger. Later leaks were caused by vertical temperature gradients at the eastern end. Both types of leaks were exacerbated by the leaking tubes within the exchanger.'[19]

The ***`GP1202 Pump Shutdown'*** was another issue in the trail of failure. The Commission explained that after GP1201 shutdown GP1202 was still pumping oil from the Oil Saturator Tank to the two absorbers at the top of the ROD tower. GP1202 then shutdown as a result of the low level shutdown switch operating when levels reached 14 percent. Although, vapour from the ROD then displaced enough liquid to raise the level in GP1202 to 25 percent permitting restart at about 9.05 am. Levels again dropped and the GP1202 pump was again stopped. The Commissioners noted:

`Despite the low level shutdown switch, the pump continued to run, and presumably lost suction when the level fell too low. It appears that there were some loose wires in the GP1202 motor control rack that prevented the circuit breaker from actuating. The pump became very hot and Visser was eventually able to shut it down by manually opening the circuit breaker' [20]

On the issue of the ***`GP1201 Attempted Restarts'*** the Commissioners found that, on the balance of probabilities:

`the most likely reason that the GP1201 could not be restarted was that they were vapour locked due to the flow of vapour back from the ROD through a partially open non-return valve.'[21]

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[17] Longford Royal Commission Report, p.83.

[18] Longford Royal Commission Report, pp.83-84.

[19] Longford Royal Commission Report, pp.84-86.

[20] Longford Royal Commission Report, p.86.

[21] Longford Royal Commission Report, p.90.

The Commissioners also examined the issue of the ***`Cool Down'*** of the various vessels. They concluded from the modelling that:

> *`within half an hour of the pumps stopping the entire ROD, GP905 were at -20°C and after an hour had cooled to -48°C and remained at this temperature for the rest of the morning.'*[22]

Finally, the Commissioners examined the technical detail of the ***`GP905 Failure'*** and thought that a significant flow of lean oil must have entered GP905 and it appears highly likely that the second attempt to restart GP1201 must have been at least partially successful. They concluded that:

> *`GP905 failed because of the combination of low temperature due to the earlier loss of lean oil circulation and the subsequent re-introduction of hot oil following restart of one of the GP1201 pumps.'*[23]

The Commissioners drew the technical issues together in the following concluding remarks. Apparently, events that occurred on 24th and the early morning of 25th September resulted in cold condensate *`overflowing from the bottom of Absorber B into the rich oil stream to the Rich Oil Flash Tank.'* That:

> *`this resulted in a decrease in temperatures in the Rich Oil Flash Tank, but, provided lean oil circulation continued, did not present a major problem. Sometime prior to 7.00am on 25 September, the ROD began to carry over additional material into its vapour line. It is likely that this was entrained liquid. The cause of this carryover has not been identified. It is known that in the past, excessively cold and light feed to the ROD has caused flooding, but the mechanism by which this occurs is unclear. Simulation shows that if the ROD internals were intact, the operating conditions on the morning of 25 September were a long way from the column's flooding limit. Although the exact mechanism of carryover is unclear, it is highly likely that carryover was the cause of the GP1201 pumps shutting down.*
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> *Once the level controller on the Oil Saturator Tank could not close its control valve any further, the level increased significantly. The discharge flowrate of the GP1201 pumps had been reduced to near to the low flow shutdown point, and eventually dipped below this trip point, causing the GP1201 pumps to shut down. The non-return valve on GP1201A stuck partially open, allowing cold vapour to flow back through the pump into the lean oil circuit. This vapour made restart of the pumps difficult until the flow from the ROD was interrupted during one of the restart attempts. Liquid then flowed back through the line from the elevated GP910 exchanger into the pump suction enabling the pump to be restarted. Residual vapour in the line continued to interfere with reliable pump operation.*

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[22] Longford Royal Commission Report, p.90.

[23] Longford Royal Commission Report, p.95.

By 9.30 am the ROD and its reboiler, GP905, had cooled to about -48°C under the influence of a continuing flow of cold, flushing condensate from the absorbers in the absence of heating from lean oil. When one GP1201 pump was eventually started around 12.17 pm, some hot lean oil entered the shell of GP905 and started to supply heat. As the tubesheet warmed up from its previous temperature, the stress in the circumferential channel-to-tubesheet weld increased until 12.25 pm the weld cracked and the exchanger failed catastrophically.' [24]

It is noted that the normal operating temperature of GP905 was in the vicinity of 100°C.

Metallurgical analysis of the failure in GP905

In Chapter 6 of the Longford Royal Commission Report, the Commissioners explained that the GP905 reboiler was a single tube pass shell and tube heat exchanger. Apparently, cold ROD tower liquid (demethanised rich oil entered the channel at the west end and was heated by the hot lean oil (230°C) on the shell side. The hot lean oil entered the reboilers shell at the east end and was cooled (120°C) as it flowed around the baffles to the west end.

Detailed examination and metallurgical tests indicated that the origin of the failure was a weld between the channel and tubesheet at the east end of GP905. It was a brittle fracture with localized ligament failures. The indications were that the failure occurred at a low temperature that was well below the normal operating temperature for the vessel.

The Commissioners concluded that GP905 failed:

`catastrophically due to brittle fracture with localized ligament failure. The internal pressure alone was not sufficient to cause the failure of the reboiler. On the balance of probabilities, the additional stress required to cause the failure arose from the temperature differences between the channel and the shell. The higher temperature in the shell was due to the introduction of hot lean oil resulting from the restart attempts of the GP1201 pumps.'[25]

Conclusion - the principal factors

The direct or proximate cause - A summary

The Royal Commission summarised the causes of the explosion and fire as being a:

`loss of lean oil circulation in GP1 occurred when the GP1201 pumps stopped. There was a failure to restart these pumps and they remained inoperative for some hours. The

[24] Longford Royal Commission Report, p.96.

[25] Longford Royal Commission, p.112. See detailed discussion pp.97-112.

consequence was that a number of vessels were deprived of a flow of hot lean oil which, if the plant had been operating normally, would have served to heat them. The purpose of those vessels was to exchange heat with cold rich oil flowing from the absorbers.

The absence of hot lean oil allowed the cold liquid from the absorbers to chill those vessels to a temperature in the vicinity of -48° C. One of the vessels involved was GP905. The reduction in temperature of that vessel caused the embrittlement of its steel shell. When hot lean oil was re-introduced into the vessel it ruptured by way of brittle fracture at its eastern end, releasing a volume of hydrocarbon vapour which travelled towards the area of the fired heaters where it ignited causing an explosion and fire. There followed further explosions as the initial fire impinged on the pipe rack at Kings Cross and caused pipes to fail.'

And, in commenting that more than one factor contributed to the *`tripping of the GP1201 pumps'* the Royal Commissioners also said, in effect by way of summary, that:

`High levels of condensate in Absorber B led to condensate entering the rich oil stream. This in turn led to an upset in the ROD which resulted in a heavy carryover of liquid and vapour from that vessel into the lean oil stream. As a consequence, the level in the Oil Saturator Tank was raised and the level controller for that vessel closed a level control valve to restrict the flow from the GP1201 pumps. This caused a low flow shut down switch in the lean oil system to shut down those pumps.'

The Royal Commissioners indicated that the *`inevitable'* conclusion was that the incident would not have occurred *`had appropriate steps been taken following the tripping of the GP1201 pumps.'* The Commissioners explained, in this context, that the *`Real Causes'* (or more proximate causes) were, when:

`efforts to restart those pumps proved unsuccessful, it should have been realised immediately that cold temperatures would ensue downstream from the absorbers and render vessels not designed to operate at low temperatures dangerous. Had this been realised, steps could and should have been taken to isolate the outlets of both rich oil and condensate from the absorbers in order to prevent those cold temperatures from developing in the ROD/ROF area.'

Unfortunately, as the Royal Commissioners explained, those:

`who were operating GP1 on 25th September 1998 did not have the knowledge of the dangers associated with loss of lean oil flow and did not take the necessary steps to avert those dangers. Nor did those charged with the supervision of the operations have the necessary knowledge and the steps taken by them were inappropriate. The lack of knowledge on the part of both operators and supervisors was directly attributable to a deficiency in their initial and subsequent training. Not only was their training inadequate, but there were no current operating procedures to guide them in dealing with the problem they encountered on 25 September 1998.'

Clearly, there were numerous individuals from managers and supervisors to operators working at the Longford Plant who performed as actors in the myriad of small events and errors which were developing over a period of days and that eventually lead to the disaster that is called *`Longford'*. All of these individuals did not have the required technical support, training and knowledge to enable them to understand what was happening and thus respond. The ability, resources and responsibility to deliver that technical support, training and knowledge was solely in the hands of the employer, Esso. Esso had systems but they were either not implemented or audited to ensure effective and ongoing compliance.

In addition, on the issue of individual contribution, even if the technical matters were well understood by the individual actors, there are elements of the incident that are not clear, for example the Commissioners found that:

> *`Sometime prior to 7.00am on 25 September, the ROD began to carry over additional material into its vapour line. It is likely that this was entrained liquid.* ***The cause of this carryover has not been identified. It is known that in the past, excessively cold and light feed to the ROD has caused flooding, but the mechanism by which this occurs is unclear. Simulation shows that if the ROD internals were intact, the operating conditions on the morning of 25 September were a long way from the column's flooding limit.*** *(Author's emphasis) Although the exact mechanism of carryover is unclear, it is highly likely that carryover was the cause of the GP1201 pumps shutting down.'*

And that the:

> ***`non-return valve on GP1201A stuck partially open, allowing cold vapour to flow back through the pump into the lean oil circuit.*** *(Author's emphasis) This vapour made restart of the pumps difficult until the flow from the ROD was interrupted during one of the restart attempts. Liquid then flowed back through the line from the elevated GP910 exchanger into the pump suction enabling the pump to be restarted. Residual vapour in the line continued to interfere with reliable pump operation.*
>
> *By 9.30 am the ROD and its reboiler, GP905, had cooled to about -48°C under the influence of a continuing flow of cold, flushing condensate from the absorbers in the absence of heating from lean oil. When one GP1201 pump was eventually started around 12.17 pm, some hot lean oil entered the shell of GP905 and started to supply heat. As the tubesheet warmed up from its previous temperature, the stress in the circumferential channel-to-tubesheet weld increased.'* [26]

From a coronial perspective, some of these issues serve to create an additional uncertainty in the area of construing the issue of individual contribution. Thus the actions of all of the individuals involved in the Longford incident can be generally seen as part of the evolving background circumstances to the incident.

A failure to `audit' for hazards in accordance with Esso's procedures - lack of a HAZOP for GP1

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[26] Longford Royal Commission Report, p.96 and see the Commissioners comment that *`the LRC2 control valve did remain partly open despite the signal that it was at 0%'* (Report pp. 83-84)

Significantly, the Royal Commissioners also earlier pointed to an audit process, which had Esso followed, would have, in all probability, identified the risk and led to appropriate countermeasures. As a precursor to explaining the problem it is necessary to look at the operation management system that was (and still is) in place at Esso - OIMS.

In the early 1990s with the introduction of Esso's `Operations Integrity Management System' (OIMS) a controlled document management system was developed under this overall management system. The controlled documents in this system did not identify the hazard associated with the loss of lean oil circulation pumps. There was no reference as to what to do with a loss of lean oil flow at the Plant. However, in an out-of-date book (the **`Red Book'**), there was an instruction which required the shutting down of the absorbers in the case of loss of lean oil flow. The `Red Book', which was not used in the operation of the Plant, and also it did not identify the hazards associated with the loss of lean oil flow. Clearly, the loss of lean oil flow was an issue that had previously been identified (albeit not in the OIMS documentation).

With this issue in mind, the Royal Commissioners commented that the:

> *`central importance of co-ordinated and planned hazard identification, assessment and control to the safe and efficient operation of a processing facility, is well recognised throughout the processing industry. Almost all modern processing operations have some form of risk management system designed to identify, evaluate and assess risks and create systems for their control.'*

Esso's OIMS system also identified this need when it said the *`identification, assessment, mitigation and control of risks is a necessary part of gas operations'* and that its system was *`intended to ensure these activities are undertaken.'* In addition, Esso said that the object of its:

> *`risk assessment and management system is to ensure hazards are identified and risks are evaluated through the life cycle of the operation.'*

And it recognised that:

> *`comprehensive risk assessment can reduce the risk or mitigate the consequences of safety, health and environmental incidents by providing essential information for decision making.'*

Esso's Risk Assessment Manual (RAMS) set out the company's risk assessment methodology. One of the methods was that of hazard and operability (**HAZOP**) studies. Also used were *`check lists and analyses based on the question "what if" '* The HAZOP studies occurred either prospective or retrospectively when *`the need appeared to identify particular hazards involved in the operation of the plants.'*[27]

[27] Longford Royal Commission. Comment of the Royal Commissioners, p.202.

As the Royal Commissioners stated the *`core ingredient of effective risk assessment and management is hazard identification.'* And the Commissioners drew attention that this fact was recognised by Esso's parent company in the United States, Exxon, in the Exxon Process Hazard and Operability Review, 1993 when it said:

> *`To prevent the undesirable consequences of accidents, one must firstly identify the hazards which can lead to accidents. Once the hazards have been identified, a major stumbling block to loss or accident prevention has been overcome.'*

The Commissioners said *`put simply, hazard identification creates knowledge.'*

Following the introduction of OIMS in the early 1990's Esso's procedures required the carrying out of retrospective HAZOP studies on all of its major existing plant (and for new plant). As the Commissioners stated GP1 was built long before this requirement. Other major Esso plants had retrospective HAZOP studies well prior to September 1998. A HAZOP study for GP1 was budgeted for in 1995, 1996, 1997 and 1998. It did not happen. The Royal Commissioners could find no satisfactory explanation for the failure to conduct the study.

Significantly, the Commissioners commented that a:

> *`HAZOP study of GP1 in accordance with Esso's methodology would have sought to identify "any significant route to process upset, operating problem or hazardous incident." the study would have systematically described and questioned each part of the GP1 process to identify what deviations from design intention could conceivably occur. It would have evaluated the causes and consequences of such deviations. It would have considered operability as well as safety. Not only that but the direction of the investigation would have been dictated by reference to guide words which included the words "high level", "low temperatures" and "no flow" '*

The Commissioners drew the conclusion that given *`this systematic approach it is inconceivable that a HAZOP study of GP1 would not have revealed factors which contributed to the accident'* on 25th September 1998. It would have revealed the consequences *`associated with the loss of lean oil flow'* and would have *`identified the procedures to be adopted in order to avoid dangerously low temperatures.'*

The Commissioners noted that Exxon's investigatory team (who were sent from the United States) in its draft report on the incident (called the **`McNeil Report'**) commented the *`lack of a detailed HAZOP for GP1 is considered a contributing factor to this incident.'* However the final report of the team did not refer to the lack of a HAZOP. Apparently there was no evidence called to explain the conclusion. The McNeil team did not return to the jurisdiction for the Royal Commission hearing.

In addition to the failure to conduct a HAZOP for GP1, there was another related audit issue that played a part. This was a failure to carry out a timely **`Periodic Risk Assessment'** (PRA). Before October 1996 PRA's were required to be conducted for existing plant.

Apparently sites were *`given priority so as to ensure that higher risk sites were more frequently re-assessed.'* GP1 was evidently given the highest priority requiring examination every three years. Following a rationalisation of the risk assessment system in 1996, the PRA's were to occur on a flat five-year basis for every site (irrespective of risk level). Apparently, there was a PRA for GP1 in 1990 and a limited PRA audit in 1994 (because a HAZOP was planned for 1995). The 1994 PRA stated:

> *`The assessment targeted higher level risks, and was designed to complement forthcoming other more detailed studies, such as HAZOP, and QRA. It is understood that a detailed HAZOP study of Gas Plant 1 is proposed for mid-1995. Therefore the focus of this risk assessment was on analysing and identifying areas of risk not previously identified, or those not likely to be covered in the detailed HAZOP analysis.'*

Thus the 1994 PRA study was *`directed away from process-related hazards and concentrated on hazards caused by mechanical equipment failure and operator error.'* The scenarios relating to the *`consequences of "low temperatures", "high level" and "no flow" were not used.'*[28] As indicated, before October 1996 a PRA was proposed for GP1 every three years and on that basis there would have been this form of audit at the plant in 1997. The October 1996 alteration to the frequency of such examinations meant that another PRA would occur in 1999.

The Commissioners concluded that the failure to conduct a HAZOP, the limitation placed on the 1994 PRA and the postponement of the 1997 PRA:

> *`meant there was no identification of major hazards for GP1 and, in particular, no identification of the hazards which revealed themselves on 25 September 1998. Notwithstanding the high aims of OIMS, no formal hazard identification or structured risk assessment of any kind took place in GP1 after 1994.'*

And, as a result the *`hazards would remain unidentified and uncontrolled.'* Had it undertaken the audits in accordance with its procedures, Esso would have *`acquired knowledge of those hazards, which as it transpired were critical.'* As the Commissioners said this *`knowledge would have been disseminated by way of training, the development and use of procedures and the adoption of protective control systems.'*

The Commissioners concluded that the *`failure to conduct a HAZOP study of GP1 contributed to the disaster which occurred on 25 September 1998.'*

It is also noted that on the issue of the HAZOP, Mr. Justice Cummins in *DPP v Esso Australia Pty. Ltd.* [29] said:

> *`Esso had in fact conducted a hazard identification, namely a Hazop, on Gas Plant 2 and on Gas Plant 3, but failed in that period to conduct one on the oldest part of the plant, Gas*

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[28] Longford Royal Commission, pp.204-05.

[29] [2001] VSC 263.

Plant 1, and failed to do so even in the face of Exhibit 12B before me, Exxon's instructions to Affiliates to conduct a retrospective Hazop on plants more that 20 years old. Gas Plant 1 commenced operation in 1969. The identification of hazards in a major hazard installation is obvious and fundamental.'

And on the issue of the 1994 PRA study Mr. Justice Cummins said that Esso:

`did in fact conduct a risk assessment in December 1994, but that it was neither timely for 1998 nor comprehensive, and was self-limiting because it anticipated the Hazop which was budgeted for, but never occurred on Gas Plant 1.'

Other factors - Management of Change; Communication Controls; Incident Reporting

The Royal Commission also dealt with other factors relating to the incident. These were considered under the headings `Management of Change', `Communication Controls' and `Incident Reporting.' The following is a summary of these factors.

Management of Change

In the area of `Management of Change' the Commissioners considered Esso's 1993 philosophy that recognised change was *`necessary and desirable'* and that *`changes potentially invalidate prior risk assessments and can create new risks, if not managed diligently.'* But the Commissioners pointed to the fact that OIMS did not make any attempt to *`define the breadth or scope of any risk assessment study to be undertaken to comply with management of change procedures.'*

In 1992 one of the changes related to condensate transfer from GP1 to GP2. A modification resulted in an additional flow path for condensate from the lower section of the GP1 absorbers to the GP2 Demethaniser. This resulted in a more efficient recovery of ethane. A hazard identification study of the effects of this modification concentrated on the effects on the transfer process and did not evaluate the impacts on vessels downstream in GP1. Further, modifications in 1993 and 1996 to overcome operational problems were not subjected to any hazard identification study.

In 1997 additional modifications were proposed by consultants (Shedden Uhde) to overcome *`flow meter measurement problems occurring in the condensate transfer line.'* [30] The hazard study following this modification *`identified the potential for process upsets to cause carry over of condensate from the absorbers into the rich oil stream but again, the study did not examine the potential impact of this carry over on existing vessels in GP1. Instead, the study dismissed this phenomenon as not significant.'* These modifications (automatic valve adjustments - required to initiate and terminate condensate transfer) did not work as planned and revised procedures (manual manipulation of valves by operators) were adopted. These revised procedures were not made the subject of any risk assessment. Thus by September

[30] Longford Royal Commission, p.207.

