Lessons Learned from Failed Barriers – Piper Alpha

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Palabras clave: Piper Alpha, Lessons learned, Risk Analysis, BowTie, Top event, Danger, Safety barriers, Degradation factors.

Resumen

Unfortunately, the most effective way to learn lessons is to suffer the consequences of our mistakes. Piper Alpha was one of those mistakes that have cost the industrial sector a lot; however, this iconic disaster has allowed us to learn many attitudes that can lead us to a catastrophe. By understanding what happened, how it happened, and why it happened, we can prevent making the same mistakes again and, better yet, be able to identify other conditions that could lead us to a tragedy.

The purpose of this article is to reconstruct the events that led to the Piper Alpha disaster materializing to understand what were the errors and attitudes of the staff and senior management, which resulted in the terrible consequences of that July 6, 1988. With In the reconstruction of the events, I will present a Bowtie diagram that, in addition to a barrier failure analysis, will facilitate the understanding of the errors made that led to the destruction of the Piper Alpha platform, the immense material losses, the irreparable environmental damage. and the tragic ending of 167 lives.

As a result of the reconstruction of the facts and their graphic representation, the difficulties in communicating and understanding the risk scenarios present in industrial facilities are evident, which, despite the implementation of complex systems of administrative controls, the low perception of danger to which one is exposed and the potential conflict between production and security, can lead to disastrous consequences.

Therefore, it is necessary to know and understand the designs of industrial facilities, subject them to rigorous analysis of operational and process safety risks, understand that any modification, temporary or permanent, must be analyzed in detail, measure the risks of the consequences that may occur. eliminate failures or errors in the operation and determine that there are sufficient barriers that can avoid or, failing that, mitigate the impacts of the consequences that may potentially occur and that said barriers are maintained and available when required.

1 Introducción

Piper Alpha was one of the most productive platforms in the 1970s and 1980s in the North Sea, UK. It was an oil facility that behaved like a city that housed 226 workers who produced, treated and exported oil, gas condensate and natural gas 24 hours a day.

On the night of July 6, 1988, following an explosion from Module C, a gas compression zone and other facilities for processing gas from the field, another series of explosions was triggered that resulted in fires in the modules. processing of well fluids that ended the lives of 165 people on board and 2 people from the crew of the FRD Sandhaven vessel while they were engaged in rescuing people from the platform.

Of the 167 people killed in the disaster, the bodies of 137 people were recovered in the weeks and months after the disaster, 81 of these bodies were rescued from the remains of the ERQ Module (East Replacement Quarters) 3 to 4 months after the event, 30 bodies were not found.

With what happened, the Secretary of State for Energy of the United Kingdom, through an act issued on July 13, 1988, ordered that a public investigation (public inquirí) be carried out to determine the circumstances of the accident and its causes, for this appointed Judge Lord William Cullen who developed this investigation with a group of technical advisors and generated a report on the circumstances of the accident, the causes and included observations and recommendations to avoid similar accidents in the future and preserve life.

36 years after the Piper Alpha disaster, it has a lot to teach us, since the failures presented and the mistakes made that July 6, 1988 are as common today as then. By understanding the disastrous consequences that can occur in the hazardous chemical industry, being aware that it is possible for equipment and people to fail, allowing large-scale events to materialize, even though we have never witnessed it, we will be able to avoid these tragic results, it is necessary to consider, understand and manage the ways in which these consequences may occur.

This article aims to recreate the events that occurred in the Piper Alpha disaster and highlight the barriers that failed with the purpose of raising awareness among the public of the importance of adequate knowledge and understanding of the risk and the need for clear and effective communication around to industry activities.

2 Description of the Disaster

The Piper Alpha platform was built in 1975, acquired by a consortium where Occidental Petroleum had the largest interest with 36.5%36.5 \%36.5%, the rest were distributed in 3 other companies. It was located 110 miles (177 km) from Aberdeen in the North Sea, Scotland, United Kingdom, see Figure 1 Geographic location Piper Alpha Platform and its connections.

At the end of 1976, production began, which considered the shipment of oil to the Flotta terminal on the coast and the controlled burning of gas in “flare”. The platform had the facilities to drill wells and extract, process and separate reservoir fluids, a mixture of oil, natural gas and water. The natural gas and oil were separated through production separator equipment, the condensate was extracted from the separated gas through cooling, this condensate was reinjected into the oil to be transported to the coast and there it was separated again. The facility had the capacity to produce 250,000 barrels of oil per day for delivery to Flotta.

Piper Alpha was highly productive and when Occidental requested permission to increase export rates, it was granted on the condition that gas would also be exported instead of flared, in accordance with a government gas conservation policy.

In 1978, the Piper Alpha platform began processing the gas it previously burned, modifying its well fluid processing modules, including a gas dehydrator unit and later a Joule-Thomson (JT) expansion valve. In 1980, new equipment was installed to improve gas drying and expansion and a distillation column to remove methane gas from the condensate. The dehydration unit was retired in 1983. These modifications became known as the GCM (Gas Conservation Module) and took up the available space gained from the removal of the second derrick and its supporting equipment. The gas produced was treated and sent to the MCP-01 Platform (Manifold Compression Platform) in company with the gas produced on the Tartan Platform. There was also a bidirectional line with the Claymore platform where gas could also be received. In MCP-01 the gas sent from Piper Alpha was mixed with the gas from Frigg to finally be sent to the Gas terminal in St Fergus.

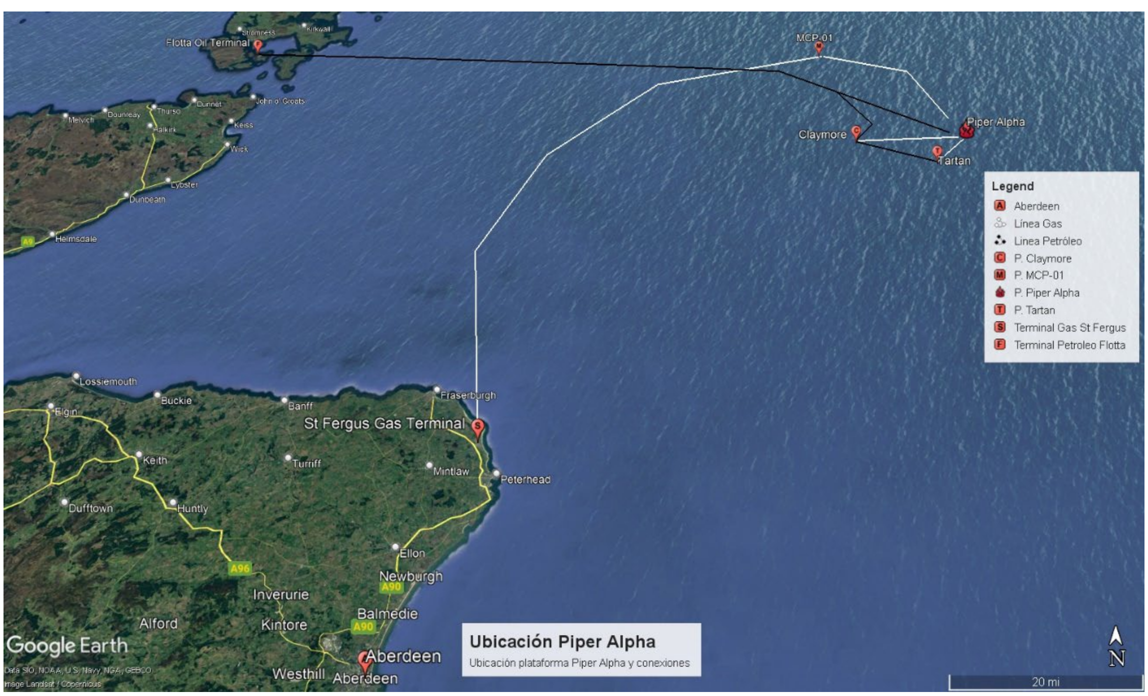


Figure 1. Geographic location Piper Alpha Platform and its connections
Source: Google Earth

With the inclusion of the GCM, two operating modes were defined, phase 1 mode, which corresponded to the initial operation of the platform, where the gas separated at the beginning of the processing was burned in the "flare" and phase 2 mode, contemplated as the normal mode, which corresponded to the use of the GCM to process the gas and send it to MCP-01. Piper Alpha was connected to 2 other platforms Claymore and Tartana through oil and gas pipelines.

