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DYNAMIC POSITIONING CONFERENCE

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Operations and Requirements

FPSO and Shuttle Tanker Positioning

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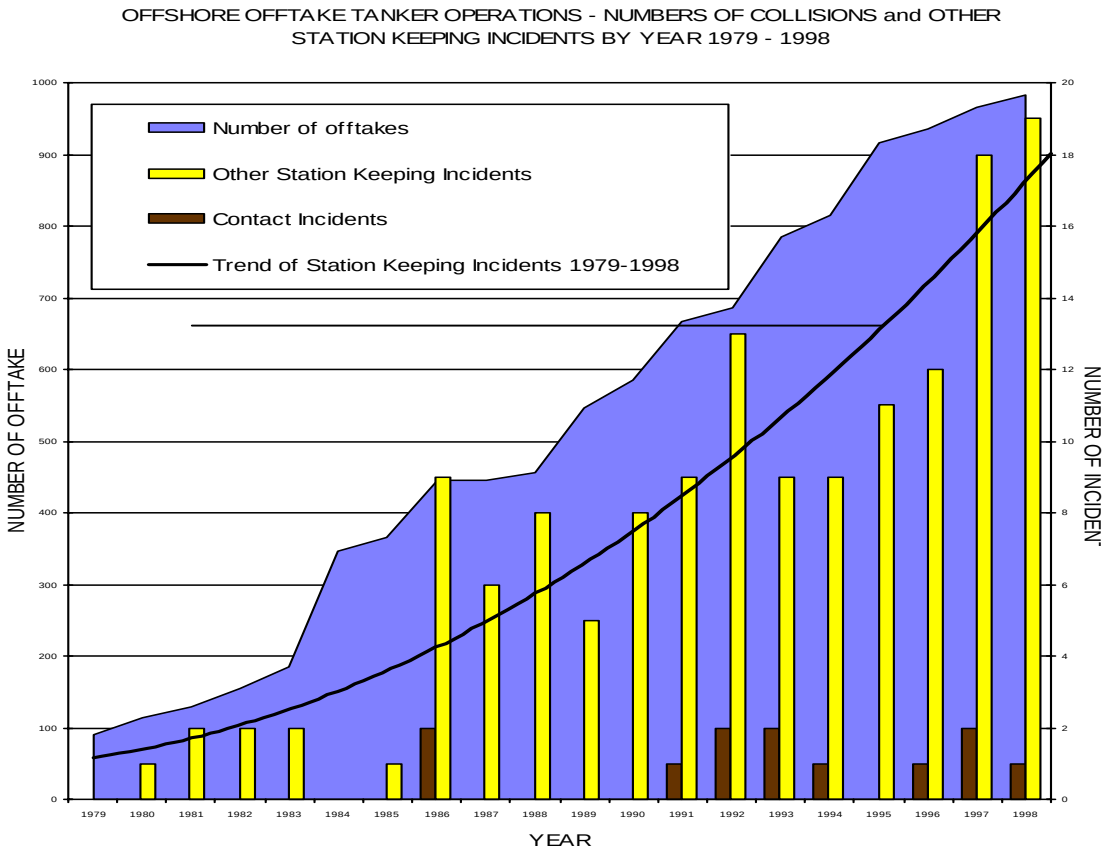
Introduction

Shuttle tankers loading offshore, as an alternative to a pipeline, have been in existence since the beginning of offshore production but the application of DP to the shuttle tanker and then to an FPSO (or FSU) are relatively recent. The trigger for DP was a fatal accident where a chief officer lost his life from the hose parting and a fire forward. The investigation and recommendations that followed brought about the Green line system for a sequenced emergency shutdown and disconnection and the introduction of DP. The Green line ESD system had a few teething problems has been a success. The advances in UHF communications making them reasonably secure and reliable can be thanked for this. For the DP side the experience was not so good. It solved some problems but created new ones.

