Analysis of the Accident with the Platform P-36

- Report of the ANP / DPC Comission of Investigation -

July / 2001

Analysis of the Accident with the Platform P-36

- Report of the ANP / DPC Comission of Investigation -
July / 2001

Members of the Comission:

Oswaldo Antunes Pedrosa Junior
Hélio Crisóstomo da Silva
Eduardo Celso Cesar dos Santos
Dante Aloysio de Carvalho Júnior
Ricardo Rios de Campos Rosa

INDEX

1 - Executive Summary

The accident occurred with the platform P-36 in the Roncador field in Campos Basin led the National Petroleum Agency (ANP) and the Directorate of Ports and Coast (DPC) of the Brazilian Naval Command to constitute a joint commission of investigation for the purpose of examining the causes of the accident and, as a result, acquire supporting information to implement corrective measures and regulations aimed at improving operational practices and procedures for offshore activities.

The analysis of the most probable causes of the accident has identified the critical event as being the drainage operation of the drains storage tank in the aft port column, which began on the night of March 14, 2001. The oily water in the tank would be pumped out to the platform production header, which receives the flow of oil and gas from the producer wells. From there, together with the production of hydrocarbons, it would flow to the processing plant. However, operational difficulties in starting up the drainage pump of this tank caused reverse flow of oil and gas through the tank discharge lines into the aft starboard tank. The intake valve of this tank was presumably damaged or partially open. The start-up of the pump after 54 minutes decreased the reverse flow of hydrocarbons and the pumped water began entering the aft starboard tank. The continuous pressurization of this tank led to its mechanical failure at about two hours after the start of the drainage operation of the other tank, characterizing the event described as the first explosion, which occurred at 0 hr 22 min of March 15, 2001.

The fluids from the failed tank and damaged lines began to fill the compartment in the fourth level of the column. There was a gas leak to the other decks through the openings in this compartment and through damaged vent and ventilation lines. Around 20 minutes after the tank failure, a gas explosion took place, striking the area of the tank top deck and the second deck level close to the column. This characterized the event described as the occurrence of the second explosion, killing eleven members of the platform's fire brigade.

The analysis performed by the Commission has identified several non-conformities related with operational procedures, maintenance and engineering design, particularly those related with the frequent movements of water in the drains storage tanks, the operation to drain the aft port tank and the classification of the risk area around these tanks.

The failure of the aft starboard tank, immediately followed by the rupture of the seawater pumping line passing through the fourth level, made the column to be flooded. As soon as the water reached the dampers of the ventilation system, it started to migrate to the lower part of the column. These dampers allowed the fluids to pass through them because their actuators had not been automatically closed due to mechanical failure.

The quantity of liquid 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 their man holes had been left open since the day prior to the accident to enable the inspection of crack repairs done in the stability box.

To compensate the list of the platform caused by the entry of water to the damaged column, water was admitted to the ballast tanks at the port side bow. This operation undesirably increased the draft of the platform.

The continuous submersion had been intensified by the flooding of the damaged column, the ballast tank at the starboard side stern, the adjacent stability box and the deliberate admission of ballast water to the port side bow tanks.

The evacuation of 138 people considered non-essential to the emergency operations began at 1:44 a.m. of March 15 and lasted roughly 2 hr 30 min. This was accomplished by the use of crane and personal transfer basket. At 6:03 a.m. in the same day, after completing all the possibilities to maintain the platform level, the team kept onboard for emergency operations abandoned the rig.

An analysis of the key events related with the flooding of the platform has led to the identification of various non-conformities with respect to operational and maintenance procedures. The failure to observe the water-tightness and integrity in critical areas to preserve the stability of the unit has been highlighted. In addition, the ineffectiveness of the actions taken to contain the flooding or dewater the flooded areas prior to the platform abandonment should be also highlighted.

After the abandonment of the platform, many attempts to save the unit were made, especially the injection of nitrogen and compressed air in the flooded compartments to expel the water. However, the attempt to maintain the unit stabilized turned out to be unsuccessful. The platform slowly and progressively submerged, coming to sink at 11:41 a.m. on March 20.

The analysis made by the ANP/DPC Commission of Investigation has resulted in the identification of weaknesses in the operational management system of Petrobras, concerning the conduction of E&P activities in the platform P-36. This was clearly characterized by the non-conformities identified with respect to operational and maintenance procedures. In addition, the contingency plans for large-scale accidents and the high-risk emergency response arrangements need to be improved, and also the engineering design criteria for floating production units need to be revised to ensure greater intrinsic protection.

The accident was caused by a series of factors which, taken separately into account, would not have been a sufficient cause. Examination of these factors led to the classification of some of them as critical and determining factors. The criterion for this classification lies on the fact that the absence of any of them would have interrupted the sequence of events that resulted in the actual outcome.

2 - Introduction

A The production platform P-36 was installed at the Roncador Field in the Campos Basin. The field was discovered in 1996 and extends over an area of 111 km2, in water depths of between 1500 and 1900 m. Its total reserves were estimated at 2.6 billion barrels of oil equivalent, whilst proven reserves attain 1.7 billion barrels of oil and 27.6 billion cubic meters of gas.

Due to the great extension of the field, the large oil and gas volumes in place and the limitations in processing capacity of offshore production units, the Roncador field is being developed in three modules. The first module was designed to have 28 wells, individually connected to an anchored production unit, precisely platform P-36, installed in a water depth of 1360 m. This module started production in May of 2000 and P-36 had a processing capacity of 180,000 barrels/day of oil and the capacity to compress 7.2 million cubic meters/day of natural gas. The oil treated at P-36 was transferred to a very large crude carrier, unit P-47, moored in a water depth of 815 m and with the capacity to store 2 million barrels. The oil was transported by a relief vessel, whilst the gas was transferred onshore through gas pipelines.

The accident with the platform P-36 started on March 15 at 0:22 a.m., when the first explosion occurred in the aft starboard column, followed 17 minutes later by a large explosion at the upper part of the column and adjacent areas, culminating with the death of eleven Petrobras employees. On March 20, at 11:41 a.m., the platform submerged completely and then sank.

A view of the platform is shown in Appendix 1, where some components related with the accident are highlighted.

At the time of the accident, the platform P-36 was producing around 84,000 barrels of oil and 1,300,000 cubic day of gas per day, from 6 wells connected to the unit. Connection of the remaining wells was planned to be completed in 2005.

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

To investigate the causes of the accident with P-36 and, as a result, obtain supporting information to implement corrective and regulatory measures aimed at improving operational practices and procedures related with offshore oil and gas exploration and production activities, the National Petroleum Agency (ANP) and the Directorate of Ports and Coast (DPC) of the Brazilian Naval Command decided to create a joint ANP/DPC commission of investigation, in accordance with Joint Administrative Rule No 1 dated March 29, 2001, modified by Administrative Rule No 2 dated April 27, 2001, and Administrative Rule No 3, dated May 31, 2001.

