Engineering Ethics: The Piper Alpha Disaster

An Online Continuing Education Course for Engineers

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Prologue

"Instrument technician Roy Carey was struggling down some stairs with breathing apparatus to a point some 70 ft. above the water when a second, more terrible, explosion struck.

A major pipeline filled with high-pressure gas ruptured.

As more than 450 cubic tonnes of gas escaped, a fireball enveloped the platform and rose to a height of 700 ft.

Carey dived overboard through the wall of flame. 'I had hoped that the flame would pass, but then I was enveloped in it and I realised I was just being burned up. So, I launched myself off. I hoped that I would not hit anything on my way down.'

Conscious of the height from which he dropped, he tried to minimise his resistance to the water. 'I tried to make as clean a dive as I could. So, I kept my hands very straight and as a result I went very, very deep.'

Carey sank so deep that he feared he would never reach the surface before the pressure on his lungs forced him to take a breath.

When he did surface, it was to an inferno that appeared to hover just a few feet above the surface of the sea, cooking the air underneath.

It was like being under a grill. He struggled and tried to keep his head underwater as his face began to burn. He thought he was going to die. 'It was a low time . . . I was being cooked alive.'

Flames were igniting his hair and burning layers of skin off his face, and every time he tried to scream, it was like swallowing fire. Convinced death was imminent, Carey preferred to drown than roast.

He deliberately sank six feet down where he could see the flaming orange above; then it turned to white and he thought of his eldest daughter's wedding dress and remembered his promise to give his youngest child the wedding of her dreams.

He decided he could not die, swam to the surface, away from the platform and finally wedged himself into the side of a wrecked lifeboat." [1]

Introduction

The full scope of the Piper Alpha disaster story is hard to comprehend. Case studies of engineering disasters generally center on discrete causes and the factors that caused the deficiencies to be overlooked. Usually, a mistake is made in the design, a contractor deviates from the plan, maintenance is erratic, or a system is stretched beyond its capacity.

The Piper's story is far different. There was no single cause of failure, nor any specific faulty part or decision to blame. Instead, a routine maintenance procedure initiated an unimaginable chain of failures and human errors, each of which contributed to the world's worst offshore oil disaster. Yet, the malfunctions were completely man-made, preventable and foreseeable.

Piper's deficiencies were said to be well known and the subject of scuttlebutt.

> "Piper Alpha produced more oil than any other platform in the North Sea, hundreds of thousands of barrels each day. Hardened roustabouts spoke of it nervously. There had been several fatalities and near misses prior to the disaster. "Piper was synonymous with accidents," recalls Jake Molloy, head of the offshore trade union OILC. "People would say, 'Piper? Oh, you don't want to go there. That place is ready to go.'"
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> Yet, in their worst nightmares, no one could have imagined the scale of the disaster. There was an ignorance of just how destructive oil and gas could be. In those days the offshore industry was an environment in which a frontiersman attitude flourished, one that is now gone. "Piper brought home to everybody just what you were sitting on," says Molloy. "If somebody had said to me that a platform could fall into the sea, I'd have laughed at them. But the reality is you're sitting on a bomb.""[2]

On July 6, 1988, 167 men were killed in a catastrophic series of explosions and fire on the North Sea platform. The generally accepted explanation is that day shift workers conducted maintenance on Pressure Safety Valve 504 (PSV) on gas condensate injection Pump A, which was out of service. The work was not completed at the time of shift change and the workers received permission to temporarily cap it with a blind flange. The fact that the work was incomplete and the pump not operational were not communicated to the night shift. That night, condensate injection pump B tripped, and the operations manager switched production to Pump A. Gas leaked through the blind flange, ignited, and exploded, leading to a series of explosions and fires that destroyed the platform.

In addition to the massive loss of human life, the total insured economic loss was about $3.4 billion (USD). The entire incident began with a failure in maintenance and safety procedures, followed by an explosion that could have been sustained, had the structure been properly designed. Safety walls were inadequate; operations were located too close to the control room and accommodations; electrical, communications and fire-fighting systems were destroyed immediately; most men made no attempt to evacuate; life boats were inaccessible; and the rescue helicopter circled helplessly a mile from the rig, held back from the evacuation helipad by the

smoke and heat. Astoundingly, the surrounding platforms continued to pump fuel into the flames throughout.

Within less than two hours, the entire platform was destroyed.

Course Objectives

Piper Alpha changed the way that industry and regulators approached offshore drilling and production. In 1988, Britain's Lord Cullen began an inquiry into the disaster and his report, *The Public Inquiry into the Piper Alpha Disaster*, was presented to Parliament in October 1990. The first part of the report investigated the cause of the disaster and the second outlined 106 recommendations for improving the safety of North Sea drilling.

