#5 – BURNING PIPER
(Human - System)

[2]*Sma.nasa.gov*, 2022. [Online]. Available: https://sma.nasa.gov/docs/default-source/safety-messages/safetymessage-2013-05-06-piperalpha.pdf?sfvrsn=3daf1ef8_6. [Accessed: 24- Jul- 2022].

Over 3 decades ago, a terrible accident affected the Piper Alpha oil platform and 167 workers tragically lost their lives. The platform, operated by Occidental Group, was located off the spectacular coast of Scotland, about 193 km northeast of Abardeen. Activities on the platform were carried out by teams of workers organized in day and night shifts.
On June 6th, 1988, workers of the day shift performed maintenance operation and Pump A of Piper Alpha had its safety valve replaced by a metal flange. During the night of the same day, Pump B experienced failure due to the accumulation of hydrate. Workers on service that night, in the attempt of solving the issue and wishing to minimize loss of oil production, decided to activate Pump A. Unfortunately, and tragically, night workers were not aware – could not be aware – that only a few hours earlier the safety valve on Pump A had been replaced. Therefore, by activating Pump A, high pressure escaped from the flange and combusted causing a series of explosions.
Up to today, this accident is considered one of the deadliest offshore oil disasters, maybe a lesson learned…in a very sad way though…

Let's have a look at what exactly happened that day….and night.

On that day, during the day shift, a worker was performing regular maintenance on Pump A, and had removed the safety valve. Additionally, the worker noticed that Pump A was meant to undergo an overhaul for already 2 weeks. Therefore, he deactivated the pump and tightened a metal flange on it to seal it, since maintenance could not be completed before the end of the day shift. He also compiled a permit stating that the pump was not ready for operation. Later that day, during the night shift, Pump B faced a hydrate buildup which compromised functionality and led to the failure of that pump. The workers, so as to avoid losses of oil production, sought to activate Pump A. Before doing so, they checked maintenance records to see if that was possible and they simply found the record stating that an overhaul was planned for the pump, however, the permit compiled by the worker during the day shift, which stated it was not ready for operation, was not found as it was placed next to Pump A itself (this action was in line with the guidelines). The night shift workers never checked the pump itself and took a decision based on the maintenance records which suggested that Pump A was fine for operation. At 9:55 in the evening, they opened Pump A and high pressure gas started leaking through the hand-tightened flange. This eventually led to an explosion and the spread of fire & fumes across the oil rig. Occidental Group, despite the explosion, issued no orders to shut down the rig and the poor workers believed they did not have the right to close Piper Alpha. Since the platform hadn't been shut down, production continued which supplied further fuel for combustion and rather propagated the initial explosion. This progressed till 12:45 am of the next day, when the entire construction crumbled into the ocean.

For which reasons all those workers tragically lost their lives, why did it happen?

Following the accident, an investigation was carried out and the root cause of the accident was determined to be the simultaneous work on the pump and safety valve. However, the magnitude of the accident was primarily due to several underlying issues with the design of Piper Alpha itself.
The platform's use of permits and lockout-tagout systems were rather inadequate leaving room for substantial error and mistakes. Piper Alpha seemed to be heavily reliant on permits as a means of sharing crucial information as opposed to having a more centralized system where workers can directly communicate with each other. This could have certainly avoided the miscommunication between the

shift workers. Additionally, there were no backup procedures or systems in place in case of loss of the control room, thus further promoting room for error and greater loss of organization and coordination.
Piper Alpha was equipped with automatic fire fighting systems which could have certainly been useful in managing and containing the fire across the platform, however, procedures of the oil rig specified that these be deactivated, therefore this safety feature proved useless. Moreover, there were several large sized gas lines connected to Piper Alpha and a study on these pipelines conducted 2 years prior to the accident revealed that these lines, due to their size, would make it very hard to suppress a fire. Despite being aware of this danger prior to the accident, these lines were not halted following the initial explosion.

What could have been done to prevent this tragedy?

Here we see the importance of the interaction between humans and a technical system. Whilst it can be argued that perhaps Piper Alpha inherently had some flaws, these flaws were greater emphasized by the interaction with the users. The method of communication established in Piper Alpha is very susceptible to error especially when humans are involved. Moreover, we also see that Piper Alpha also didn't include complementary protective measures in an effective way, but proved to be rather useless in this accident. There are some options which could have been implemented to minimize the risks in compliance with ISO 12100's 3-step method.

Step 1: Inherently Safe Design measures
Piper Alpha clearly had inadequacies in terms of how information is communicated. Piper Alpha had a rather decentralized system of sharing information via the use of permits. Moreover, not all permits would be placed in the same location making it significantly harder to gather all critical information. It rather makes it more difficult and more susceptible to error. A more centralized way of communication would have been more effective, either via direct communication between workers or through the use of digitalized methods of communication. This could have certainly improved the exchange of information throughout Piper Alpha. Additionally, the operator that worked on pump A had sealed it with a hand-tightened metal flange. This is not a particularly safe way of sealing a pump especially when dealing with high pressure gasses!!! The flange should have been bolted on as opposed to hand tightened and additionally a liquid sealant could have applied around the edges to minimize the risk of leakage. Another element which would have made Piper Alpha inherently safer would have been emergency evacuation systems, such as lifeboats, to remove workers from the platform in case of an emergency. This also could have minimized the number of deaths in Piper Alpha.

Step 2: Safeguarding and complementary protective measures
Additional safety measures in the event something goes wrong are always necessary and can play a big difference in the outcome of a situation. Piper Alpha did not have backup/safety procedures in the event the control room was lost. This is exactly what happened in the accident, and without normative procedures the workers went into chaos causing disorganization and further complicating the situation for themselves. Had there been instructions as to how to operate in such an event, perhaps some human life could have been preserved and perhaps the damage to the system could have also been mitigated. The oil rig had automated firefighting equipment; however, procedures of Piper Alpha established that oftentimes this equipment should be set to manual mode. In terms of safety, that is not the best choice as, in the event of such an accident, it becomes borderline impossible for workers to manually operate such a system. In fact, these firefighting equipment were not used during the fire. It would be more beneficial to leave such safety equipment in an automated mode to ensure a response of the system in

case of hazard. As aforementioned, Piper Alpha was connected to multiple large gas pipelines which were left open during the accident feeding more fuel to the flame. These pipelines, in such situations, should be shut down to prevent further damage to the platform.

Step 3: Information for use

In the event that the above procedures still prove insufficient then this needs to be communicated. For example, a sign/symbol placed on pump A could have signaled a potential issue with the pump. Perhaps, audio signals could have been used upon the erroneous activation of pump A to suggest a problem/issue. These are all methods of effectively communicating danger and if implemented in Piper Alpha may have made a difference.

We see how the underlying issues of a technical system may be enhanced when humans interact incorrectly with the technical system. It could be argued that the underlying issues may not have caused such an accident if the interaction with the workers was conducted properly, on the other hand it can also be argued that having a technical system which is not inherently safe by design largely makes failure more probable when an incorrect interaction between the system and the users occurs.

[2]*Sma.nasa.gov*, 2022. [Online]. Available: https://sma.nasa.gov/docs/default-source/safety-messages/safetymessage-2013-05-06-piperalpha.pdf?sfvrsn=3daf1ef8_6. [Accessed: 24- Jul- 2022].

[3]"Piper Alpha: The Disaster in Detail", *Thechemicalengineer.com*, 2022. [Online]. Available: https://www.thechemicalengineer.com/features/piper-alpha-the-disaster-in-detail/. [Accessed: 24- Jul- 2022].