The analysis performed by the commission was based on testimonies obtained from the administrative inquiry by the Rio de Janeiro Port Authorities and information obtained from Petrobras staff, plus interpretation of engineering documents and operational manuals. The outcomes of the interaction between members of the Commission and the technical team of Petrobras responsible for the design and operation of the platform, as well as with Petrobras's own Commission of Inquiry, were particularly relevant.

The investigation performed was executed according to the analysis sequence shown diagrammatically in the figure of Appendix 2 and described below:

- chronology of the events together with the causal relationship with the accident;
- analysis of the causes of explosions;
- analysis of the causes of the sinking;
- recommendations.

The events having a causal relationship with the accident were carefully identified and a description, in chronological order, is presented in Appendix 3. The analysis of the causes of the explosions and the sinking was focused on the selection of the key events and subsequent identification of non-conformities with operational, maintenance and project designing procedures.

3 - Analysis of the Explosions

A The Commission of Investigation identified the drainage operation of the drains storage tank in the aft port column as a critical factor directly related with the explosions occurred in platform P-36. The flow diagram given in Appendix 4a illustrates the hydraulic layout of the drains storage tanks and their drainage system.

The key events with causal relationships with the incident are described below, together with the characterization of the non-conformities found.

3.1 - Frequent movements of water in the drains storage tanks

Analysis

The origin of the water contaminated with oily residues in the drains storage tanks was not unequivocally identified, but could be derived from:

- the overflow of water from the open drainage vessel through its vent line due to a blockage of the drainage pump of this vessel or a failure in its level controller (the water penetrating into the vent line of the platform system would flow by gravity to the drains storage tanks);
- emptying of the waste oil tank through a branch pipe to the closed drain vessel and from there to the drains storage tank;
- drainage of water used in the hydrostatic testing of process plant equipment being directed to the tanks mentioned.

Information on the volumetric soundings of the drains storage tanks stated in the Ballast Record Book demonstrates that there were frequent movements of water contaminated with oily residues in these tanks. The testimonies and the interaction with the Petrobras teams also contributed towards this conclusion.

Identification of non-conformities

The main non-conformity identified is related with the storage of a large quantity of contaminated water in the drains storage tanks during a considerable part of the period in which the platform was in operation, contrary to the Platform Operating Manual - Process - ET3010.38-1200-941-AMK-924 and DE-3010.38-5336-943-AMK-033. According to the manual, the status of these tanks during normal operation is to remain isolated, and they should only be used for the emergency draining of large volumes of petroleum from the process vessels, or in an emergency situation that required the storage of large volumes of production water in the tanks.

In addition, the following non-conformities were identified related with regulatory operational and maintenance procedures:

- systematic errors in the manual volumetric soundings and operating failures in the level indicators of the drains storage tanks;
- blockage of the open drain vessel, which receives water flowing from the platform equipment sumps.

3.2 - Maintenance of the aft starboard drains storage tank

Analysis

The drainage pump of the aft starboard drains storage tank was removed for repairs on February 10, when a considerable part of the tank's capacity was occupied by contaminated water, and it was not put back into operation. Subsequently the vent line of this tank was sealed with a blind flange to avoid water entering the tank from the open drain vessel due to the blockage of its draining, as can be seen in Appendix 4b and Appendix 9.

The isolation of the vent line altered the design characteristics of the tank, since it was constructed to operate at atmospheric pressure and, in this case, was subject to improper pressurization. This procedure could only have been performed after previously emptying the tank, also followed by isolation of the. tank intake line.

It should be stressed that this procedure was a determining factor that allowed the tank to be subsequently pressurized and to rupture.

Identification of non-conformities

The following non-conformity related with standard operational procedures can be characterized:

- Isolation of the tank vent line without isolating the intake line as well.

3.3 - Operation to empty the aft port drains storage tank

Analysis

The operation to drain the port tank began at 10:21 p.m. on March 14, consisting of the following sequence of actions:

- verification of the closure of the starboard tank intake valve;
- opening of the valve in the production header line to align the port tank with this equipment; and
- start-up of the port tank drainage pump.

Operational difficulties were encountered in starting up the pump, which only occurred 54 minutes after the beginning of the action. During this period a reverse flow of hydrocarbons occurred in the lines of the drains storage tanks.

The intake valve of the starboard tank allowed the passage of fluids into the tank, presumably because it was partially open or damaged. Consequently, since the tank vent line was blocked, as described above, continuous pressurization occurred in the tank as a result of incoming oil and gas from the production header.

After 54 minutes the pump was started up, considerably reducing the reverse flow of hydrocarbons, but not interrupting pressurization of the starboard tank because the pumped water flowed into this unit. Pumping of the water lasted 67 minutes.

An illustration of this scenario can be observed in Appendix 4.b.
It should be emphasized that this transfer of load was sufficient to cause the platform to begin to heel.

Identification of non-conformities

The operation described above was characterized as a critical non-conformity with regard to standard operational and process procedures, determining the cause of the accident.

Although the hydraulic configuration of the drainage system of the drains storage tanks allowed their contents to be pumped to the processing plant through the production header, the standard draining procedure required that the operation should have been carried out through the production caisson with the subsequent discharge of the water into the sea. The option to remove water from the tank via the production header was contrary to the operating requirements of the Platform Operating Manual - Process (ET3010.38-1200-941-AMK-924).

The following non-conformities related to standard operational and maintenance procedures were also identified:

- The operation was carried out without the supervision of the Platform Coordinator or the Production Supervisor (it was not possible to ascertain whether the valve in the production header line which, according to testimony, required a password for its controlled opening, was opened with authorization from the Platform Coordinator);

- Mechanical failure or incomplete closure of the starboard tank intake valve.

Although it cannot be characterized as a non-conformity, the following design deficiency was found:

- vulnerability in the connection arrangements of the drains storage tanks with the production header due to the lack of any additional protection or redundancy in the case of a simple failure of one of the tank inlet valves.

3.4 - First explosion

Analysis

The aft starboard drains storage tank was pressurized during 121 minutes until it reached a pressure of around 10 bar, receiving approximately 13 cubic meters of oil, 1460 cubic meters of gas and 64 cubic meters of water, expressed at basic pressure and temperature conditions. These results were obtained from a mathematical simulation performed by ANP, considering an opening of the intake valve of 24% of its area to allow the tank to reach the above-mentioned pressure in 67 minutes after start-up of the port tank drainage pump, as can be seen in Appendix 5.

At 12:22 a.m. on March 15, upon reaching a pressure of around 10 bar, described by the Petrobras technical team as the failure pressure, the tank ruptured, releasing water, oil and gas to the inside of the column. The increase of the internal volume of the tank as a result of mechanical strain before failure was not taken into account.

