JRC - Learning Opportunity Notification (LON) - 001

Incident Details	
Incident	Piper Alpha
Date of Incident	06-Jul-88
Location/Country	North Sea, UK
Type of Incident	Explosion
Offshore/Onshore	Offshore
Asset Type	Fixed Platform
Asset Status	Operational
Immediate Cause	Loss of Containment
Similar Root Cause Incidents	LON - 002, LON - 003
Date Updated	01-Oct-20

Incident Impact	
People	167 dead
Environment	Pollution
Asset (adjusted claim at the time of loss)	USD $1,480 million
Reputation	Operator withdrew from UK

Incident Description

Piper Alpha was a fully integrated platform located in 144m water depth, 120 miles northeast of Aberdeen, Scotland, UK. Piper Alpha was designed to produce and export oil and the production started in December 1976. The requirement to export gas — with the associated separation of condensate — was a later consideration and involved extensive modification to the original design. The retrofitting went on in several phases, starting with separation of condensate and ending with production of export-quality gas.

On the morning of 6 July, 1988, a Pressure Safety Valve (PSV) had been removed from pump A in the gas compression module for routine maintenance, with a Permit To Work (PTW) being raised and left at the main control room. The task was not completed during that shift and to seal the open pipe, blind flanges were bolted to the open PSV pipe connections. However, it was not clear whether the flanges were tightened adequately. This was judged to be safe because, the pump was switched off and contained no hydrocarbon at the time workers finished their shift and fitted with the temporary flanges, planning to continue their work the following day.

Just before 22:00hrs, whilst pump A's PTW was still active, pump B tripped and could not be restarted. The operator checked the live PTWs and could not locate the PTW of Pump A (as it was placed at a different location) and started pump A, believing the maintenance work had not yet started. Due to pressure built up in the line and a possible loose connection of the temporary blind flanges, a release and ignition of gas condensate from the blind flange set off a chain of fires, explosions and three high pressure gas line ruptures, resulting in the almost total destruction of the facility.

The severity of the accident was largely due to the contribution of oil and gas from ruptured pipelines and the disabling of nearly all emergency systems, as a result of the initial explosion. Firewalls between the modules failed and damaged the pipings connected to the adjacent module. The compression module had been retrofitted to the platform adjacent to the control room, which was rendered useless by the initial explosion. In addition, the firewater pumps had been placed in to manual operation mode due to divers being in the water prior to the accident. Living quarters were located directly above the initial release, which was a major contributory factor to the loss of life. Smoke and flames outside of the accommodation module made evacuation by helicopter or lifeboat impossible.

At the time of the incident, 226 people were on the platform, 165 died and 61 survived. Two rescuers from the Standby Vessel Sandhaven were also killed. It is believed that the insurance loss was made up of property damage, business interruption and the liability.

Incident Analysis and Findings (including Causal Factors)

Incident analysis has been performed based on causal factors and are presented below together with the findings:

Process Safety Management (PSM) – Pump A PSV had been removed for maintenance under a dedicated and separate permit and blind flanges fitted in its place, whilst Pump A was isolated on its motor drive coupling, without cross-reference to the PSV removal permit. The integrity of the blind flanges were not verified. When pump B tripped, the operators tried unsuccessfully to restart it. Because of the way in which work permits were organised on Piper Alpha, the operators would not have known that the PSV for pump A was missing, without actual field verification. It was believed that the operator took steps to reinstate pump A and condensate leaked from the temporary blind flanges. The escaping condensate ignited. The first explosion was quickly followed by an oil pipe rupture and fire. The sequential failure of the gas lines then caused a rapid escalation of the disaster. It should also be noted there weren't any shut-off valves on gas risers.

Communication - The severity of the accident was largely due to the contribution of oil and gas from ruptured pipelines connected to the platform and the disabling of nearly all emergency systems because of the initial explosion. Tartan and Claymore Platforms both continued to flow hydrocarbon to the Piper Alpha after the initial explosion, with Claymore only stopping oil flow 55 minutes after first explosion. Oil exported from Tartan and Claymore platforms flowed out of the ruptured oil line on Piper Alpha, flooded the floor and overflowed to the floor beneath, starting a large pool fire which impinged directly on the gas import and export lines, leading to their rupture – and hence to the inevitable escalation of events on Piper Alpha.

