

## Piper Alpha

*“Safety is not an intellectual exercise to keep us in work. It is a matter of life and death. It is the sum of our contributions to safety management that determines whether the people we work with live or die”.* Sir Brian Appleton

About eight miles from my home, in Strathclyde Park, Lanarkshire, there is a memorial to the 167 people who were killed on 6<sup>th</sup> July 1988 when huge explosions and fire engulfed and destroyed Occidental Petroleum’s Piper Alpha production platform, about 340 kilometres east of Aberdeen in the North Sea. The first explosion took place at 2200 hours, and further explosions happened at 2220 hours, 2250 hours and a final huge explosion happened at 2320 hours.



Fig 1: Piper Alpha in flames

The subsequent report by Lord Cullen<sup>1</sup> into the accident caused a complete re-baselining of safety management in North Sea oil and gas. Cullen carried out a very detailed analysis of the accident and the management systems in place at the time, and made sweeping recommendations which were adopted by the industry. His report is a model of its kind. Today, it remains the starting point for any discussion of offshore oil and gas safety.

In particular, Cullen highlighted two main areas of weakness: Failure of the 'Permit to Work' arrangements, and Inadequacy of the emergency evacuation and escape arrangements.

First, the initial fire and explosion was caused by a ***failure of the 'Permit to Work' arrangements.***

All hazardous facilities – offshore or onshore, oil and gas, petrochemical, nuclear, pharmaceutical, etcetera – must have clear controls over how maintenance, inspection or test work is carried out on the plant. Hazardous equipment needs to be carefully isolated, and work needs to be carried out in a planned, careful way. 'Isolation' means ensuring that sources of electricity or high pressure fluid or other hazards cannot reach the equipment being worked on. After the maintenance work is completed, the equipment needs to be tested, de-isolated and re-commissioned carefully.

So-called 'essential' equipment, such as fire-fighting equipment or smoke or fire detection equipment, or back-up electricity supply equipment, can only be taken out of service when suitable alternative arrangements have been agreed and are in place.

Before any maintenance work can take place, therefore, a Permit to Work is written which defines what work is going to be done, what isolations are necessary, how the job is going to be done, and how the equipment will be returned to service. A robust Permit to Work system is therefore a cornerstone of ensuring safe means of working. It should be signed (at least) by the Operations foreman and by the person doing the maintenance work.

When equipment is isolated, padlocks should be fitted so that it is impossible to re-start the equipment. The keys for the locks should be kept in a cabinet which is itself padlocked, and the keys for the cabinet should be held *personally* by the maintenance person(s) who has signed the Permit to Work form. Hence the person(s) doing the work knows that the equipment he is working on cannot be de-isolated.

Sometimes problems arise, such as people going home with isolation keys still in their pockets. Any decision to break into isolation cabinets in order to de-isolate equipment, without the Permit to Work having been signed off by the person doing the work, should only be taken after very careful management review and inspection of the plant.

Cullen noted many deficiencies in the Permit to Work system on Piper Alpha, including the lack of any consistent practice of physically locking-off isolated equipment, and the absence of a review or discussion of permits at shift handover.

In the Piper Alpha Enquiry, Cullen reviewed evidence from survivors and experts and tried to reconstruct events. This was difficult because many of the people most directly involved in events

---

<sup>1</sup> The Public Enquiry into the Piper Alpha Disaster, Department of Energy, HMSO, 1990

had died. Cullen concluded that the most likely cause of the explosions and fire was because a member of the night shift operations team, George Vernon, had started up a condensate (light hydrocarbon) pump, here called pump A, when it was still under maintenance with an outstanding Permit to Work, and was not in a safe condition. George Vernon died in the accident.

Lord Cullen's report details at some length the sometimes conflicting survivors' accounts of what happened. A summary of the most likely sequence of events is as follows:

Production from the platform depended on having one condensate pump available, so the platform had two condensate pumps located in the Gas Compression Module. Either pump could supply the required flowrate. Hence, to enable the maintenance on pump A, the standby pump (pump B) was operational, with suitably closed isolation valves. However, at 2145 hours on 6<sup>th</sup> July 1988, for reasons unknown, pump B stopped and could not be restarted.

Pump A had been isolated for maintenance. The maintenance team on day shift had removed a pressure relief valve, and the open flange where the relief valve was normally attached had had a temporary cover fitted which was neither leak-tested nor pressure-tested. A Permit to Work was still in force for the job, and the night shift team were aware that pump A had been undergoing maintenance. However, the night shift operator, George Vernon, decided it was actually fit to return to service. He apparently didn't see the temporary cover on the open flange. (The open flange was some distance away from the pump, so this may be why George Vernon thought the pump looked OK to return to service, that is, he maybe didn't think to look beyond the area immediately around the pump.)