The characteristics of this event correspond with the testimony given by the onboard staff members, who described that they heard a muffled and intense thud coming from the aft starboard side of the platform.

The collapse of the tank structure caused the transfer of the fluids inside it to the fourth level compartment, in addition to the rupture of the 18-inch saltwater pipe passing alongside it, beginning the flooding of the column. As a result the main fire ring line was depressurized, leading to the automatic shutdown of the process plant. The tank vent lines located below the third level of the column also ruptured.

The gas released from the tank reached the internal area of the tank top deck and the main deck through the column ventilation system and the ruptured tank vent lines located below the fourth level, activating the gas sensors. The release of gas was confirmed seconds after the "first explosion" by the detection of gas in two of the ventilation air intakes, one for the aft starboard column and the other for the internal area of the tank top deck, and by other sensors located on the main deck.

The areas of the platform that were invaded by the gas released from the drains storage tank are shown in Appendix 6 and Appendix 7.

Since the third and fourth level areas were not classified as a risk zone, as shown on the engineering drawings DE-3010.38-5400-947-AMK-120 Rev. B and DE-3010.38-1200-200-AMK-008 Ref. F, the gas released after the rupture was not immediately detected in the tank

compartment. For the same reason the hydrocarbons were not contained in this area since there were no adequate containment devices or explosion-proof equipment.

Identification of non-conformities

The analysis performed lead to identification of the following non-conformity as regards project and design procedures:

- inadequate classification of the area around the drains storage tank.

3.5 - Second explosion

Analysis

With the rupture of the starboard tank, the fourth level compartment was filled with water, oil and natural gas. Shortly afterwards the platform team responsible for emergency response went to the location of the accident. The hatch between the third and fourth levels was opened for inspection of the lower compartments, and the presence of a white mist was noted, without any heat or flames. The inspection was hampered by a lack of lighting in the area. Opening the hatch allowed gas to escape to the upper decks through the column. The ascending flow of gas also occurred via the ruptured air vent lines and ventilation ducts.

It should be mentioned that the column ventilation system was automatically interrupted due to the gas alarm on the main deck. The ventilation dampers that interconnect the column compartments did not automatically close as designed.

At 12:39 a.m. on March 15, the second intense explosion occurred, caused by the ignition of natural gas released by the column reaching the tank top deck and second deck areas. This explosion was extremely strong and killed 11 Petrobras employees in charge of emergency response and caused extensive material damage over a wide area of the decks mentioned.

Just after the second explosion, the main power generation system of the platform was automatically shutdown and the emergency generating system started up promptly.

Identification of non-conformities

The analysis performed lead to the identification of a non-conformity with the standard emergency response procedures, particularly with respect to:

- ineffective communication system and coordination between the emergency response team and the platform command.

4 - Analysis of the Sinking

The analysis performed sought to identify the critical elements related with the progressive loss of stability and sinking of the platform, and also evaluate the effectiveness of action taken to salvage the unit.

The key events having a causal relationship with the sinking are presented as follows, together with the characterization of the non conformities found.

4.1 - Flooding of the column and pontoon

Analysis

The mechanical failure of the aft starboard drains storage tank, followed by the rupture of a section of the salt water pressurized line passing close to the tank at the fourth level, led to the flooding of the column. The determining cause of this incident was the following:

- water and oil from the collapsed tank invaded the fourth level compartment;
- the salt water pumps located aft starboard and forward starboard, activated automatically by the depressurization of the main fire ring line, continually increased the flooding through the fractured pipe; and
- all the remaining water from the seawater system and the main fire ring line flowed by gravity to the fourth level compartment.

When the water level in this compartment reached the level of the column's ventilation system dampers, the water migrated to the lower part of the column through the existing opening, due to the failure of the dampers to close automatically (the actuators were not functioning). The compartments that were flooded first were the pump, thruster and water injection system equipment rooms.

Due to the quantity of water inside the aft starboard column, the platform heeled, acquiring a list (transverse inclination) to starboard and trim (longitudinal inclination) towards the stern. However the platform would have already commenced heeling before the rupture in the aft starboard drains storage tank due to the transfer of load from the aft port tank and the production header, to this tank.

On the day prior to the accident, the man holes that provide access to the ballast tank on the aft starboard column and the stability box located above the pontoon close to this column, had been opened to inspection of repairs of cracks found in this compartment. This inspection was programmed to take place on the following day.

It is important to mention that the opening of the ballast tank and the stability box, enabled the flooding of the lower part of the column to progress to these open spaces, since they communicated with the pump room that was already flooded. This flooding contributed decisively to the accelerated heeling of the platform.

The figure shown in Appendix 8 illustrates the column and pontoons compartments that were flooded.

Just after the failure of the seawater pump of the damaged column and the isolation of this seawater system, the flooding proceeded through the sea chest connected to the pump suction. This sea chest remained open after the pump was shut down because its device was designed to maintain the status at the moment the equipment fails (fail set system).

Identification of non conformities

Non conformities were found related with the maintenance and operational procedures, as listed below:

- failure in the functioning of the dampers of the column ventilation system, as a result of defects in their electro-hydraulic actuators;
- man holes to the aft starboard ballast tank and the adjacent stability box left open during more time than necessary to perform the inspection and repair, altering the behavior of the platform considered in the intact and damaged status stability studies, contrary to

the procedures stated in the Operation Manual - Item Hull and Structure - Water tightness;

Although it cannot be characterized as a non conformity, utilization of the fail set system for the sea chest valve made it impossible for any operator to modify its position after the failure, since the system did not have any alternatives to enable the restriction imposed to be overridden.

4.2 - Admission of ballast water at the port bow

Analysis

When the inclination of the platform caused by the entry of water to the damaged column was found, the unit's coordination determined that the ballast tanks located on the diametrically opposed column (forward port) should be loaded with sea water to re-establish the operating conditions of the platform. It is important to emphasize that the action taken to correct the inclination of the platform accelerated the undesirable increase in its draft.

The admission of ballast water to the port bow, carried out by gravity, only ended when the tanks were completely full. At this time the platform continued to be flooded by seawater through the open sea chest on the damaged column.

No additional action was taken to contain the flooding of the aft starboard column neither to de-water it, or transfer ballast water between the intact columns to maintain the platform level with the least possible alteration in draft. On the other hand, actions of this nature would have been difficult since two of the seawater pumps (port side aft and forward) were not operating.

Identification of non conformities

With respect to the control of stability of a floating platform in a damaged condition, the following non conformities were identified:

- ineffectiveness of the action to contain flooding of the damaged column, dewater it or transfer ballast water between the undamaged columns; and
- insufficient coordination and training of personnel in emergency stability control.

The following non conformity with respect to maintenance procedures was also identified:

- two seawater pressure pumps out of operation due to maintenance problems.

