

FINAL REPORT



INCIDENT DESCRIPTION

CAUSES OF THE INCIDENT

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South Pars oil layer is located in Persian Gulf, 105 km south of Assaluyeh, in the maritime border between Iran and Qatar. The FPSO Cyrus is used in South Pars field in order to process, store and finally load hydrocarbon liquid onto oil tankers. In order to fix the position of FPSO of AFRAMAX class which is 246 m in length and 42 m wide, an advanced system of mooring including 12 chains with the approximate length of 800 m is used. Each chain is connected to heavy weights of 27 tons in the seabed. In order to loading, oil tankers enter the Marine terminal FPSO Cyrus and berth nearby. The type of berthing process in this terminal is Tandem Mooring. Some elements including the location of SPOL platform within 100m of FPSO Cyrus bow, the existence of 12 chains on both sides of it and also optical Fibers and pipes in the field within 1-3 miles of production platforms makes the operation difficult and hazardous.

In addition to the foregoing, there are many strong currents and vortexes in the geographical position of FPSO in Persian Gulf, causing trouble for the stabilization of oil tankers whose loading takes more than 24-hours. These currents intensify at the peak of tides time which occur 3-4 times a day. Most of tides occur on the first day of lunar month. It's the pilot's duty to keep the tanker along with FPSO Cyrus using tugs in any condition. The permissible range of deviation for tanker is 25 degrees from Cyrus's course. At deviation of 35 degrees, loading shall be stopped and if the deviation is over 40 degrees, the tanker shall be separated from FPSO Cyrus. In the 18th loading operation of this terminal, SOL tanker of Suezmax class which is under the ownership of the National Iranian Tanker Company NITC entered the field to receive 500,000 barrels of crude oil.

The oil tanker is 274 m in length and 48 m in width. As it was her second loading, it's draft was 10 meters. The pilots were provided with 7 vessels for this operation. Sea Falcon, DARYABANDAR 4, KAREN 6 tugs and DELNIA 2 vessel were selected to participate in this maneuver. While berthing at about 10 a.m., DARYABANDAR 4 announced that only 50% of vessel engine power was usable. Therefore, pilot decided

to replace it with KAREN6. At 11:36, SOL tanker was connected to FPSO. At 12:20, SEA FALCON engine broke, so it was excluded from the maneuver and left the location despite the pilot's preference. Afterwards, the pilot replaced it with DELNIA2. At 13:30, the winch of DELNIA 2 broke. It was at 14:00 that the pilot announced the impossibility of loading until the status of three out of 4 tugs present in maneuver was determined. At 14:30, a team of three FPSO Cyrus sailors who were on tanker deck with pilots could connect the export loading hose to the manifold of the tanker. It was 15:00 that the captain of DELNIA 2 announced that winch is repaired and ensured its performance. So after lengthy negotiations on continuing or stopping it; it was decided to carry on the operation. At 16:00 loading began and continued successfully until midnight.

From 12:00 midnight to 1:30 a.m. the tanker deviated to the portside of FPSO Cyrus due to the water currents. The more time passed, the stronger the current became, so DAYABAND 4 had to use more power. At 1:10 the tug engine probably overheated and without any notice, as stated by the pilot left the location until 1:45. In the meanwhile, nobody or no supervising group members noticed the deviation of the tanker, so no warning was issued.

As the process of loading takes 24-36 hours and both pilots are responsible for supervising the process and also positioning the tugs to stabilize the tanker, they should work night shifts separately. At about 1:50 a.m. the copilot noticed the tanker deviation of over 35 degrees and informed the pilot who had been taking some rest. As the pilot entered the control room, he determined the new position of the tugs and asks for taking the tanker back firmly to its original place. Based on his previous experience in this terminal, the pilot believed that he could resist the tide peak which was probably going to occur in successive minutes by means of tugs and afterwards, as the water currents subside or even reverse, the tanker will return to its original location. The same thing happened in some loadings like the third one. Therefore, if tugs could resist or restore the tanker to a safe position or if the tanker could return to a safe location because of the reversal of subsurface water currents or the current,

they could continue loading. To ensure that, he ordered to take the tanker Engine for service checks and asked the tanker captain to be present in command center. The tanker was quickly rotating and tugs could only slow it down, but they were not capable of holding and restoring it.