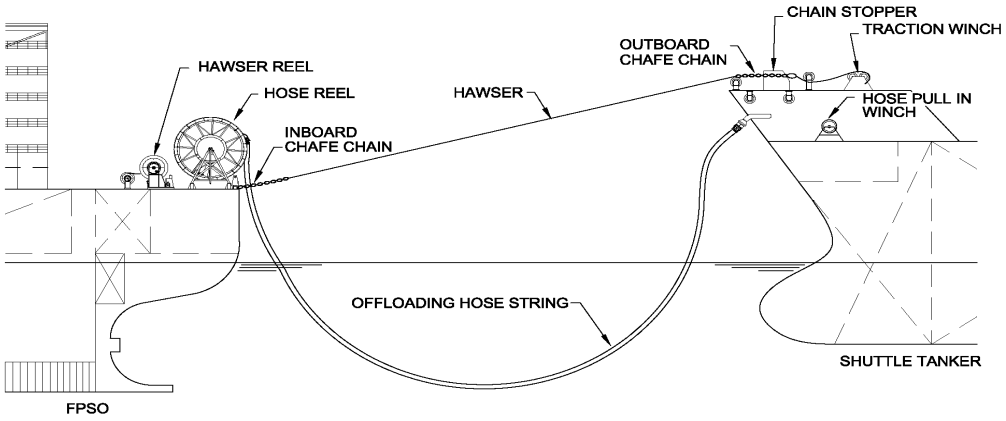
Quantified Risk Analysis

In 1998 a joint industry project was set up because collisions seemed to be increasing but this was difficult to quantify because there was also an increase in the exposure. The result of this study (Ref 1) which covered all areas of the world from which data could be obtained and DP as well as non DP tankers, showed that collision frequency was too high. It also showed (see figure below) that there had been a significant increase in tanker offtake operations between 1979 and 1998.



The other features of this graph that are interesting are that in 1984 and 1985 there were few incident reports. In 1986 there were two collisions and the reporting of lesser incidents increased significantly. Reporting then decreased until the next collision in late 1991 and the two collisions

in 1992. This feature; a sudden increase in near miss incidents is then repeated again in 1997. This is a caricature of human nature. A reduction in near miss reports can signify a real improvement or just be the lull before a storm. The collision frequency was 5.89 x 10^{-5} per DP hour. However this frequency was for all collisions and many were with the loading point; a buoy or tower structure. In these cases the clearance distance was less (about 40m) whereas the FPSO-shuttle tanker distance is about 70m.



The handling of the data was difficult because of the DP and non DP loading operations, but the results were as follows for the four incident categories.

L1 3.92 x 10^{-6}

Loss of Position and Loss of Life or Major Pollution

L2 5.89 x 10^{-5}

Loss of Position and Collision with Loading Point, ESD and Minor Pollution

L3 4.94 x 10^{-4}

Loss of Position causing ESD, near miss or high Hawser Tension

L4 3.06 x 10^{-3}

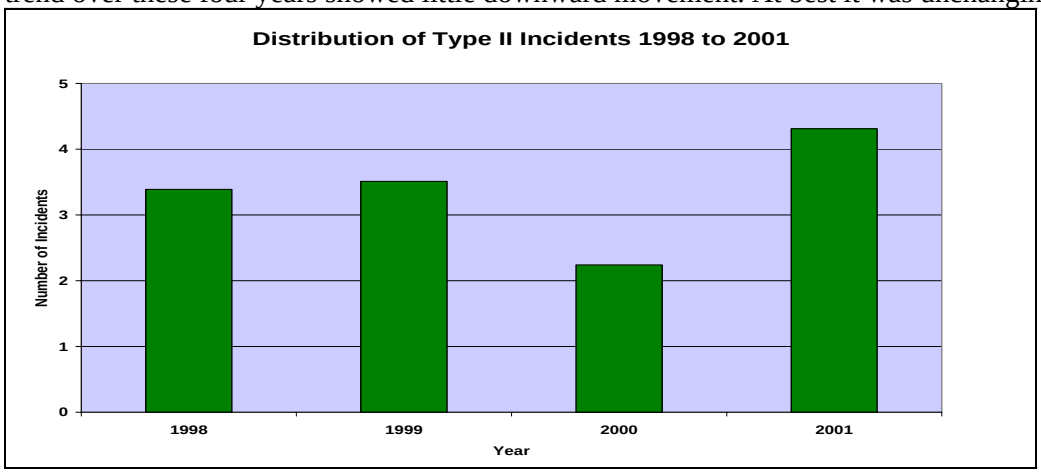
Station keeping problem causing concern to operator problems

The causes of the incidents from this study showed that the usual suspects can be blamed.