4.3 - Continuous submersion of the platform

Analysis

The submersion of the platform was intensified by the following factors:

- flooding of the compartments in the damaged column and rooms adjacent inside the pontoon ;
- flooding of the aft starboard ballast tank and the adjacent stability box; and
- the admission of ballast water in the forward port tanks.

Since the ballast tank and stability box had a very high volume (around 1,500 cubic meters), the flooding resulting from the man holes left open contributed decisively to the acceleration of the continual submersion of the platform. This process reached a critical point when the sea level

reached the chain locker opening. These facts are demonstrated by simulations carried out by the Petrobras technical team and examined by this Commission.

Identification of non conformities

The fact that the ballast tank and stability box mentioned above had been left open characterized a critical non conformity related to standard operating procedures in areas requiring water tightness and integrity, contrary to the Operating Manual (MA-3010.38-1320-915-NBD-909-01) - Stability in the Case of Damage item, constituting a major cause for the sinking.

In addition, the ineffectiveness of actions taken to contain the flooding or carry out dewatering can be identified as a nonconformity with respect to operational procedures to control stability in the case of damage.

4.4 - Evacuation and abandonment of the platform

Analysis

Once they noticed the platform was flooded, actions were taken to maintain the rig leveled in order to facilitate evacuation of the crew. Beginning at 1:44 a.m. on March 15, 138 people considered non-essential for the emergency operations were evacuated. The evacuation was carried out using a crane and personal transfer basket, finishing up at 4:20 a.m. in the same day. The lifeboats available were not used.

The emergency response team that remained aboard made attempts to reach the areas damaged by the explosion to locate victims and evaluate the consequences and extent of the accident.

The decision to abandon the platform was taken after having exhausted all possibilities of maintaining the unit level, due to the total loss of the unit's operational control system. At that time, the list of the platform was around six degrees, which is less than the limit established by MODU-89 Code for abandoning a unit using lifeboats.

The final abandonment was carried out by helicopters and was concluded at 6:03 a.m. on March 15. From that time on, all subsequent operations to save the platform were managed by the Petrobras management coordination at Macae.

4.5 - Attempts to salvage the platform

Analysis

With the progressive heel of the platform, the indication that the following compartments of the aft starboard column and adjacent areas of the pontoon were totally or partially flooded was confirmed: thruster room, pump room, water injection system equipment room, ballast tank and adjacent stability box, in addition to the fourth level.

At 8:15 a.m. on March 15, the platform was at around 20 degrees of list and the water level reached the aft starboard chain locker entry. The progressive flooding process started through the entry of water into the compartments that were still empty.

The substantial increase in average draft associated with the heel of the platform enabled water to also enter the vents lines close to the damaged column.

The first submarine inspections using a remote control vehicle demonstrated that there was no external damage to the aft starboard column and pontoon.

The platform continued to list as a result of the slow and progressive flooding, reaching 21 degrees around 3:00 p.m. on the same day.

At daybreak on March 16, it was found that the platform had sunk a further 20 cm and water was probably entering the hull by the open sea chest.

To reverse the situation and re-float the platform, the Petrobras coordination team decided to inject nitrogen through the stability box next to the damaged column to expel the water from the flooded compartments. On the same day, two vessels equipped with nitrogen and compressed air injection devices had been sent to the site of the accident and began the nitrogen pumping operation on the same night.

On March 17, in addition to proceeding with the nitrogen injections, it was decided to inject compressed air in other tanks of the platform.

A specialized team contracted from the Dutch company Smit Tak took over the salvage operations, whilst the Petrobras team managed the support for the operations.

According to the monitoring performed, the platform remained stabilized throughout the day. At 6:00 p.m., the specialized team decided to stop pumping because they considered that a sufficient volume of air had been injected to fill up the flooded compartments.

At daybreak on March 18, the specialized team boarded the platform in order to seal off the air vents. Just afterwards it was decided to restart nitrogen pumping, but it was not possible to successfully reconnect the hoses needed for this purpose.

On March 19, attempts to inject nitrogen and compressed air were once again frustrated as a result of difficulties encountered by the divers to make the connections. However the platform remained listing with a small variation in draft, maintaining the 25 degree list as shown by the support vessel log book reporting the evolution of the situation.

Due to technical problems in carrying out the dive, the alternative to open holes in the lower lateral part of the buoyancy tanks to facilitate the placement of compressed air or nitrogen hoses was not carried out.

After midnight on March 20, the support vessel staff reported that the situation was worsening, when the platform reached a list of 30 degrees at 2:45 a.m.

According to this scenario the specialized team concluded that the only alternative available was to cut the mooring lines and risers by using a controlled explosive technique. However, there was no time to implement this initiative.

During the morning of March 20, the platform continued sinking and totally submerged around 11:40 a.m.

4.6 - Environmental Impact

Analysis

At the time of the accident, the platform P-36 had around 1200 m³ of diesel oil and 350 m³ of crude oil stored on board and in its production lines and vessels.

After the sinking, these fluids began to leak into the ocean, at an approximate distance of 150 km from the coast. Around 350 m3 of oil emerged during the first 24 hours after the sinking, according to the "Notification of a Spill of a Polluting Substance" dated March 21, issued by Petrobras in compliance with ANP Administrative Rule No 14, article 3, dated February 1, 2000.

The spill was treated by collecting part of the oil and using chemical and mechanical dispersion on the other part.

5 - Conclusions and recommendations

The investigation performed on the accident with the platform P-36 led to the identification of non conformities with respect to standard operational, maintenance and engineering design procedures. The operations carried out in disagreement with the platform Manuals and critically related with the accident were the following:

- frequent movements of water contaminated with oily residues in the drains storage tanks;
- isolation of the vent line of the aft starboard drains storage tank;
- operation to drain the aft starboard drains storage tank via the production header; and
- man holes to the aft starboard ballast tank and adjacent stability box remaining open.

Regarding maintenance procedures, the failure in closing the dampers of the ventilation system of the aft starboard column was characterized as a critical nonconformity because it drastically affected the isolation of the watertight areas, allowing them to be flooded.

The analysis of the engineering documentation available enabled the Commission to characterize as critical the classification inadequacy of the risk area around the drains storage tanks.

The ineffectiveness of actions taken to contain the flooding or to dewater the aft starboard column after the rupture of the emergency drainage tank demonstrated failures in the operation control system to stabilize a floating unit in a damaged condition.

The situation described shows deficiencies in the operating management system of the Petrobras offshore oil and gas activities in conducting the specific activities of the platform P-36.

Bearing in mind the conclusions presented, the ANP/DPC Commission of Investigation recommends that the following procedures should be adopted:

a) Improvement to the operational management system.

Review and application of a management system to ensure a strict compliance with standard procedures, including reviewing the definition of responsibilities with respect to maintenance, operation and safety.

b) Review of project design criteria.

Review rules and procedures applicable to project design in order to ensure intrinsic protection of critical systems and components of offshore units.

c) Classification of risk areas.