The production deck at 84 feet (25.5 m) above mean sea level consisted of 4 production modules, the AD modules. Module A contained the wellhead, module B the production separators, module C the gas compression plant, and module D the power plant and various service facilities. Above these modules, at the 107 ft (32.5 m) level, were several other modules and, above these, the rooms. There was a helicopter pad on top of the main living module.

Below the C module production deck, at the 68 ft (20.7 m) level, was the deck support frame (DSF), which supported the condensate injection pumps and pipe terminations and traps. of pig traps, except for the MOL (Main Oil Line), which was below module A and B. Below this were 2 other levels, the 45 ft (13.7 m) and 20 ft (13.7 m) levels. feet (6.1 m). The drilling platform was located above Module A, the two flare booms in the southeast and southwest corners at the end of Module A, and the cranes, one on the east side and one on the west side between the Modules B and C.

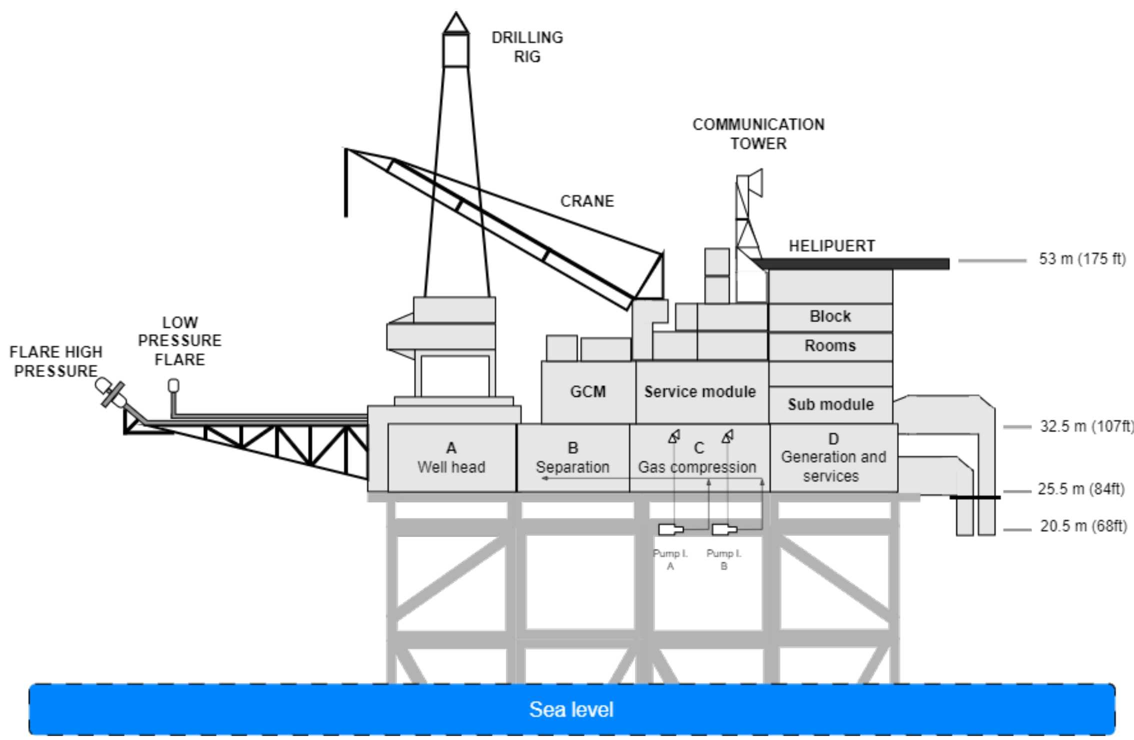


Figure 2. Piper Alpha Platform Diagram – View from the East
Source: CST Risk – CONSERTO S.A.S.

Figure 3. Piper Alpha Platform – View from the West

Figure 4. Piper Alpha Platform – View from the Southeast

On July 6, 1988, various maintenance works were being carried out on the production deck, modules A, B, C, D and GCM, mainly on the recently included GCM module and the equipment associated with gas and condensate processing. At 7:45 AM the work permits for that day were opened and activities continued as planned. At 12:00 noon the safety pressure relief valve on pump A was removed for maintenance. At 5:10 PM the shift change was brought forward and the operator who was in charge that night entered the last shift.

At 6:00 PM, the maintenance work associated with the safety pressure relief valve of Condensate Injection Pump A was completed, which was not installed, so the shut-off valves downstream of the valve were closed. safety valve and a blind was installed on the connection flanges to the safety valve. There was no urgency in installing this safety valve because Condensate Injection Pump A was de-energized since a major maintenance (overhall) had begun that day that took 2 weeks, this activity was carried out by a different contractor than the valve of relief.

The operations room was alarmed by the sudden stop of Condensate Injection Pump B at 9:45 PM, so an operations team was sent to try to start Pump B. It was of utmost importance to continue pumping. of condensate from Piper Alpha to MCP-01, which allowed the production of the field to continue receiving fluid, separate the gas and use it for the platform's electrical generation. Otherwise, by suspending the injection of condensate (mainly propane) to the oil line to Flotta, the security systems would generate a general plant shutdown (Shut Down) due to a high level in the condensate storage. They had less than 30 minutes to resolve the situation, otherwise the impact on production would be significant.

The condensate injection had 2 pumps to carry out this activity, 2-G-200 A and 2-G-200 B Condensate Injection pumps, 1 in operation and the other as a backup to continue the process in case of failure or if it is necessary to remove the other pump. However, that same day, Condensate Injection pump A had been electrically isolated to begin major maintenance (Overhall), so an attempt was made on several occasions to restart pump B. As the restart of the condensate injection pump was not successful, Condensate Injection B, and increasing the level of condensate in the suction container of the pumps, the operation reviewed the intervention status of the Condensate Injection pump A in the work permits issued that day in the morning, to consider its use.

The work permit for intervention on the pump did not include activities on the safety pressure relief valve of this same pump, so they saw that the only intervention on pump A was its electrical isolation and the closing of the valves. suction and discharge. They proceeded to connect it, align it and start the operation of injecting Condensate into Flotta through Pump A and did not notice the absence of the safety pressure relief valve, since its location was 5 meters above the location of the pump. and the activities on this safety valve were in another work permit left on the operator's table during the shift change, which is why he was not aware.