- people
- procedures
- position references
- propellers

Taking the vessels that had reported comprehensively the average number of incidents or events reported could be expected to be 7, based on 80 x 24 hour loadings per year. The UK HSE (one of the sponsors of the JIP) was determined to improve the situation and took note of the work being carried out in Norway and supported a UKOOA committee looking into this important type of offshore operation.

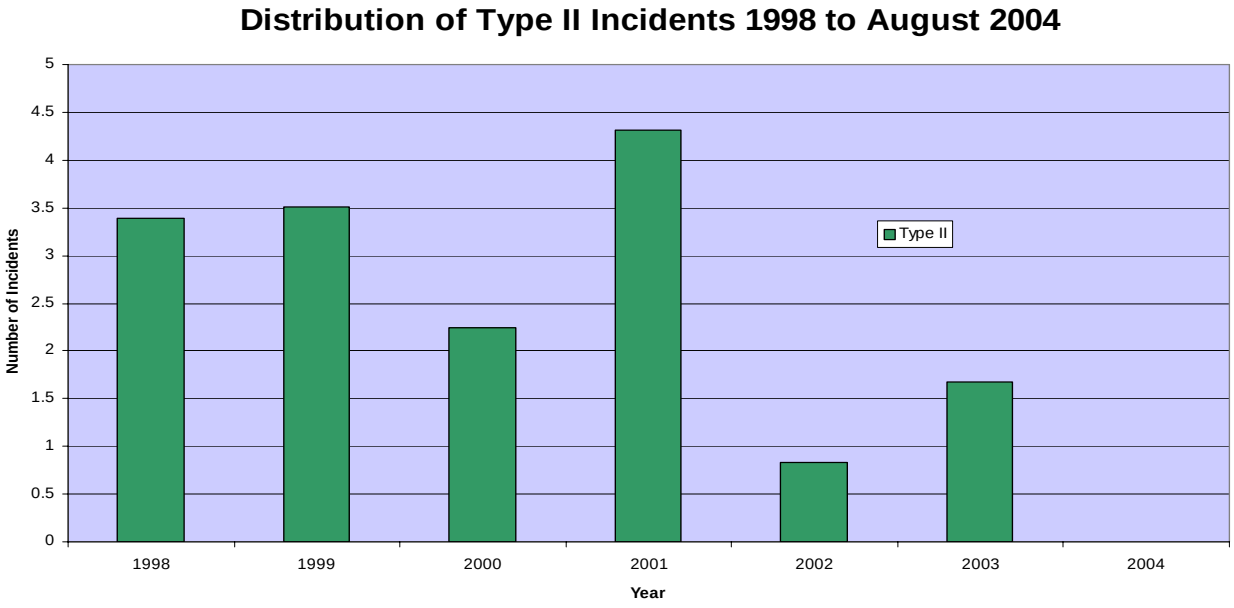
In 2001 they wanted to check if their target of 25% reduction in incidents had been achieved. (Ref 2) The results showed that there had been 16 level 2 incidents but that only 6 of these had been reported to the UK HSE. This was a disturbing fact. However out of these incidents there was only one collision with an FPSO and on this basis the improvement was 59% to 2.4 x 10^{-5}. The improvement target was not met if a collision with a loading buoy was also included. Also the trend over these four years showed little downward movement. At best it was unchanging.



So the pressure for improvement continued and the report was updated in 2004.