Establish additional criteria for the simultaneous application of standards related with the classification of risk zones.

d) Simultaneous commissioning, maintenance and operation actions.

Establish criteria to identify the limits for commissioning activities in parallel with the operation and maintenance of offshore units.

e) Staff dimensioning and capabilities.

Re-evaluate the dimensioning and qualification of operating and maintenance teams for offshore units, and also those responsible for high-risk emergency response.

f) Management of unit conversion projects.

Implement rules and procedures for compatibilizing original systems and projects alterations to ensure operational safety and environmental protection.

g) International Safety Management Code.

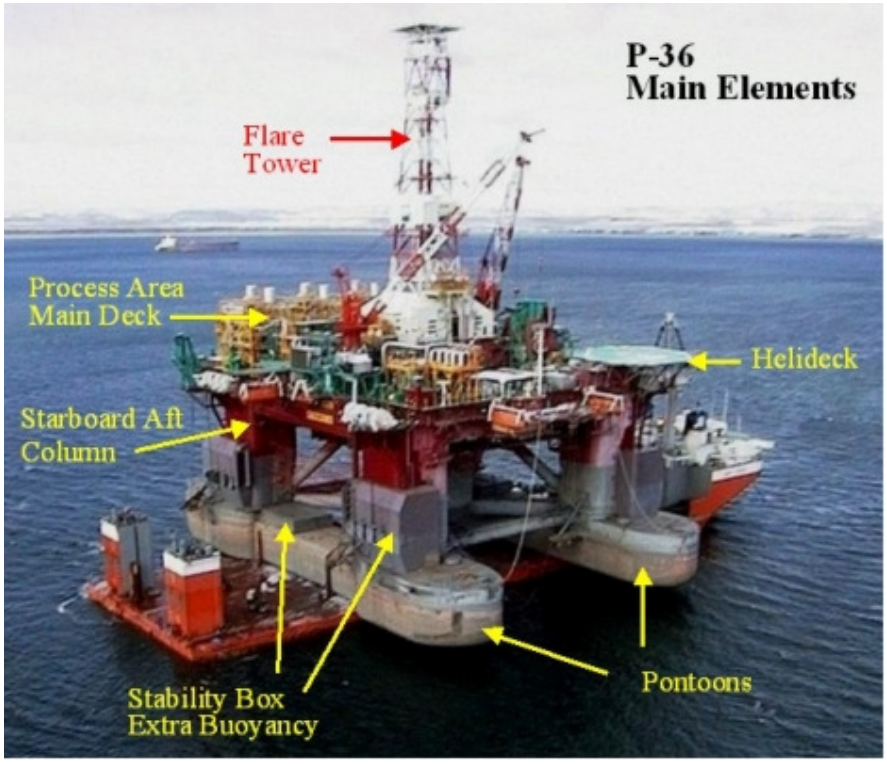
Evaluate the convenience of anticipating adoption of the International Safety Management Code approved by Resolution A 741(18) of the International Maritime Organization (IMO) for offshore units.

h) High-risk emergency response.

Prepare an emergency plan and implement a response scheme for situations involving high risks in saving human lives, shipping safety, environmental and asset protection.

6 - Appendixes

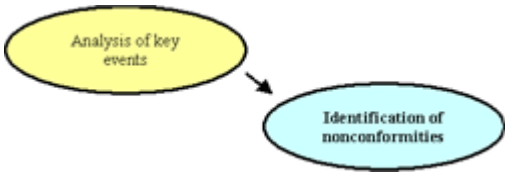
Appendix 1- Platform P-36



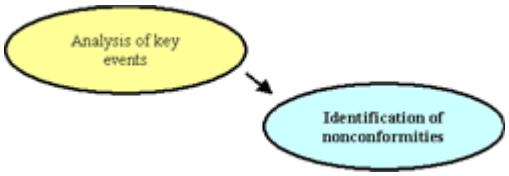
Platform P-36

Appendix 2 - Methodology of Analysis

- Chronology of events having a causal relationship with the accident



- Analysis of the causes of the explosions



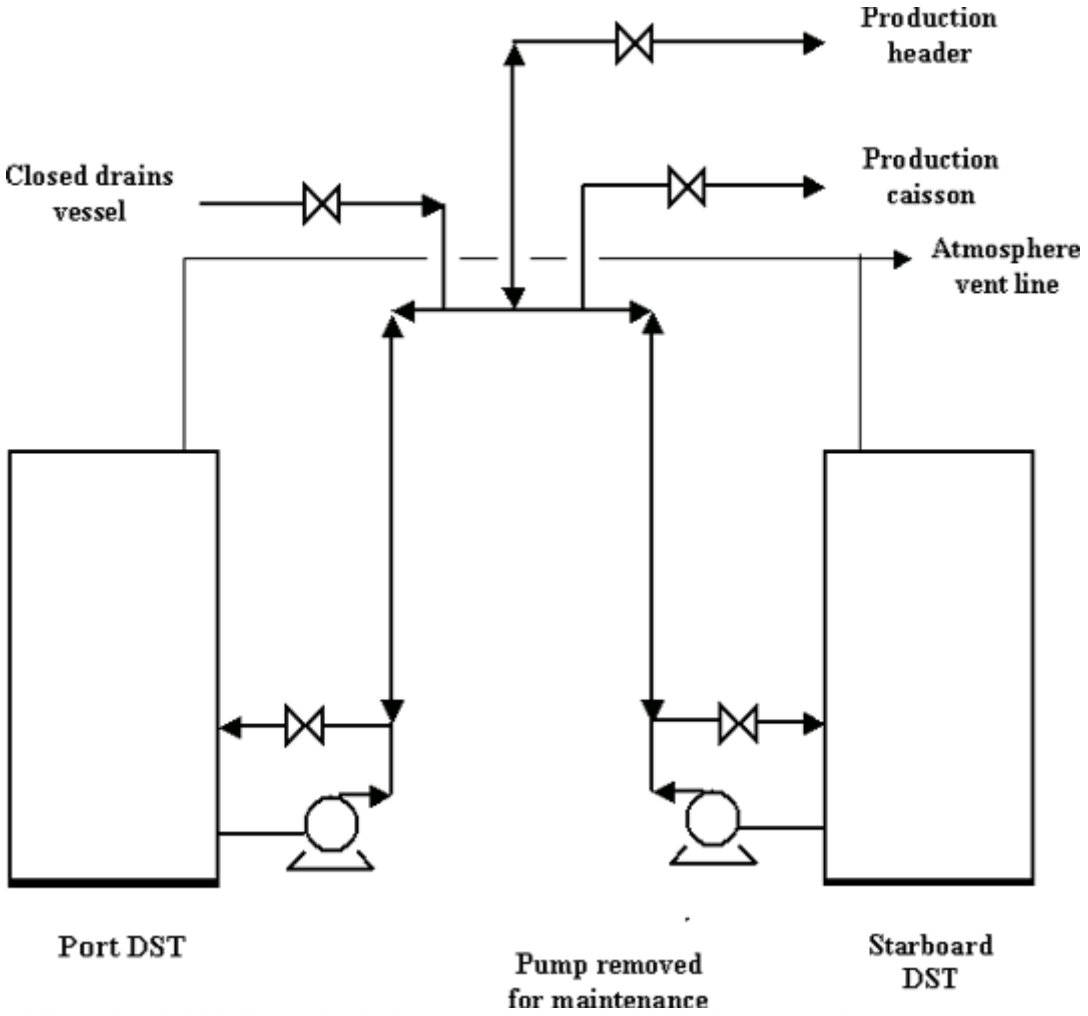
- Analysis of the causes of the sinking
- Recommendations