Layout/Design - The retrofitting to allow for condensate and gas handling went on in several phases. The new process equipment was located beside the control room, under the electrical power, radio room and accommodation modules, so that when the explosion occurred, it did so with disastrous effect on the rest of Piper Alpha. There were no blast walls between process modules. Retrofitting was performed without any due consideration for process safety and proper HAZID/HAZOP assessments. Management of Change (MoC) was not rigorously followed during the retrofitting stage and retrofitting had major flaws.

Fire/Blast Protection - Despite the extensive fixed fire protection system on Piper Alpha, the fire water system was not activated during the incident. In addition, the firewater pumps had been placed into manual operation mode due to divers being in the water prior to the accident and the operator could not reach the fire pump room to restart the fire pump (personal safety over process safety). If the fire water system had worked, the severity of the incident could have been reduced. Since the platform was originally designed for oil production, there was an inadequate blast protection. Further, it is also clear that there was inadequate fire protection (passive) on structures and gas risers.

Emergency Response – A further major contributor to loss of life was the inability to evacuate the personnel on-board. It had been assumed that, whatever happened, evacuation would be (at least substantially) by helicopter. However, within about a minute of the first explosion, the helideck became enveloped in black smoke and helicopters could not land on it. The multi-function support vessel Tharos was close to Piper Alpha throughout the disaster. Although not intended as a fire-fighting vessel, Tharos did have significant fire-fighting capabilities.

Training and Procedure compliance - There is evidence that procedures were not followed on numerous occasions and there was a relaxed culture with regard to training. MOC procedures, PTW, Isolations and shift handover were not followed rigorously.

Safety Culture - There were many warnings that all was not well with safety management systems on Piper Alpha before the accident. On 7 September 1987, a contract rigger was killed in an accident on Piper Alpha. The accident highlighted the inadequacies of both the permit to work and the shift handover procedures. An opportunity to put this right was missed prior to the disaster.

Root Causes

Equipment Failure				Human Performance				Other	
Repeat Failure		Unexpected Failure		Human Engineering	X	Training	X	Sabotage	
Preventive/Predictive Maintenance				Procedures		Management System	X	Natural Peril	
Design	X			Communications	X	Quality Control		Other	
Equipment/Parts Defective				Immediate Supervision					

Lessons Learned

Management of Change (MoC) - Management of Change to be rigorously applied to modifications, with due consideration of process safety, including adequate Process Hazard Analysis (PHA).

Permit to Work (PTW) and Isolation - Requirement of formal, cross-referenced and audited PTW and safe isolation systems with regular training to the personnel.

Emergency Shutdown Valves (ESDV) - Requirement of Emergency Shutdown Valves (ESDV) on risers – both onboard and as required sub-sea.

Fire/ Blast Protection - Production platforms should be provided with fire and gas detection systems, explosion protection and active and passive fire protection systems.

Design Layout - Control rooms, accommodation units should be placed well away from the process and power units, and should be protected from fire and gas explosions. Manned platforms should have **Temporary Refuges** to protect personnel from external fire, blast and smoke until preparations are made for evacuation.

Safety Case – Design and Operation to be supported by a 'Safety Case'. This is perhaps the most significant global legacy from and Piper Alpha disaster and encourages a goal-based rather than rule-based approach to Process Safety.

Process Safety Management (PSM) - Process safety should be treated as same weight as personnel safety and PSM is key in managing the hazards.

Effective Communication - Effective communication channel should be established together with proper procedures to isolate and depressurise the connecting pipelines during emergency.

Emergency Response – Ensure adequate alternative modes of evacuation methods with well-written and audited procedures and regular emergency drills on all possible evacuation scenarios.

References

1. The Honourable Lord Cullen Report: Piper-alpha-public-inquiry-volume1

2. The legacy of Piper Alpha, The journal of Petroleum Safety Authority, dialogue-no.1, 2018.

3. Piper Alpha: The Disaster in Detail - Features - The Chemical Engineer.

4. Lloyds - Catastrophes and Claims/ Piper-Alpha.

5. The Willis Loss database.