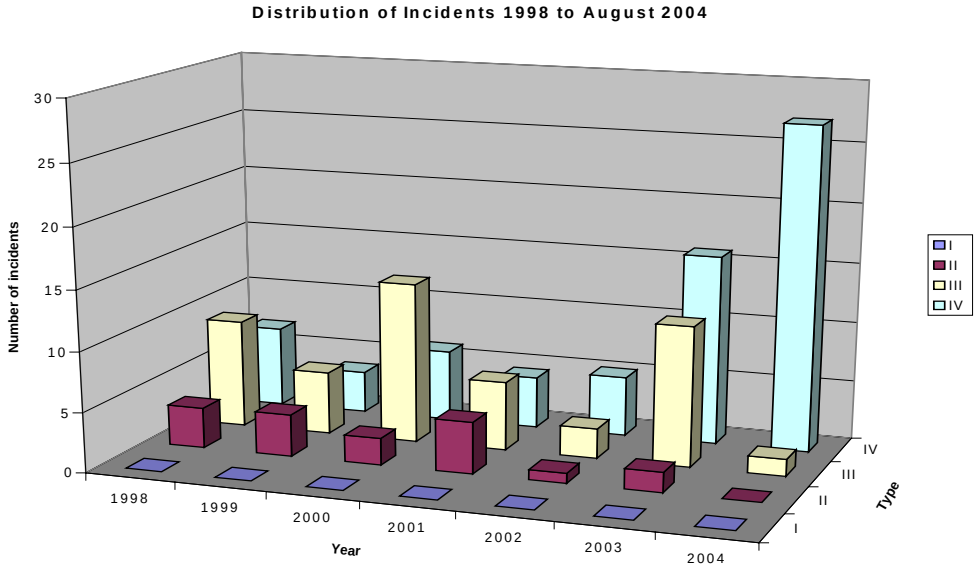
Improvement

The UK HSE agreed that rather than wanting a 25% improvement for all types of incident, they would consider their goal to be met if there was an improvement in the level 2 incidents because these were reportable under their RIDDER (Ref 3) system. An increase in the reporting of lesser incidents or events would not cause them concern but would be considered a good thing. The 2001 check of progress was also before the UKOOA FPSO Committee published their guidelines in 2001 (Ref 4). As can be seen from the figure below there was a significant reduction in level 2 incidents in 2002 – 2004 and there were no type 1 incidents.



So the collision frequency for the period 1998 – 2004 was reduced to 1.45 x 10^{-5} taking the UKCS alone. The more significant factor was the trend reduction in this level (level 2) of reported incidents. No data has been collected for the HSE since this time. However data has been supplied to IMCA by Teekay in Norway. Teekay is the only shuttle tanker operator providing data and from their data the number and the seriousness of incidents has reduced in 2004 and again in 2005. At the height of the concern it was agreed that not only would tanker operators supply data but also FPSO operators would contribute if this meant a duplication of data. This only took place a couple of times.

For the trend of all levels of incident (or event) reporting there have however been some encouraging signs. The figure below shows that there has been an increase in the level 4 over 2003 and 2004. This is considered a good thing.



It is difficult however to be sure that this shows better reporting from a technical and safety point of view because much of it is downtime related which is to do with contracts and money. Nevertheless the conclusion could only be that there has been a significant improvement. The causes of this improvement can be summarised as follows:

- Close attention by Oil Companies backed by good budgets and pushed by authorities.
- Training and Auditing by owners and Oil Companies.
- Better procedures and DP CAP
-

In the last year or so the attention being applied to this area of offshore has decreased, the auditing has also decreased in some areas and even the DP CAP initiative is lagging the initial plans. DP CAP is targeted at the training and experience of DP operators and making good use of stand by time offshore (Ref 5). The CAP stands for Competence Assurance Practice.

Operations

The hardware and software improvements have been significant but this also means that there are different DP control systems not just between Converteam (Alstom) and Kongsberg but also between different software releases from the same supplier. The other major change is the systems installed on the FPSOs. On the Terra Nova FPSO heading control is always used for offtake operations and the heading for the approach and offtake operations is decided between the FPSO and the shuttle tanker Master. On the Sea Rose FPSO installed in the same sea area and now served by the same shuttle tankers heading control is not used. When Masters, familiar with Terra Nova first came to White Rose Field the difference in approach and the sudden thruster activity during loading caused some concern. In some instances the misalignment becomes so great that the whole approach has to be aborted and restarted. The picture below shows such an approach. The misalignment became >60° at a late stage of the approach.