1998, operators were *`transferring condensate to GP2 for product recoveries without a full understanding of the potential hazards associated with the process.'* [31]

As indicated, the relocation of Plant Engineers from Longford to Melbourne was also a problem. The Commissioners said that prior to 1991 engineers worked at the plant on a daily basis and thus:

> *`had a close involvement with the ongoing operation of the plant and constant interaction with operations personnel. This placed them in an ideal position to monitor the plant operating conditions and operator practices.'*

And that the expert knowledge of engineers:

> *`of plant operating parameters, of the metallurgical limits of equipment and vessels in GP1 and of the consequences of cold temperatures resulting from loss of lean oil circulation in the ROD/ROF area, were absent.*

Also in 1993, 1996 and 1997 there were changes to the roles of Operators and Supervisors with the result that they assumed *`a greater responsibility for the day to day operation of the plant, including troubleshooting to overcome process irregularities.'* There was also a reduction in the number of plant supervisors. There was no risk assessment for this change.[32]

In conclusion, there were a number of significant changes in operating processes, staffing and procedures at GP1 from the early 1990's until the incident in September 1998. Here, Esso's own words are apposite *`changes potentially invalidate prior risk assessments and can create new risks, if not managed diligently.'* It is clear that the relevant risk assessment processes in these areas of change were either inadequate or not conducted.

Communication Controls

The Royal Commissioners broadly commented that safe and efficient operation depends upon the *`dissemination of information and knowledge amongst those involved in the operation of the plant.'* Evidently OIMS was designed to ensure transfer of knowledge. It did not work as planned. There were other protective systems such as alarms which were meant to ensure that information about process came to the attention of the plant operators.

The Commissioners noted by way of general criticism:

> *`Also important in the operation of a processing facility is the existence of some means whereby the operation of the plant and practices of operators are systematically monitored to eliminate unsafe or efficient operations. There was no evidence that any system existed at Longford for the regular monitoring of operating conditions or operating practices.'*

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[31] Longford Royal Commission, p.208.

[32] Longford Royal Commission, pp.209-210.

As to handovers between shifts, the Commissioners noted that the relevant work manual required a verbal handover and the completion of log book entries. In practice it appeared that on handover there were verbal discussions but *`without any real effort to convey problems or discuss the content of log entries.'* Apparently there were shortcomings in the shift handover at the critical day shift on 25th September. For example, the alarm system indicating high levels of condensate had been acknowledged prior to shift change over and this fact was not given to the incoming operator. Also, in practice log books had only limited entries on process information and these issues often received *`scant attention.'* Log entries were often *`confusing and incomplete.'* The Commissioners also noted that:

> *`The log book entries made by the GP1 Panel operators leading up to the accident on 25 September 1998, did not contain any reference to the abnormal process conditions occurring in Absorber B. These conditions had been occurring almost constantly from the afternoon of 23 September until the accident.'* [33]

The Commissioners pointed to the failure of the outgoing panel operator on 25th September to inform the incoming operator of *`not only the cold temperatures in Absorber B, but about the off-scale levels of condensate in that vessel.'* Both of these conditions had existed for some time. The outgoing operator's log book entries were also not informative on these issues. The night shift supervisor, who was also involved in managing the difficulties, did not communicate the difficulties to the incoming shift supervisor.

The Commissioners noted that the log books were not the subject of any monitoring by management at Longford or from head office in Melbourne (Southbank).

Also alarms were connected to instrumentation control loops at the plant. The purpose of the alarms were to:

> *`facilitate safe and efficient plant operation by warning operators when process conditions within vessels or equipment strayed outside normal operating parameters.'*

The Commissioners found that, in the GP1 control room, it was *`common for a large number of alarms to be active at any one time'* and that many of these alarms *`were nuisance alarms activated because the process variable monitored by the alarm was operated at the upper or lower end of its operating range and was constantly moving in and out of alarm range.'* In particular, as a result of the modifications in 1992, to enable ethane to be recovered more efficiently, the transfer was taking place at a lower temperature than normal (-20° C to -25°C instead of -10°C). This resulted in alarms operating regularly - which was tolerated by operators. One operator indicated that there were an inordinate number of Absorber B high level alarms, which was not unusual. It was considered that an absorber could run at a *`high level for hours and did so on occasions.'* This particular operator ran the absorbers at high level on the night before the incident and *`saw no danger associated with the practice.'*[34] The

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[33] Longford Royal Commission, p.212.

[34] Longford Royal Commission, p.216.

operator noted that it was *`quite common for the TC9B override alarm to be active for periods during the shift and for the plant to be run with TC9B in alarm.'* The operator regarded these alarms as a normal situation and he *`was not aware that such high levels could be dangerous.'*

Apparently, the practice of operating the absorbers in alarm occurred over a number of shifts in the days leading up to the incident. The Commissioners noted *`that well before the accident, panel operators had become accustomed to the frequent occurrence of alarm conditions at the base of the absorbers.'* The alarms were so frequent as to be regarded *`as a nuisance rather than a warning of process upsets requiring attention.'* The Royal Commission was of the view that this went some way to explain why it was not mentioned between operators on shift change over.

The Commissioners concluded:

> *`Operators would, no doubt, have reacted more appropriately to high levels in the absorbers had they appreciated the potential for condensate carryover and the dangers associated with cold temperatures. But even with this understanding, operators did know that operation of the plant for any length of time in alarm generally carried risks with it.*
>
> *There was no evidence of any system to give priority to important alarms. Good operating practice would have dictated that critical alarms be identified and given priority over other alarms. It would also have dictated that operators be informed of the correct way to respond to process upsets identified by the occurrence of critical alarms.*
>
> *The lack of any system of priority for critical alarms may explain why Ward failed to respond properly or adequately to the activation of the LFSD8 alarm at 8.20am on the morning of the accident. The alarm, which warned of a low flow shut down of the GP1201 pumps, was critical because it warned the operator of loss of the protective lean oil circulation system. Yet it was apparently ignored by Ward. Moreover, there were no procedures to assist the operator to respond to such loss of flow'*

The Commissioners were also critical of the control room monitoring of operating conditions at the plant. The process charts and the Bailey system were a potentially valuable source of process information. They could have been used to analyse process trends or patterns and identify potentially unsafe conditions. They said:

> *`the evidence before the Commission indicates that such records were not used as effectively as they might have been in GP1. Indeed it is possible that their ineffective use played a part in the occurrence of the accident on 25 September 1998.'*

In addition, charts once used were not retained. Thus they were not reviewed over time for trends.

Apparently, one engineer had monitored the charts in the 1970's but some time after the relocation of the engineers to Melbourne in 1992 there was a Plants Surveillance Group established. However it did not undertake off-site monitoring or surveillance of ongoing

process conditions. Typically, it was engaged in specific engineering projects. The Commissioners made the point:

> *`Following the relocation, the plant engineers based in Melbourne made frequent visits to the Longford Plant so that some opportunity for surveillance activities existed. However, these occasions were obviously more limited than the opportunity presented by the constant exposure of onsite engineers to plant operations and to operations personnel. Off-site engineers do not have the same opportunities for day to day close contact as did no site engineers.'*

And:

> *`The consequences of the relocation of plant engineers to Melbourne was that the important task of continuous monitoring of process conditions within the Longford facility was diminished. Moreover, what was done was no longer carried out by plant engineers. Instead, it was undertaken almost exclusively by operators and plant supervisors whose surveillance work was focused on immediate production requirements rather than trend analysis or the analysis of recurring process problems.'*

Finally, the Commissioners were of the view that the lack of use of the charts for ongoing analysis and evaluation of process trends within GP1 diminished the likelihood that the upsets (operating conditions in the absorbers or condensate carryover) would be detected. Had regular surveillance been undertaken by qualified engineers:

> *`warning signals relevant to the accident (low absorber operating temperatures, high condensate levels, frequent TC9B interference with level control, the occurrence of condensate carryover, operation "in alarm") would, in all likelihood, have been identified.*

And:

> *`the absence of regular monitoring of process operations by senior personnel in a high pressure hydrocarbon processing plant, which was not equipped with protective devices to make it completely fail-safe, exposed that plant to unacceptable risk.'* [35]

Incident Reporting

OIMS recognised the importance of effective incident reporting by stating that incident investigation, reporting and follow up provides *`the opportunity to learn from incidents and to use the information to take corrective action to prevent recurrence.'* The process for incident reporting was set out in Esso's Safety Management Manual and commented that all incidents *`no matter how minor'* are to be reported. **`Near miss'** incidents were also defined in Esso's manual as *`an unintended or unwanted event or circumstance which under slightly different conditions would have resulted in an incident.'*

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[35] Generally see Longford Royal Commission Report , pp.210-220.

However, in spite of these procedures which were wide enough to require personnel to report a process upset, in practice this was not done. The obligation to report was construed narrowly by Esso's management and operations personnel. The Commissioners commented:

> *`process upsets were rarely, if ever, the subject of an incident report, unless they were accompanied by injury to persons or damage to property.'*

An example of the lost opportunity to learn was the failure to report an incident on 28th August 1998. The Commissioners were of the view that this incident was similar to the events leading to the explosion and fire on 25th September. There was a loss of lean oil flow but because of reduced gas flow, a small flow of cold fluids, the fact that heaters were left on during shut down, the fact that the vessels did not reach temperatures low enough to result in embrittlement (i.e. below -27°C) and an orderly shut down process occurred. This particular incident did not result in a catastrophe.

Significantly, the incident on 28th August was not reported. The Commissioners were of the view that it should have been reported. In their observation the Commissioners were yet again critical of Esso's management:

> *`Had the incident on 28 August 1998 been reported as it should have been, the danger of equipment becoming subject to dangerously low temperatures upon loss of lean oil flow for any length of time would, in all probability, have become known as would the steps available to avert the danger. The failure to report this incident thus stands as another example of a failure in Esso's implementation of its management systems.'* [36]

Contribution to the deaths and fire

Esso Australia Pty. Ltd. contributed to the deaths of Peter Brubeck Wilson and John Francis Lowery. Esso also contributed to the fire.

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[36] Longford Royal Commission, p.222. This is not the only case of a failure to learn from an incident. See for example the fire on Esso's 'Tuna' Offshore Oil Platform in the Bass Strait on 24th April 1989. Lord Cullen's interim report on Piper Alpha was distributed to the petroleum industry prior to the Tuna fire. The circumstances of the Tuna fire were not dissimilar from the Piper Alpha Disaster in the North Sea on 6th July 1988 (Coroner's finding on the Tuna Fire attached).

COMMENTS AND RECOMMENDATIONS

The view of the families on occupational safety

The families in their submission to the Coroner conclude by saying:

> *`The Wilson family and the Executor of John Lowery applaud and commend any positive actions taken by Esso to prevent the occurrence of any similar event, either at Longford or elsewhere. In doing so they say to the company, (and indeed any and all persons who are responsible for the safety of workers), that no cost is worth the loss and grief they have had to endure, and that no compromise should be made or accepted in ensuring that the place in, or the processes with which they require persons to work, are safe.'*

This should be the underlying moral philosophy combined with a balance of practical application operating in all work places.

The application of this philosophy requires an employer to have constant vigilance, commitment and an ongoing corporate memory and ethic that refuses to forget the lessons of history or compromise the goal of safety. Employees too, need to commit to providing information that assists employers, by identifying potential problem areas for the employers in the safe operation of systems.

Comments and Recommendations of the Royal Commission on `safety'

The Royal Commission made a range of recommendations with *`safety'* in mind (it was also concerned with another parallel issue - the continuity of gas supply). The Commission was of the view that:

> *`reliance on OIMS to achieve a safe working environment in GP1 on 25 September 1998 was misplaced. The Commission is of the view that external obligations of a detailed and comprehensive kind (albeit identified by Esso itself) should be imposed upon Esso in order to avoid the repetition of an accident such as occurred on that day. Those obligations must be monitored to ensure that they are met and that aims similar to those expressed in OIMS are achieved in practice.'*

And:

`Esso should also be required to demonstrate that its operating standards, practices and policies are periodically reviewed and that the documentation of each identified.'

The Coroner's process has also identified other cases where operating systems which are designed to *`achieve a safe working environment'*, although documented, were not effectively used (i.e. the Linton Wildfire).[37]

The Regulator's response to the Royal Commission

As a result of the recommendations of the Royal Commissioners, a *`Major Hazards Division'* has been established within WorkSafe which now has the power to regulate the operation of major hazard facilities. Such a facility is defined in Regulation 104 of the *Occupational Health and Safety (Major Hazard Facilities) Regulations 2000*. It is a facility *`where prescribed materials are held in quantities exceeding "threshold quantities" or determined to be a facility by the Authority if it forms the opinion that there is a potential for a major incident to occur. '*

The Major Hazards Regulations have *`the objective of providing for the safe operation of major hazard facilities'* in order to:

`(a) reduce the likelihood of a major incident occurring; and
(b) reduce the consequences to health and safety and damage to property in the event of a major incident.'

The submission of WorkSafe indicates that the Regulations *`embody the generally accepted international model of Safety Case'* and that the *`key requirements'* of these Regulations include:

- *implementing a comprehensive safety management system;*
- *identification of all major incidents that may occur and the hazards that may cause major incidents;*
- *assessment of risk associated with major incident hazards*
- *adoption of control measures to eliminate, prevent, mitigate or reduce, so far as is practicable, risk to health and safety;*
- *preparation of emergency plans in conjunction with local emergency services and municipal councils;*
- *consultation with employees and health and safety representatives in all relevant matters; and*
- *provision of safety information to local communities and consultation with municipal councils in relation to matter that could affect the local community.*

Esso's approach to safety following the incident at Longford

[37] Finding into the deaths of five volunteer fire-fighters during a wildfire at Linton in 1998 (Coroner's Case Numbers 3656/98 to 3660/98) at p.597.

Introduction

Certainly, since Longford, there have been considerable improvements in the overseeing safety systems as applying to major hazard facilities. In its submission to the Coroner, Esso has documented a raft of improvements that have been put into place since the incident in September 1998. It is to be commended for this work. In addition, the WorkCover Authority (WorkSafe) and the Country Fire Authority, in submissions, have identified a range of systems improvements.

The WorkSafe submission places Esso's submission in its context when the Regulator states (in response to Esso's comment *`all indications are that Esso is progressing on schedule to achieve its objectives and that Esso will be issued a MHF licence towards the end of 2002'*) that, as *`Esso's application is currently being assessed, it is premature to comment at this stage regarding the outcome of this process.'*

Esso's summary of its work since the incident

Esso provided the Coroner with an *`Executive Summary'* of the work undertaken post Longford. The summary is as follows:

1. *Immediately following the hydrocarbon release and fire ("Longford Fire" or "Fire") at Gas Plant 1 ("GP1") on 25 September 1998 Esso's initial priorities were to assist those who were injured (and their families and those of the deceased) and to secure the facilities at Longford ("Longford Plants") to ensure the safety of all personnel in and around the site.*

2. *Having secured the Longford Plants, the next priority was to determine the safest means to restore a reliable gas supply to GASCOR. Esso quickly mobilised management, technical and operational teams to assess damage to the plant and then to determine the safest and most effective method of restoring gas supply capability. These teams subsequently designed and implemented repairs that enabled safe resumption of gas supply to GASCOR 9 days after the Longford Fire.*

3. *Following the initial emergency response and restoration of gas supply, Esso's response to the hydrocarbon release and fire at Gas Plant 1, and to the observations of the Royal Commission, can be categorised into a number of major programs of work, namely:*

    - *The near-term response completed by the Longford Restoration Team ("LRT") activity which undertook the work required immediately following the Fire and prepared the Longford Plants to safely meet gas delivery obligations to GASCOR corresponding with its peak gas demand in winter 1999. The LRT also restored the processing capacity of the Longford Crude Stabilisation Plant.*

- *Subsequently, a Continuous Improvement Initiative ("CII") was undertaken which reviewed in detail Esso's operations and integrity management systems and procedures. Three CII teams were formed. These teams were directed to address the findings and recommendations of the Royal Commission Report and to implement any other improvement initiatives that would add significantly to the safety and integrity of operations at Esso's sites. Work programs were implemented to ensure all observations and recommendations identified in the CII were appropriately addressed. The three CII teams were organised to address three broad subject areas, namely: risk assessment, operating procedures and training, and supervision and engineering support. Detailed work programs were developed, managed and implemented within each of these areas.*

- *The longer-term operational response completed by the Longford Project Organisation ("LPO") which included implementing the various Continuous Improvement Initiatives, the restoration of GP1 and the restarting of the GP1 lean oil system (containing significant modifications to the system that existed on the day of the Fire) in May 2002. The LPO also made modifications to the other facilities at the Longford Plants and enhancements to its systems and processes designed to enable it to continue to operate safely, efficiently and in conformity with new regulatory requirements into the future.*

- *The development of a "Safety Case" in response to the requirements of the Victorian Major Hazard Facilities Regulations (which arose out of a recommendation made by the Royal Commission to adopt a Major Hazard Facilities and safety case regime in Victoria).*

4. *Esso's priority in responding to the Royal Commission's Report has been to acknowledge and constructively assess the observations and recommendations and implement positive responses to each of them.*

5. *During 2003 Esso expects to complete all work required to restore the Longford Plants (including addressing the issues arising from the recommendations of the Royal Commission) and to complete a range of enhancement projects not directly associated with the events of 1998. By that time, approximately A$500 million will have been spent on these activities since September 1998.*

The balance of the submission contains a number of key points. It is noted that Esso's submission on the work it has undertaken is a lengthy document and it is intended, in the comments and recommendations to refer to some of the key areas. In a covering letter with the submission to the Coroner, Esso notes that it *`has always considered safety to be the most important priority in everything'* it does. Esso has *`therefore been resolute in its efforts to address and build on the lessons learned from this tragic event in a positive and constructive way.'* Further it notes that this has resulted in:

`extensive assessment and enhancement of operating systems, procedures and training as well as significant engineering work to ensure, as far as possible that such an event does not recur.'

This approach is commendable.

Emergency planning and management

Introduction

The Country Fire Authority (CFA) also provided the Coroner with a detailed submission on the issues that it has been involved with both before and after Longford. It is not intended to examine these issues in detail as they are contained in the full text of the submission by the Authority. The following is a brief overview.

It is trite to say that preventative activities, emergency planning and management is an important aspect of running a potentially hazardous facility. That preventative work and planning for potential disaster must be undertaken with full knowledge and in co-operation with the responsible authority (in this case the Major Hazards Unit and the CFA). Without full knowledge and co-operation between the operator and regulator there is greater potential for issues to be missed or mitigation activities to go awry and not achieve the best outcome in the circumstances.

The CFA and Esso

Since the Longford incident there have been significant improvements in issues associated with emergency planning and management by virtue of co-operative work on these issues between the Country Fire Authority (CFA) and Esso. The CFA has also assisted Esso in its work which is aimed at complying with the Recommendations of the Royal Commission.

Obviously there are common issues between the Company and the Fire Agency with the emergency response that developed immediately after the incident and its aftermath. Apparently the CFA has also been involved with Esso in developing the Emergency Response Procedures for the *`Safety Case'*. For example it has been involved in developing *`Emergency Plans.'*

The CFA has developed a Memorandum of Understanding with Esso on *`Joint Response to Fires and Emergencies in the Longford Gas Processing and Crude Oil Stabilisation Plant.'* It sets out the relevant expertise of each agency and an agreed and documented notification procedure. It provides for *`a co-operative approach whilst acknowledging the responsibilities imposed on the CFA under the Country Fire Authority Act 1958.'* A formal notification system has been developed for any failure of the fire detection, suppression or detection equipment at the Plant. Also if the equipment is out of service or no longer capable of providing the required level of service notice to the CFA is required.

The CFA was also involved in commenting on a *`Fire Safety Study'* that was required to be undertaken by the Company as a precursor to restarting the Plant after the incident.