Appendix 3 - Chronology of events having a causal relationship with the accident

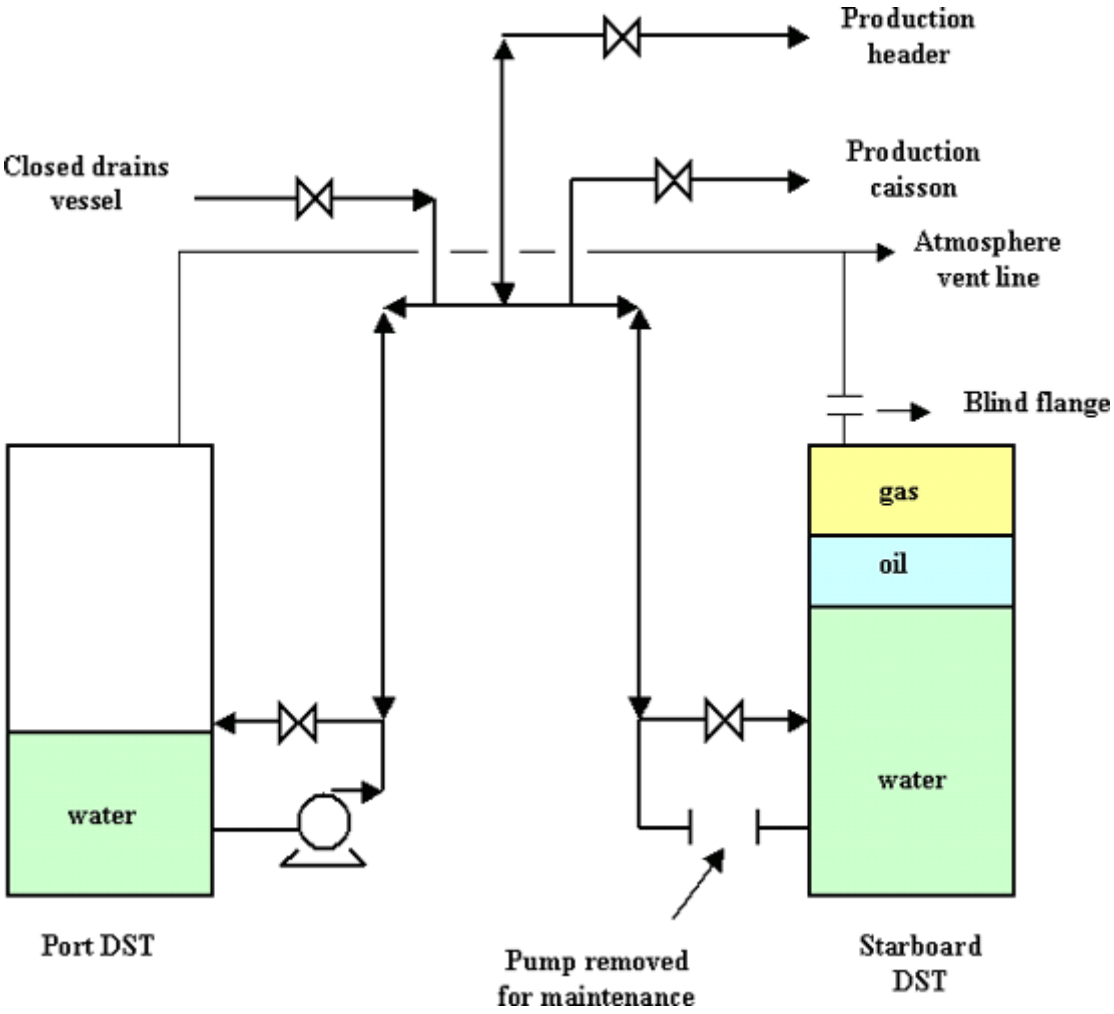
Date	Time	Event
-	-	Overflow of the open drainage vessel with the supply of contaminated water to the DST's and the presence of a large volume of water in the starboard and port DST's.
-	-	Frequent movement of water contaminated with oily residues in the DST's.
02/10/2001	-	Removal of the starboard DST's drainage pump for maintenance.
03/14/2001	19:00	Opening of the man holes of the ballast tank (26 S) and stability box (61 S).
03/14/2001	22:21	Start of the operation to drain the port side DST by opening the production header valve and attempts to start up its drainage pump.
03/14/2001	23:15	Start-up of the port side DST drainage pump.
03/15/2001	00:22	Event related with the first explosion, with immediate detection of gas on the deck and flooding of the fourth level compartment of the aft starboard column.
-	-	Flooding alarm in rooms of the aft starboard pontoon , rupture of the pressurized seawater line and depressurization of the main fire ring, detection of heeling of the platform and deliberate admission of ballast water in the forward port tanks.
-	-	Inspection of the site of the accident by safety technicians with the fire brigade team, opening of the access hatch between the third and fourth levels and detection of smoke / white mist without the presence of heat or flames, in the aft starboard column.

03/15/2001	00:39	Occurrence of the second explosion caused by ignition of natural gas released from the column reaching areas of the tank top deck and second deck.
-	-	Continual sinking of the platform by flooding of the column, ballast tank, stability box and rooms in the aft starboard pontoon, in addition to ballast water being admitted in the forward port tanks.
03/15/2001	06:03	Final abandonment of the platform.
03/15/2001	08:15	Start of the progressive flooding process of the platform due to the water level reaching the chain locker openings and vents lines of the empty tanks.
03/20/2001	11:40	Sinking of the platform.

