# *JRC - Learning Opportunity Notification (LON) - 004*

## Incident Details

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| Incident | P - 36 |
| Date of Incident | 15-Mar-01 |
| Location/Country | Campos Basin, Brazil |
| Type of Incident | Capsize |
| Offshore/Onshore | Offshore |
| Asset Type | Semi-Submersible |
| Asset Status | Operational |
| Immediate Cause | Loss of Containment |
| Similar Root Cause Incidents | LON - 001, LON - 003 |
| Date Updated | 31-Dec-21 |

## Incident Impact

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| People | 11 dead |
| Environment | Pollution |
| Asset (adjusted claim at the time of loss) | USD $497 million |
| Reputation | |

## Incident Description

The Platform 36 (P-36) was a semi -submersible floating production unit, located in the Roncador field, Campos Basin, Brazil, in water depth of around 1,350 m. The P-36 started production in May 2000 and had a processing capacity of 180,000 barrels/day of oil and the capacity to compress 7.2 million m3/day of natural gas. At the time of the incident, the P-36 was producing around 84,000 barrels of oil and 1.3 million m3/day of gas, from a total of 6 wells. Connection of the remaining wells was planned to be completed in 2005. The P36 was originally built as the MODU 'Spirit of Columbus' by Fincantieri in Italy and was subsequently converted to a FPU at the Davie Yard in Quebec, Canada. The original MODU design was a Friede & Goldman L 1020 Trendsetter type semi-submersible.

Before the incident, on 10 February 2001, a Drain Storage Tank (DST) located in starboard aft column had been shut-down and supposedly isolated. However, leakage of volatile fluids and gases through a valve, over-pressurized the tank, bursting at 00h22 on 15 March 2001. Figure 1 presents the P-36 unit and the process flow diagram of the drainage tanks.

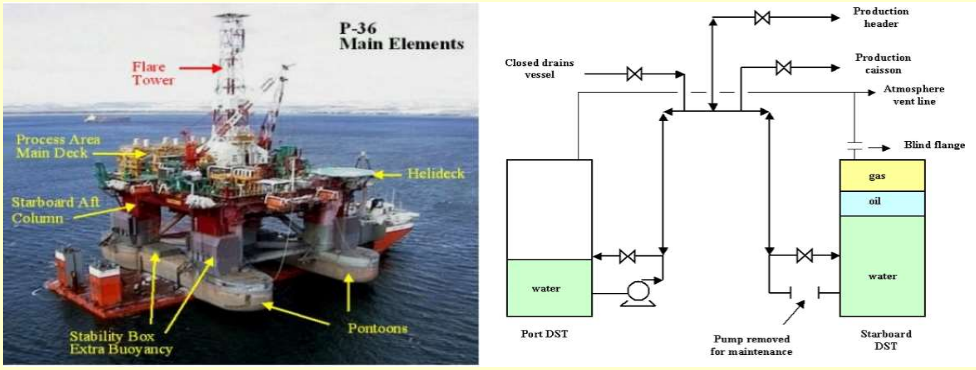


Figure 1: P-36 Unit and The Process Flow Diagram of Drainage Tank (Ref 2)

On 14 March 2001, two non-routine operations were performed: emptying the Port DST beginning at 22h21; and the preparation for inspection of a stability box adjacent to the Starboard DST. The oily water in the Port DST was supposed to be pumped to the platform's production header and then to the process units. However, operational difficulties in starting up the discharge pump on that tank allowed a reverse flow of oil and gas from the production header, so that they entered the other DST (aft starboard), although the intake valve should have been closed. It was not possible to confirm whether the flow to the Starboard DST was due to some damage to the valve or whether it was partially open.

After 54 minutes (23h15), the Port DST pump finally started-up, and whilst considerably decreasing the backflow of hydrocarbons, the water pumped out of the port tank now also entered the starboard tank, further increasing its pressure. It should be noted that the pump on the starboard DST had been removed for repair. This pump's air vent line, suction, and offload had also been blinded.