The Permit to Work had not been signed off by the day maintenance crew as 'work completed'. Once the night shift operators in the Control Room (Mr Vernon and Mr Bollands, the Control Room operator) had decided that they really needed to have pump A working, the day maintenance foreman should have been woken up and asked what had to be done so that pump A could be restored to service. But the nightshift operator didn't wake up the day maintenance foreman; he consulted the night shift maintenance lead hand (Mr Clark) in the Control Room, and they apparently decided that it looked OK to re-start pump A. George Vernon left the Control Room and quickly de-isolated it – without any consultation with the day shift people who had been doing the work on pump A.

The above decision-making process sounds cavalier and ill-thought-out, of course - that was exactly the problem. George Vernon restarted Pump A at about 2200 hours, only fifteen minutes after pump B had tripped; the short time interval shows that no detailed review or inspection of the condition of pump A could possibly have been carried out.

Re-starting pump A so quickly would never have occurred if a robust Permit to Work and isolation process had existed. The rapidity with which the decision to re-start pump A despite the outstanding Permit to Work suggests to me that overriding of Permits to Work was done on a semi-routine basis on Piper Alpha. It appears to me that there was a culture of lip-service to Permits to Work. Hence I am not necessarily blaming George Vernon – he was just working within that culture. The sanctity of the Permit to Work system was something that I had been used to in the nuclear industry; the idea that, within fifteen minutes, someone could decide that it would be alright to de-isolate and restore

to service a piece of safety-critical equipment, part-way through maintenance, is quite frankly amazing.

I repeat: I don't want to sound too critical of George Vernon. The system was faulty – it should have been far harder to re-instate isolated equipment - and the culture clearly placed production over safety.

When pump A was re-started at 2200 hours, the temporary cover on the open flange (where the pressure relief valve would normally have been) failed, and a large quantity of light hydrocarbon liquid and vapour spewed out. Shortly afterwards it found a source of ignition and the initial explosion and fire occurred. The fire then escalated with more explosions, as we have noted, at 2220 hours, 2250 hours and a final huge explosion happened at 2320 hours. There were also other factors which made control of the fire difficult or impossible – for example, the switches to start the firewater system were located too near the initial explosion, and the Emergency Shut Down (ESD) valves on the oil export line were leaking (which allowed oil to come back up the export pipe and feed the fire).

Secondly, ***the emergency evacuation and escape arrangements were inadequate.***

All North Sea oil platforms today have a 'Temporary Refuge' – that is, a designated enclosed area of the platform which should be secure from smoke and should have a minimum assessed time of fire resistance. In the event of an emergency, all personnel muster in the Temporary Refuge and await further instructions.

Nowadays, offshore oil platforms in UK waters normally have primary, secondary, and tertiary means of escape. *Primary escape* means the preferred means of evacuating the platform if time allows, which generally means lots of helicopters. Aberdeen is the busiest heliport in the world. In an emergency, all available helicopters will be diverted from routine operations and proceed to assist with evacuation of a platform in trouble. This process has been triggered a few times over the years, and is generally used if there is an incident (such as a gas leak) which might possibly escalate into something bigger.

If a fire or explosion has already occurred, or if there is bad weather, such that helicopter operations are not possible, then the crew onboard the platform may be directed instead to go to the lifeboats (called TEMPSCs in North Sea jargon, which stands for Totally Enclosed Motor-Propelled Safety Craft). TEMPSCs are the *secondary means of escape*. It is normally expected that, from any point on an offshore oil platform, there will be two possible routes to the TEMPSCs, so that an alternate route is available if the primary route is blocked by fire.

*Tertiary escape* constitutes 'direct escape to sea', that is, if people cannot find their ways to a TEMPSC, they climb down to sea level, or even jump from high level, and hope for the best. Tertiary escape is clearly not advised in the North Sea where sea temperature is low all the year round, and death from hypothermia may occur quickly, even for good swimmers.

On Piper Alpha, primary (helicopter) escape was simply not an option because of the fire. Smoke had quickly engulfed the landing pad. Many of the crew mustered in the dining room of the Accommodation Module as the emergency plan required, but no clear further instructions were ever given. No secondary escape was even attempted, and no lifeboats were launched. When the final

huge explosion occurred at 2320 hours the Accommodation Module fell into the sea, but by that time the eighty-one people inside the module had already died from smoke inhalation.

The sixty-one survivors of the Piper Alpha accident survived *because they disobeyed the standing instructions*; they didn't wait for an order to evacuate, they opted for tertiary escape and jumped into the sea where they were rescued by support vessels and fast rescue boats from nearby platforms.

Why were no further instructions issued to personnel mustered in the Temporary Refuge? Cullen was extremely critical of Occidental Petroleum's emergency arrangements on Piper Alpha. ".....the system was almost entirely inoperative and little command or control was exercised over the movements of personnel" (Paragraph 8.8, page 152). Apart from asking the Radio Operator to issue a 'Mayday' message at 2203, the Offshore Installation Manager (OIM), Colin Seaton, did not give any other clear instructions, and he certainly gave no instructions to abandon the platform.