The CFA and Major Hazard Facilities

Since the incident at Longford the CFA also indicated that it has worked with the Regulator and Esso to ensure *`it is kept up to date with developments towards managing fires in major industries.'* It has also been included (with the Melbourne Fire and Emergency Services Board [MFESB]) in the Memorandum of Understanding with other Major Hazard Facilities. Officers from both these fire agencies have been seconded to the Major Hazards Unit of WorkSafe. It has also introduced a performance review system for the evaluation of its performance during the management of an incident. The CFA's Community Safety Directorate also has Fire Safety Officers at Area Level and the duties of these officers include:

> *`managing statutory referrals from other government and local government agencies and submissions seeking approvals and recommendations from companies such as Esso which operate major industrial facilities.'*

Coroner's recommendations

> *`no one incident, even one as disastrous as that on Piper, can point up more than a few important improvements in onshore safety. Equally in practice exactly the same accident hardly ever repeats itself, so management needs to address the spectrum of possibilities and not just seek to prevent recurrences.'* [38] *(Lord Cullen in the Public Inquiry into the Piper Alpha Disaster Report, 1990)*

Obviously, since Longford there has been a raft of improvements in relation to the safe operation of Esso's plant at that site. However, there are some additional protective suggestions potentially *`addressing the spectrum of possibilities'* that may be usefully added to the new safety systems run by the Regulator and Esso. In effect, the following suggestions should be regarded as enhancements to some of the points in Esso's submission to the Coroner.

Esso is developing a *`Safety Case'* for the operation of its Plant in accordance with the requirements of the regulator. The development and implementation of an effective *`Safety Case'* is but one of the major protective systems aimed at reducing the risk of disaster in a potentially hazardous industry. By adding to its work developing the *`Safety Case'* Esso appears to have recognised this fact.

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38 Lord Cullen, *`The Public Inquiry into the Piper Alpha Disaster'*, Volume Two, London HMSO Cm 1310, para. 18.3, p.291.

It is noted that Esso has now undertaken a HAZOP review for Longford Plant Number 1. No doubt, had this type of audit been thoroughly undertaken well before September 1998, in accordance with the Company's pre-existing procedures, there was a real prospect that the potential hazard with cold temperature operation would have been identified, and provided rectification was undertaken, the incident at Longford would not have occurred. Therefore the importance of regular thorough audit aimed at identifying potential hazards and reviewing the operation of systems for safety cannot be underestimated. Longford should send a clear message that the failure proactively audit can result in hidden but potentially identifiable hazards eventually leading to disaster, causing injury, death and, perhaps the failure of a business.

The role of Audit - `hunting for errors' in a background of no-blame

The use of regular and pro-active audit of safety and operations systems is vital for the safe operation of the type of work undertaken at Esso's Longford Plant. In this regard, it is important that any audit process be dedicated to ***`hunting for errors'*** in operational and safety systems. The discovery of any error in a system should be regarded as an **achievement** (provided rectification is undertaken in a timely way or where a problem is identified appropriate steps are immediately taken to render the operation and system safe). Even if the finding of an error results in plant shutdown to avoid the possibility of failure, the discovery should still be considered in a positive light. In order to maximise the potential to identify problems this type of audit system should operate within a *`no-blame'* culture.[39] *`Hunting for errors'* in operational and safety systems would, as Lord Cullen has said, begin a process aimed at identifying and addressing *`the spectrum of possibilities.'*

This issue has been extensively canvassed in the inquest into the deaths of five volunteer fire fighters in the 1998 wildfire at Linton. It is not proposed to repeat the argument in favour of such an audit system as it is covered in some detail in the Linton Findings (Chapter 23, p. 643 et seq.). Such a system has similar application to a potentially hazardous operation like a gas plant. The consequences and lessons of the Longford explosion and fire provide the essential reason for audit processes constantly *`hunting for errors'* in systems to be adopted for this type of operation.

As we have seen the consequence of even a small failure (or series of failures) in the safety and operational systems can be catastrophic. The failure to undertake an audit (which Esso calls `HAZOP') is at the core of the problem that eventually beset Esso in September 1998.

WorkSafe notes, as part of its submission to the Coroner that the scope of Esso's 2002 internal Operations Integrity Management System (OIMS) audit indicates *`a more focused approach to auditing and suggests that Esso is looking for errors which may occur in its systems.'* This approach should continue.

Recommendation 1

[39] See also Kevin Gallagher-Green (Coroner's Case No. 1207/93) where the issue of investigating for factors that result in incidents (beyond blame). Finding attached.

*That Esso ensure that its audit processes are based on a philosophy of pro-actively **`hunting for errors'** in operations and related safety systems and provide that such audit be regularly conducted in the context of a `no-blame' culture.*

*The discovery of any `error' in systems should be considered as a major **achievement** for the audit process, the organisation and by those individuals involved in recognising and drawing attention to the problem. The discovery of an error in the system should then lead to countermeasures.*

Enhancing a non-blame based reporting culture - a `Confidential Worker Safety Reporting Scheme'

For the purpose of identifying safety or system problems before these issues develop to contribute to an incident that may cause economic loss, injury or death it is essential to develop innovative systems to encourage reporting of all problems. By way of example, the Australian Aviation Industry uses anonymity to encourage the reporting of aviation related incidents.[40] The aim of this system is to ensure as many safety related incidents as possible are reported so that the lessons can be identified and safety within the industry can be improved.

Traditional systems currently operating within Victorian workplaces do focus on incident reporting and discussion of potential safety problems following an event or identified system/product problem (i.e. compulsory incident/near miss reporting systems and Occupational Health and Safety Committees). However, there is still a risk in any workplace that workers may not report near miss incidents or safety related problems for any number of reasons, including: embarrassment or fear of approbation of fellow workers; thinking that the issue is far too minor to report; fear of being disciplined or losing a job, etc. An anonymous reporting scheme like that used by the Aviation Industry might be a useful addition to ensure that all potential problems are captured. Also management should not be excluded from contributing to this type of reporting scheme.

Any anonymous incident (and `near miss') reporting scheme should be carefully developed to ensure that criticisms of individuals are not encouraged, as the primary purpose of the scheme should be aimed at capturing safety related systems problems and not criticisms of individuals.

With this in mind it is suggested that Esso (in conjunction with the Peak Unions) establish, for the want of a better phrase, a *`Confidential Worker Safety Reporting Scheme'*, where the reporting of a problem to the scheme is anonymous and designed to encourage the identification and recording of all incidents or problems that may potentially effect safety. Such a scheme should operate in conjunction with (and not in substitution for) the more traditional Audit processes, required `near miss' and incident reporting and Occupational Health and Safety Committees.

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[40] It may be useful to contact the Australian Transport Safety Bureau for details of its anonymous incident reporting system (`CAIR' - Confidential Aviation Incident Reporting).

To be effective any such scheme should be well resourced, workers should be well aware of its potential, its limits and have confidence that the identity of the supplier of information will be kept confidential. Workers would also need to know that any information gathered is being used for safety, therefore it is essential to provide regular reports of issues discovered and resolved as a result of anonymous reporting.

It may be advisable to establish a small committee made up of representatives of the Company and Unions with an independent Chair to ensure that such a scheme reaches its potential and does operate anonymously.

Recommendation 2

That Esso consider establishing (in conjunction with the Peak Unions) a `Confidential Worker Safety Reporting Scheme' which operates anonymously, as an additional mechanism, to help ensure that all incidents and near misses and any safety related problems are reported, recorded and used to improve safety in Esso's operations.

Esso should regularly report to its workforce the problems identified and solutions implemented as a result of such a scheme. The reporting should not compromise anonymity.

The importance of the role of the on-site engineer and corporate memory

There is little doubt that the lack of on-site engineering support contributed to the disaster. Whilst Esso's submission recognises the criticism of the Royal Commission on this issue its response is not clear as to the precise level of support physically offered at the Plant. Esso states that it established a Longford Restoration Team, which is working on the hazards identified by the HAZOP and that:

> *`Engineering groups within Esso will continue to undertake significant work and expenditure to resolve HAZOP findings not addressed by other major facility modifications at the Plants.'*

Esso also states that in response to the Royal Commission recommendations concerning *`engineering response system'* (and other recommendations) it formed project teams to implement *`continuous improvement initiatives'* (called `CII'). It has provided a *`Longford Supervision and Engineering Support Review Charter'* which details a number of points to be addressed as a result of the Royal Commission criticism and notes that the focus of Esso's review *`will be towards supervision and support at the Longford Plant' but also `improvements may be proposed for the consideration of other sites.'* In part of the document it does state that the review will:

`Examine the expectations for engineering support, including, frequency of site visits. Tenure and experience of resources, accountability and back up. Consider formalising surveillance engineering roster arrangements for operating sites. Address how much time to spend validating critical aspects of operations (level of interaction with operators).'

Esso notes that particular criticism was made by the Royal Commission of *`the coverage, responsibilities and communication processes of the supervision, and the access to, location and surveillance by engineering personnel supporting the operations at the Longford Plant. '*

Rapid availability of senior professional engineering knowledge of a potential for materials or systems failure in the context of a complex and critical operation like Longford ought to be a vital tenant for Esso's safety systems. That availability ought to be on site and well resourced with the professionals involved having corporate and detailed knowledge of the plant and its potential problem areas. On site engineering support in a plant that is constantly operating should be *`around the clock'* availability, accessible to all staff working at the plant. Any handovers between shifts by engineering professionals should be thoroughly documented and, where problems are potentially emerging or remain to be rectified, contact numbers for the retiring engineering shift staff should be available for future discussion, if required.

Obviously, support for those engineers working at the Plant from a central engineering team stationed at Southbank (Head Office) is important. However, nothing can replace the direct, hands on knowledge, understanding and relationships that can be built with on site, continual and approachable senior engineering support. As indicated, that support must be readily accessible to all operators working at the Plant. This engineering support also must be available on a 24-hour basis, seven days per week, as the plant operates on that basis and systems failures do not respect time schedules. This does not appear on the available documentation to be the focus of Esso's work on this issue.
Significantly, WorkSafe notes, as part of its submission to the Coroner that Esso's roster for Longford ensures *`Surveillance Engineers are present on site Monday to Friday during normal working hours'* and that *`Esso has advised WorkSafe that there is also a callout roster for after hours access to engineers.'* WorkSafe notes, that whilst this *`addresses the `formal' requirements for engineering presence on site'* it:

`may not allow informal relationships to be formed if the Surveillance Engineers are rotated too frequently'

Thus the level of support of the on-site engineering team would appear to have significant limits which may need to be **further addressed** by Esso and the Regulator.

Significantly, WorkSafe underscores the importance of on site engineering support when it discusses the requirement of the Safety Case regulations for the operators to develop *`a role for employees in hazard identification, safety assessment, control measure assessment and Safety Management System implementation.'* It notes, when reviewing Esso's compliance in this area:

`both employees and Surveillance Engineers were present at all workshops. Comments from Esso employees and Surveillance Engineers during the preparation for the Safety Case indicate that both parties benefited from working together. Operators commented about learning more about the basis for plants, Engineers gained information on the actual operation of the facility. As such WorkSafe Victoria's inquiries to date indicate that Esso has benefited from building the relationship between the two groups.'

Clearly the building of these relationships are important for safety and need to be continually fostered.

Also it is important that the all engineering professionals working at the Plant or with Plant systems have a detailed knowledge of **how systems fail** and accordingly may need to be regularly brought up to date with the detail on near misses and incidents.[41] This would also require a training system that regularly reviews, in a timely way, failures in similar work places across the world and also provides detail on how systems and mechanical failures have occurred in other workplaces. Training for engineers in **safe design issues and how systems failures happen is vital** so they are in the best position to recognise problems that may lead to incidents well before they occur. This does mean that the engineers may be required to think beyond particular standards or guidelines, as sometimes standards do not anticipate safety problems in particular circumstances.[42] Coroners have seen other circumstances where standards have not been effective to solve safety problems.

It is noted that Esso appears, in part, to have acknowledged the importance of work to alert operations staff and engineers of particular systems failures as it is providing training on *`cold temperature awareness'* and that the *`revised processes will further enhance each individual's understanding of the potential hazards.'* The training includes *`tabletop drills'* to *`test all critical procedures and upper range medium risks identified for all the plants.'*

Using reports of Commissions of Inquiry and Coroners pro-actively to identify system problems

In Piper Alpha, Lord Cullen talked about the *`spectrum of possibilities'* and the fact that exactly the same accident hardly ever repeats itself. This argument may well apply to an event in a particular plant, like that operated by Esso at Longford. However, coroners regularly see repeats of smaller types of events involving different individuals and agencies at different places and at different times. Similar systems failures have also occurred within a particular industry resulting in disaster.[43] These events are called the *`diffuse disaster.'* By identifying the *`spectrum'* and possible areas across which systems failures have occurred in the past and working pro-actively to build countermeasures the incidents could be reduced. An organisation such as Esso has the capacity and potential to begin undertake this innovative type of work, but it requires regular and timely identification of the wide range cases where

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41 See also finding in the death of Mark Crossley, an engineer working for Esso on an oil platform in the Bass Strait. (Finding attached)

42 See for example finding and recommendations on the death of Colin Taylor in 1988 (Finding attached).

43 See for example the 1988 Piper Alpha Disaster in the North Sea and the 1989 Bass Strait Tuna Oil Rig Fire (Finding attached)

system problems have resulted in a disaster (small or large). It would require Esso to regularly look for (and in a timely way) reports of Royal Commissions, Commissions or Boards of Inquiry and Coroners into system failures across a diverse range of industries or areas and to analyse and use this vast learning pro-actively as a countermeasure within its own sphere of operation.[44]

Clearly, had Esso used its own incident and `near miss' reporting system effectively and pro-actively, there was real potential to avoid the incident that was *`Longford.'* That fact in itself should point to the need for a broader approach to learning from the varied incidents that occur across a range of industries or other relevant areas of human endeavour, to provide a far safer system.

For a large operation like Esso to concentrate only on rectifying the particular system problem or problems that resulted in Longford would be a mistake. Obviously, Esso has recognised this fact by the variety of work it is undertaking to improve safety and that it is using incident data that *`is now more extensively shared and utilised.'* The Regulator also recognises the need for a broader approach. Esso's comment that it identified *`other improvement initiatives not necessarily related to the events of September 1998'* also underscores the importance of a broader approach to learning from a disaster like Longford. By way of practical example, although the Royal Commission did not identify maintenance as a contributing factor in the fire, Esso *`nevertheless also reviewed the procedures and training relating to its maintenance function and has applied'* certain enhancements to this function.

Of course, as Esso in effect acknowledges, much of the work on the development of safety systems and identifying hazards is also part of the requirement for establishment of the *`Safety Case.'* Its plan is to (in part):

> *`Identify and record hazards that could cause or contribute to the cause of potential major incidents and assess the risks of those hazards'*

And:

> *`ensure a full understanding of site hazards, potential major incidents, control measures and roles and responsibilities in relation to managing these hazards and assessed risks (training) '*

Esso also acknowledges that it is working with the Australian petroleum and chemical industry and is continuing to *`liaise with other local petroleum/chemical industry participants on a regular basis in order to ensure experiences are drawn from an industry wide basis.'*

On this issue WorkSafe notes, as part of its submission to the Coroner, that its own Hazard Identification Guidance Note 13 *`advises operators of major hazard facilities to review reports of incidents or near misses at other facilities for their relevance.'* Apparently, as part

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[44] See for example the recent work undertaken by the CFA following the Linton fire on its 'Performance Improvement Database.

of its work Esso *`has used lessons from incidents at other gas processing plants to investigate their processes.'* WorkSafe quotes, by way of example the fact that Esso advised it that:

> *`a "Safety Newsletter" from Shell Global Solutions International triggered a review by Esso of their processes in relation to molecular sieves at Longford.'*

However, whilst useful, as already indicated, it would also be a mistake for Esso (or the Regulator) only to concentrate on failures that have occurred within its own industry group's sphere of operations. Experience has shown that systems failures can occur in a range of different industries or areas and some of those failures have common themes. These themes need to be identified by the specific case studies, which should be used to develop improvements in systems aimed at safety and in the training of managers, engineers and operators to help them understand the risk areas, how these events can occur and to how to use this knowledge to improve the safety of the relevant operation.

The pro-active use of case studies of failures across a range of industries would have potential to enhance the development, review and long term effectiveness of the *`Safety Case'* system. It would require considerable work on Esso's part to build a timely data library of case studies and to identify and use the common themes whether they be from systems, engineering design and maintenance or human factors problems, etc. Accordingly, as the work would be of potential benefit to a range of industry areas, there may well be a need for the petroleum industry, the Regulator (WorkSafe) and perhaps a university engineering school and/or accident research department to also be involved with the development of such a project.[45]

Recommendation 3

That Esso (with representatives of the petroleum/chemical industry, the regulator [WorkSafe] and with assistance of a university) consider developing a timely database of significant case studies associated with systems, design, maintenance and human factors related failures as evidenced in reports of Royal Commissions, Boards of Inquiry or Coroners Findings, etc. This information would need to be collected across industry areas and not limited to the petroleum/chemical industry.

The collected data should be analysed and used pro-actively to identify possible common areas where similar occurrences might happen in the petroleum industry, for timely countermeasures and in the training of managers, engineers, supervisors and operators.

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[45] See for example some the work undertaken at Monash University Accident Research Centre (and Engineering Department) on individual design and related engineering failures. Refer also to the research work being undertaken on occupational health and safety and safe design at the James Goldston Faculty of Engineering and Physical Systems, Central Queensland University, Rockhampton.

Conclusion

Clearly, Esso is solely responsible for the disaster and tragedy that is known as *`Longford.'* The incident caused the deaths of two workers and injuries to a number of other workers. Esso failed to conduct a detailed Periodic Risk Assessment or a more comprehensive hazard audit (called a HAZOP), in accordance with its own procedures. Either of these two hazard audit systems would have identified the problem, and no doubt resulted in countermeasures to prevent the incident. In addition, Esso's own incident or `Near Miss' reporting system, if it had been operating as planned, would have resulted in an earlier, but similar, near miss incident (August 1998) having been reported. If this reporting had occurred, the problems that resulted in the Longford disaster may well have been recognised and avoided. Significantly, Esso also failed provide its employees with the required technical support, training and knowledge to enable them to understand what was happening and thus respond.

Thus Esso already had systems in place, which if fully implemented, would have avoided the tragic outcome. It is noted that this problem is not uncommon in other disasters. For example, in the Linton Wildfire the relevant fire fighting agency had an incident management system (called AIIMS-ICS) that was meant to operate to manage large wildfires instead of an older, more localised, Group System. Both management systems operated in some conflict and confusion at Linton with dire consequences. AIIMS-ICS was operating in some sectors of the fire, but not in the areas where all the problems occurred. The point was made then, and it has equal force in the *`Longford'* disaster, that *`in effect, AIIMS was only a paper system for much of the area of the Linton fire. Paper systems are not effective systems of work unless they are* ***actually*** *implemented.'* [46]

It is also clear that Esso has undertaken considerable work and committed significant resources towards improving its safety systems since *`Longford',* and accordingly it must be commended for this work.

The recommendations and supporting comments are designed to encourage **free communication** between management, engineers, plant operators and supervisors on issues associated with the operation of safety systems and to build on the work already undertaken by the Regulator (WorkSafe) and Esso following the handing down of the Royal Commission Report.

Also it is essential that where problems are discovered following the examination of Reports/Boards of Inquiry, etc. on incidents in other sectors of the petroleum industry (or in different industries) that the causes of the failure are looked at in a way that **seriously tests** the existing safety systems in the operation of a Plant like Longford. All those involved in working at the Plant (from management and engineers to those at the shop floor) should, irrespective of existing safety systems, ask the question **`Could it happen here?'** (the `What if' test). The answers and testing may lead to further improvement in safety systems and start to address some other areas in the *`spectrum of possibilities.'*

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[46] Report of the Investigation and Inquests into a Wildfire and the deaths of Five Firefighters at Linton, p.597.

Graeme Johnstone
State Coroner
15th November 2002

Mr. Gavan Burns for the families of Messrs. Wilson and Lowery
Mr. Neil Clelland for the WorkCover Authority (WorkSafe),
Ms. Mandy Fox for the Country Fire Authority,
Mr. Michael Hennessy for Esso, and
Mr. Jim Kennan SC with Ms. Fiona Ellis, Assisting the Coroner.

Glossary

For ease of reference the following abbreviations and definitions are used throughout this finding (taken from the Glossary in the Royal Commission Report) :

Absorber	A tower where the absorption process takes place. GP1 has two absorbers (A and B) which are equipped with valve cap trays that allow direct contact between inlet gas and absorption oil.
Absorption	A process whereby one or more components are removed from a gas by bringing the gas into contact with a liquid that has an affinity for the components to be removed.
Absorption Oil	See Lean Oil.