There was a risk that tanker would collide with FPSO Cyrus. Standby vessels were of service, firefighting and anchor handling types so their movement caused long delays. As the result of the new arrangement of tugs trying to restore the tanker to its original position, the tanker's rotation slowed down; however, it sailed rapidly toward FPSO Cyrus and moved along with it. It was a horrifying experience. Owing to the length of tandem which was 100m, the tanker bow couldn't proceed more than this length, so after passing this distance, it began to rotate. Tandem bumped to the portside Lifeboat of FPSO and damaged some part of it. Vessels were in the position of pushing the tanker and tried hard to prevent the tanker from more rotations. But it was not very successful. Therefore, at 2:15 the pilot ordered to stop loading and disconnect the export hose from the tanker. At about 2:25, the tanker Engine became operational and then pilot ensured that he could somehow control tanker movements and avoid possible collision and constant bumps into FPSO Cyrus.

However, he couldn't keep the tanker at a distance until the export hose was removed from tanker manifold. It was about 2:30 a.m. that the pilot sought emergency aid from all present vessels in the area. In the meanwhile, at state of emergency was announced in both tanker and FPSO Cyrus. Everybody gathered in command center of the tanker making the situation more difficult for the pilots. In FPSO Cyrus individuals were asked to collect in the Gathering place located on the starboard side of the vessel. As disconnecting the export hose and delivering it to a vessel would takes at least 45 minutes and one of the vessels would be involved with it, the pilot ordered to disconnect the hose from the tanker manifold, then urgently release it from the Crane hoke and let it go into the sea.

As long as the export hose was connected, it was impossible to retract the tanker since stretching the hose would damage tanker crane, export pipes and tandem rail

area in FPSO Cyrus. These incidents not only would increase the costs but they could be hazardous. The connection of tandem from the tanker bow to Cyrus stern limited the movement and maneuver of the tanker. The tanker bow had to approach FPSO Cyrus in order to unlock tandem chain as usual. After a long delay, at 2:45, the export hose was disconnected from the manifold, but it still hung on the crane hook. The pilot couldn't wait anymore, so based on his past experience, he decided to perform some maneuvers using the tanker engine and its steering wheel to prevent the tanker from rotating more and crashing into FPSO Cyrus and even SPOL production platform until the export hose is released into the sea.

As the range of tanker front/back motion was only 10-15m, it was a difficult and delicate thing for a 274-meter-long ship with 14 m draft and high inertia. In the second maneuver of the tanker, there was a slight bump between bulbous bow tanker and FPSO Cyrus. Thanks to the export hose which was between them, the collision was not serious. After this accident, the pilot with respect to the suggestion of FPSO maritime affairs authority, ordered to urgently release tandem from FPSO Cyrus. As it was too hazardous to release the stretched tandem, safety considerations should have been taken into account.

Unfortunately, the process of unlocking tandem from control room failed due to the lack of necessary training and practice, so they had to go to the AFT station panel to press emergency release push bottom or manual release by hydraulic oil pump. At 2:56 FPSO Cyrus crew gathered in Starboard Muster Station and were waiting for the command to leave the tanker. During the third maneuver, the Rope of Karen 6 was torn and it caused the tanker port Anchor touched the portside FPSO hull for the second time at 3:02, so it slightly damaged the FPSO Cyrus. During the last maneuver, the pilot directed the tanker to sail forward so that its Stern moves to the right. Suddenly tandem separated from FPSO Cyrus and tanker bow started to rotate rapidly sailing toward FPSO Cyrus. It was at 3:11 that the third collision occurred between the tanker port Anchor and FPSO Cyrus hull.

As a result, a hole of several meters in diameter occurred in the exterior wall of balancing water tank. The pilot gradually retracted the tanker and cleared off FPSO Cyrus, in the meanwhile, the cargo hose was still hung on tanker crane hook. The export hose broke on FPSO Cyrus side, fell into the water and sank. After a while, the tanker crew noticed that hose wasn't connected to Cyrus anymore and it was only connected to the tanker crane. Knowing this, the pilot moved the tanker away from Cyrus terminal. According to CCTV cameras, before the tandem fell, it had collided with the export hose resulting in end spool rupture of the export pipeline.

As a result, about 230 oil barrels leaked into the sea. Then, the contaminated area by the oil spill was cleaned up at 3:25 by applying OSE using ERA Indonesia vessel.