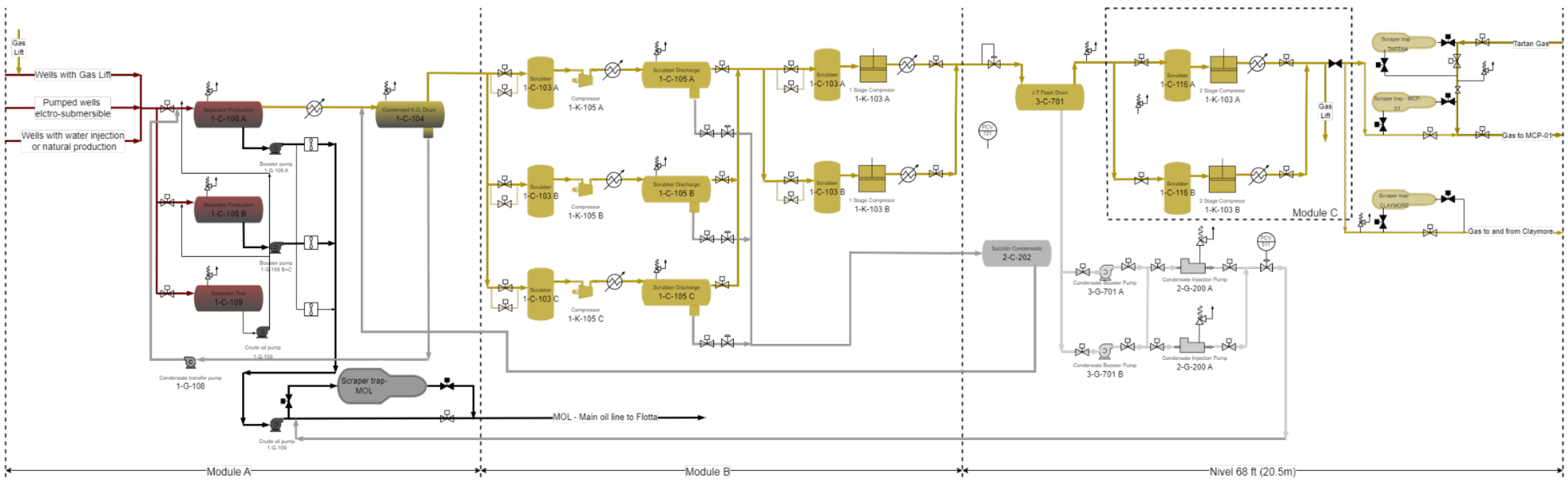


Figure 5. Process flow diagram - Piper Alpha

At 9:55 PM, after starting pumping with Condensate Injection pump A, gas leak alarms began to go off in module C of the production deck, followed by high pressure alarms, and at 10:00 PM An explosion occurs on the production deck of the platform, the explosion breaks the walls of module C and affects the crude oil processing section, continuing with an oil fire. The supervisor, upon recovering from the explosion, manages to activate the shutdown of the platform, interrupting production from the well; however, the Claymore and Tartan platforms, which were pumping oil to Flotta through Piper Alpha, did not stop pumping, which continued to fuel the fire. Coordination had never been developed between the platforms to deal with an emergency, nor had there been a drill to prepare for an event of this type, so there was no clear or specific condition to proceed with the interruption of pumping, a decision that implies a great loss of production for whoever takes it.

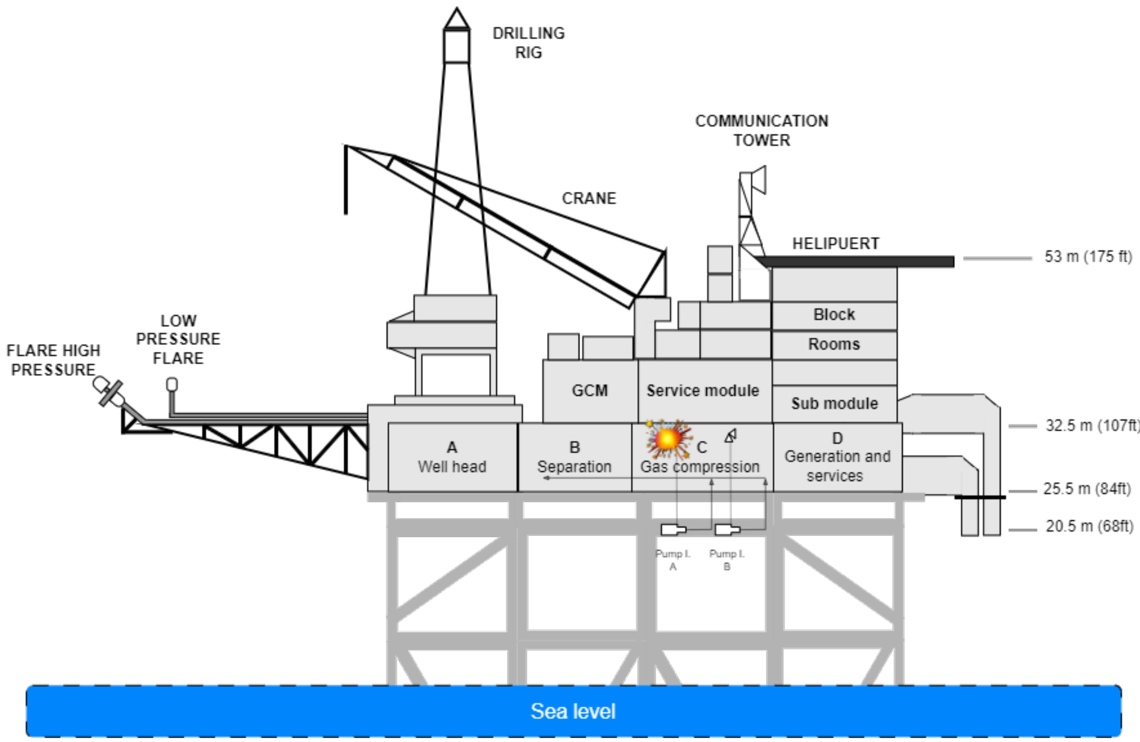


Figure 6. Piper Alpha Platform Diagram – First Explosion Location 10:00PM -View from the East

Source: CST Risk – CONSERTO S.A.S.

The conclusion of the public inquiry (Public Inquiry) carried out by the United Kingdom government through Lord W Cullen, concluded that the leak occurred due to the poorly secured blind flange in the intervention of the safety pressure relief valve of the condensate injection pump A, thereby generating an explosive atmosphere of propane gas that culminated in an explosion in module C. Because an extensive risk analysis was not performed during the initial design of the platform, it was not identified The existence of an explosion was considered probable, even though methane and propane gas were processed at high pressures, only the installation of fire walls, not explosion walls, was considered.

Subsequently, there were a series of small explosions that, together with the main one, affected several electrical circuits. The emergency systems were not activated, including the fire-fighting water system, since the latter were deactivated from the automatic to manual system, because sea water was used for the extinguishing systems and the divers approached the suction of the pumps in their routine tasks and thus avoid affecting them, however, the automatic system was not reestablished later and that night there was no one who could activate them.

Around 10:20 PM a large explosion occurred, associated with the rupture of the Tartan Platform's gas riser pipeline, resulting in a massive and prolonged fire of high-pressure gas that caused very high levels of radiation on the structure of the platform. platform that was rapidly weakening it.

Another strong explosion occurred around 10:50 PM, it was concluded that it corresponded to the descending line that connected the Piper Alpha with MCP-01, with the radiation after this explosion generated the failure of the support structure of the room block and it fell. to the sea, this was the meeting point for the evacuations, since all these were always considered by helicopter, however, given the conditions of the fire and smoke, the arrival of a helicopter was not possible and 81 people were trapped in this block .

At 11:20 PM another large explosion was generated, which is associated with the rupture of the rising gas pipeline of the Claymore Platform. At this time, a large part of the structure of the platform had collapsed due to the high radiation and was being destroyed. collapsing on the sea. Only 61 people, of the 226 who were in Piper Alpha that night, were able to return home the next day.

3 Construction of the BowTie Pathway associated with the top event that started the disaster

To expand the understanding of the events of July 6, 1988 in the North Sea, I present the BowTie developed for this article with the detail of the "Main Pathway" along which the events of the Piper Alpha disaster unfolded.

Before getting into the subject and with the purpose of taking full advantage of the qualities of the Bow tie, I will proceed with a description of the elements of the BowTie and the characterization of the barriers that were used for this exercise.

The BowTie methodology is a risk assessment methodology that can be used to analyze and demonstrate causal and consequential relationships in high risk/consequence scenarios. The method takes its name from the shape of the diagram that is developed, which looks like a bow tie, see Figure 7 Generic Bow Tie Diagram.