Actuator The part of a control valve that moves the valve plug. May be pneumatic, electric, hydraulic or gas powered.

Bailey System The modern computer-based control system used to control the CSP, GP2 and GP3, as well as parts of GP1.

Brittle Fracture A brittle fracture is defined as one that occurs without ductility or deformation. Characteristic features of a brittle fracture are:

Fracture straight across the component section.

Retention of original dimensions if a broken component is reassembled. An example is broken glass.

Microscopic fracture features include cleavage (of metal grains) or an intergranular fracture path. In steels, a scanning electron microscope (SEM) is required to view such microscopic features.

Tends to occur at lower temperatures, where deformation is inhibited or prevented.

Tends to occur is component is restrained from moving or deforming under a load, i.e. a condition of high restraint. Typically, a well-braced, large or solid structure has more restraint.

Tends to occur at high strain rates, which do not allow the material time to deform. An extreme example of higher strain rate loading is impact loading, for example the impact of a hammer on an item.

Less energy is required to fracture. Hence, where conditions are such that a component tends to fracture in a brittle manner, fracture tends to be more likely (easier) than if it were ductile.

Bypass A pipe connection around a valve, regulator, or filter, which is opened to permit the passage of fluids while repairs or adjustments are being made to the valve, regulator, or filter.

A pipe connection around a vessel that is partially to fully opened to control the amount of fluid that passes through the vessel.

Condensate A light hydrocarbon liquid that is obtained by the condensation of hydrocarbon vapours. Condensate consists of varying amounts of propane, butane, pentane and heavier hydrocarbon fractions. It contains little if any methane or ethane, unless it is produced by chilling of the hydrocarbon vapour.

Any vapour that has condensed into a liquid (e.g. steam condensate).

Condensate De-ethaniser tower (GP1106A)

Condensate Flash Tank (GP1105A)

Condenser A heat exchanger in which the heat of vapours is transferred to a flow of air or other fluid, thereby causing all or a portion of the vapour to condense into a liquid. In the absorption system, a condenser is used to condense a large portion of the overhead vapours from the ROF.

Control Valve A valve that can be controlled automatically to regulate the flow through a pipe.

De-ethaniser See demethanisation.

Demethanisation The process of removing methane from a process stream (demethanising). Similar processes to remove ethane and butane respectively are called de-ethanising / de-ethanisation and debutanising / debutanisation. Equipment items used for these processes are demethaniser / de-ethaniser and debutaniser.

Distillation A heat dependent process that is used to separate one or more components (sometimes called fractions) from a substance that contains these components. In a lean oil absorption system, distillation is used to reject methane as well as recover heavier hydrocarbons from rich oil.

Ethane See Hydrocarbon.

Flash Tank A two or three phase separator that operates at a lower pressure than upstream equipment. The resulting pressure drop that occurs as process liquids enter the flash tank causes lighter material in the liquid to vapourise or flash out of the liquid. In a lean oil absorption system, one or more flash tanks are used to recover methane vapours from rich oil.

GP1 Gas Plant 1

GP903A This Absorber (which is relevant for the failure) was regulated by a temperature control system known as TRC3B, which by means of automatic valve (this could be manually overridden) controlled the flow or warm propane liquid to GP903B.

HAZOP Hazard and Operability Study

Heat Exchanger (GP905) - The vessel that failed.

Heat Exchanger (GP922) - This vessel had developed leaks at its flanges

Heat Exchangers (re-boilers [Absorbers] - GP903A and B). These re-boilers are designed to heat the condensate.

Heat Exchanger Equipment used to transfer heat between two streams via indirect contact (e.g. transfer of heat through a tube wall). Parts of a shell and tube type heat exchanger are the *tube bundle* (the surface through which heat exchange occurs), the *channel* (the section through which tube side material enters the tubes), the *tubesheet* (a plate separating the shell the tube sides). Material that passes through the tubes is said to be on the *tubeside*, while material outside the tubes but within the shell are on the *shellside.* Heat exchangers can be *concurrent* (with material passing through the sides in opposing directions).

Hydrate A crystalline hydrocarbon and water compound, which forms under certain temperature and pressure conditions in gas processing and transmission facilities. Hydrates can accumulate in process equipment, thereby impeding fluid flow and causing hazardous pressure conditions.

Hydrocarbon Any compound whose molecules are comprised solely of hydrogen (H) and carbon (C) atoms. Oil and natural gas are hydrocarbons. Common hydrocarbons found in natural gas include methane (CH4), ethane (C2H6), propane (C3H8), butane (C4H10), pentane (C5H12) and hexane (C6H14).

Kings Cross Piperack A rack containing pipes transferring fluids between various equipment items through the Longford site, and located near the area affected by the fire.

Lean Oil Also called absorption oil.

A hydrocarbon liquid, similar to aviation kerosene, that is used as an absorbent to remove product-type hydrocarbons from natural gas.

Absorption oil that is essentially free of product-type hydrocarbons.

LPG Liquefied Petroleum Gas, a hydrocarbon mixture consisting mostly of propane and butane. The raw LPG produced at Longford has a significant ethane fraction.

Methane See Hydrocarbon.

OIMS	Operations Integrity Management System
PRA	Periodic Risk Assessment
Pressure Vessel	A tank designed to withstand pressure. Must comply with specific regulations.
Pump	(eg: GP1201)
Reboiler	A vessel, which uses direct (fired) or indirect heat exchange to add heat to process materials. In a lean oil absorption system, reboilers are used in rich oil demethanisation and lean oil distillation.
Rich Oil	Absorption oil that contains absorbed hydrocarbons.
Rich Oil Demethaniser (ROD)	A distillation tower that is used to remove ethane or methane (depending on the mode of operation) from rich absorption oil while retaining heavier hydrocarbons for later recovery.
ROD	Rich Oil Demethaniser
Rich Oil Fractionator (ROF)	A distillation tower that is used to remove all of the absorbed light hydrocarbons remaining in the rich oil leaving the bottom of the ROD.
ROF	Rich Oil Fractionator
Slugs	Condensed water and hydrocarbons which accumulates in the lower part of the pipeline when gas flow rates are low.
Slugcatcher	Is designed to dissipate energy from the slugs as they arrive and stores the liquid prior to processing.
Upset	A disturbance or abrupt change in the operating conditions of a vessel or column that results in unstable operation, the production of off-specification product or carry over of liquid.

Inquest into the death of KEVIN GALLAGHER-GREEN at BHP Western Port Works on 17th April 1993

[Held at the Coronial Services Centre, Southbank on 13th and 18th April, 23rd June 1995, 2nd May and 28th August 1996]

The death of Kevin Gallagher-Green occurred on the 17th April 1993, at BHP Western Port Steel Works, Bayview Road, Hastings from neck injuries.

Incident summary

Mr. Gallagher-Green, aged 39, an `Adult Apprentice Maintenance Fitter', was working on a pickle line at BHP Western Port Steel Works [John Lysaght], Hastings when, in the process of adjusting the height of the Transfer Tilt Table, he was crushed between an hydraulic ram and a hydraulically operated beam moving under the table. The incident occurred when the machine was running.

The Pickle Line is approximately 300 metres long, and provides a continuous process for sheet steel. The point where the incident occurred is the welder transfer clamp which is a hydraulically operated ram, operating on a cyclic system.

Mr. Gallagher-Green was inducted into BHP's safety procedures on 24th January 1993 by a Leading Maintenance Fitter, Mr. Glen Hawkett. Although Gallagher-Green worked there for 14 years he was only in his 2nd/3rd training year as a maintenance fitter. From Hawkett's evidence at inquest it appeared Gallagher-Green was aware of the Company's isolation and tagging procedures. Gallagher-Green had worked at BHP Western Port from about 1978.

At about 1.30am on 17th April 1993, shortly prior to the incident, Steelworker Mr. Geoffrey Edwards drew Leading Maintenance Fitter Hawkett's attention to a problem on the line relating to the height of the Tilt Table. Hawkett and Gallagher-Green then went under the machine to inspect the problem. Hawkett told Gallagher-Green he was going to isolate the welding section of the line.

Mr. Hawkett left, Gallagher-Green apparently stayed where he was. Edwards then restarted the welding operation. Edwards was unable to see the area where Gallagher-Green was moving when he restarted the machine, as the control panel and angle of his position blocked full vision of the tilt table. The last time he saw Gallagher-Green he was standing on the north side near the transformer [about 2 feet from the cylinder].

Initially, in his statement to the HSO inspector Hawkett was unable to explain why he did not completely exclude Gallagher-Green from the line before isolation procedures were put into place. However a later statement taken 30th June 1993 and his evidence at inquest sheds a different light on the subject. Without Hawkett's further explanation on 30th June it

would not have been possible to discover all of the causative factors involved in the incident.

The lead up and incident

Mr. Edwards explained in his statement [taken 4th June 1993]:

> *`The welding machine that I was working on wasn't operating properly prior to the accident so another worker, Glen Hawkett, had been working underneath it. I had seen Kevin standing near the machine opposite Glen on the south side and that was the last I recall seeing him. Once Glen, who was working on the machine had left the area I reset the machine and started it again. I wasn't aware anyone else was under the machine at the time'*

When the machine restarted Gallagher-Green was struck by an eye beam moving under the table. The eye beam was not clearly visible when standing beside machine.

Mr. Edwards further explained the events as:

> *`...I said to Glen `Can you have a look at the exit Tilt Table, it's up to high' . The three of us [including Gallagher-Green] went to the table area and I explained to Glen it was up to high. Glen Hawkett got down on his knees and hands and crawled into the space between the Tilt Table and No. 1 Bridle. The line was ruining at normal speed at this time. Glen, when he reached the table cylinder he had a pair of multi-grips with him in his right hand.*
>
> *He placed the multi-grips onto the top of the shaft of the cylinder and tried to turn it. At this time Kevin Gallagher-Green was still standing beside me watching Glen. Glen, after attempting to make the adjustments, came out from below the table and told Kevin to go off to the store and get a pair of Stillsons. Kevin...[on his return]...gave the Stillsons to Glen. I was still standing alongside Glen when Kevin done this. Glen took the Stillsons from Kevin and crawled under the table with them. Kevin and I were standing watching Glen. He put the Stillsons onto the shaft of the cylinder and tried to turn it. The whole time he was trying to make this adjustment the line was still running. When Glen was under the table the line stopped. By that time the strip comes off the mandrel and the strip had stopped running. At this time I was still standing beside Kevin at the Tilt Table area on the operators side [north]. Glen crawled straight through to the other side of the Pickle Line without coming back out to the north side and crossing the footbridge.*
>
> *I watched Glen come out the other side of the line. I then went to the welder controls to set up the tail end of the strip. This is done by shearing the end and running the strip past the welder section to the Tilt Table side. It is then returned to the space bar at the welder where it is straightened and clamped against the space bar. While I was carrying out this process I seen Kevin standing beside the transformer which was near the Tilt Table. I think that he was watching Glen who I know was at the other side of the line. I did not think anything of it that Kevin was standing there as that is where I left him. As I*

was returning the strip to the space bar I tried to tilt the table to throw a loop and the table would not operate. This was due to the fact there was no air to operate it. At that time I thought to myself that Glen had turned of the air at the supply which I know is at the side of the line where Glen was working [south].

I was waiting for the front end to come up to carry out the same operation on that side. When I carried out this operation which is done manually I commenced the weld cycle which take from 6 secs to 16secs depending on the gauge. When I was carrying out this operation I did not notice if Kevin was still where I had last seen him as I was concentrating on what I was doing...'

And as to the operation:

`The area where the Tilt Table is situated is used to inspect the bottom of the weld after scarfing and that is the only time that an operator would be in that area. When the weld cycle is ongoing there is a lot of noise but someone underneath the table would be aware that a weld was in progress because the line is stopped. I am aware that the top part of the transfer clamp moves but upto that time I was not aware there was a large stabiliser bar beneath the table which moved at the same time as the top section...'

As to his knowledge of Hawkett's intention:

`I knew that Glen had isolated the air to the table and I assumed he was about to isolate the hydraulics next. The hydraulics on the welder operate space bar - die clamps, and the transfer clamp for the trimmer tools, without the hydraulics the welder cuts down. When the hydraulics are isolated the transfer clamp won't operate and therefore the area below the clamp would be safe.'

Mr. Hawkett said in his statement [after Gallagher-Green retrieved the Stillsons from the store];

`Kevin then stayed on the north side and was crouching down looking towards the rein. I then went to the south side and did likewise. At this stage Kevin was in possession of the Stillsons so I yelled to him `Hang on a minute, I'm going to isolate the table.' Kevin was looking towards me and nodded in acknowledgment.

For me to isolate the pneumatic rein I had to turn off the air supply which was located next to where I was standing. After doing so I was to cross to the north side of the machine to cause the welding operator Geoff Edwards to stop the line and then turn off the hydraulics.'

Then when moving towards the bridge he heard the machine operate. Hawkett's initial explanation of Gallagher-Green's attempting to adjust the pneumatic rein before the line was halted was `being so enthusiastic he thought he could adjust the fault quickly.' Gallagher-Green did not know the mechanical operation of the machine and Hawkett had only

adjusted it once before. However in the later statement Hawkett gives a different explanation to what happened. He explained that he:

> *`crouched down and crawled into the area where the cylinder was. I attempted to adjust the shaft with the multi-grips. As I done this the strip was running overhead...[after explaining he could not move the shaft and sending Gallagher-Green to get the Stillsons]...When Kevin returned I went into the space between the Tilt Table cylinder and the side guide base...continued right through...[and when reaching the other side]...I was facing Kevin. Kevin was at this time just under the tilt table and in a space between the tilt table and the side guide base. I also was in the same position but on the south side. We both looked at the shaft while in this position. At this time both Kevin and myself would have been about an arms length from the shaft and below the table...I called to Kevin to hang on a minute, that I was going to stop the line, meaning I was going to isolate the air line.'*

After backing out Hawkett only had to move about 12 inches to be in a position to turn off the valve. He then had to go over the bridge to speak to Edwards and turn off the hydraulics. As noted he did not reach the bridge before the welding operation commenced and the incident occurred. On leaving to continue the isolation procedure Hawkett did not see Gallagher-Green get out from under the table. Hawkett explained he was `not fully aware of the workings of the underside of the transfer clamp' and neither was Gallagher-Green. Hawkett goes on to say in his statement `I was unaware of the dangers associated with entering the tilt table underside when the line was operating'. This was his only explanation for not following the procedures. Hawkett's previous adjustment of the machine was undertaken on a `down day' and as the line was not operating the movement of the tilt table could not be observed.

He agreed that the correct company procedures according to the danger tag regulations would be to isolate before entering the work space under the table.

Mr. Edwards was the elected Occupational Health and Safety Representative for the employees at the plant. He had received a weeks training at the Trade Union Training Association. Although Edwards was the Health and Safety Representative, and admitted the isolation procedures were an important safety area, he did not see the need to have an understanding of the issue. He was not trained in the area of isolation although training was given in lockout procedures. Hawkett was of the view that Edwards would just keep doing his job until he was informed [by Hawkett] that the line was being isolated. This was because it might take some time to complete the procedure. He admitted that he started the procedure without talking to Edwards.

Mr. Edwards was aware that Hawkett was at some stage going to isolate the machine, but continued the operation as:

> *`They hadn't actually come up to tell me they were going to stop the machine.'*

There was no conversation between Hawkett and Edwards as to the intention to isolate. However, Edwards saw Hawkett turn off the valve on the south side of the machine - this turns off the air. Even though Edwards had not seen this process before he believed it was the commencement of the isolation process. He considered there was no other explanation for the turning off of the valve. Apparently the machine can still operate with the air shut off. In answer to the question as to why he attempted to activate the weld cycle - `Because I wasn't told not to do it.'

Had Mr. Edwards received training in isolation procedures he agreed that he would have known in greater detail what Hawkett was doing. However, he also agreed to the effect that knowledge would not have made a difference in to the events in this case. Edwards rotated through different parts of the Pickle Line's operation. It is clear that Edwards knew what was going on but had not identified the risk his actions put on Gallagher-Green. He was not aware of Gallagher-Green's position as it related to the tilt table. He was also unaware of the hazard.

Evidently line stoppages are frequent. However, this was the first time to Edward's knowledge of a problem with the tilt table.

One additional issue to be considered is - whether Edwards' initial contact [as operator] and proximity during Hawkett's first attempts to alter the height lulled the maintenance fitter into a false sense of security He may have considered the machine would not be operated Gallagher-Green may have considered the situation to be safe because of Edwards' initial contact and presence. Although not considered in evidence it would not be unreasonable to pose the possibility.

Knowledge of the danger - movement of the beam

An inspection of the nut used to vary the height of the Transfer Tilt Table indicated it had been adjusted before. Considerable burring on the adjusting nut was visually evident. Some of that damage occurred as a result of Hawkett's attempts with the multi-grips. As the adjustment nut had been used before knowledge of the dangers [or the risks] of entry into the area might be assumed. That would be incorrect.

Mr. Edwards was not aware of the movement of the beam under the sliding transfer clamp. Hawkett was also not aware of its movement although he had adjusted it once before - on a down day. As Gallagher-Green had not previously worked in the area it is unlikely he was aware of its operation.

Mr. John Wolverson, a leading hand shift fitter, employed by BHP since 1984 was familiar with the tilt table. He indicated that the table was `seldom' adjusted. Since his employment it had been worked on about half a dozen times. He had adjusted the height of the table during times the machine was not operating [down time]. As he had worked on this area of the machine he had an understanding of the `parts of the line which move'. On previous occasions Wolverson had seen the transfer clamp move. He agreed that:

`You could walk past that beam 1000 times and you wouldn't know that it moved unless you had actually crouched down or being involved with it.' ...

And of his knowledge of the movement of the beam:

`I've known that for a long time, like say, we had a problem years back where the cylinder came apart.'...[then]... `We had to go underneath there and fix up the cylinder.'

Mr. Wolverson indicated some surprise when discovering how the machine worked as `...it doesn't look as though this part of the welder will move.' It could only be discovered by crawling underneath. Apparently there was no system to ensure any particularities of the machine were notified to other fitters. When the issue of how other fitters would tackle a maintenance problem was discussed Wolverson said:

`...you would get as close as you...safely could to the equipment.'

When asked as to whether the fitter would get close to the level where the repairs were to be effected:

`...but if the piece of equipment did not move while you were looking, you wouldn't know it was going to move.'

Mr. Hawkett stated that although he was familiar with the movement of the top section of the tilt table he was unfamiliar with the underside. In answer to a question; Can you explain...why it is that you failed to appreciate the position that you and Mr. Gallagher-Green were in, that that was not going to be homing in on you as you were on your haunches beside that cylinder Hawkett said:

`We were looking at the cylinder, not looking at the other part of it.'...[and to a further question]...I didn't know that was attached - that would move with the rest of the clamp...'

Mr. Hawkett relates that he and Gallagher-Green were crouching down examining the cylinder when he said `Hang on a minute, I'm going to `isolate' or `turn it off' probably something like that.' Hawkett saw Gallagher-Green `nod' in response. Apparently both Hawkett and Gallagher-Green were wearing ear plugs because of the noise levels in the factory. Although Gallagher-Green nodded in response it is not possible to further ascertain his level of understanding of the instruction.

It is interesting to note that Wolverson understood that the beam moved because:

`During our normal work...we carry out line checks we go through and we check for oil leaks or anything coming loose and this involves crouching down and crawling under things...So, we get a general understanding on basically which parts of the line move.'

However, a video of the full operation of the sliding transfer clamp presented in evidence clearly shows its operation. The video illustrates that a thorough audit of all adjustment

points on the line would have identified the danger. However, the area was not guarded as it was never `recognised as a hazard' [Mr. Terry Opie, Occupational Health and Safety Officer - BHP]. Following the incident the immediate area was guarded and written safety procedures were adopted.

Mr. Opie also agreed the current safety procedures [mesh fence] could be breached.

The `isolation' procedures

As can be seen from the requirements of the Company's `Handbook of Danger Tag and Warning Tag Regulations' before proceeding it is necessary to assess *`where you are exposed to the risk of personal injury.'* It is noted that Hawkett only worked on the tilt table once before during a `down day'. Where there is a `down day' there are no operators present [and, obviously, the line does not operate]. Therefore, in `down day' maintenance the operator would not be approached before isolation procedures commenced.