CAUSES OF THE INCIDENT

Fortunately, this accident had no human casualty but it caused property damage to two ships, especially FPSO Cyrus. Before referring to the cause of the accident, safety considerations regarding this vessel and some significant points concerning the 18th loading are mentioned:

- The platform and the vessel are located in a very special part of Persian Gulf. There are massive vortex currents in this area
- Based on the terminal design, the proper tug for this operation shall have a power of over 85 bollard pull. Replacing two tugs with approximate powers of 50 Bollard pull with a strong tug was not an efficient solution from what was the experience of primitive loadings. Unfortunately, in spite of official correspondence, it was impossible to buy or hire a tug whose power is over 85 Bollard pull for several reasons.
- After all official correspondence, special marine conditions and lack of proper tugs prompted the authority to consider tanker of AFRAMAX type appropriate for the first or second loading and tankers of Suez Max type only for first loading from FPSO. However, it was too difficult to find a proper tank in a short while, owing to the limited storage capacity of Cyrus. Therefore, in the 18th

loading, SUEZ MAX tanker was asked to receive 500000 barrels from Cyprus terminal, while it could have returned for the second loading

- Owing to the limitations stated before, loading was performed during new Moon when it was the peak of tides. Unluckily, the tides on that day were the highest of the year and it was a week before the full lunar eclipse. Due to the lack of measuring equipment and accessibility to the data regarding tide predictions, pilots were not fully prepared to confront the most severe water current of the Year. Unlike the initial presupposition, the peak tide time had been at 2:58.
- handover of this terminal to operate was done with many problems including lack of proper training and establishing telemetry system. Telemetry system is a control device monitoring the position of tanker which activates the interlock to turn off the export pump and emergency releases the tandem. However, there was no interlock for an emergency stop because of the old method of controlling pumps.
- In addition to all deficiencies and potential hazards, the presence of incompatible goals and activities had a profound effect. Preserving national interests, exporting more oil and foreign currency import are valuable national goals which are sometimes in contrast to safety requirements.
- Unfortunately, nothing was learnt from previous near misses in the terminal as most of other industrial accidents. The near misses were not sufficiently analyzed so no proper precaution or action was taken in order to avoid repeating such accidents.

This accident occurred in three steps which means it could have been prevented if defensive actions and control measures had been taken at the time.

- The first step was tanker deviation of 40 degrees which was directly caused by the following items stated briefly:
 1. **The absence of proper tugs with required power.** As the time passed and it was about peak tide time, the tanker started to rotate due to the absence of suitable tugs with high power.

2. **Lack of close monitoring of the tugs in their position.** Unfortunately, the second reason of tanker deviation was the leaving of the area by a tug probably because of engine overheating. As the pilot mentioned, it was without any notice.
3. **Improper arrangement of tugs.** As the tanker was deviated, tugs were asked to quickly restore the tanker to its original position; however, DELNIA 2 mistakenly started to pull it in a wrong position, in parallel with tanker. Considering the resultant force, it caused tanker to approach the terminal. In the first hours of the operation, this tanker's winch had broken and had been temporarily repaired by the Crew. Apparently, this problem caused the winch to become faulty again while retracting the tanker to its original position during which it had undergone a great deal of pressure. Then, it released the rope.
 - The second step was the continuation of the tanker's rotation for which defensive and control actions hadn't been correctly taken:
 1. **Emergency Release of export hose was not done.** As it was stated in the tanker captain's report, the tanker crew didn't put the quick-release Hook on towing rope connected to the crane hook, so it was impossible to release the hose into the sea urgently. Moreover, they imagined delivering the hose to a vessel was as usual. If tanker crew had been skillful and experienced enough, they could have released the hose into the sea even without quick-release hooks. The tanker captain, as the director of tanker safety and the whole loading process, and also the Copilot could have come to the deck to ensure the accuracy and progress of this operation and guided the crew as required. However, for some reasons it didn't happen.
 2. **Delay in tanker engine coming into service.** Unfortunately, the tanker engine wasn't operational until 2:25 which means more than 20 minutes. This prevented the pilot to use the tanker's own power for resisting tides and tanker rotation. According to the issued instructions and the pilot's emphasis,

the tanker engine should have been operational in 5-minutes. In other words, the pilots should have taken tanker engine power at 2:10 at most.