As a result, pressure had built up to around 10 bar in the starboard tank and it ruptured at around 00h:22 on 15 March 2001. This caused the 18" seawater service pipe adjacent to the DST to rupture and the process plant automatically entered into emergency shutdown mode, with the 4th level of the starboard aft column starting to flood. Over the next 17 minutes, 1,723 alarms were triggered. Operations dispatched the Emergency Response Team (ERT) and activated the seawater service pipe, which instead of supplying water to the ERT was now also contributing to the flooding of the starboard aft column. Around 20 minutes after the first explosion (00h39), there was a second, high-intensity explosion caused by the ignition of the natural gas released from the column (although the ignition source was not identified), reaching the tank top and the second deck and killed ERT members. Rapid flooding of the lower levels of column was in part caused by flow through the ventilation system from the 4th level, when dampers failed to close.

Flooding of the column caused an electrical short-circuit of the seawater pump located at the bottom of the column in the pontoon. The sea chest valve to the ocean was designed to fail-set, contributing to flooding of both the column and pontoon. Within minutes, P-36 tilted by 5 degrees.

Evacuation of 138 non-essential crew began at 01h44. Evacuation took around 2.5 hours and at 06h03 the platform was completely abandoned with the departure of those tasked with maintaining the platform level, and total loss of the platform's control system.

At 08h15, the flooding exceeded the capability for the platform to maintain stable floatation and an entire corner of the platform submerged. After numerous unsuccessful attempts to correct the platform's heeling, the P36 sank at around 11h40 on 20 March 2001.

At the time of the incident, the total number of people on board was 175, of which 85 were operational crew members. The remaining personnel were on board to carry out commissioning and maintenance services on various platform systems.

## Incident Analysis and Findings (including Causal Factors)

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

**Operating Procedures:** The main non-conformities identified which were both contrary to the Platform Operating Manual, are related to the storage of a large quantity of contaminated water in the DSTs over a considerable period and the discharge of water from the DST to the production header. Standard operation was to line up to the production caisson. This operational failing was the cause of the first explosion and the subsequent damages and flooding. The quantity of liquid released inside the column and in some parts of the pontoon caused the platform to heel, which was intensified with the progression of water to the ballast tank in the aft starboard column and in the adjacent stability box. These spaces had been flooded because watertight manholes had been left open since the day prior to the accident to enable the inspection of crack repairs in the stability box. The drainage pump of the Starboard DST was removed for repairs when a considerable part of the tank's capacity was occupied by contaminated water (contrary to the Platform Operating Manuals), and it was not put back into operation. Subsequently the vent line of this tank was sealed with a blind flange, but the intake line was not isolated, causing the vessel designed to be operated at atmospheric pressure to be subject to pressurization and rupture.

Incident investigation identified non-conformities with respect to operational and maintenance procedures. Isolations and bypass procedures were not followed adequately. The operators were not able to assess the situation and act accordingly due to lack of documentation and good practices.

Admission of ballast water by gravity into the opposite forward port column with a view to correct the trim, also worsened the draft. At the time of incident, two seawater pumps were not in operation, and further inhibited the ability to control the trim and draft after the explosions. This reiterates the importance of SIMOP procedures and adherence.

**Design:** The gas released from the tank reached the internal area of the top of the tank and the main deck, activating the gas sensors. The third- and fourth-level areas had not been classified as risk zones. Furthermore, it is also evident that gas sensors were not placed next to the DST.

The seawater service pipe was installed inside the column adjacent to the DST, running inside the support column and leading from the pump room located inside the pontoon. DSTs are a key sub-system element of oil production operations and form part of vent and drain systems. DSTs are usually located on the bottom deck of the platform, but to save space and cost for the design of P-36, the DSTs were installed inside the support columns.

The open fail-set sea-chest valve significantly hindered attempts to prevent further column flooding and eventual capsize after evacuation.