It is interesting to note that while the `Danger/Warning Tag Regulations' are prescriptive they are silent as to the need to first approach the operator before the `isolation' procedure is to be commenced. The only possible indication that contact is required in the procedure is the comment under the heading `PURPOSE' - `To protect you when working on isolating by instructing others that a control must not be altered.' However, from the evidence there appeared to be an understanding of all concerned that the operator was to be approached before isolation was to be commenced. Evidently it was part of training.

As indicated the work system that applied to BHP's Western Port Plant was governed by a `Handbook of Danger Tag and Warning Tag Regulations' [Updated June 92]. The summary of the Basic Rules [omitting sections not relevant] states:

> `(a) Before commencing work on any equipment you *must* ensure that the correct isolating procedures have been applied.
> (b) You *must* place DANGER tags before commencing work on any job where you are exposed to the risk of personal injury.
> ....Failure to comply with the above will make you liable to *instant dismissal...'*

and under the heading `ISOLATION OF EQUIPMENT'

> `...(b) For hydraulically operated equipment - closing the relevant shut-off valves or where valves are not provided, switching off and isolating the pumps. Ensure that pressure is released from the system.
> (c) For air operated equipment - closing the shut-off valves and releasing the pressure.'

Currently it is understood these procedures have been reviewed by BHP. In addition `work permits' are being considered. One of the real difficulties is the apparent lack of training in the `risk assessment' area.

Level of training at the plant

Although there was a level of training in safety procedures at the plant there are concerns at the level of understanding. Edwards [the Health and Safety Representative], for example, in his statement to the HSO inspector said:

> *`...I have no formal qualifications but have attended a week safety course at TUTA. I have not attended any other safety courses.'*

and

> *`...there is a book of procedures for operating the machine in the welder's cab. My training on the machine consisted of on the job training by Tom Merks leading hand of the pickle line. This was about 18 months ago and he was with me for about 2 weeks full time. I have not received any further on going training. I went through the book of procedures at that time...I was aware f isolating procedures which is another small booklet which I would have got from Steve Slater. These are handed out about every 12 months to read. There is no formal training on isolating procedure.'*

Mr. Edwards' level of understanding of the `isolation' procedures is explained by the Company on the basis that, as an operator [as distinct from maintenance personnel], he did not need to know isolation procedures. Hawkett acknowledged that when he started work at BHP he *`underwent induction procedures which included safety procedures, lockout and isolation procedures, also the full understanding of the danger and warning tag system.'* However, he could not recall the last time that he received training in this area of safety. This in spite of the fact that testing on the procedures is on an annual basis.

As to training on isolation procedures Wolverson said:

> *`...I have never been trained in proper isolation procedures'...and...`followed out my own isolation procedures which I had been shown by other, other fitters that's the procedure that I used.'*

Mr. Wolverson appeared confused as to the procedures to be used. He later acknowledged that `general isolation procedures' were in fact followed. He indicated that before the area was to be isolated the operator was informed.

The evidence of the staff on the issue of training was presented during the inquest hearing and there must be an understandable allowance for the possibility of confusion between the questions and answers. However, these [and other] statements during the inquest indicate the need for a critical review of the training methods [and audit]. It is understood this is being undertaken by BHP.

The possible fatigue issue

Mr. Hawkett indicated he had commenced at 11pm and was on a rotating shift. This was his first period of night shift following two days off. The shift process is seven days straight

[followed by one day off]. Evidently there are three consecutive shifts with a five day break at the end before starting the day shift. Hawkett had taken an extra day.

He said that he was *`tired on night'... `its just the start of the night shift, you usually don't get a lot of sleep during the day. Because you're body is changing I suppose...the nightshift's especially hard on you. Your not getting enough sleep or what ever. Its just because your body's not used to it and doesn't get time to get used to it before you change again.'* Whilst Hawkett then acknowledges that not appreciating the danger was the explanation for the incident this is a general issue which may need further examination by BHP.

The drug issue

The toxicological analysis at post mortem showed presumptive evidence of amphetamines or stimulants and opiates in urine. The clinical significance of this finding was not likely to have effected this incident. Evidence from the Toxicologist suggested that the analysis could have resulted from self treatment for a cold with preparations available over the counter at chemists. Hawkett commented that Gallagher-Green was `his normal self, and appeared to be fit, well and sober.'

Guarding of Dangerous Machines [Occupational Health and Safety Regulations (1986)]

The Occupational Health and Safety Regulations [1986] `Guarding of Dangerous Machines' applying at the time of the incident provide a useful indication of responsibility. The relevant section [10] states that guards are to be provided for `all dangerous parts of the plant of a workplace...so as to prevent as far as practicable loss of life or bodily injury'.

The Australian Standards

The Australian Standards [unless called up in specific state/territory regulations] are not mandatory. They provide a useful guide for various aspects relating to occupational health and safety - in the design of machinery and guarding, work systems, hazard control, incident reporting and investigation, etc.

It should be noted that many of the controls and systems provided in the various Australian Standards were in place at BHP's Western Port Works at the time of the incident. Considerable work has been undertaken at Western Port relating to safety since this incident. However, whether the Standards were considered in the original [and ongoing] systems development before the incident is a moot point. Of Australian Standard 1755-1986 in the review BHP [after submitting that the Standard does not apply] states `...Furthermore, at no time have the officers of the Health & Safety Organisation...referred the Company to the Australian Standard for Conveyors.'

It is considered that Australian Standard 1755-1986 `Conveyors, Design, Construction, Installation and Operations' does not in its definition section exclude the `Pickle Line' from its scope. Sheet steel is `conveyed' over a continuous line. Clause 5.1 would operate to

require [if the Standard was mandatory]... `Fixed guards shall be provided where the conveyor can be serviced without the removal of the guards [eg; for adjustments, cleaning or lubrication].' It is noted that the Standard did not apply at the time of commissioning of the Pickle Line [which was prior to the introduction of the Standard].

Australian Standard 1470-1986 `Health & Safety at Work - Principles & Practices applies to provide guidance in a number of areas and in particular 6.3.4 [Workplace Training] and the need for supervisors to undertake a `job hazard analysis'. This was not addressed in BHP's review.

And 9.8.4 [Provision of Guards]:

> *`Portions of machinery, plant and equipment being processed that are not constructed or positioned so as to be permanently safe should be guarded or screened to the greatest possible extent.*
>
> *The basic principle is that, unless a danger point or area is safe by virtue of its design or its position, the machinery should be provided with an appropriate safeguard which eliminates danger before access...'*

Here there was a hidden hazard [albeit a hazard that could have been identified by careful audit]. BHP in their Standard Review said:

> *`...in this particular case the area underneath the tilt table had not been identified as a `danger point or area' (despite frequent internal and external [HSO] inspections], and therefore had not been guarded in the traditional sense. As stated in relation to section 9.8.2, the area in question is not an area requiring anything other than maintenance personnel access, and is not close to operating personnel. The Company requires that all personnel, prior to working on any equipment, ensure that it is fully isolated and de-energised...'*

This is not an appropriate way of managing a hazard where guarding can be provided. Mr. Gregory Clapp, BHP Steel Division, Occupational Health and Safety Manager said [of the Company's danger tag warning regulations and training]:

> *`I believe that the system has always been very adequate, that the training has been very good but constantly improved, it does rely on behaviour, the danger warning tag system and there in lies its inherent weakness.'*

That weakness has long been recognised in other industry sectors and needs addressing.

The corporate and HSO explanation for the incident

An examination of both the corporate and HSO explanations indicates a limited view of the multi-faceted nature of the incident. While a limited number of causative factors are identified other potential problems were not investigated. The HSO investigation even in its

initial stages was limited and once Hawkett's role became clear other factors were not examined. Evidently there was no detailed internal investigation by BHP with a total preventative focus aimed at identifying all the factors as they relate to this incident. Although it must be noted that following the event a general review of health and safety was undertaken it was stressed the review was ongoing and did not occur as a result of this incident. Evidently the review related to safety procedures throughout all BHP operations.

An examination of the comments of various individuals both at HSO and corporate level indicates a focus on blame related issues. Mr. Stephen Slater, Shift Supervisor in charge of production [in his initial statement] indicated that Gallagher-Green:

> *`...would have known the operation of the equipment and would have been aware of any dangers in this area.*
>
> *...I can see no reason why this has happened. As I have said, the line is in normal working order and in my estimation Kevin was aware of its operation.'*

Later, at the inquest, Slater was of the view that Gallagher-Green was aware of the isolation procedures but was not aware of the danger. Slater's reason for the change of view appears to relate to the fact that the beam is not visible from a standing position. Of the training system he said:

> *`Well, its is common knowledge to everyone at BHP Western Port that tradespeople physically do operations and that operators physically do lockouts, that all people involved use Danger Warning Tags. The operators do not have the electrical or mechanical qualifications to enable them to carry out the isolations. Those isolations are done on their behalf by the tradespeople and the operators then put their danger tags on it to protect them and signify that they are the people that are working in the area.'*

Of the reason why the incident happened Slater said:

> *`...because there was a failure to follow the isolation procedure...*[and]*...It's impossible in this instance to look past Mr. Hawkett. Its my firm belief that Mr. Hawkett was going through the routine of isolating. He was - had all the intentions of carrying that out...*[he]*... understands the systems and operates by those systems '*

Mr. Opie and other witnesses indicated that it was:

> *`common sense'... `a normal practice that you stand back and observe the job, so you understand what is wrong with it and then you, also can gauge what equipment you may need and what steps you then have to take.'*

Also that Edwards knew what was going on. Hawkett was effectively of the view that Opie's `common sense' approach of observing the job was the safety procedure. He could not remember the last time he referred to the `safety manual' and the most important safety procedure was the `isolation procedure.'

In its response to the HSO report on the applicability of the Australian Standards BHP states of the employees responsibility to take care for their own safety...[and to]...comply with instructions given for their own health and safety [AS 1470-1986] that:

> *`Had these responsibilities been met on the day in question, it is the Company's belief that the incident would not have occurred.'*

The HSO inspector, Mr. Andrew Gildea, concludes:

> *`I am therefore of the opinion that the leading hand Glen Hawkett set a bad example to the deceased, by entering an area where dangerous machinery was in operation.*
>
> *It is appropriate to assume that the deceased was influenced by the actions of his supervisor Hawkett, when he witnessed Hawkett crawl through the area where dangerous machinery was in operation, ie below the tilt table.*
>
> *Further Gallagher-Green may have assumed without further thought for his own safety it was appropriate to follow the example set by Hawkett, and moved closer to the cylinder with the intention of attempting to make the adjustment.'*

Apparently a thorough examination of the employees' knowledge of the particular `danger' or `hazard' was not examined before that assessment was made. Neither were other issues such as the possible applicability of the Australian Standards; where safety hazard identification audits either of the line on commissioning or those conducted at regular intervals have fallen down; why a full audit of the training/systems was not undertaken following this event; or why the possible fatigue factor was not investigated. These are to name but a few possible systems problems.

Conclusion

The causes of the incident on the 17th April 1993 at BHP's Western Port Plant were multi-faceted. They range from a failure to adequately audit the plant [for hazards] on commissioning, the failure to have adequate systems to identify potential hazards during maintenance, the failure to effectively audit the line for hazards, the failure to provide guarding for the area [where a latent hazard existed] and the failure of Hawkett to closely follow the isolation procedures [in circumstances where he did not appreciate the danger]. Another factor is Edwards continuing an operation in circumstances where he ought to have queried Hawkett when, by his actions, he indicated an intention to start the isolation procedure.

It must be noted that a detailed audit of the Pickle Line's operation at commissioning would have detected the hazard. Any later ongoing audit aimed at identifying potential hazards would also have identified the problem. A system aimed at encouraging employees to report potential hazards would also have identified the problem. It is worth noting that Mr. Pincott in his evidence indicated that the Company had a `formal hazard audit system' in

place before the incident. This system involved `management...operations and maintenance' personnel. It did not detect the hazard. It is reasonable to expect that it should have.

No doubt Gallagher-Green did not appreciate the danger and he probably followed his superior's [Hawkett's] example in an attempt `to get the job done.' Equally Edwards was obviously focused on the same issue - keeping the line running. In a busy and extremely noisy environment there clearly needs to be far more attention on eliminating potential hazards. This case is illustrative of the fact that by the very nature of human behaviour concentrating on `getting the job done' isolation procedures of themselves may not be sufficient. BHP's Occupational Health & Safety Manager began to recognise the problem when he said [of the isolation procedures] *`it does rely on behaviour...and there in lies its inherent weakness.'*

The possible involvement of fatigue resulting from shift changes has not been examined by experts. The system of training [and the qualification of the trainers] and its effect on this incident, apart from the general comment on the problems with the division between operators and maintenance personnel, has not been examined by appropriate experts.

Because of the limited nature of the initial investigation detailed program analysis on systems, design/engineering, training, fatigue in shifts, noise factors, behavioural issues and audit was not done. This should have been done.

Contribution

While it may be considered that Messrs Glen Hawkett and Geoffrey Edwards contributed to the death their contribution must be seen in the context of a number of systems problems relating to safety at the Western Port Plant. Mr. Kevin Gallagher-Green, who had been trained in isolation procedures, remained in position when Hawkett was going to isolate. He was told by Hawkett to `Hang on a minute'. Hawkett, the supervisor, did not seek to remove Gallagher-Green from that area. Edwards continued with the operation when he should reasonably have checked with the leading maintenance fitter, Hawkett.

In considering the issue of contribution, from the perspective of BHP, the decision by the High Court in *McLean v Tedman [1984] ALJR, Vol. 58, p541* was referred to by counsel for the family. The court, in summary, held:

> *`The employer's duty to provide a safe system of work is a duty to establish, maintain and enforce such a system and includes a duty to take account of the employee's negligence, inadvertence and carelessness in carrying out the work'....and... `Accident prevention is unquestionably one of the modern responsibilities of an employer.'.... `in deciding whether an employer has discharged his common law obligation to his employees the court must take into account of the power of the employer to prescribe, warn, command and enforce obedience...'*

The facts of that case involved an injured garbage man who was struck by a car whilst crossing the road. The employer clearly knew of the risk but did not manage it. The

evidence of an alternative, safe and practical method of work was given by the driver of the garbage truck:

> *`Q: Did it ever occur to you to cross the street and do them on the other side? A: We have since, we do go down one side and come up the other side because of safety reasons. Q: Because it is a busy street? A: Yes.'*

In that case there was only one clear work procedure and the risk was obvious. The employees were apparently not trained to avoid that risk nor were simple work procedures adopted to avoid the hazard. In the case under consideration apparently both the deceased and Hawkett were trained to avoid hazards through an isolation/tagging process. In the Tedman Case there was no system. In this case there was a structured system of training [with isolation/tagging]. In essence a comparison between this case and Tedman is further complicated by some work undertaken by BHP at the Western Port plant in health and safety issues.

However, what was not done was a detailed safety audit of the Pickle Line on commissioning which would have identified the potential latent hazard and provided lockout. Lockout would allow for, what the judges in Tedman aptly point to as a problem `the employee's negligence, inadvertence and carelessness in carrying out the work'. In this case the employees did not appreciate the danger from the sliding beam under the tilt table.

This case is illustrative of the proposition that training, isolation/danger tagging may not be sufficient when dealing with a latent hazard. Albeit a hazard that should have become obvious when commissioning the machine or during the first adjustment process. The hazard is latent in the sense that, as adjustment is a relatively rare event, employees may not become aware of the problem. In addition the adjustment may be done in `down time' when the problem would not be evident. Therefore, in spite of regular training on safety procedures, inadvertence [or a lack of awareness] may rule in a busy work environment and disaster follow.

BHP failed to identify the latent hazard on the Pickle Line when it was first installed and/or during the regular maintenance adjustment. Modern lockout methods [in addition to the then existing training, tagging and isolation procedures] were a reasonable solution to maintenance and adjustment on this particular section of the line. Automatic lockout did not [and does not at this time] apply to restrict access to the area when adjustment was to be carried out. It should.

The training was apparently fragmented as between operators and maintenance personnel with the result that an operator started the welding process even though he was aware that the maintenance fitter had commenced the isolation process. Whilst it is understood that it is necessary to have a demarcation [for safety purposes] between operators/maintenance the training should be aimed at a greater level of understanding of each function. Even though there was regular examination of operators/maintenance employees' knowledge of safety procedures that knowledge appeared lacking at inquest. It must be noted that safety

training [with testing audit] was part of the system at Western Port at the time of the incident.

There was no evidence that the employees involved were aware of the specific hazard and thereby able to identify `risk' under the Company's isolation/tagging procedures. Not having that level of awareness the immediacy of commencing the isolation in accordance with the procedures before the work may not have been evident.

Edwards' initial action in requesting adjustment, moving to a position with Hawkett and Gallagher-Green and observing them in the vicinity of the gap in the table may have given a false sense of security to the work at hand. Unfortunately, he then went back to the operator's panel and started the weld. This is a posibility only. It was not examined.

The `common sense' process of standing back and watching the machine in operation is another way of defining `risk assessment'. It would appear that there was no training in `risk assessment' - vital for the effective operation of the `isolation' procedures [in the event that mechanical protection is not practical]. A word of caution - one person's view of `common sense' may be very different from another's.

In summary there were a number of factors involved:

(a) There was no evidence of a developed procedure aimed at identifying [and reporting] potential hazards during regular maintenance on the `Pickle Line' [see Wolverston's evidence] ;

(b) There was no evidence of a thorough audit of potential hazards [whether latent or patent] on the `Pickle Line' when the line was first commissioned;

(c) The regular audits of the line aimed at identifying potential hazards did not identify the hazard in tilt table area - they should have;

(d) As the particular hazard had not been identified [because of a lack of adequate reviews] guarding and/or danger signs had not been provided;

(e) Whilst there was a training system in place aimed at lockout, isolation and tagging it appeared to be fragmented between operators and maintenance personnel. In addition, in spite of annual testing, there appeared to be some difficulties in the understanding of the safety training procedures by the relevant personnel; and

(f) There was no evidence that employees directly involved had identified, been trained to identify `risk' or were likely to know of the hazard. `Common sense' apparently was the rule. With a full `risk management' approach to safety this would not have developed.

Accordingly the employer, BHP, also contributed to the death.

Recommendations and Comments

I propose to forward the Findings, Recommendations and Comments to the Attorney General as a matter of information. The findings will be disseminated to the :

- Minister, Department of Business and Employment,
- Chief Executive Officer, Workcover Authority [and its Health & Safety Division],
- The Managing Director, BHP,
- Secretary, Trades Hall Council,
- Monash University Accident Research Centre, and
- The Dean of Engineering, Monash University.

General Comment

Whilst it is clearly recognised that there are significant differences in petroleum offshore drilling operations to the work done in a steel mill the issues in this case are similar and result from a failure to allow adequately for human error [or behaviour]. The concentration in this case by those directly involved perhaps was on `getting the job done' rather than the safety procedures. The corporation appeared to concentrate on blaming the individuals for the outcome.

There are lessons to be learnt in this area from the Petroleum Industry. In the Offshore Platform [Tuna Fire] which occurred on 24th April 1989, Esso in its report on the incident states (in part):

> ``*to assist in ensuring that this task was properly performed the electrician took the MOV instruction book to the work site.*" *...and...* ``*he was focusing his attention on the mechanics of setting the electrical limits and as part of this he elected to open the valve and check the limit*".