It can be used to analyze and communicate how high consequence scenarios might play out. The essence of bow tie is plausible or meritorious risk scenarios around a given hazard, and the ways in which the organization stops those scenarios.

Provide the appropriate level of detail to facilitate understanding and risk-based decision making without oversimplification or complexity. The right level of detail depends on your goal. The method takes its name from the shape of the diagram it creates, which looks like a bow tie for men (Bow Tie).

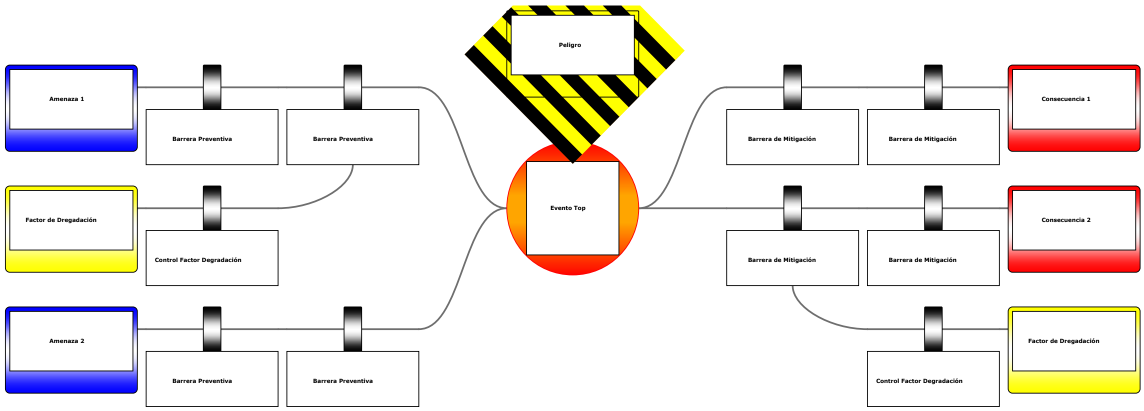


Figure 7. BowTie genetic diagram
Source: CST Risk – CONSERTO S.A.S.

The Bow tie has eight elements for its construction, the six (6) main elements allow them to generate causal and consequential relationships. In Figure 8 Main Elements of the Bow Tie, the description of each element is made:

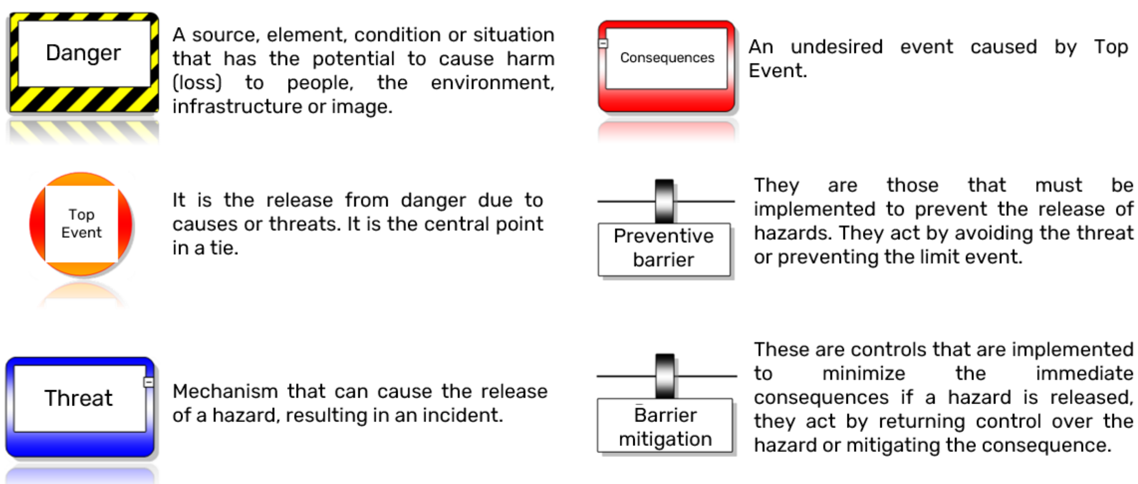


Figure 8. Main Elements of the BowTie
Source: CST Risk – CONSERTO S.A.S.

On the other hand, Bow Tie diagrams have the particular characteristic that degradations of the effectiveness of a barrier can be identified, recorded and communicated. For this, two (2) additional elements are used that facilitate the understanding, communication and management of the barrier. See Figure 9 Barrier degradation management elements.

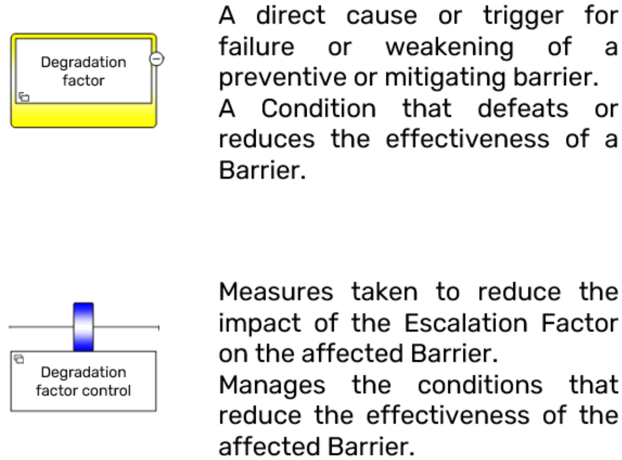


Figure 9. Elements of barrier degradation management
Source: CST Risk – CONSERTO S.A.S.

One of the greatest potentials of the Bow Tie is that it allows a specific analysis to be carried out in a simple way on the barriers available for the different scenarios (paths) associated with a top event and a danger. This is achieved through the characterization of the barriers of the diagrams. In order to analyze the behavior of the barriers that Piper Alpha had, I have applied a specific characterization, facilitating the understanding of the functioning of said barriers during the disaster. The characterization includes five (5) aspects to apply to each barrier of the Bow Tie executed, the aspects are:

Function of the barrier: This characteristic indicates the place or element on which the barrier acts, see Figure 10 and the different functions in which the barrier can be classified can be seen in Table 1.

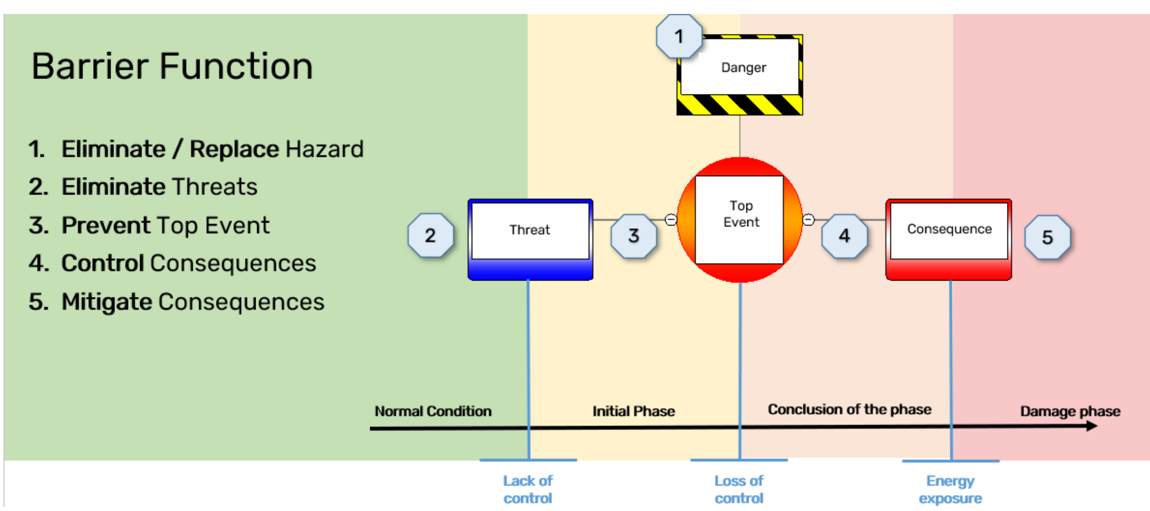


Figure 10. Characteristic – Function of the Barrier
Source: Wolters Kluwer – BowtieXP

Table 1. Barrier Functions

Función	Descripción	Color
Remove Threat	Its function is to prevent the threat that the Top Event unleashes from occurring.	
Prevent Top Event	The materialization of the threat prevents the danger from being released and reaching the Top Event.	
Control the Consequence	When the top event occurs, control over the danger returns, preventing the consequence from occurring.	
Mitigate the Consequence	When the top event happens, it reduces the effects of the consequence.	