Survivors from the Accommodation Module reported that there was confusion, and that no-one seemed to be in charge or giving instructions or advice. Personnel received no further instruction than to wait for a helicopter to take them off. Colin Seaton apparently tried to calm people by saying that a Mayday signal had been put out and that help would arrive, but it should already have been obvious that helicopters could not land on the platform because of fire and smoke. Cullen quotes one survivor: "He did not know whether the OIM was in shock or not, but he did not seem able to come up with any answer." Colin Seaton's failure of leadership was judged by Cullen to be a major factor in the high death toll. It should have been clear to him that anything was better than staying in the Accommodation Module. Fire and smoke meant that helicopters were simply not going to be able to land on the platform, but fast recovery boats and the semi-submersible support vessel *Tharos* were nearby. Hence the only alternative was, somehow or other, to find a way onto the water.

I have sympathy for Colin Seaton's predicament. As Offshore Installation Manager, he was on call twenty-four hours a day, seven days per week while offshore. The sudden emergency will have been as much a surprise to him as it was to everyone else – he will almost certainly not have known about the condensate pump problems or the decision to re-start pump A. I imagine the first thing he knew was when the first explosion occurred at about 2200 hours. He should have been trained in dealing with emergencies and the need for clear leadership in crises. (Nowadays, that would be the norm.) I imagine that, in the few minutes after 2200, when something could have perhaps been done to save more lives, Colin Seaton was struggling to appreciate the scale of the disaster, and to accept that his platform was already a write-off. Also, evacuation to the sea will always be a high-risk option, and in such a scenario it was likely that some people would die. Seaton had, very quickly, to make a judgment on the balance of risk: Was it better to risk some deaths in evacuating to the sea, or to stay where they were and hope for rescue to arrive? He wouldn't immediately have realised that the fire and explosions were going to cascade out of control. Because of these internal conflicts, he perhaps failed to understand quickly enough that his *only* focus had to be on getting as many personnel as possible, as quickly as possible, onto the water.

The question we all have to ask ourselves in these scenarios is this: "In the same circumstances, would I have done any better?" Given the state of Occidental Petroleum's emergency planning and training arrangements, I think my answer would be, "Maybe, but I am really not sure".

Smoke began filling the dining room and people had to crouch below the tables to try to keep under the smoke. By 2220 – only twenty minutes after the initial explosion - some personnel had already decided to take matters into their own hands. One survivor, JM McDonald, reported to Cullen, “I just said to myself ‘get yourself off’. I got my pal Francis, and I got him as far as the reception, but he would not go down the stairs because he says ‘We have done our muster job; they’ll send the choppers in’. I said to Francis, ‘.....There is something drastically wrong on this rig. We’ll have to get off’. Francis would not go, and he just slumped down. ....That was as far as I could get him.”

JM McDonald found the wind was blowing from the south. He used his knowledge of the platform to find his way to the south-west corner, where he climbed down a hose before dropping into the sea.

Twenty-seven others survived who, like JM McDonald, left the Accommodation Module. However, the rest apparently made no attempt to leave. There was no systematic attempt to lead men to an escape route. The eighty-one who remained, including Colin Seaton, all died from smoke inhalation.

The other thirty-three survivors (that is, those who had never been able to reach the muster point in the Accommodation Module) jumped into the sea from various heights, some extremely high indeed. Fifteen survivors jumped from a deck at the 133 feet level, and five jumped from the helideck at 175 feet (53 metres!) above the sea.

Of the 167 fatalities, only thirteen were attributed to drowning. The vast majority of fatalities were due to smoke inhalation. Thirty bodies were never recovered.

The accident happened in calm summer weather. There would undoubtedly have been even fewer survivors if it had happened during a winter storm.

Lord Cullen made very extensive recommendations for improving safety in the offshore oil and gas industry. His recommendations were implemented in full, and they addressed the root causes of the accident, as follows.

His first sixteen recommendations concerned the requirement for, and content of, safety cases that were to be presented by operators to the safety regulator. The safety cases must address the Safety Management System, the potential major hazards at the platform and the risk to personnel, and emergency evacuation, escape and rescue.

He then made recommendations about legislation and the safety regulatory body. Prior to his report, the regulator for offshore safety was the Department of Energy, which therefore had a perceived conflict of interest between advocating the development of North Sea oil, and managing its safe exploitation. Hence, safety regulation was moved to the Health and Safety Executive.

He made seven specific recommendations regarding the Permit to Work arrangements, including training and harmonisation of Permit to Work practices within the industry, and the need for physical locking-off of isolation valves.

He made eight recommendations about fire and gas detection, emergency shutdown, and fire and explosion protection. These included specific recommendations regarding the

vulnerability of the emergency shutdown valves, and also the fire water deluge system, to damage caused by severe accident conditions.

Finally, he made a further fifty-one recommendations about emergency escape and evacuation, command and control, and emergency training.

As a result of the accident and the Cullen report, responsibility for offshore safety regulation was moved from the Department of Energy to the UK Health and Safety Executive, which set up an Offshore Safety Directorate.