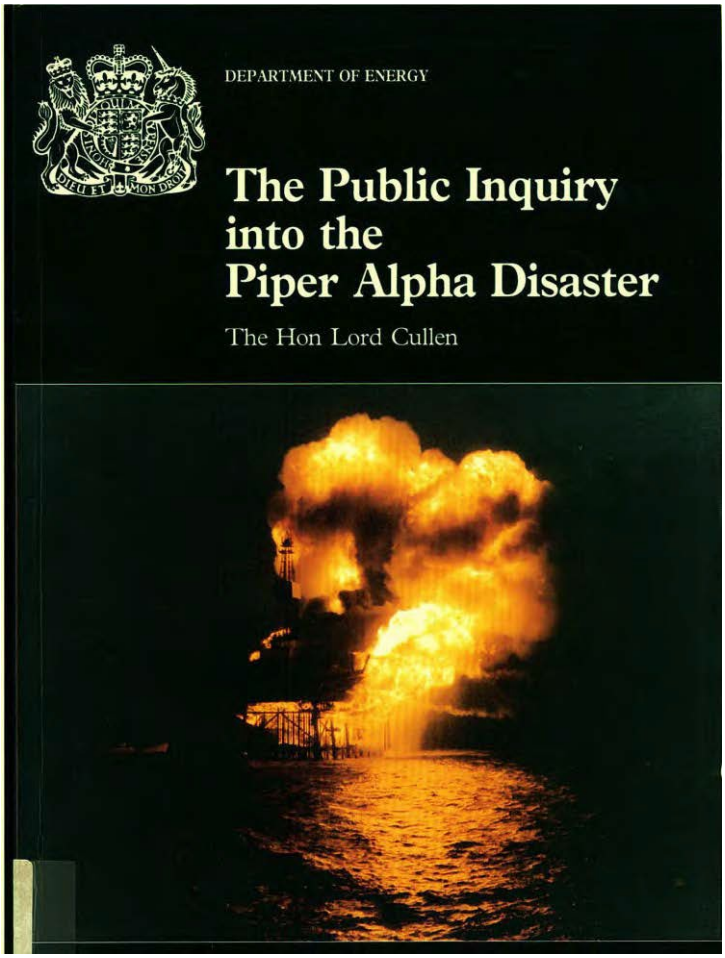
In simple terms, the factors that contributed to the disaster were as follows;

1) There was a failure to adhere to the platform's permit to work system, the protocol for the safe management of maintenance operations. As a result, there was fatally inadequate communication between maintenance and operations crews.
2) There were major flaws in the platform's design and those of the safety, evacuation and fire-fighting systems.
3) The safety management system was insufficient. The Cullen Report faulted Occidental management for a "superficial attitude" to risk management. [3] Managers were underqualified and poorly trained, leading to poorly implemented procedures and inadequate safety audits. Remediation of known deficiencies, even in critical safety systems such as the faulty fire protection system, was not prioritized.
4) There were shortcomings in the then-existing regulations and guidance.

This course will examine the first three factors, focusing on events leading up to the blast; the failures in engineering design and procedures related to maintenance and safety and problems in the operations, management and safety cultures.

This case study will present the generally accepted analysis of the event. The primary sources used are Lord Cullen's *The Public Inquiry into the Piper Alpha Disaster* and documents from the Scottish Court[4]. For simplicity, the investigation will be referred to as "the Cullen Inquiry" or "Cullen" and the report, "the Cullen Report". Testimony and opinions from the Scottish Court will be referred to as "the Scottish Court".

All images, diagrams and photographs, are from the Cullen Report. The captions are based on those from the Report.



The lessons learned encompass engineering design, operations and management. They are readily applicable across all industries, operations and facilities.

We begin with a reminder of the first canon of every engineering code of ethics, this one from the National Society of Professional Engineers' *Code of Ethics for Engineers*, Fundamental Canon 1:

> Engineers, in the fulfillment of their professional duties, shall hold paramount the safety, health, and welfare of the public.

Background

Piper Alpha's operator and majority interest owner at the time of the accident was Occidental Petroleum (Caledonia) Ltd., (OPCAL). OPCAL effectively acted as agent for a joint venture with three other companies, operating the platform and entering into contracts on behalf of the venture. OPCAL's share was 36.5%, Texaco's 23.5%, Union Texas Petroleum's 20%, and Thomson's 20%. [4]

McDermott Engineering in Ardesier, Scotland and UIE in Cherbourg, France constructed the platform. The structures were towed to sea and put in place in 474 feet of water in the Piper Field in the North Sea, about 143 miles northeas Aberdeen. The com nts were placed in 1975 and production began in 1976.

Piper Alpha produced erved as a hub, receiving ga A 30-inch oil export riser e Orkney Islands, a 16-inch dia ser ran gas to the MCP-01 plat

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