Source: Wolters Kluwer - BowtieXP

Barrier Type: This classification is according to the way the barrier acts on the danger, see Figure 11 and Table 2.

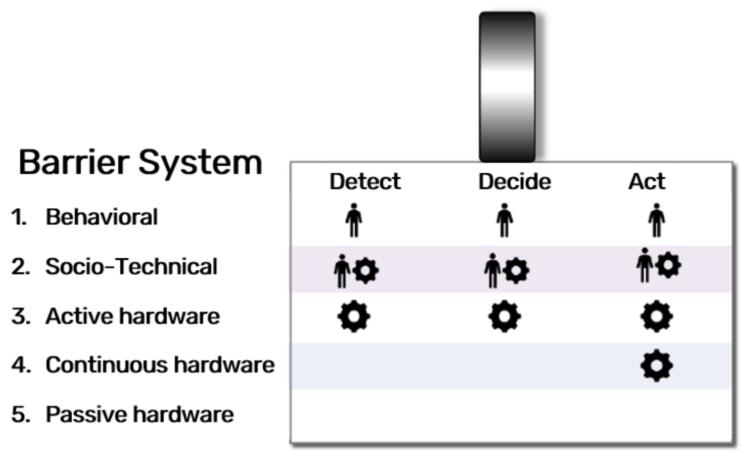


Figure 11. Characteristic – Barrier Type
Source: Wolters Kluwer - BowtieXP

Tabla 2. Tipo de Barrera

Tipo	Descripción	Color
Behavioral	This type is used when a person is responsible for both detecting, making a decision, and performing an action.	
Sociologist	This type is used when a combination of people and hardware work together to create a functional barrier system. In the cycle of detection, decision and action, detection can be performed by a person, while the action is performed by an automated technical system. The opposite is also possible.	

Tipo	Descripción	Color
	The steps must be independent. If the detection is a person with a pair of binoculars, for example, it can still be classified as a behavioral or behavioral step. Binoculars are necessary support equipment, but they do not perform part of the cycle on their own, so they are not classified as a technical step. Sometimes the ranking will be the other way around, based on who the lead actor is.	
Active hardware	This type is used when the detection, decision and action are performed by some technical system, without any direct human intervention.	
Continuous Hardware	This type is used when a technical system needs to act continuously rather than activating based on some input. An example may be a ventilation system.	
Passive hardware	This type is used when a barrier does not act or detect, it remains passive and its main function is to absorb or avoid energy. Examples of this are dams, fences and anti-explosion walls, the separation of objects in time or space, the controlled breakage of equipment. Source: Wolters Kluwer - BowtieXP	

Source: Wolters Kluwer - BowtieXP

Barrier Effectiveness: The effectiveness of a barrier is a way to determine how well the barrier performs. The combination of reliability and the appropriateness of the barrier will allow us to differentiate its effectiveness. See Figure 12 and see Table 3.

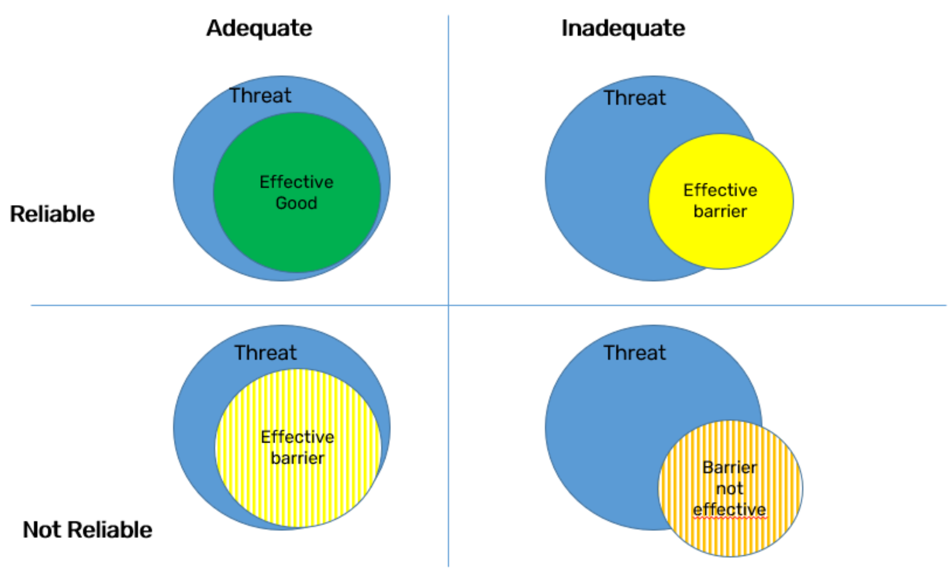


Figure 12. Characteristic – Barrier Effectiveness
Source: Wolters Kluwer - BowtieXP

Table 3. Barrier Effectiveness

Effectiveness	Description	Color
Unknown	There is no knowledge of the effectiveness of the barrier.	
Very poor	Barrier with low reliability and inadequate.	
Poor	Barrier with reliable but inadequate.	
Good	Barrier with low reliability, but adequate.	
Very good	Reliable and adequate barrier.	

Source: Wolters Kluwer - BowtieXP

Barrier Availability: This characteristic indicates whether at the time the installation is reviewed the barrier is available or not available, see Table 4.

Table 4. Barrier Availability

Barrier Availability	Color
Available	
Unavailable	

Source: Wolters Kluwer – BowtieXP

Barrier Manager: This characteristic indicates the person who must respond to the organization for the proper maintenance of the barrier in question. For this characteristic, the responsible role or position is indicated.

Once these criteria have been defined for the application of the Bow tie to the Piper Alpha disaster, Figure 13 presents the complete diagram with the elements associated with the results of the disaster investigation.

The Bow Tie diagram, Figure 13, identifies the Threat that allowed the release of the danger and the materialization of the first consequence, the first explosion in module C at the level of 68 ft (20.5m) at the relief valve. safety pressure (PSV) of the condensate injection pump A. On this path and until the last consequence, all the barriers failed, except for one (1) which was the one that allowed the rescue of the 61 survivors.