In addition the alarm limits on the shuttle tanker, which are seldom (if ever) activated when loading from a heading controlled FPSO, are much more frequent when the FPSO has no heading control. When the experience of the key DP personnel is only with the former, the latter is initially a matter of great concern so is the suggestion to use the taut hawser mode.

The decision on whether to use DP or taut hawser is often made difficult perhaps because of pre-conceived ideas, the promotion of DP by vendor and training establishments and the reliance on one main engine in many cases. During the years of the author's data collection and discussions with vessel operators, there have been quite some changes and instances where a change of Master has completely changed the offtake operation. Generally operators trained on DP and used to DP do not venture to use the taut hawser mode until forced to by circumstance. However once a Master is comfortable with the taut hawser mode he sees some advantages. The classic DP problems of people, procedure, position references and propellers are reduced to just one propeller.

Remaining Problems (FPSOs)

Heading Control

The care and attention given to shuttle tankers especially when they are first in service at a new field is often extensive. They are tested and have HAZIDS, FMEA reports and verification trials. The same is applied to the FPSO but the time for DP trials is never available. The intentions are usually good but in practice production usually wins. Heading control is relied on yet there is sometimes just one gyro compass for the heading control and the DARPS.

Marine Personnel

If heading control is required for the moorings as well as the offtake operations then there is a long term need for marine personnel which at first seems a good thing. However it is difficult to retain competent and well trained marine personnel if the job does not meet their career aspirations.

Weather

The weather limits are usually well defined but normally there is an element of judgement allowed between the OIM and the shuttle tanker Master. In some cases the OIM will have a marine adviser but in others there can be an imbalance of knowledge and judgement. Shuttle tanker Masters usually manage this situation well but it is a potential problem and source of uncertainty and for the limits to be exceeded. These limits are not just wind, waves and current there is also the question of visibility. Off Newfoundland the criteria tends to be if the stem of the FPSO is visible at 70m from the bow of the shuttle tanker, then connection will go ahead. This is a pragmatic approach because the fog can last for weeks. In the North Sea this criteria is quite different and is more often > 200m.

Position References

Frequently the position references used are dual DARPS and an Artemis. However there is a growing reliance on DARPS and less attention to the Artemis. The Artemis unit is usually difficult to access, spares or enough spares are not always carried and there is often nobody trained in the maintenance and repair of the unit. Even with personnel and parts the time needed to fix the Artemis is extensive; just the permit to work procedure which can take 2 – 3 hours. These factors and good experience with the DARPS can create a situation that can cause a loss of position and ESDII that may escalate into a collision and/or pollution. There should be three independent position references so that operations are rarely (if ever) continued with one position reference.

Consistent Standard

Most FPSO projects are quite separate developments and although much of the experience is transferred it is not uncommon for the offtake manuals, procedures and practices to be different; not at the high level but in the detail. This is not a problem if it is rational because of the different sea conditions vessel arrangements etc but it is a potential problem if there are differences that have no good technical or safety reasons. If a serious incident occurs on one FPSO it is inevitable that the others in that sea area are compared and others under the operation of the same oil company are compared to see if “best practice” was being used.

Thruster Reliability

If thrusters are required for heading control to reduce mooring line loads in storm conditions then the FPSO is likely to have an adequate number of thrusters. If however the thrusters are just used for offtake operations they might not be considered as critical. In fact they are not critical if there is good experience on the shuttle tankers with this situation. If there is not good experience then there has to be training and practice. If the thrusters are not considered as critical they may have no priority in situations where there is inadequate process power such that they can all be tripped from a partial blackout. This should not be a problem if the FPSO is close to her natural heading.

It will be a problem if this is not the situation and a rapid heading change takes place. It can be worse if this happens during a connection or disconnection because the ESDII facility may not be set up and available.