The ANP investigation (Ref 2), highlighted several areas relating to design and construction – specifically:
- Review of project design criteria
- Classification of risk areas
- Management of unit conversion projects with a focus on compatibility of systems

**Process Safety Management (PSM):** Frequent movements of water contaminated with oily residues in the DSTs was performed without an MOC.

When the seawater pump short-circuited and failed from the flooding, the valves to the ocean were fail-set and thus locked in the open position accelerating the flooding of column and pontoon.

An overwhelming 1,723 alarms were triggered in 17 minutes after the DST ruptured with no method of prioritization.

Managers on the rig had reported pressurization problems in the piping in the days leading up to the accident, and even recommended temporary shut-down, but the head office stated that they had never been notified.

A thorough HAZID/HAZOP analysis should have identified the risks associated with placing so many safety-critical parts and sub-systems next to one another and susceptible to a common cause of failure.

**Training and competency:** There was no evidence that the proper training including refresher training were given to the crew. There was also a gap or a lack of linkage between the knowledge of engineers and decision-makers and that of the operators. Operators were inadequately trained to deal with emergencies.

**Emergency Response:** The ERT quickly deployed to the incident area, and some of the ERT members entered the column. The response was hampered by a lack of lighting in the area. The brigade carried no portable gas detectors. Further, communication between the ERT and the platform's command proved deficient. ERT did not receive a clear instruction from the command centre. This reiterates the importance of well written and well-rehearsed emergency procedures.

## Root Causes

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

## Lessons Learned

**PSM & Risk Assessment -** This incident, in the context of a major conversion of a drilling unit to a FPU, emphasises the importance of a rigorous HAZID / HAZOP analysis during both the project phase and the subsequent operation of the facility. The HAZID/ HAZOP should be regularly updated in the operational phase. The fact that the P36 was a modified drilling unit meant that space was limited with the potential for design compromises, including greater congestion of the process equipment.

The leakage of volatile fluids into an isolated DST resulted in bursting of the tank and rupturing the seawater caisson. The proximity of the DST to the seawater service pipe inside a key support column created a common mode of failure, but there was no record of hazard analysis conducted for this design.

**PSM - Isolation -** The poor isolation practice, blocking off all tank connections apart from the inlet were the key issues for this incident and shows the importance of creating isolation procedures and permit to work system and conducting a toolbox talk prior to performing critical operations.

**Regulatory Body -** The Brazilian regulatory authority implemented a series of reforms in their role of managing the offshore operations in the aftermath of this incident.

**Operating Procedures/Training -** An importance of establishing a clear operating procedure and to ensure adherence to procedures. The manhole left open after the inspection, and deviation of intended practice with regard the DSTs are clear examples of lack of a culture that allowed unchallenged 'drift' from design and operational intent.

**Design Layout -** Poor design placement of key safety-critical parts - pressurization and mechanical bursting of the tank, rupturing the seawater service pipe and releasing flammable materials into the support column should have been avoided. During the design stage, abstain from placing any tanks or vessels linked to the production process inside the support columns or pontoons, or other components where damage could compromise stability. Seawater service pipe redundancy should also be considered during the design stage. Further, redundancy or protection of inlet valves of DST should be considered for future designs.

**Design Conversion –** A clear procedures should be developed during conversion to ensure the compliance and compatibility of the safety system.

**Effective Communication and Training -** Effective communication channels should be established together with proper procedures to manage emergencies and conducting regular drills. Further, the importance of operators training on critical operational activities.

**Emergency Response –** This incident proved that the importance of establishing a well written and a well-rehearsed emergency procedure. Eleven ERT lives would have been saved by carrying a portable gas detector and a clear instruction from the command centre.

## References


1.World's deadliest Offshore-oil Rig Disasters, Offshore Technology

2. Analysis of the Accident with the Platform P-36 - Report of the ANP / DPC Commission of Investigation - July / 2001

3. Revisiting the P-36 oil rig accident 15 years later: from the management of incidental and accidental situations to organizational factors. CSP – Reports in Public Health, Marcelo Goncalves Figueiredo et al.

4. The Willis Loss database.