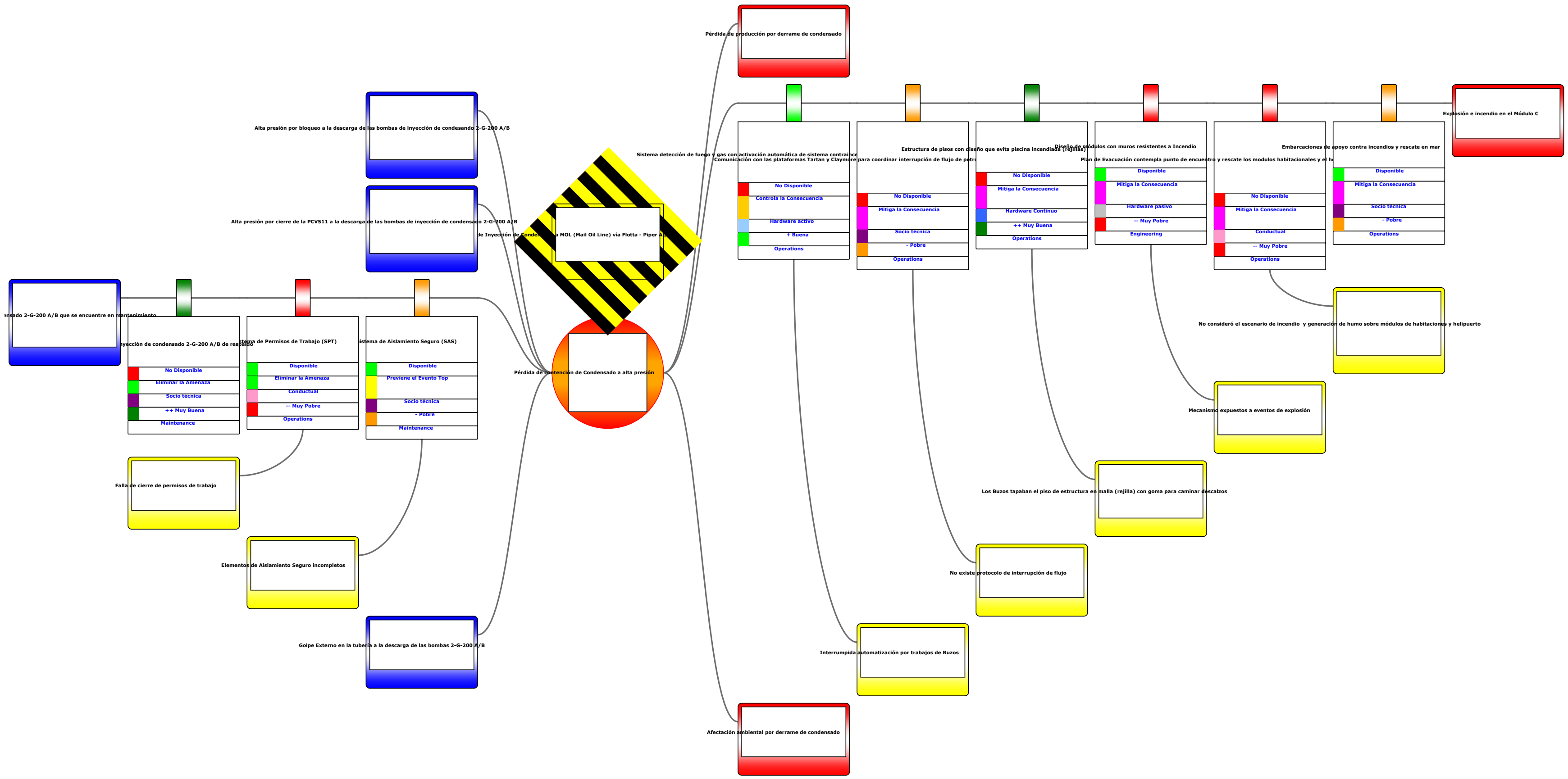


Figure 13. Bow Tie Piper Alpha

4 Barrier Failure Analysis – The barriers that failed

Although nine (9) barriers were found available on the Piper Alfa, three (3) preventive and six (6) mitigation, the results of a single failure allowed a “snowball” to be unleashed that led to the total destruction of the platform. and the sad death of 167 lives.

With the characterization applied to the barriers defined for the “Main Pathway”, the failures of each one and their crucial importance for the safe operation of activities on the platform.

Preventive barriers: The Piper Alpha had three (3) preventive barriers for the operational error scenario with the “Pump Alignment in Maintenance” (Initiating event defined in the investigation).

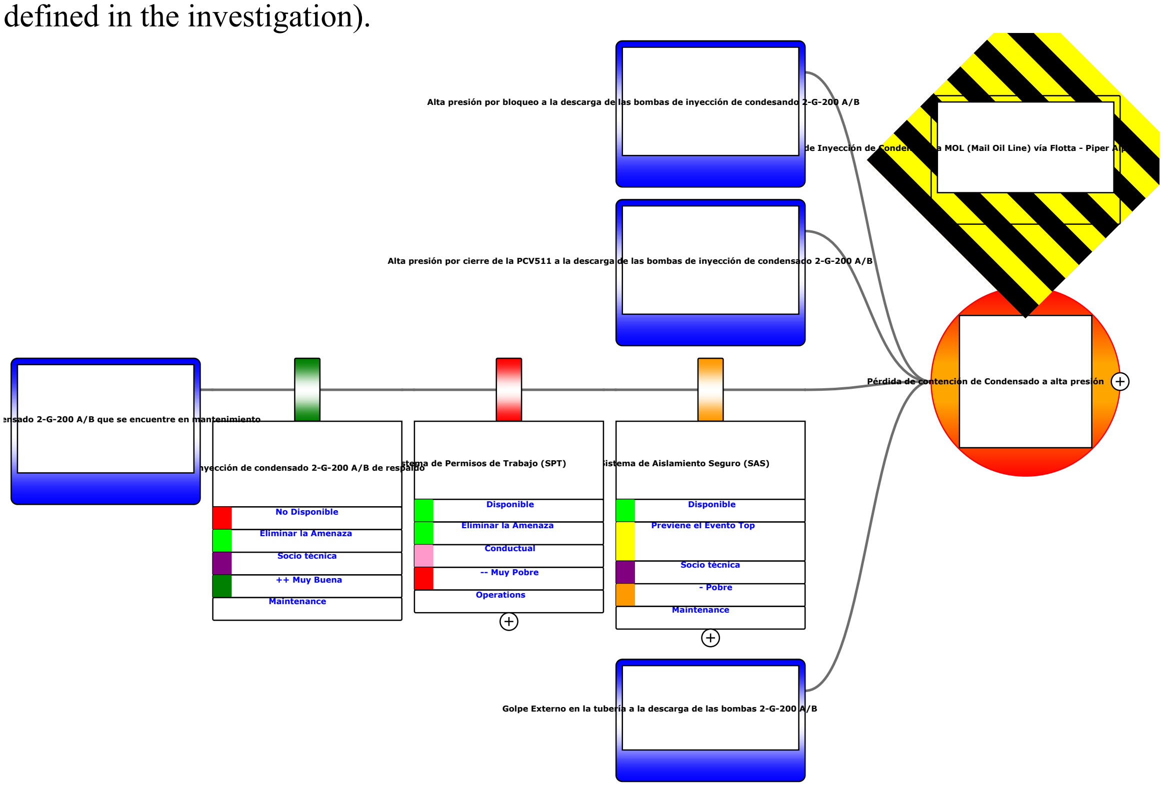


Figure 14. Characterized Preventive Barriers – Piper Alpha

As a first preventive element, there were two (2) pumps for injecting condensate into the main oil shipping line to Flotta, where there was a backup in case the pump in use failed, this barrier would have the possibility of eliminating the threatens socio-technical action. On July 6, 1988, the pump in use, 2-G-200 B, failed; however, the backup was initiating major maintenance (overhall) that would take 2 weeks, so they could not make the change immediately. Based on this condition the first barrier, with a high efficiency, was not available.

The second barrier corresponds to behavioral control regarding the work permit system. This barrier should have the ability to interrupt the sequence of events eliminating the threat, however, was not given the corresponding importance, so it became simply a piece of paperwork requested. Due to this inadequate and unreliable system, the shift operator was partially aware of the intervention of the condensate injection pump 2-G-200 A, he identified the work permit with which he started the Overhall of the pump that day. It only isolated it physically and electrically, but did not indicate anything about the work on the PSV valve (safety pressure relief), that activity was in another work permit format, which was not closed in an adequate way, it was not was known to the operator on duty, so the failure of this system led to the alignment of the pump during maintenance. The responsibility for proper use of this important safety barrier was daily overshadowed by the importance given to production.