Remaining problems

Shuttle Tankers

Maintaining the Improvement

As with all areas of safety it is always difficult to maintain an improvement. It is even more difficult if there are personnel changes and an increasing number of vessels to man and operate. In many instances the vessels are also different in DP Class, DP Control System, and thrusters. Some are DP Class 2, other DP Class 1 and several are in the middle (referred to as enhanced DP1 or DP1.75). In these circumstances there have to be clear principles so that the approach is consistent in safety (risk and reliability) even though the equipment is quite different. A twin screw shuttle tanker is not the same as a single screw shuttle tanker and a single screw shuttle tanker with an azimuth thruster forward is somewhere in between these two.

DP Experience

It is difficult for DP operators on shuttle tankers to get their hours in for obtaining a DP certificate. Even if they manage the hours in practice it is usually only the Master that gets the really useful experience because he does the final approach and connection and the disconnection when there are moves to make and decisions to be made. The chief officer is likely to be forward for this interesting part of the DP operation until he is promoted to Master and then he has to learn quite fast. It is here where the full scale simulator training is most useful.

The other problem that the different DP shuttle tankers pose is that of full and limited certificates. The personnel on the “DP Class 1.75” tanker can only get a limited certificate whereas the operators on the DP Class 2 (which is not much different) can get a full certificate and use this to transfer to a DP DSV.

Position References

When loading it is quite common to find that the DPO has selected and active 2 DGPS, 2 DARPS and one Artemis and the vessel to be in FSU follow or align FSU mode (depending on the DP control system vendor). In this situation the position is controlled by the two DGPS within the box controlled by the three relative position references. The downside of this arrangement is that the best position reference for maintaining the separation distance, the Artemis, can be rejected by the two DARPS. In 2001 when this had become a common practice IMCA issued an information note M24/01 making this point and also reminding operators that 2 DARPS could not be considered as good as two independent position references. This means that loading should not continue on DGPS and DARPS alone.

Thruster Reliability

If there is to be a high energy impact between a shuttle tanker and the stem of an FPSO the cause has to be operator error and / or a failure of the fore and aft propulsion. From the data collected the frequency of main propeller(s), main engine(s), diesel generators and the thrusters are quite high.

Thruster (CPP) control	4.35×10^{-5}
ME / DG failures	4.35×10^{-5}
Thruster failures	1.45×10^{-5}
TOTAL	1.015×10^{-5} / DP hour

This situation is highlighted in the early work (Ref 1) and although failures have decreased, these problems are still present. In single screw vessels (and on some twin screw vessels as well) a back up control system or zero pitch system has been installed to give additional security for stopping ahead pitch and thrust. The problems with this system are:

- not completely independent
- has failure modes itself
- not always understood by the relevant key DP personnel
- not tested and maintained to be sure it will be effective when needed

In addition the cause of the unwanted thrust ahead could be an increase of engine rpm and not a pitch failure at all. So there is a case for continuous misalignment of heading between the FPSO and the shuttle tanker.

Conclusions

There is no doubt that there has been a significant improvement in DP shuttle tanker operations from the incident data provided over the last three or four years. The only slight doubt is that this sort of reduction has happened before and could have been described as a lull before the storm.

The biggest challenge is to maintain the improvement and the remaining problems make this task quite difficult.

From the data collected, the vessels audited and the manuals read it is clear that there are inconsistencies in thinking and hence the resulting procedures, such that in the event of a serious collision, with or without pollution, embarrassment is inevitable. The embarrassment might also be very costly.

References

1. IMCA M150 Quantified Frequency of Shuttle Tanker Collision During Offtake Operations
2. UK HSE Report on UKCS DP Shuttle Tanker Incidents published March 2005.
3. UK HSE RIDDOR Report of Injuries, Diseases and Dangerous Occurrences
4. UKOOA FPSO Committee Tandem Loading Guidelines 2001
5. IMCA Conference paper Singapore 2004 DP Shuttle Tankers by Kjell Helgoy