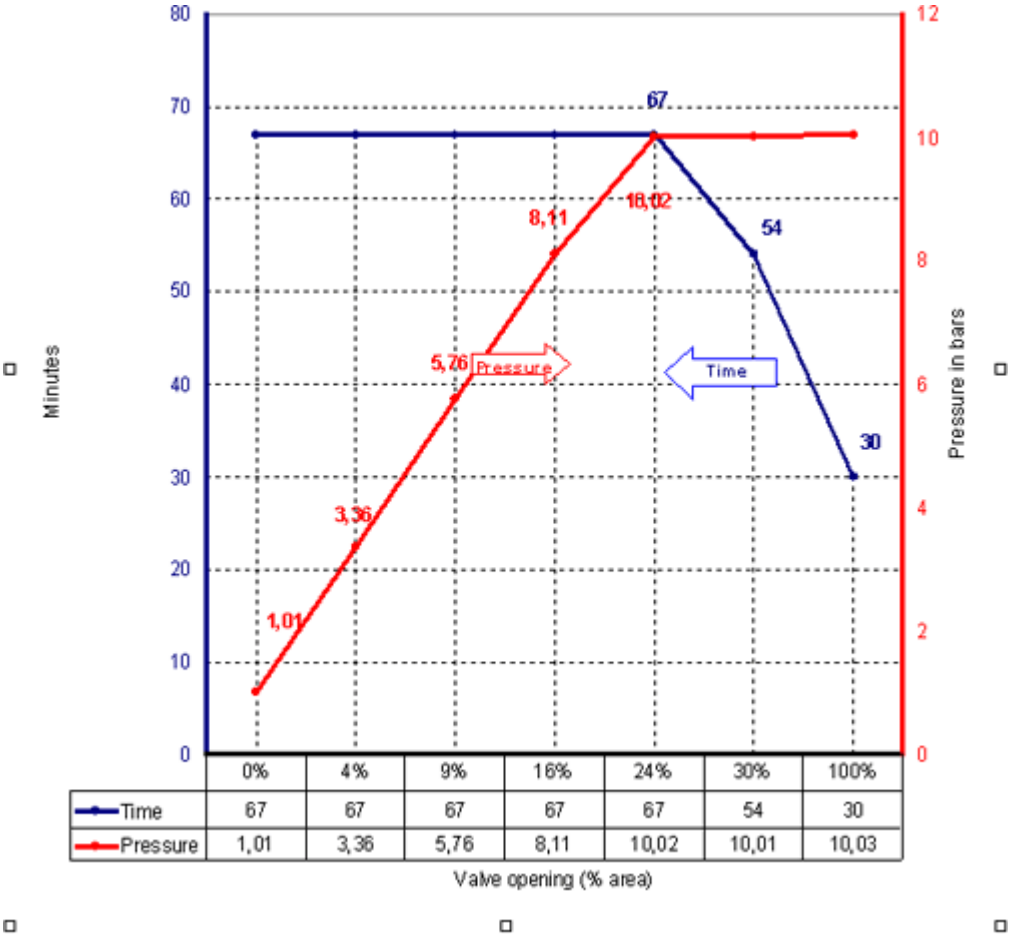
Appendix 4a - Process Flow Diagram of the Drains Storage Tanks



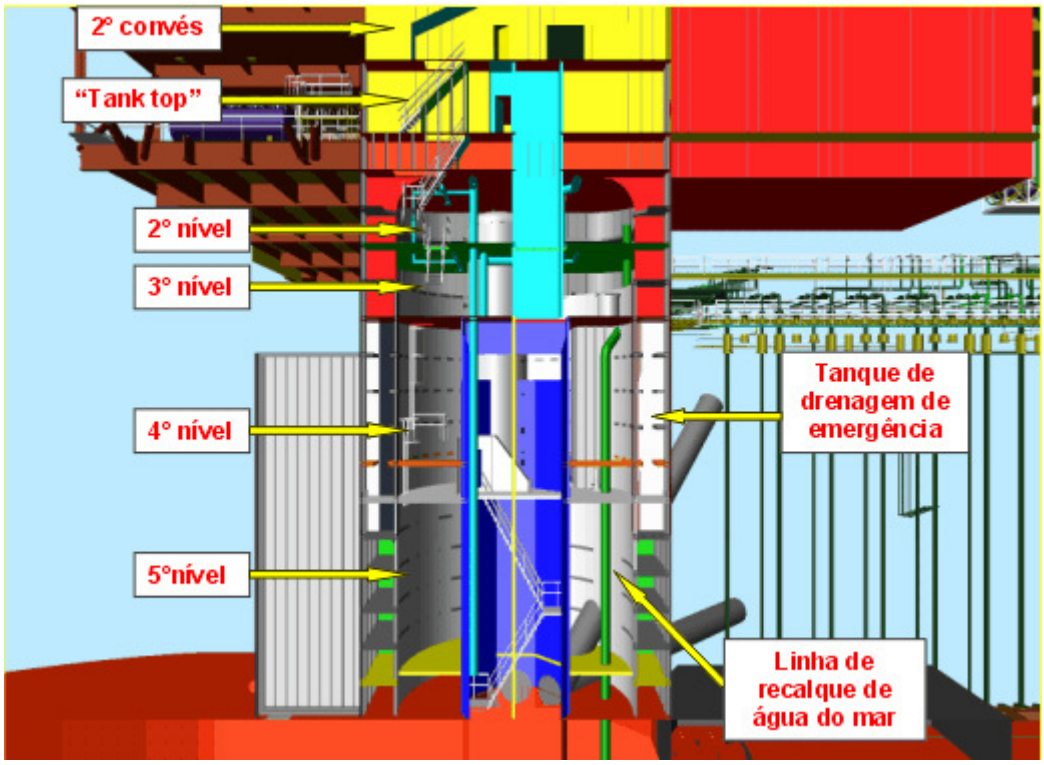
Appendix 4b - Process Flow Diagram of the Drains Storage Tanks at the Time of the First Explosion



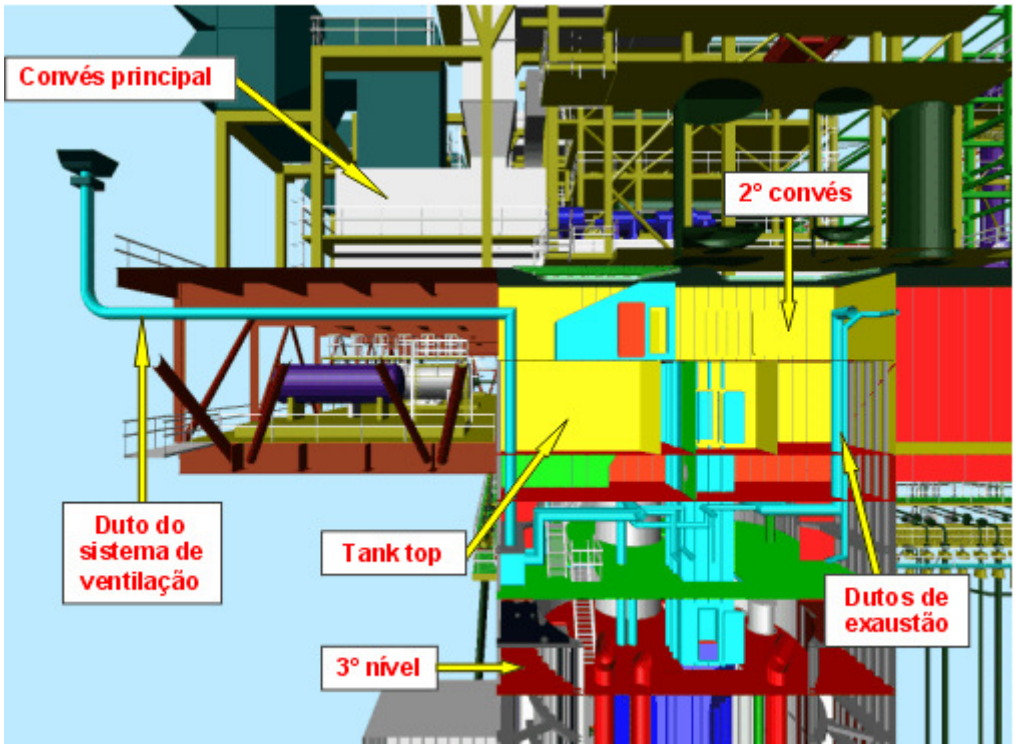
Appendix 5 - Time elapsed and pressure in the tank versus opening of the valve