However, Piper Alpha had a third preventive barrier available and it corresponded to a safe isolation system where the PSV (safety pressure relief) valve was removed; its function was aimed at preventing the top event, the leak, considered for the exercise of socio-technical type, but with a high behavioral component, so it was unreliable, although available, but it took the same course as the two previous barriers, it also failed, since the maintenance contractors in charge of the PSV, different from those They intervened on the pump, confident in the physical and energy insulation of the pump, they did not adequately secure the blind flange installed on the flange where they removed the PSV.

The coincidence of failures in preventive barriers, with a tiny probability, were occurring, the sequence of events was allowing the top event to occur. Finally, at 10:00 PM on July 6, 1988 in the North Sea, 5 minutes after aligning the 2-G-200 A bomb, all the gas detection alarms in Module C began to go off and The explosion occurred that began the high consequences of the disaster.

Mitigation Barriers: The Piper Alpha platform had six (6) mitigation barriers aimed at addressing a loss of containment of a flammable substance in the process zone. Unfortunately, there was no risk analysis that considered explosion events. , characteristic in processes that handle flammable gases such as methane and propane present in the process.

The first mitigation barrier identified is the fire and gas detection system with automatic activation of the firefighting system, its function is to control the consequence, type of active hardware with good effectiveness, since it covers the entire process area and would support with the cooling of the equipment and structures, however, due to the explosion the electrical systems were deactivated and the backup pumping system with diesel is not available, since the operation authorized switching the pumps to manual to avoid affecting the divers when carried out maintenance activities.

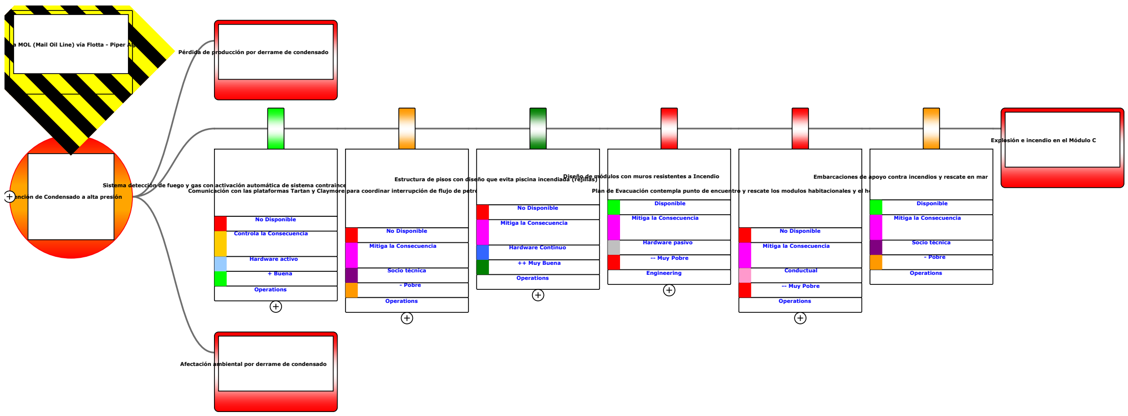


Figure 15. Characterized mitigation barriers – Piper Alpha

The second mitigation barrier corresponds to the communication between the Tarta, Claymore and Piper Alpha platforms, so that, in case of emergency, mainly on the Piper Alpha, since both Claymore and Tartan sent their oil and gas production to the coast to through Piper, interrupted the flow to avoid increasing the fuel supply in the event of a fire. The function of the barrier is to mitigate the socio-technical consequence of poor efficiency since it depends on a large behavioral participation, unfortunately there was no flow interruption protocol if there was no direct indication. On the day of the disaster, Piper Alpha was unable to communicate with Tartan and Claymore, so the flow interruption occurred long after the fire.

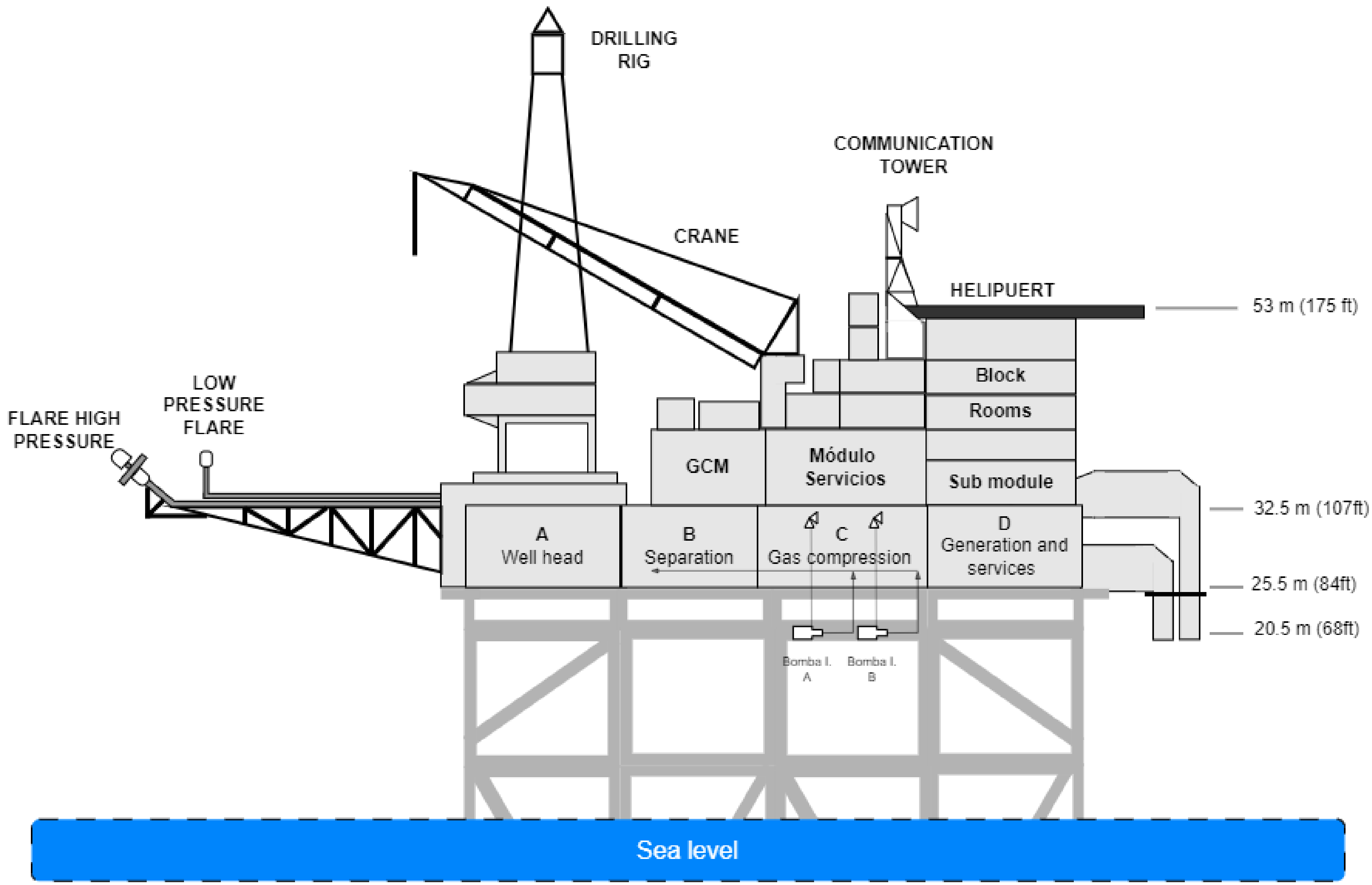
The third mitigation barrier is the structure of the floors with a design that prevents a burning pool (grids). This condition would allow spills of flammable fluids to not be contained in the structure and radiate delicate areas of the structure or process. It is a barrier with The function of mitigating the consequence of very effective continuous hardware type, however, a very critical area, below the process modules, the floors were covered with rubber so that divers could walk barefoot when entering and leaving their work, which which allowed containing hydrocarbons that helped increase fires, explosions and weaken the structure, so the barrier was Unavailable.