Coronial comment, following a fire inquest, also indicated:

> ``*The precise reason for the fire results from inadequate danger tagging, work permit procedures and a failure of communication leading to the inevitable but understandable human error where concentration was focussed on getting the work done rather than on safety procedures that were inadequately communicated.*"

and

> ``*..the system of work permits and danger tagging procedures is also inadequate and this ought to have been well recognised by Esso prior to this incident. It was certainly recognised in Onshore operations with far more sophisticated, permit, tagging and lockout procedures which were obviously designed for the ever present and well recognised likelihood of human error.*"

The potential consequences of a poorly managed Permit to Work System can be seen by the 1988 Piper Alpha Disaster in the North Sea where 167 lives were lost. And that `human error' was recognised as a factor in offshore drilling operation incidents in a Report on a Meeting of Health of Offshore Oil Drillers [Tunis, May 1985] which stated [of platform accidents]:

> ``*...(most) were traced to errors related to human factors. The personnel errors are due to lack of training, negligence, lapses in safety practices...*"

Probably the most important lesson from events such as the one under investigation is to be found in a general comment in the `Interim Australian Standard' - Safeguarding of Machinery Part 1 General Principles [AS4024 - 1992]:

> ``*Accidents with machinery have often been attributed to ``unsafe acts*", *when a more thorough study would have revealed a design deficiency which did not allow for typical human characteristics or behaviour*"*[p.8, 3.1]*.

This case is a prime example. Neither the HSO investigation nor BHP's subsequent approach to the event discussed this issue. The issue was alluded to in the comments [at inquest] by the Company's Health and Safety Manager, Mr. Clapp, when he cautions of the isolation system *`it does rely on behaviour, the danger warning tag system and there in lies its inherent weakness.'*

On balance, it must be noted, that considerable work had been undertaken at the Western Port plant by BHP [both before and after this incident] on health and safety issues. There were isolation/danger tagging, training, some audit procedures and record keeping to name but a few. The company has recently [in 1994] undertaken a review of its safety involving the DuPont Corporation. The significance of DuPont's involvement is its reputation throughout industry of an excellent safety record. BHP is also establishing an incident review procedure. For this new approach BHP must be commended.

Investigation for `prevention' and beyond blame

In addition, rather than attempt to identify all of the factors involved there has been a focus on the employees' responsibility and drawing attention to `frequent internal and external HSO inspections' each failing to identify `a danger point or area.' [BHP Standards Review]. Throughout the inquest regular HSO inspections were alluded to as an explanation for failing to identify the problem area. This again tends to avoid the issue of corporate responsibility for safety.

The investigation was left with the impression that, rather than seek to identify all of the factors that may have resulted in this incident, the concentration was on the factors involving the employees. Mr. John Pincott, former Cold Reduction Manager at the Western Port plant stated in evidence:

`[of the non compliance with isolation procedures by Hawkett] [he] appears to have breached the isolation procedures that are required to afford him the appropriate protection...[and]...it is of concern that a senior tradesperson would operate in that fashion'...

A word of caution as Mr Pincott only discovered that Hawkett was involved about two weeks before commencement of the inquest. The HSO inspector took a second statement from Hawkett in which he admits direct involvement in the incident. BHP was not notified of the subsequent statement and only became aware of the issue on reading of the `Brief' to the coroner. On reading the brief and considering the evidence at inquest Pincott was of the view:

`...in relation to Mr. Hawkett's position, [I] need to assess what relevant discipline would apply commensurate with the conduct that he has followed at the time and that would be in conjunction with our industrial relations people, or legal people seeing it is two years after the event. But clearly that if I had been in knowledge of that information, at the time, it would have been, I would suggest a fairly severe discipline applied to Mr. Hawkett...which can go as far as dismissal...'

Possible responsibility of the employees [including the deceased] was but one of the issues. There were many others. A thorough internal critical incident review investigation aimed at prevention following the event would have identified some of the problem areas. Apparently this was not done [although some level of investigation was evidently undertaken by the company]. A critical review aimed at prevention would have identified the problems with hazard identification and highlighted Mr. Clapp's problem with the isolation system.

It should be noted that a detailed external investigation into liability and workers compensation issues was undertaken. This was regarded as privileged was not seen by the court.

To be effective an incident review process must seek to identify all of the factors [whether design, training, systems, behavioural, etc.]. Investigation to identify all factors with a focus on prevention of future events has long been recognised in some key safety areas - aviation/anaesthetic related mishaps. In that context an internal blame free investigatory process has merit.

Without Mr Hawkett's subsequent statement [even though faced with the risk of dismissal] many of the additional factors may not have been identified. The risk of dismissal needs to be carefully balanced against the need to learn as much as possible about all of the factors surrounding an incident if the aim of the investigation is prevention. Clearly, although discipline and legal liability issues have their appropriate place in prevention, experience has shown in crucial safety areas such as aviation investigation sometimes more may be achieved by the `blame free' process.

The failure of the initial investigatory process [HSO and Corporate] to identify all of the factors highlights the issue. Once again it is necessary to emphasise the need to balance two competing areas - legal liability [criminal and regulatory breaches; civil negligence; compensation issues; etc] and internal discipline with a blame free process aimed at identifying all of the factors. Prevention should be the key direction for both systems. The balancing of the two methods is not easy as each has particular merit. However if death and injury at work is to be reduced a balance must be found. In finding that balance we may have to look at separating the two concepts.

It must be remembered that issues of accountability, either of individuals or corporations, whilst appropriate for any investigation to consider, may cause problems. It is possible that concentration on accountability may cloud issues and limit effective development of preventative countermeasures.

Any investigation, to be effective, must look at:

(a) program analysis;
(b) systems;
(c) training;
(d) design, engineering and maintenance factors;
(e) behavioural factors;
(f) trends and research;
(g) audit;
(h) legal issues [regulatory breaches, etc.]; and
(i) solutions, etc.

Appropriate expertise in these areas may be needed for specific investigations. This was the type of investigation that needed all those skills. A team approach may be needed. In this regard it may be worth considering the Bureau of Air Safety's investigatory system or that employed by the Directorate of Flying Safety, Royal Australian Air Force.

Recommendation 1 - Workcover, HSD

That Workcover, HSD consider reviewing its investigatory procedures and protocols with a `team' approach for appropriate cases. Such an approach would require experts with diverse skills.

The Bureau of Air Safety investigatory model may be useful to consider. A word of caution - there needs to be a careful balance between investigation with legal liability issues in mind and the `blame' free process. Each has a valuable part to play in the prevention of injury and injury related death.

Recommendation 2 - BHP [Western Port]

That BHP [Western Port] consider reviewing its incident [near misses, injury and death] investigatory procedures and protocols with a `team' approach for appropriate cases. Such an approach would require experts with diverse skills.

The Bureau of Air Safety investigatory model may be useful to consider. A `blame free' approach may assist in better identifying problem areas - leading to solutions.

The relevance of the Australian Standards to prevention [also in HSD and corporate incident investigations]

AS 4024.1 [and AS 4024.2 Interim Australian Standard - Safeguarding of Machinery, Part 2, Presence sensing systems] both provide a useful framework in which to consider improved safe design, installation, operation, maintenance of machinery and work practices. Whilst the latter Standard applies to modern warning systems the former still provides an up to date structure on which to consider systems improvements to avoid the type of injury involved in this inquest.

It is interesting to note that neither the `Interim Standards' nor any other Australian Standards were mentioned by the occupational health and safety specialists giving evidence for the employer at this inquest. Evidence was given that isolation/danger tagging procedures, etc. were to be part of the subject of a lengthy review at the Western Port Plant. However, even then, there was no additional comment on the Standards.

Also officers from the then Health and Safety Organisation, Victoria did not raise the issue of the Australian Standards. The inquest was adjourned for a lengthy period for the inspector from HSO to undertake further investigatory work. The matter of the application of the Australian Standards had to be raised by the Coronial Service [November 1995] before the issue was investigated. The initial/additional investigation process by the inspector involved caused considerable delay to the inquiry.

Following the issue of the Standards being raised BHP [Western Port Works] appropriately put a considerable amount of resources into looking at the issue. An `Australian Standards Review - Kevin Gallagher-Green Inquest' was prepared [attached]. This review followed a written report by the inspector from HSO [also attached]. The conclusions of the BHP review differ significantly with the inspector's report. However, a thorough examination of all of the applicable standards would indicate further potential for systems improvements.

What is of concern is that specialist Health and Safety experts [whether at BHP or HSO] do not appear to have considered Australian Standards as part of a review following the incident. The BHP Standards Review argues that one of the Standards [AS 1755-1986] does not apply and that:

> *`at no time have officers of the Health & Safety Organisation..., who have inspected the pickle line on numerous occasions, referred to it as a conveyor system, or referred the Company to the Australian Standard for conveyors.'*

This may be illustrative of a less than thorough approach to the safety systems applying at the time of the incident. If sound alternatives had been instigated this comment would not apply. The failure to identify the hazard and take steps to eliminate it is a problem.

However, it would also not be unreasonable to expect a large organisation to pro-actively seek to identify all standards and systems [whether local or international] in an endeavour to find the best possible practice for reducing the risk of injury, thereby improving safety and minimising problems for production. No doubt the new Australian Standard - `Safeguarding of Machinery' 4024.1 - 1996 will be considered.

Recommendation 3 - Workcover, HSD

Workcover - HSD consider examining the application of the Australian Standards to aspects of investigations into deaths/injuries at work. Where relevant work practices, training, design, hazard identification and incident reporting may need consideration.

The importance of regular and thorough examination of Australian [and international] standards for applications cannot be underestimated in the area of improvements in safety systems. Hence appropriate investigations need to target these areas of best practice to assist in finding solutions.

Recommendation 4 - BHP [Western Port]

BHP [Western Port] consider re-examining the application of the Australian Standards to aspects of work practices, training, design, hazard identification and incident reporting as they apply to the Pickle Line.

The importance of regular and thorough examination of Australian [and international] standards for applications cannot be underestimated in the area of improvements in safety systems.

Supervision of the investigation - Workcover, HSD

There were significant difficulties in the investigation ranging from a failure to re-interview management after Hawkett explained his actions [and not informing the Company of the new issues], the failure to consider a variety of issues [including the Australian Standards] and the difficulty of obtaining further reports.

Currently there is a Central Investigation Unit for HSD and it is understood that its supervisory responsibilities are limited. This may need reviewing.

Recommendation 5 - Workcover, HSD

Workcover, HSD consider reviewing the Central Investigation Unit's supervisory role for work related death investigations.

Guarding of the tilt table adjustment area - automatic lockout/warning signs

One must not lose sight of one of the principal causes of this incident - the failure of the employer to adequately identify danger points on the Pickle Line and provide fail-safe guarding systems to avoid inadvertent entry into a hazard situation. Also there were no warning signs advising of the danger.

Although the eye beam was not normally visible, attention to detail when the machine was commissioned, should have identified the potential nip point near the table adjusting nut under the tilt table. This area should have then been guarded. The system currently employed still does not fully address the risk of entry where the employee does not appreciate the hidden hazard.

It is of concern that apparently an `independent [engineering] investigation into the operation of the machine...disclosed no defect in it.' This investigation was undertaken by BHP. Clearly there was a hidden hazard - an engineering investigation should have identified this problem and provided solutions. This report was not seen by the court.

This is yet another case regularly observed in the coronial jurisdiction where original machinery design issues lead to potential for injury. In addition attention to detail in identifying hazards when commissioning plant is vital for the management of safety issues. Machinery manufacturers, designers, engineers and educational institutions have a role in this area.

Recommendation 6 - BHP [Western Port]

That BHP [Western Port] consider providing a secure fenced area with locked gate providing automatic lockout of the tilt table welding operation on entry. This would prevent inadvertent operation when an employee has entered the area.

In addition `Danger signs' need to be considered.

Recommendation 7 - Engineering Department, Monash University

The findings are referred to the Engineering Department, Monash University with the intention of highlighting an opportunity for detailed research in this area.

Hopefully detailed research will lead to long term improvements in teaching, design and engineering solutions for safety problems.

Engineers, designers [with their associations] and machinery manufacturers would no doubt benefit from such research.

Full audit of `Pickle Line' for potentially hazardous [latent/patent] maintenance points

While it is understood that an audit has been conducted of the pickle line in the light of the multi-faceted nature of this incident this issue may require revisiting. What is of concern is the evidence of Mr. Pincott:

> *`Question [Mr. Griffin]: So the guard itself does not prevent injury?*
> *Answer: No.*
> *Question; It is the adherence to the isolation procedures?*
> *Answer: Correct.*
> *Question: Are there other parts of the machine process, the whole 300 meters which and I suppose it goes without saying, also is equally dangerous? [the underlining is mine]*
> *Answer: Yes.*
> *Question: If they are not isolated?*
> *Answer: Yes.*
> *Question: The Department of Occupational Health & Safety have been over the line a number of times over the years?*
> *Answer: Yes [and there had never been a request to guard].'*

The reassessment of this issue is vital as can be seen by the comments by the Company's Health and Safety Manager, Mr. Clapp, when he cautions of the isolation system `*it does rely on behaviour, the danger warning tag system and there in lies its inherent weakness.'*

Recommendation 8 - BHP [Western Port]

BHP [Western Port] consider re-examining the audits of the Pickle Line in view of the matters raised in this inquest. There may be other danger areas that need guarding. If necessary a new audit should be considered.

Work Permit Procedures for Hazardous Areas - where guarding is not practicable

It is also clear that specific `work permit' procedures should have been instituted for entry into areas such as the tilt table. This would have been a minimum approach in the event guarding was not practical - this may have avoided this event.

There may have been a problem with a perceived need by Hawkett to initially assess the adjustment, and in not perceiving a danger, saw no problem in entering the area and then conducting isolation processes. This may indicate a need to develop a separate work permit procedure designed for `initial inspection' - an `initial inspection work permit'. This may assist employees in directing their attention towards developing a `job hazard analysis' [AS 1470-1986, Cl 6.3.4].

It should be noted that this comment should not be taken to justify a lesser approach to safety as applying to the tilt table - adequate guarding is the solution.

Recommendation 9 - BHP [Western Port]

BHP [Western Port] consider developing an `interim inspection work permit' to assist in clarifying the message to employees that even moving into plant with an intention to merely assess maintenance/adjustment needs requires `risk assessment' and safety measures.

This would be as a precursor to full `work permit' and lockout/isolation.

The `Danger Tag and Warning Tag' Regulations at Western Port - the need for training in `risk identification'

Whilst BHP Western Port Plant had training, isolation and danger/warning tag procedures which addressed the work practices the human behavioural factors do not seem to be adequately addressed. It is noted that the system is currently under review.

The work system that applied to BHP's Western Port Plant was governed by a `Handbook of Danger Tag and Warning Tag Regulations' [Updated June 92]. The summary of the Basic Rules [omitting sections not relevant] states:

> ``(a) Before commencing work on any equipment you *must* ensure that the correct isolating procedures have been applied.
> (b) You *must* place DANGER tags before commencing work on any job where you are exposed to the risk of personal injury.
> ....Failure to comply with the above will make you liable to *instant dismissal...'*

Here there was not full appreciation of the risk of personal injury. There is a need to train employees in `risk assessment' and not rely on `common sense' as the sole guide. Apparently `job hazard analysis' was not part of BHP's systems. Hazard analysis [or `risk assessment'] is understood to be part of Victoria Police's Operational Safety & Tactics Training. This may be a useful system to consider.

Recommendation 10 - BHP [Western Port]

BHP [Western Port] consider the introduction of a training program aimed at improving employees' ability in the area of `risk assessment', `risk identification' or `job hazard analysis'. A risk assessment system should be considered where isolation procedures, etc. are the only alternative.

The new Occupational Health & Safety [Plant] Regulations 1995

Whilst it is not intended to comment on the new `Occupational Health & Safety [Plant] Regulations 1995 and the non-regulatory approach to workplace health and safety the recommendations are designed with this new regulatory thrust in mind [See generally Regulations 702 to 708, et seq].

Graeme Johnstone
STATE CORONER

Senior Constable P.Ashby, Assisting the Coroner,
Mr.G.Gilbert for Geoffrey Edwards,
Mr.B.McCullagh for Glen Hawkett,
Mr.B.Griffin for BHP, and
Mr.P. Misso for the Family.

Case No: 1690/89
18th November 1991

INTRODUCTION

Following the Fire on the Esso Offshore Oil Platform known as "Tuna" on 24th April 1989 it was necessary to determine whether the Coroners Act 1985 (Victoria) gave jurisdiction to the State Coroner to investigate the fire. The Tuna fire occurred on an oil platform in Bass Strait, 70 kilometres from the Victorian Coast.

The Coroners Act 1985 Section 31(1) gives jurisdiction to the Coroner to investigate a fire .... "if the fire occurred in or partly in Victoria" and Section 36 provides that the Coroner must find if possible –

(a) the cause and origin of the fire; and
(b) the circumstances in which the fire occurred; and
(c) the identity of any person who contributed to the cause of the fire.

Section 36 further provides that the Coroner –

"(2) .....may comment on any matter connected with the fire including public health or safety or the administration of justice.

(3) .....must not include in a finding or comment any statement that a person is or may be guilty of an offence."

In conducting the Inquest the Coroner is "not bound by the rules of evidence" and may be informed and conduct an inquest in any manner that the Coroner reasonably thinks fit (Section 44).

In determining the threshold issue it is necessary to examine as to whether an area 70 kilometres from the Victorian Coast is deemed to be "in or partly in Victoria" for the purposes of Section 31(1) of the Coroners Act 1985.

It is recognised that pursuant to the 1982 Law of the Sea Convention every State can establish the breach of its territorial sea up to 12 nautical miles beyond its land. Australia has not extended its territorial sea from the three nautical mile limit. International law also gives sovereignty to a Coastal State over the Continental shelf adjacent to its Coast but outside the territorial sea to explore and exploit its natural resources – See the Convention of the Continental Shelf.

In 1967 there was an offshore Constitutional Settlement between the Australian Government (then call the Commonwealth of Australia) and the various Government of each of the States and territories which was called "An Agreement Relating to the Exploration for an the Exploitation of the Petroleum Resources and Certain ..... Resources of the Continental Shelf of Australia and of Certain Territories of the Commonwealth and of Certain Other Submerged

Land." The respective Governments agreed to legislate in identical terms over offshore petroleum mining and not to alter the legislation without prior agreement.

The Territorial Seas and Continental Shelf were divided by agreement into "adjacent areas" applying to each State although the Commonwealth (Australian) legislation applied to all adjacent areas. State or Territory Legislation pertained to its individual area. The royalties were shared between the Australian Government and the State to which the relevant adjacent area applied.

This did not however resolve the constitutional debate as to the issue of territorial Sovereignty of the States in offshore areas.

In 1976 the High Court determined that the seabed beyond the low water make was not part of a State (see Seas and Submerged Lands case – New South Wales v Commonwealth (1976) 135 C.L.R. 337) and that the Constitution Act 1900 had conferred power on the Commonwealth to legislate upon the subject matter of the Territorial Sea.

Following the Submerged Lands Case the Australian Government negotiated with the States which resulted in the current offshore Constitutional Settlement which conferred jurisdiction on the States over the 3 nautical territorial sea off their respective Coasts. (Coastal Waters (State Powers) Act 1980).

The Settlement between the Australian Government, its States and Territories provided that the Administration of the exploration and exploitation of petroleum resources beyond the outer limits of the territorial limits (3 nautical miles) should be between the Australian Government and the relevant States and that Australian Government and the States should endeavour to have common principles applying to exploration and exploitation of petroleum resources of submerged lands seaward of the inner limits of the Territorial Sea.

The Victorian "Adjacent Area" is defined in the Petroleum Submerged Lands Act 1982 (Victoria) as extending from the low water make to the 3 nautical mile limit. Beyond the 3 nautical mile limit the Commonwealth has jurisdiction for the "adjacent area" to the outer limits of the Continental Shelf (See Section 9 of the Victorian Act and Section 5A of the Petroleum Submerged Land Act 1967 (Commonwealth)).

The Commonwealth "adjacent area" is co-administered by a joint authority consisting of the Federal and State Ministers for Mining.

For the purpose of ascertaining whether the Coroner has jurisdiction to investigate the fire it remains to be determined which law applies to the "Commonwealth Adjacent Area" which is by agreement jointly administered by the Australian Government and the State of Victoria.

In summary the adjacent area is territorially joined into –

(1) State adjacent area – the 3 nautical mile limit.

(2) Commonwealth adjacent area to the outer limit of the Continental Shelf as administered by the joint Commonwealth / State Authority.