3. **Tandem emergency release.** The designer has designed tandem emergency release for such situations. According to the terminal Handbook, the tanker should disconnect from FPSO Cyrus at deviations over 40 degrees. It's better if disconnection operation happens as usual; however, if the deviation is increasing, tandem shall be urgently released and tanker cast off from FPSO by tugs or its engine power. There are several reasons why no one applied this layer of defense to prevent the tanker from deviating more. The possibility of restoring the tanker to its original position by the reversal of Tide currents, the danger of releasing stretched Tandem, the tearing the export hose, training issue and so on are some of these reasons.
- Now, the causes of the third accident, the collision of two vessels, are explained. During the first and second maneuver, the pilot managed to prevent it from rotating, but the third time, one of the tugs rope tore and led to the collision of the tankers with the vessel. In the fifth maneuver, when the tanker was sailing forward, marine operations team could urgently release the tandem. Owing to the second cause which was the release of the Tandem, its resistance of about 90 tones against the tanker bow movement disappeared, so the tanker hit the vessel stronger causing the 5-meter hole on its hull. In fact, the prediction of such situation was too difficult and crew members were only thinking over tandem release.

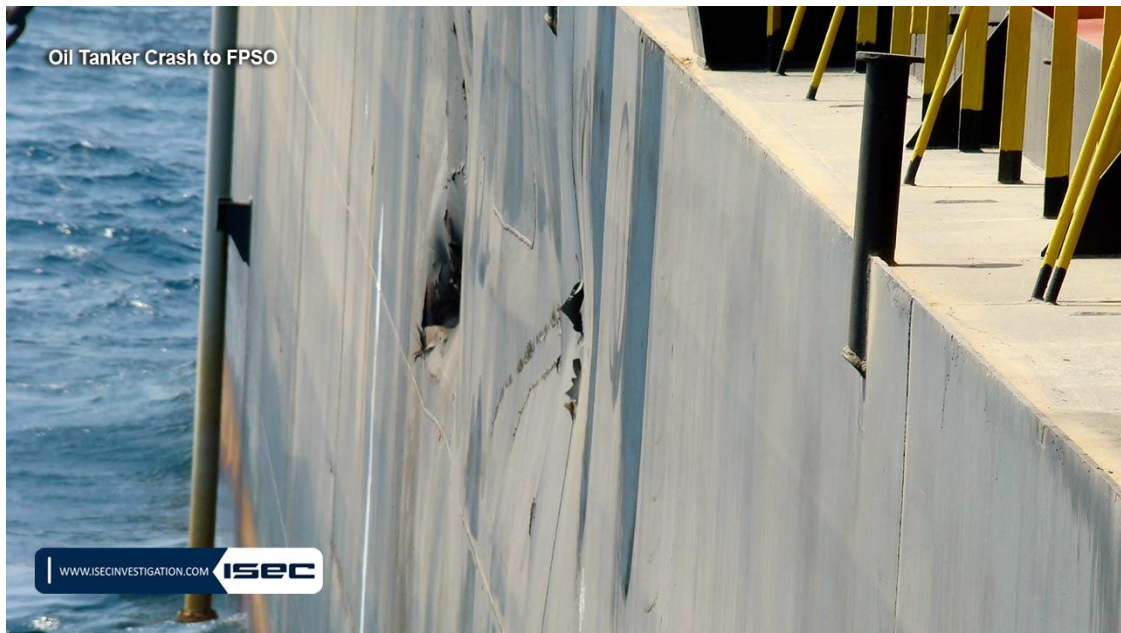


Figure 1. 5-meter hole on vessel hull

They had no clue of the fact that this release shall be performed as the tanker is sailing backwards. After disconnection, tandem collided with the export hose which resulted in a spool damage above the flange connect to the hose. Half of spool pipe was cut but it wasn't fully separated. As the tandem was released, the tanker could sail backwards. A few minutes later, the 300-meter-export hose, still connected to the tanker crane, was pulled and then with the connected flange was separated from the broken part of spool and dropped in the water and it was all before the operation of marine breakable coupling MBC. Unlike the initial presupposition, if tandem had urgently released in the first moments of 40 degrees deviation and they had not waited for the quick release of export hose, MBC would have had a stretch of 60 tons and operated as the tanker was sailing back. Therefore, no damage or loss would have occurred. The applied spool was 20 schedule thick; while according to the standards design, it should be 80. Fortunately, as tandem was released, a crew member of FPSO courageously pushed the total shutdown bottom so that the collision got under the control and a serious accident was prevented in

case hydrocarbon spills would occurred because of a major collision of tanker and Cyrus or tanker rotation and crashing into the platform.



Figure 2. spool pipe

After visits, interviews and analyzing reports, pictures and movies related to the accident, the committee on research and analysis of Iranian offshore oil company accidents, has prepared a detailed report on it and presented recommendations in the end to prevent such accident.