The fourth barrier was identified: the evacuation plan includes the housing modules and heliport as a meeting and rescue point, which has the function of mitigating the consequence and behavioral type of very poor efficiency, since, for the event of July 6, 1988, the helipad was unavailable for the large fire and smoke above it, leading to 81 people waiting for a rescue that never came.

As the last barrier and one of the few that functioned on this fateful day, were the firefighting and sea rescue support vessels, whose function is also to mitigate the consequence, of a socio-technical type and poor effectiveness, the vessels were close and available and through All of the 61 survivors were rescued.

Tabla 5. Análisis de Barreras - Piper Alpha

Item	Barrier	Location	Characterization					Degradation factor	FD Control
			Function	Tipe	Effectiveness	Availability	Responsable		
1	There is a 2-G-200 A/B backup condensate injection pump.	Barrera Preventiva	Eliminate the Threat	Sociologist	Very good	Not Available	Maintenance	Empty	Empty
2	Work Permit System (SPT).	Barrera Preventiva	Eliminate the Threat	Behavioral	Very poor	Available	Operations	Failure to close work permits.	Empty
3	Safe Isolation System (SAS).	Barrera Preventiva	Prevent Top Event	Sociologist	Poor	Available	Maintenance	Incomplete Safe Isolation Elements.	Empty
4	Fire and gas detection system with automatic activation of the fire protection system.	Barrera de mitigación	Control the Consequence	Active hardware	Good	Not Available	Operations	Automation interrupted due to divers work.	Empty
5	Communication with the Tartan and Claymore platforms to coordinate interruption of oil and gas flow.	Barrera de mitigación	Mitigate the Consequence	Sociologist	Poor	Not Available	Operations	No Flow interruption protocol exists	Empty
6	Structure and floors with a design that prevents pool fire (grids).	Barrera de mitigación	Mitigate the Consequence	Continuous hardware	Very good	Not Available	Operations	The divers covered the floor of the Maya structure with rubber to walk barefoot.	Empty
7	Design of modules with fire-resistant walls.	Barrera de mitigación	Mitigate the Consequence	Passive hardware	Very poor	Available	Engineering	Mechanism exposed to explosion events.	Empty
8	Evacuation plan includes meeting and rescue point, housing modules and heliport.	Barrera de mitigación	Mitigate the Consequence	Behavioral	Very poor	Not Available	Operations	The scenario of fire and smoke generation over room modules and heliport was not considered.	Empty
9	Fire support and sea rescue vessels	Barrera de mitigación	Mitigate the Consequence	Sociologist	Poor	Available	Operations	Empty	Empty


DRILLING
RIG
COMMUNICATION
TOWER
CRANE
HELIPUERT
53 m (175 ft)
Block
Rooms
LOW
PRESSURE
FLARE
FLARE HIGH
PRESSURE
GCM
Módulo
Servicios
Sub module
32.5 m (107ft)
A
Well head
B
Separation
C
Gas compression
D
Generation and
services
25.5 m (84ft)
20.5 m (68ft)
Sea level

5 Lessons Learned

From the “Public Inquiry”, which began as a judicial investigation, having all the rigor of a criminal investigation, allowed one of Lord Cullen's technical advisors, Brian Appleton, to conclude seven determining factors for what happened at Piper Alpha:

Factor 1: Deficient training and qualification of direct and contracted personnel. Formal training was never carried out for the people who were on the platform, therefore the work permit system procedure was not known.

Factor 2: Deficient risk analysis and identification of danger scenarios. A thorough identification of the danger scenarios that justified the installation of anti-explosion walls was not carried out, so, due to a generalized condition, only the installation of fire walls was contemplated.

Factor 3: Poor security management. In a study carried out a year before the accident, the danger associated with the gas risers that connected Piper Alpha with the other platforms and the coast was identified, however, the identification of this possible scenario was not questioned and no action was taken. Action in this regard was not managed.

Factor 4: Poor quality in security decisions. The problem of the divers with the suction of the fire pumps was identified, however, it was decided to deactivate an automatic system that protected 226 people to protect 4 people sporadically. A security decision of questionable quality.

Factor 5: Poor hazard management and emergency management. It was evident in the investigation that the people who were sheltering in the housing modules died from poisoning and drowning due to the smoke, this despite the fact that the containers had "dampers" in the ventilation that closed when a fire was detected, however, the Fire doors were kept open to facilitate traffic, so smoke could invade the rooms.

Factor 6: Non-existent training in evacuation and drills. The manager of the offshore facility had had inadequate training in emergency management; in fact, he had not had a single drill since he entered the platform.

Factor 7: Poor Quality in security audits. On a daily basis, a security supervisor was requested to review the operation of the work permits, however, he never reported failures to the system. Six months before the disaster, an internal audit was carried out, where one of the audited topics was work permits; the audit did not report any failures in work permits.

Failures in the quality of audits generate a double risk: on the one hand, the possibility of identifying shortcomings is lost and, on the other hand, a false sense of security is generated, so management becomes numb and distracted by other less important aspects.

Having clarity about the factors that led to the disaster, and continuing with the results of the investigation, four main lessons were concluded to be taken into account by organizations, which would later be considered in UK legislation:

Lesson 1: Safety is the responsibility of senior management. In the day-to-day operations of the facilities, the security department or its representative is usually designated as responsible for the security of the operation; however, those who can ensure the proper behavior and condition of the facilities are those associated with the direct line of the facility. management. From the CEO to the lowest supervisor.

Lesson 2: Systematic approach to security. Systems associated with safety, such as work permit systems (preventive barrier 2), safe isolation system (preventive barrier 3), fire system (mitigation barrier 1), failed or were not available or even there were no systems where were required, therefore, the need was seen to focus on security in a systematic way that allows its operation when required and in a disciplined manner, turning it into a culture for its proper execution.

Lesson 3: Quality in security management. Many decisions that were made based on safety conditions were inappropriate or inadequate, mainly based on a very low perception of danger and prioritizing production over safety, with this, latent danger conditions that were not managed were once again failed to be identified. Therefore, line management personnel must consider the quality of the decisions that are made based on the safety of people and the facility, based on sources of experience and knowledge in this regard.

Lesson 4: Quality in security audits. From poor security management to audits that continued in the same direction. The proper application of audits is essential to have a true judgment of the condition of the facility, preferably with an impartial point of view. Even if the current security conditions are very good, there will surely be opportunities to improve something even more.

6 Conclusions

As a result of all this analysis and the consultation of all related bibliographic sources, I consider that the central axis on which the entire disaster was given the possibility of existence is the low perception of danger and the bad habit of human beings to believe that Your own experience is enough to care for and protect the future of a community. It is very common to see the behavior of staff in operations so focused on their production goals that they hardly see the potential for harm that can be caused, even to themselves.

I have extensive experience in applying risk analysis and during process safety scenario identification exercises, it is very common to find a plant shutdown as a consequence of interest in a process event. While it is true that plant shutdown is an undesirable event, facility designs include this condition as a protective barrier for a consequence that has the potential to affect people, assets or the environment, however, Since these protections usually work, the perception of the operation is that it never happens, but the day it does can be a matter of life or death.

It is essential to understand that high consequence scenarios have the possibility of occurring in our facilities, since, if they are possible, we must consider them.

"The sum and quality of our individual contribution to de management of safety determines whether the colleagues we work with live or die."
Sir Brian Appleton
Technical Assessor at Lord Cullen Inquiry

7 References

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