It is also necessary to consider Section 57 of the Interpretation of Legislation Act (Victoria) 1984 which deals with application of laws in offshore areas specifically relates to acts done within the outer limits of the Victorian Coastal Waters (ie. 3 nautical miles seaward) and to the edge of the Continental Shelf (adjacent area) where acts done or admitted to be done "involves or relates to persons connected with Victoria.....as if the adjacent area were part of Victoria."

Where the act done (or committed) relates to a person in Victoria, Victorian laws will therefore apply. "Person connected with Victoria" is defined as a person who is –

57(6)(c) (i) domiciled in Victoria;
(ii) permanently or temporarily resident in Victoria;
(iii) being a body corporate has a place of business in Victoria or is registered in or incorporated or established in Victoria;
.....
(v) on or operating from a rig or other structure or installation of any kind in the adjacent area in the operation or function which is regulated by a law of the Commonwealth or of Victoria.

As the platform is within the described "adjacent area" under the Commonwealth and Victorian Legislation the Coroner has jurisdiction to investigate the fire under Section 31 of the Coroners Act because the adjacent area is deemed part of the State of Victoria. Also sufficient connection exists as the Company involved carried on business in Victoria and it is reasonable to conclude that individuals involved were domiciled or permanently residents in Victoria.

THE ESSO OFFSHORE PLATFORM (TUNA)

The Esso Offshore Platform which is called "Tuna" was one of a number of Platforms owned and operated in Bass Strait by Esso Australia Limited at the time of the Fire (24th April 1989). The company operated 13 manned and 3 un-manned platforms. The Tuna platform was known as a Second Generation platform and was constructed in the late 1970's.

First Generation platforms such as Barracuda, Marlin, Halibut, King Fish were constructed in the late 1960's and early 1970's, second generation such as Tuna and Mackerel in late 1970's and the Third Generation since 1980.

At the time of the fire there were 28 personnel on the Platform which included the normal compliment of staff (14) and 14 additional diving related staff.

THE FIRE

At approximately 1.10pm on 24th April 1989, a fire commenced on the Tuna Platform in the Main Oil Line Pump engine enclosure and spread to the adjacent service module under the crew quarters.

A leak of crude oil had occurred under high pressure from the Main Oil Line Pump which was being overhauled by an electrician, Mr. Graham Lambert who was adjusting the limits on a discharge valve. On opening the crude oil, under pressure escaped from a 16mm threaded inspection hole in the pump housing. A Bull plug had been removed from the hole during earlier maintenance procedures.

A mechanic, Mr. Russell Wain who was working on an engine below and adjacent to Lambert and had removed a small wall panel (3' x 3') between the pump and the drive engine and the oil and gas mixture under pressure entered the engine enclosure where two of the three engines were still operating and most probably provided the ignition source for the fire.

The fire door which was adjacent to the pump was partly open and permitted vapours to escape into the nearby utilities area and created a secondary explosion with combustion gases and smoke being pushed up the duct in the laundry into the crew quarters.

WORK PRACTICES LEADING TO THE FIRE

An inspection of the work diaries reveals that work was undertaken on Pump 430 on 5th April when diary notes indicate "Pump was started and seal pump leaked also valve. Mechanics had to remove spool and I removed heat (trace?) for them." The author of the diary note has not been identified. Other diary notes on 4th, 6th and 13th April reveal work on the pump. It appears that a mechanic had removed the bull plug (an inspection valve – which secured a small inspection hole) during this operation which eventually resulted in the crude escaping and fire on 24th April. Details of whether any tagging procedure had been undertaken during this work have not been ascertained either by the Esso Investigation or during the fire Inquest. As a result of the subsequent events it appears unlikely that the missing valve at any stage was danger tagged. The danger tagging procedure was not, in any event, mandatory, as part of the work practice and relied on the discretion of the employee.

The valve continued to leak and work was undertaken on the pump during mid April. On 23rd April the platform was shut down to enable work to be undertaken on P430 and the power supply to the pump was isolated and tagged and various work was undertaken on the pump. The mechanic who was working on the pump did not notice the missing valve (bull plug) nor did he notice the open thread hole. The missing valve and inspection hole is small and may be compared (in diameter and scale) with a 50c piece. Without danger tagging it is understandable why the omission of such a small item on the pump should be overlooked. The system was re-pressurised, with the exception of pump 430. Pump 430 had not been danger tagged and it had not been pressure tested. As the Esso report states the "pump status was not effectively communicated to the crews".

A work permit system had been established at Tuna and it is the operation of this system and the failure to adequately danger tag the pump which is the key to the cause of the fire. Lambert, the electrician, had worked until about 9pm on the evening previous to the fire had not attended the normal work meeting which planned the next day's operation. A permit to work on the pump had been written on the previous evening and at the morning meeting Lambert mentioned he would be adjusting the limits on P430 in accordance with the permit which stated "finish fitting off pump and motor and adjust limits on MOV."

Unfortunately a stop work meeting for operators was arranged for the day when the fire occurred and they were to be absent from the platform for most of that day.

Early on the morning of the fire the operator processed the hot work permit for pump 430 (along with 2 others). The supervisor on the platform approved the permit with the provision that the operator's checks should be performed before work commenced. As the operator would be off the platform at a "stop work" meeting the work permit was amended from 1800 hours back to 0800 hours. This change was not communicated to the Supervisor or the Crew, although it is clear on reading the permit. Following the amendments the morning work co-ordination meeting took place and Lambert, the electrician received the permit. Apparently at the meeting there was no explanation as to the effects on work to be undertaken during the remainder of the day by the operators being offshore. The alteration time was not discussed.

Shortly after lunch work commenced on P430 and after setting the limits of the valve, Lambert restarted the MOV by activating the circuit breaker in the switch gear room and removing the danger tag which he had previously installed. Lambert was inexperienced in this operation as he had only performed the task 4 or 5 times during his 4 years of working on the Platform. The Esso Report states on this issue To assist in ensuring that this task was properly performed the electrician took the MOV instruction book to the work site and he was focusing his attention on the mechanics of setting the electrical limits and as part of this he elected to open the valve and check the open limit. The valve was opened electrically without prior reference to the operator (who was not on the platform).

The precise reason for the fire results from inadequate danger tagging, work permit procedures and a failure of communication leading to the inevitable but understandable human error where concentration was focused on getting the work done rather than on safety procedures that were in adequately communicated. Whilst it was clear that Lambert on a careful reading of the work permit should have seen it was not operable because the time had expired and it was necessary to refer to the operator who was not on the platform and accordingly ought not to have opened the valve, it is equally understandable that he was concentrating on the work to be done and without adequate experience of that particular work combined with a lack of communication and instruction at the morning meeting failed to appreciate the potential effect of opening the valve without first referring to the operator and going through all the checking procedures. The problems associated with the cause of the fire are summarised in the Recommendations of the Esso Report as being –

"RECOMMENDATIONS

CONTROL OF WORK / EQUIPMENT ISOLATION

In this instance some major deficiencies were noted in work control, communication and isolation procedures, viz:

- At the 0600 co-ordination meeting on 24/04/89 the scope of maintenance work to be undertaken during the absence of the operators should have been defined more explicitly.
- Before handing out the permits on 24/04/89, the operator altered the permit expiry time on all permits from 1800 to 0800. This time change was not effectively communicated to the platform supervisor or the crew and consequently all work continued after 0800 without valid work permits.
- The specification of work conditions in the check list was not specific enough, eg. The operational requirements to be fulfilled before stroking of the discharge valve were not exactly specified.
- The permit to work was approved before the check list items had been properly completed, ie. conditional approval to work was given.
- While the status of the suction and discharge valves to pump P430 were known to the operators on board, neither the valve was tagged or locked to indicate potential hazard to third parties.

In summary, on this occasion the work permit procedures were not followed properly, the communications were ineffective and the isolation procedures were inadequate.

In general, the Operations/Maintenance team on the Tuna Platform is very effective in achieving a safe working environment. The crew's performance in achieving the objectives of the work permit system relies heavily on informal co-ordination and team experience rather than rigid procedures. In this incident, the absence of the operator reduced the team effectiveness and hence the integrity of the work permit / isolation practices.

Normally the electrician would most likely have consulted the operator before opening the discharge valve to set the open limits. As mentioned elsewhere, the electrician was engrossed in the technical details involved in setting the MOV limits and was closely following MOV instruction manual. Before opening the discharge valve the electrician realised that he should gain operational approval for this action. He realised that the operator was not on board, and further realised that he should then have consulted the platform supervisor for approval to open the valve. He chose not to worry his supervisor with this request and elected to open the discharge valve without the necessary operational approval. This situation was compounded by the lack of danger tags on the suction/discharge valves to warn others of the potential hazard in opening the valves without first checking the status of the pump and its associated pipework. "

The primary cause of the fire is the opening by Lambert of the valve. However, the system of work permits and danger tagging procedures is also inadequate and this ought to have been well recognised by Esso prior to this incident. It was certainly recognised in Onshore

operations with far more sophisticated permit, tagging and lockout procedures which obviously were designed to allow for the ever present and well recognised likelihood of human error. With the potential for disaster from error as a result of lack of supervision, inexperience with particular work task or work procedures which rely "heavily on informal co-ordination and team experience rather than rigid procedures." Inevitably once the co-ordination breaks down for some reason that cannot always be envisaged the lack of strict procedures can lead to potentially disastrous results. It is obvious that work procedures involving permit, danger tagging and lockout had been adopted in onshore operations as a recognition of the very aspect of the potential for mistakes to be made, by experts in a professional team and management alike.

The critical point is that efficient danger tagging, lockout and permit systems were not new to the Petroleum Industry and had been long recognised onshore as methods of eliminating the ever present possibility of human error following a breakdown of communication or for some other reason.

THE PIPER ALPHA DISASTER

Following the Piper Alpha disaster in the North Sea on 6th July 1988 with 167 lives lost a preliminary report was made available to the Petroleum Industry. A study of the report indicates remarkable similarities in the respective causes of the North Sea disaster with that of the Tuna Fire. Whilst there are considerable differences in the scale of the respective operations and the obvious effect of both disasters the failures involve essentially the same issues inadequately developed and followed work permit, danger tagging and lockout procedures. As was stated by Lord Cullen in his final report –

> "there was no consistently used system for affixing a tag to an isolation valve which had been closed as part of the isolation of equipment for maintenance where the tag warned that the valve should not be opened."

At Tuna the use of danger tags was discretionary and there were no lockout procedures. The valve was not danger tagged by the unknown mechanic when removed and the electrician was only aware of his own tagging in the switch room. The small valve which was removed was also in the relatively inaccessible part of the pump and difficult to see with available light conditions. Also in his general comments on the Permit to Work System in operation on Piper Alpha Lord Cullen stated –

> "The evidence which I considered. showed that this failure was not an isolated mistake, but that in a number of respects, the P.T.W. system had been operated routinely, in a casual and unsafe manner. There were failures for which management was responsible. If there had been adequate monitoring and auditing, it is likely that these deficiencies in the P.T.W. system would have been corrected. "

Irrespective of the differences in scale the risk management issues are essentially the same and that is to expect a failure in systems following anticipated and understandable human error and develop appropriate systems, as far as is practicable, to eliminate the risk. Whilst it could be

said that Esso had systems in place, which, if followed, would have avoided the Tuna Fire. What must be appreciated is that existing onshore systems were far more sophisticated and allowed as far as practicable for the inevitable human error. In the context of highly flammable and explosive material with the potential for disaster on a platform the only appropriate course was then and is now to ensure integrity of the system by using the most effective and up to date work practices, procedures and equipment with regular audits. As was also stated by Lord Cullen "the major hazard involved in the risk of high pressure gas fire, whether prolonged or not, underlined once more the need for the highest standards in incident prevention and the means of fire fighting."

Human error as a factor in offshore drilling operation incidents was well recognised as is observed in a "Report of a Meeting on Health of Offshore Oil Drillers" at Tunis in May 1985 -

> "In a report from the United States, most of the platform accidents were traced to errors related to human factors. The personnel errors are due to lack of training, negligence, lapses in safety procedures, deficient regulations, rapid turnover of personnel, abuse of alcohol and drugs, and monotonous and onerous working and living conditions combined with psychological problems.
>
> .... The working area for a platform worker may also be physically restricted, and he often has to work long hours to finish a job on time."

It is trite to say that had the mechanic danger tagged the valve when removed, the operator adequately communicated the change in the operative times of the permit or had the electrician adequately read the permit and followed the instructions the fire would not have occurred. The real issue is that reliance on a small team as distinct from recognising that errors will inevitably occur and providing the best possible systems to combat potential failure, is a mistake. That mistake must rest with management as the potential for the inevitable human error has long been well recognised not only in the petroleum industry but also in other areas where the risk is appreciable.

REPORTED FIRES ON OFFSHORE PLATFORMS SINCE 1982

Since 1982 there have been 20 reported fires on Bass Strait Platforms varying in degree from a small fire during an electric welding process to the Tuna Fire. In all cases improvements in work practices were undertaken as a result of the experience of the fire.

On 6th November 1986 a fire occurred on West Kingfish Platform following the skimmer pile being over pressurised due to the blockage of a non-return valve on a vent line during a test. Hydrocarbons gushed out of the deck drains and were ignited by the hot MOL pump. An engineer was killed and another employee was injured. A Coronial Inquest was held and a number of recommendations were made.

A study of the incidents indicates that fire and explosion are an ever present risk, and in a compact environment, that risk is magnified and the potential for consequences as have been seen on Tuna are obvious. The risk with proper management by Industry, Unions and

Government is capable of reduction with efficient and the most up to date work practices, procedures and equipment. Effective risk management of the offshore platforms also requires a co-operative effort, and although Esso, being the Operator, has prime responsibility, it would be a mistake to view that responsibility in isolation. The effective and rapid introduction of improvements in any system also rely on the cooperation of the other agencies involved which sometimes will result in delay, and where safety is involved this can in some cases, be unsatisfactory.

OPERATION OF FIRE CONTROL AND DELUGE SYSTEM

Following the fire in the Pump Engine Room gas was detected by the Fire Deluge System in the Main Oil Line Pump Area and the platform shutdown sequence commenced.

The thermal detectors in the Pump Engine Room also automatically sent signals to commence fire alarms and fire pumps.

The Electric Shutdown and three deluge handles were pulled by personnel which also commenced the shutdown procedure, alarms and deluge systems. Fire hoses were being operated by personnel.

It would appear that the Deluge System and fire pumps had an early opportunity (within moments of the fire commencing) to operate by both personnel normally operating the System and the automatic system being initiated.

However, in spite of the combination of both manual and automatic systems failure occurred with the potential for loss of life, injury and further fire spread.

It is noted that the investigation undertaken by Esso following the fire deals with the fire identification control and deluge systems on the platform and considers the possible reasons for failure in the system. The Esso report also makes various recommendations to remedy the deficiency in the system. Other than to say that the system did not operate efficiently it is not proposed to comment further in the findings other than to adopt the Esso Report and Recommendations.

RESCUE / ESCAPE SYSTEMS

The Esso Report makes recommendations on improvements in the Rescue / Escape mechanisms which are appropriate.

CONTRIBUTION

The following parties contributed to the fire -

(a) Graham Lambert, electrician, in failing to observe the formalities of the existing work permit procedures before opening the valve. The contribution of Lambert to the fire

must also be seen in the context of the contribution and comments on the role of his employer, Esso.

(b) Esso Australia Limited in failing to introduce procedures to allow for a breakdown in team operation by way of failure to communicate or loss of an important element of the team. It was clearly recognised in on shore procedures and accordingly more sophisticated and appropriate work permit, danger tagging and lockout methods were introduced. There was the false assumption applicable to the offshore operation of reliance on "informal co-ordination and team experience rather than rigid procedures".

Whilst it could be legitimately argued had the then existing work permit procedures been followed the fire would not have occurred better risk management in onshore operations had long recognised the fallacy of this argument when working with highly volatile and dangerous substances with the ever present potential for explosion and fire.

Because of isolation on a relatively confined area Esso ought to have recognised that the risk on a platform has many more complexities for the work force. The problems associated with combating an explosion or fire in a restricted environment are also magnified accordingly the concentration should have been on providing the offshore platforms with state of the art work procedures and systems aimed at prevention. It is for this reason that the failure of Esso to introduce an improved permit, tagging and lockout system results in a contribution to the fire.

The contribution by Esso must also be seen in the context of a regulated Petroleum Industry in Australia where a system of approval of Safety Procedures has been established through a co-operative approach between Industry, Unions and the Authorities (both State and Commonwealth). The work permit procedures in operation on Tuna at the time of the fire had been adopted by the Operator, the Unions and the respective Authorities as a result of this process. As the adequacy of the system had been approved by the Authorities it would appear that some degree of understandable complacency may have avoided upgrading of the work permit, danger tagging and lockout procedures and mistakenly emphasis was unduly placed on the effectiveness of a relatively small and professional team.

Following the preliminary report on Piper Alpha work had been commenced on upgrading systems as a result of the initial recommendations, however the co-operative approach takes considerable time with agreement necessary between Unions, the Operator and Governments. Unfortunately the events at Tuna overtook the review and introduction of effective procedures that would have avoided the Fire.

The potential for delay in the introduction of new safe working procedures can be seen by the fact that the final revised "Offshore Work Management" Procedures were not introduced following the history of Piper Alpha and Tuna until late 1990 after a lengthy consultative process. Any criticism of Esso must be seen in the context of a consultative process that takes a considerable time to see results even on the most vital of safety issues and after clear messages have been given to Government, Industry and Unions alike by way of identified work procedure problems following two disasters. Comment must also be made about the delay of the eventual implementation of new permit, danger tagging and lockout systems as a

result of some Union negotiations inappropriately mixing Industrial issues with the early implementation of safety procedures.

A history of fires and incidents in the Bass Strait and overseas (including Piper Alpha) clearly indicates the obvious risk where even the smallest error can lead to a potential for disaster. The lessons ought to have been learnt well before 1989 and that work permit, danger tagging and lockout procedures should have been the most advanced available to Industry to alleviate, as far as is practicable, the risk. The reliance on a small team, however professional and efficient, is a mistake for as the Tuna Fire has evidenced poor communication and human error will occur with inevitable potential for disastrous results.

COMMENTS AND RECOMMENDATIONS

I propose to forward the Findings, Comments and Recommendations to the Attorney-General, Victoria for dissemination to the Minister, Department of Labour (Victoria), the Minister for Resources, Esso Australia Limited and the A.C.T.U.

Whilst it is understood that since both the Piper Alpha disaster and the Tuna Fire considerable work has been undertaken by the Authorities, Esso and relevant Unions the key to appropriate risk management on offshore oil platforms is the full use of the most up to date and advanced work practices, procedures and equipment combined with appropriate levels of supervision and training. It is obviously not sufficient to rely on the effectiveness of a relatively small team, however professional, as human error can occur with the potential for disastrous results. The potential for disaster is magnified in the confines of an offshore oil platform where highly volatile substances are in the close vicinity of potential ignition sources and it is reasonable to expect because of the ever present danger all of the procedures and equipment should have been the most advanced available to industry.

Because of the confines of the platform and the relative isolation it is also essential that fire fighting, rescue procedures and equipment are also the most advanced with vigilant and effective audit to ensure that problems are identified at an early stage and rectified.

Many of the issues involving operation of the fire fighting equipment, safety and rescue procedures and improvements in systems have been adequately identified in the Esso Report on the Tuna Fire. The exhaustive inquiry into Piper Alpha has also identified similar issues.

What is of concern is that these issues are raised following inquiries and not as a result of effective and efficient audit of safety procedures and equipment before incidents or disasters. Effective audit of the deluge system and fire fighting equipment on Tuna ought to have identified and rectified the problems associated with items such as blocked fire hose nozzles well before the fire. Issues associated with fire fighting are crucial for the safety and integrity of all the systems on the platform and the eventual survival of personnel in the event of fire. Effective audit also ought to have identified the short comings in the permit danger tagging and lockout procedures which would have prevented the event.

The investigation by the authorities and the inquest relied heavily on the Esso Report, and whilst the court has no real problem with the Report its essential emphasis fails to reach the real point associated with the Systems failure that led to the fire and that is human error has long been associated with incidents (especially on oil platforms) and with the potential for catastrophic disaster when working with highly volatile substances in a confined area the system must be at the leading edge and not following improvements onshore.