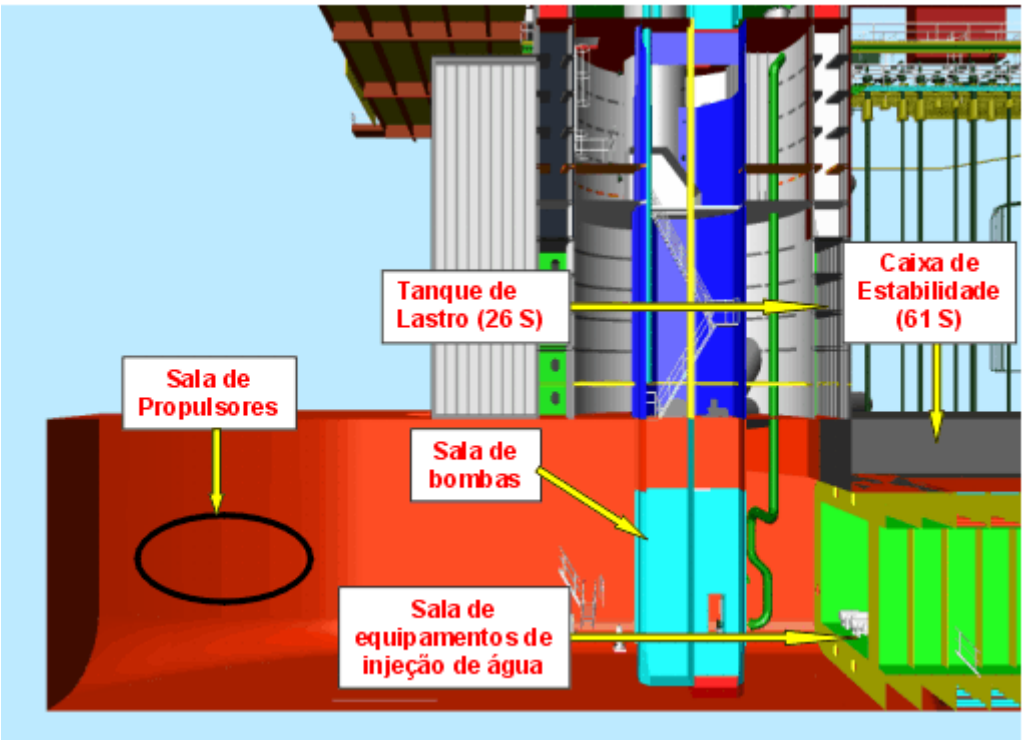
Appendix 6 - Aft Starboard Column



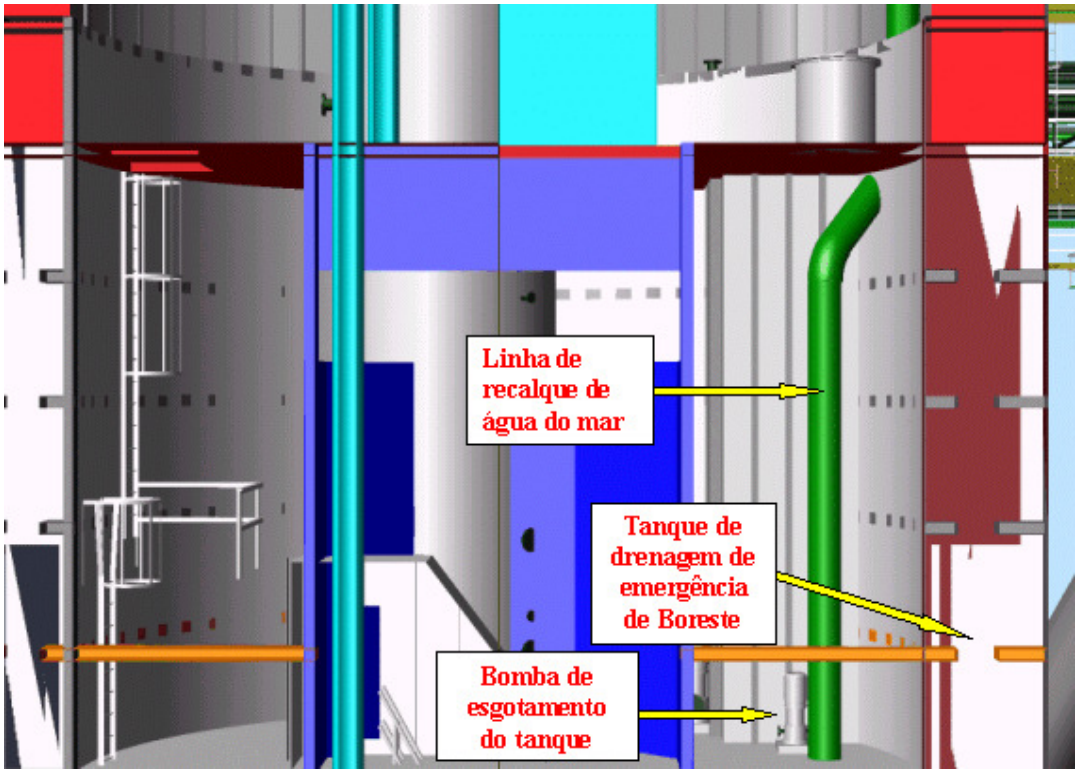
Appendix 7 - Decks and Upper Part of the Column



Appendix 8 - Column and part of the Aft Starboard Pontoon



Appendix 9 - Fourth level of the Aft Starboard Column



Rio de Janeiro, July 16th, 2001.

- Oswaldo Antunes Pedrosa Junior
- Hélio Crisóstomo da Silva
- Eduardo Celso César dos Santos
- Dante Aloysio de Carvalho Júnior
- Ricardo Rios de Campos Rosa