Graeme Johnstone
Coroner

Case No. 4453/88
27th April 1990

CONFINED SPACES

Inquest into the death of COLIN EDWARD TAYLOR held at the Coronial Services Centre, South Melbourne on the 20th and the 21st March 1989, 20th and 21st February 1990 and 26th and 27th April 1990.

The death of COLIN EDWARD TAYLOR occurred on the 17th October 1988 at Vaucluse Hospital, Brunswick from bilateral bronchopneumonia with empyema in the left pleural cavity and a contributory cause of hypoxic brain damage in the following circumstances:

1. At approximately 6.30pm on the 14th January 1988 the deceased, who was employed by Garrick and Dind Pty Ltd was working in a vertical L.P.G. storage tank situated at the Esso Service Station, Torquay Road, Grovedale when he collapsed due to a lack of oxygen in the tank.

2. The deceased was employed as a Tradesman's Assistant with Garrick and Dind and was working with John Ewan Wilkie, a Supervisor who was also employed by that company.

   The deceased and Wilkie were generally required to install, service and maintain L.P.G. gas tanks for their employer.

3. The 14.5 kilometre upright L.P.G. storage tank manufactured by Pinnacle Engineering Pty Ltd (Queensland) had been installed at the Service Station by Garrick and Dind in October 1987.

   Shortly after installation it was found to have a problem associated with the float valve.

   A purging operation was commenced by Wilkie and the deceased. The tank was purged with nitrogen approximately three times and left it to stand for one hour. Wilkie sniffed the tank atmosphere for the presence of L.P.G. and stated he could smell no L.P.G. He also indicated

that he had been hanging head first at the top of the tank for approximately 20 minutes with no ill effects. The deceased then entered the tank. Shortly after entering the tank the deceased collapsed. Mr. Robert Spanno, a mechanic employed at the Service Station attempted to rescue the deceased however, he collapsed in the tank and also had to be rescued. Spanno later recovered from the incident in hospital.

The deceased entered the tank without the use of a parachute harness or ropes.

4. The deceased was being supervised by Wilkie. Wilkie was not in a position to enter the manhole as he was too big in stature.

The manhole measured 400 millimetres and had been recently approved by the Department of Labour Design Review Section as complying with the relevant Australian Standard 1210-1982 (Unfired Pressure Vessels Code).

5. Wilkie, a Licensed Gas Fitter, had approximately 27 years experience in working with pressure vessels but had an inadequate knowledge of the safety procedures. Safety harness, breathing apparatus and atmosphere testing equipment were not normally carried.

It was indicated by Wilkie that safety equipment would only be hired by the employer Garrick and Dind when required. It is noted that such equipment had not been hired in for any previous operation with L.P.G. tanks.

In spite of an instruction by an Engineer employed by Esso Australia Limited to finish the job the next day Wilkie was in a hurry to complete the work as he had another job to attend to in Scoresby. The Esso Engineer had left the site prior to the deceased entering the tank.

6. There were no training procedures for either Wilkie or other employees established by Garrick and Dind in relation to safety and confined spaces. That company appeared to rely on Wilkie's expertise which was clearly inadequate.

7. Esso Australia Limited who employed Garrick and Dind as Sub-contractor to install the L.P.G. tank relied on Garrick and Dind's reputation as experts within the area of L.P.G. installation maintenance and service and also on the contractual arrangement which required Garrick and Dind to complete the work in compliance with the relevant regulations and Esso's "Safety Rules for Contractors".

It is noted that Esso did not undertake any training for its sub-contractors but sought to rely on the terms of the agreement and the Safety Rules for Contractors which requires the issue of a permit on entry into a confined space.

Wilkie was not aware of Esso's Safety Rules for Contractors.

The work performed was under the control of an inexperienced Esso Engineer who had no knowledge of his Company's safety procedures or requirements for entry into confined spaces.

8. There was a delay during the rescue process due to difficulties of access for the Emergency Services through the 400 millimetre manhole.

Concerns have been expressed about whether the delay contributed to the death. It is considered that time is of the essence in any rescue from a confined space where oxygen deprivation or toxic effects are concerned. I am only able to say that it is likely the deceased's chances of survival would have improved had he been extricated from the tank earlier.

9. At the date of the accident, Garrick and Dind Pty Ltd is the trustee for the G.A.S.E. Unit Trust. The Unit holders for the Trust are A. Dind & Son Pty Ltd. (Directors A. Dind and N. Mills as Trustees for A. Dind Family Trust) and Gas and Steam Engineering Pty Ltd (Directors G. Thompson and A. Dind as Trustee for Wilkie Family Trust).

AND I FURTHER FIND that the following parties contributed to the death of the deceased.

(a) The deceased, a Tradesman's Assistant in entering the confined space;

(b) John Ewin Wilkie, Supervisor in –
  (i) failing to properly supervise the deceased;
  (ii) failing to provide and use the appropriate atmosphere testing and safety equipment;
  (iii) permitting the deceased to enter an unsafe environment;

(c) Garrick and Dind Pty Ltd, the employer for failing to –
  (i) properly supervise Wilkie and the deceased;
  (ii) properly train Wilkie and the deceased;
  (iii) provide appropriate atmosphere testing and safety equipment (harnesses and breathing apparatus)

(d) Esso Australia Limited, in failing to –
  (i) provide on site at all relevant times an employee with the appropriate knowledge of the relevant safety procedures;
  (ii) properly supervise its subcontractors;
  (iii) properly inform and train its subcontractors in the relevant safety requirements; and
  (iv) ensure that subcontractors had the required atmosphere testing and safety equipment.

RECOMMENDATIONS AND COMMENTS

I propose to forward my recommendations and comments to the Attorney-General for dissemination to the Minister Department of Labour, the Victorian Employers Federation, the Australian Chamber of Manufacturers and the Trades Hall Council. Esso Australia Limited and Garrick and Dind Pty Ltd.

It is considered essential that relevant information on safe working procedures and the required safety equipment for entry into confined spaces be disseminated as a matter of urgency to all relevant employer and employee groups and this would include Boilermakers, Cleaners, Electricians, Plumbers, Fitters, Trades Assistants, Riggers, Supervisors, Engineers and Emergency Services personnel and Department of Labour Inspectors. The process of distribution of such information may be assisted by the forwarding of the relevant information not only to Employer Groups and Unions but also to all Relevant Oil Companies with a request that they disseminate the information throughout their industry.

Whilst the initial investigation of this matter was unsatisfactory in that many witnesses were not interviewed by the relevant Department of Labour Inspectors and this has caused delay in the hearing process it must be noted that since the Central Investigation Unit of the Department of Labour became

recently involved in the investigatory process the amount of information and assistance given to the Coroner cannot be faulted. It must be noted however, that the Inspector from the Central Investigation Unit had some difficulty either in further interviewing or interviewing new witnesses due to legal advice given to those witnesses. In the circumstances of this case that legal advice was appropriate.

A conflict between the regulations made under the Health Act 1958 (Health) (Entry into Confined Spaces) (Regulations 1984) and the provisions of the Australian Standard 1210-1982 has been identified in that the (Health) Entry into Confined Spaces Regulations provide for a minimum manhole dimension (diameter) of 457 millimetres and the Australian Standard provides minimum dimension as low as 380 millimetres. The storage tank in this case was approved by the Design Review Section of the Department of Labour pursuant to the Australian Standard 1210-1982 with a manhole diameter of 400 millimetres.

It is also noted there is an Australian Standard 2865-1986 which sets out a procedure for safe working in a confined space however, that Standard does not apply to unfired boiler and pressure vessels for the relevant procedures for entry into unfired boilers and pressure vessels it is necessary to refer to the (Health) (Entry into Confined Spaces) Regulations 1984.

Whilst it has been suggested that entry into a manhole (in an unfired boiler or pressure vessel) under 457 millimetres is not envisaged or permitted in view of the Health (Entry into Confined Spaces) Regulations 1984 where a manhole is provided with a diameter of less than 457 millimetres (ie. in this case 400 millimetres) invariably this will effectively encourage entry by the vary provision of the access hole when entry may be required.

It is understood that the tank as originally designed was provided with a 200 millimetres hand-hole for inspection however, the manufacturer increased the size to 400 millimetres to enable entry for internal welding purposes.

From evidence adduced during this inquest it would appear that there is a lack of uniformity on safety procedures throughout the industry in relating to entry into confined spaces. Whilst this Court is aware that since this inquest commenced a Code of Practice being developed by the Occupational Health and Safety Commission and the Department of Labour and new Regulations are being drafted it is essential that pending completion of the Code and Regulations all employers and employees working with confined spaces be aware of the minimum safety procedures.

Accordingly, pending completion of the relevant Code and Regulations it is suggested that the Department forward further Alerts to relevant industry and Union groups to ensure a maximum level of information on safety procedures is given to the industry pending completion of the Code of Practice and Regulations.

This case highlights the need for specific training for all entry and work to be undertaken into Confined Spaces with the emphasis on initial and regular atmosphere testing, the provision and availability of safety equipment such as harness, line and breathing apparatus.

Any rescue process must be thoroughly planned and provided for prior to entry being undertaken.

In this case it is trite to say that had the proper entry procedures been undertaken this accident would not have occurred, however, it must also be recognised that in event of rescue being necessary there are a number of problems that this case has identified –

(a) restricted size of manhole;
(b) lack of appropriate rescue equipment on site ie.
    (i) harness, breathing apparatus; and
    (ii) winch – (provision should be made in the design of the Tank for installation of a portable winch);
(c) need for all entry into Confined Spaces (whether the atmosphere is declared safe or not) to require the use of harness and line (where practicable);
(d) need to recognise that an observer may not be in a position to pull an unconscious or semiconscious person out of the Confined Space event when a harness and line is attached. The observer may also not be able to summon help quickly enough to overt a tragedy.

Accordingly, it is recommended that specific rescue planning be undertaken as part of the requirement for each entry into a Confined Space.

It is also recommended that a review be undertaken of the minimum requirements for the size of manholes in view of the difficulties associated with the rescue process.

Whilst a review of the size of manholes (where practicable in the design of the confined space – relating to the facilitating of entry exit and rescue) has been recommended it is also essential to ensure that unauthorised, or unplanned entry is discouraged that existing confined spaces with difficult entry and exit be fitted with an appropriate Warning Sign.

Accordingly, it is recommended that the relevant Australian Standard by reviewed with the view to requiring the fitting of Warning Signs (including graphic illustrations to provide for language difficulties) to further highlight the danger associated with unplanned entry into Confined Spaces.

Mr Robert Spanno must be commended by this Court for his actions in attempting to rescue the deceased when he put his own life at risk on the day of this incident.

Comment must also be made about the appropriate response of the Rescue Services involved, who although labouring under difficulties associated with the restricted size of the manhole, succeeded in avoiding further tragedy.

Graeme Johnstone
DEPUTY STATE CORONER

Coroners Regulations 1986

Form 1

Case No. 4235/86

RECORD OF INVESTIGATION INTO DEATH

I, BARRY JOHN MAHER, Coroner, having investigated the death of **MARK STEVEN CROSSLEY** with inquest held at Sale on the 1st and 2nd days of October 1987,
FIND THAT the identity of the deceased was MARK STEVEN CROSSLEY and that the death occurred on 6th November 1986, in water west of oil platform from

1(A) DROWNING

in the following circumstances:

He attended with two other engineers to conduct tests concerning pressure changes in the skimmer pile. Because of a build up of pressure an eruption of oil occurred in the drains and caught fire. The deceased also caught fire and jumped overboard.

AND I FURTHER FIND that No other person contributed to the cause of death.

MAGISTRATES' COURT
SALE
*
THURSDAY, 1st OCTOBER 1987
And
FRIDAY, 2nd OCTOBER 1987
*
BEFORE:
B.MAHER, ESQ., MAGISTRATE

SERGEANT MANN appeared on behalf of the Police

Mr. TITSHALL appeared on behalf of ESSO AUSTRALIA LTD.

Mr. McARDLE appeared on behalf of Ms. JAMES

Mr. SULLIVAN appeared on behalf of Mrs. C. CROSSLEY (widow of the deceased)

Mr. ISAAC appeared on behalf of RESTECH PTY LTD (on 1/10/87)

Mr. SACCARDO appeared on behalf of RESTECH PTY LTD (on 2/10/87)
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INQUEST INTO THE DEATH OF MARK STEVEN CROSSLEY

The evidence relating to the inquest touching the death of Mark Steven CROSSLEY was recorded at Sale on the 1st and 2nd October 1987.

Before recording my official finding concerning the death of Mr. Crossley there are many observations that I wish to make about the whole unfortunate set of events.

I have divided my comments into the following headings:

(a) The tests and the personnel involved
(b) Safety aspects
(c) Summary of events which contributed to Mr Crossley's death
(d) General discussion.

THE TESTS AND THE PERSONNEL INVOLVED

The evidence discloses that the deceased together with M/s James and M/s Hayes attended at Kingfish West Platform on the 6th of November 1986, to conduct tests for future design parameters. The crux of the tests was to observe pressure changes on the skimmer pile.

The deceased, an engineer, was an employee of Restech Consultants Pty Ltd and he was employed as a consultant on the project. Both James and Hayes were also engineers but were employed by Esso Australia Limited. M/s James indicated that for the purpose of the exercise she was effectively in charge.

The proposed tests had been circularised by the deceased to each of the participants prior to their attendance at the rig, in a general fashion. The safety factor did not seem to play any part in the preparation of the tests. M/s Hayes through previous tests had determined a safe cut off point of 86 kilopascals. However, it appeared to me from the evidence that although each engineer thought that some danger may be involved, nobody, including the deceased, gave serious thought to a major back flow or the possibility of fire.

Similarly, it is no obvious that the deceased intended to run gas as well as liquid through the lines, but this wasn't made known to the other members of the team.

There was no consensus reached between the engineering participants as to when a dangerous pressure would be reached and the test shut down. M/s James calculated that 130 kilopascals would be the maximum pressure before the situation became dangerous, M/s Hayes apparently agreed, but at no time was a decision made to shut down the test if the pressure reached 130 kilopascals.

It would seem that the deceased had certain objects in his mind insofar as the tests were concerned which he did not convey to his co-engineers James and Hayes both believed that there was to be a liquid flow only.

I am unsure as to the experience of the engineering team engaged in the tests, but I find it alarming that after the first two tests when the pressure didn't come back to normal as quickly as it should have, the possibility of the flame arrestor or strainer being blocked should have been further explored.

It is my view that the whole series of tests was ill conceived and insufficient leadership was evident. From their evidence James and Hayes believed that liquid only was to be passed through the lines, but I am certain that the deceased intended that both liquid and gas should flow.

I would suggest that in future all tests should be submitted to an independent person, for consideration of the safety factors involved. Such test blue prints should be in fine detail and once approval has been given by the independent person, be he or she engineer or of whatever professional expertise is necessary, the tests should then be followed as itemised. It may be that responsibility should be given to an independent person, such as the platform supervisor, to ensure that tests are appropriately carried out. It would seem to me that any variation to the tests would also need his approval.

There also needs to be defined leadership in any test team. Decisions must be made by individuals and not by consensus, as was the case in the current situation. Someone should have been in charge and have made the decision to close the valve. The communication of such a decision I will discuss later.

"I cannot over stress the importance of a complete documentation of all tests and independent approval of the safety aspects contained therein."

SAFETY ASPECTS

The most glaring safety omission that concerned me on the rig was the location and use of safety showers. From the evidence before me it was really only luck that M/s James was aware of safety showers and she had sufficient sense of mind, when she caught fire, to look for a shower. It is obvious that she had not been properly instructed in the location of the showers as she passed one before finding another. Esso kindly took Counsel and myself out to the platform to view the scene, we were not instructed as to what would happen in case of fire, nor were safety showers mentioned.

To me, it is a matter of extreme importance that anybody going out to an oil rig, be it an employee or a visitor, should be instructed as to what to do in case of fire, including the use of safety showers. The very nature of oil rigs makes them vulnerable to accidents by fire, it is important that all persons be forewarned.

Similarly, warnings should be given as to the danger of jumping overboard from oil rigs. I noted that M/s James, in her evidence, said that she had never been told what to do if she caught fire, nor had she been instructed not to jump overboard. She had never specifically been instructed in the use of safety showers. M/s Hayes gave similar evidence. It is important that all persons attending oil rigs receive precautionary instruction in these matters.

Hand held radios were also an area that caused me some concern. It seems to me that when various personnel are spread throughout an oil rig, such as Kingfish West, engaged in a common purpose, then they should be in communication. But, this becomes more important in a situation where tests involving some dangers are concerned. I mentioned earlier that there should be one person in charge making decisions, but they will be irrelevant if he or she cannot communicate the decision.

In the situation under investigation, in hindsight, it was imperative that the players should have been in radio communication. An order to the valve operator to close down the flow, should have been able to be communicated instantaneously.

Two aspects of the actual search for Mr Crossley should be noted. When it was realised that the deceased was overboard, it would seem to be expedient to place the crew at locations around the platform to look for the man overboard. In the case in question such as a scheme would have taken time to organise because of the fire, but I think that it would be of great assistance, if the crew were so deployed to locate a body in the water.

Similarly, having heard Mr Dorber's evidence, I agree with his comment that there should be a designated person outside the control room to coordinate any emergency that may occur and to report directly to the control room. In other words the platform supervisor needs eyes and ears on the outside of the control room to keep him informed as to exactly what has happened or is happening. On this day he had the following matters to content with (a) a man overboard, (b) a burns victim, (c) a fire. I would commend this suggestion to Esso Australia.

A minor point that may be worth some thought is the question of chin straps on safety helmets. Obviously Mr. Crossley's helmet came off before he hit the water. If it had stayed on it may have cushioned the impact. I wonder whether some light material, such as a type of plastic, could be fitted to helmets for anybody who wished to wear one. Certainly I'm not suggesting that they should be compulsory.

I leave the question of the blockage in the flame arrestor and the strainer to management. But it would seem to be desirable that a close watch be kept on both pieces of equipment to make sure that blockages are quickly detected. However, I make no recommendations relating to these functions.

SUMMARY OF EVENTS WHICH CONTRIBUTED TO MR CROSSLEY'S DEATH

The following events contributed to the death of Mark Crossley:

(i) The failure of the deceased to convey to the other engineers involved in the test his intention to run both liquid and gas in the course of the experiments.
(ii) The failure to recognise the danger of an upper limit of safe pressure in the system and the likely gush or back flow and subsequent fire.
(iii) The partial blockage of the flame arrestor and the blockage of the strainer which caused the extremely high pressure build up.
(iv) The lack of adequate leadership and decision making amongst the participants of the tests.
(v) The lack of adequate instruction concerning jumping overboard from platform.
(vi) The lack of instruction as to persons on fire and the use of safety showers.
(vii) Failure to use radios in the course of the tests.
(viii) The failure by any of the engineers concerned to order the valve closed.

All of these factors contributed to his death, but I cannot lay the blame on any one person or Esso Australia Limited. My finding will in fact be one of accidental death.

GENERAL DISCUSSION

I have recommended that certain warnings be given to persons, both employees and visitors, as to fire and jumping overboard. I noted on our visit to the platform that a video was used prior to us leaving Longford to explain the requirements of helicopter safety to us.

It would seem feasible that a video could be shown either at the heliport or on each platform to all employees or visitors setting out safety precautions that should be observed together with advice as to what to do and what not to do in an emergency. I offer this only be way of suggestion.

Further, it was evident to me that the Police Officer who prepared the inquest brief in the matter had no idea as to the working of platforms in Bass Strait. It may be prudent in the future for a select team of Police from Sale to be given instruction as to the functions of Platforms, so that when investigation is required on a platform, officers with the understanding of the mechanics of the same, should be sent to investigate.

FORMAL FINDING

I formally find that the identity of the deceased was Mark Steven CROSSLEY and that he died on the 6th day of November 1986, at West Kingfish Oil Drilling Platform by drowning in the following circumstances. He attended with two other engineers to conduct tests concerning pressure changes in the skimmer pile. Because of a build up of pressure an eruption of oil occurred in the drains and caught fire. The deceased also caught fire and jumped overboard.

I find that no other person contributed to his death.