FPSOs Present and Future Workshop

Minutes

Session I
Oil Storage and Offloading
June 8, 2000

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Minutes of Session I: Oil Storage and Offloading

CAPTAIN SALOMONE: Ladies and gentlemen, good morning, and welcome to Section I. I hope that you will enjoy this one and a half hour with us. Be very kind because yesterday we had an example of lots going on, right, so please be kind with our panelists here that will do their very best out of their experience to fulfill your requests.

My name is Pino Salomone. I'm a captain. I work for Chevron. Right now I'm involved in offshore as manager of international (inaudible). We deal a lot with FPSO and FSO, mooring tandem and so on, and our panelists here have a lot to say about that.

And I right away pass the microphone to Ken here, who will introduce himself, and the same for the other two. So please go ahead and introduce yourself.

MR. MacKENZIE: Thank you. I'm Ken MacKenzie. I'm a naval architect. I've been in the marine offshore business all of my working life, 40 years.

CAPTAIN HOLMES: Good morning I'm John Holmes. I'm replacing David Wood who -- it has nothing to do with the fact (inaudible).

MR. LEEMEIJER: Good morning. My name is John Leemeijer, FPSO engineering manager for SBM, background in operations over the last 20-odd years.

CAPTAIN SALOMONE: What we are going to do right now is just to start giving an overview of the expertise of our panelists. Each one of them will present five minutes on their expertise and then something that they would like to tell you about FPSOs and we will go from there.

As you see from my agenda, there are examples of topics that can be related to storage and offloading, but I suggest a list then you can pick up whatever you like or anything else. Remember that the main topic today is Today and the Future, so what we can expect in the future on FPSOs, what's the new technology, anything new that can come out to help us on promoting FPSOs.

So here I start with Ken that will give the introduction.

MR. MacKENZIE: Thank you. I'd like to talk about offloading this morning. Since 1984 I've worked exclusively on FSO/FPSO projects on both new builds and conversions, on the design, construction and to a lesser extent the operations. I've spent time offshore witnessing various types of offloadings and I feel that there are three primary types of offloadings that have been and are being used to offload FSOs/FPSOs.

The first one is the alongside method, the second is the remote terminal method which we discussed yesterday, and the third is the tandem method. All three have been used throughout the world and in general have been successful and are still being used today.

Alongside offloading is somewhat similar to the lightering operation that is going on in the Gulf daily, except the FSO/FPSO is moored and doesn't move and the shuttle tanker comes alongside, separated by Yokohama type fenders.

The export terminal can be an SPM, it can be an STL, various options. For the alongside you hear Chicksan type loading arms are used or conventional loading hoses, midship manifolds. The loading terminal can use conventional trading tankers. It's a well-proven option. It's been used for years with conventional single-point moorings.

The FSO Cavenas, which was 400,000 dead weight, operated successfully in South America for about 15 years alongside offloading. The FSO Safer, which was installed in 1988, also used alongside offloading successfully. The new built (inaudible) offshore Malaysia installed in 1991, used it for many years. They recently changed over to tandem offloading.

Offloading to a remote terminal is also a well-proven option. The terminal may be a kilometer and a half or 2 kilometers away, can be installed in deep water, as I said, can be a (inaudible) buoy type, top moored. It can be an STL or another option.

The offloading terminal is often used with a spread mooring. As was mentioned yesterday the (inaudible) producer used tandem offloading initially but when the production rates increased they had to go to a remote terminal. Several large FPSOs that are going to be installed in West Africa are also going to use this system.

Tandem offloading can be from the bow or from the stern, a majority of them are from the stern, can utilize either a conventional trading tanker or a DP shuttle tanker. The ATB, articulated tuck barge, is a good possibility that will be used in the Gulf of Mexico with or without thruster assist or DP.

The majority of tandem systems, as I've said, are designed to offload from the stern. In the North Sea they are all DP shuttle tankers because of the environment. In many parts of the world where they have a benign environment, conventional trading tankers are used, usually with tug assist.

Which type of offloading system will be used in the Gulf of Mexico? I think that's still to be determined, but again all three systems have been used successfully throughout the world.

Thank you.

CAPTAIN HOLMES: Okay. What I'd like to talk about in turn, just give you a quick background, my background in the industry. I joined Shell 25 years ago. I got my master's license in '87 and worked as an OIM on the offshore storage units in West Africa.

Since then I've been working on the Anasyria (Phonetic) and other major Shell projects. I'm currently working on the Bonga project which is in West Africa, offshore West Africa. What I'd like to do today is give you a quick overview of the way we're going about selecting the offloading methodology for Bonga.

The Bonga is in about 1,000 meters of water. It's about 75 miles offshore, 36 subsea wells and approximately 40 risers coming into the vessel. Obviously with that number of risers, high pressure gas, the obvious choice was to spread moor.

Daily production is going to be 225,000 barrels a day, offloading roughly once every five days. That doesn't give us very much room for error with regard to the offloading system.

The FPSO itself has approximately 2 million barrel capacity. The length, typical (inaudible) 305 meters, about 58 meters wide, so it's going to be (inaudible).

One of the biggest problems is that we have noncolinear wind and waves. The majority of the current's from the north, the majority of the wind is from the west (inaudible) in the south, so we have a nice equal spread of all the available environments which does create a problem for us.

As the previous speaker indicated, there are three major methods of offloading. There is the tandem, the SPM and proprietary systems. I'll go through briefly these three systems and show you how we viewed them. Also with an SPM you've got to have various methods of getting the product to the SPM itself. This is one method of doing it, basically have the pipeline going down to the sea floor, along and back up again. The problem with that, obviously, is that you have a lot of pipe, big distance involved; moreover, the SPM is situated about 2 kilometers away from the FPSO for safety reasons. That issue also means you've got to have bigger lengths of pipeline with associated pressure and also big boosters on the FPSO to get the oil out the other side.

Another method of doing it is looking at catenary configurations. As a matter of fact, this is the final design of Bonga, the concept of a distributed buoyancy on steel pipe and having two pipes. The base station design is two 22-inch steel risers suspended in water, roughly about 300 meters and 600 meters of water, to get the flow through the actual pipe.

Basically where the FPSO is situated, it's a line roughly north-south and the calm buoy on the northeast position of that, about a nautical mile away. That really gives us enough maneuverability space to get into the area before we decide to berth the tankers. (Inaudible) is obviously with a pipeline of that size the normal SPM requires 8 meters across (inaudible) given the weight of the risers and everything else you have to support, then clearly you go to a bigger SPM, 20 meters across, (inaudible) so a much larger piece floating in the water.

You'll see different methods of loading. One of them is what they call deep water salvage. I think (inaudible) is going to be talking about that later in another session. This basically involves floating continuing risers, but here you've actually gone with a submerged buoy. The advantage of that is it decouples the motions of the SPM from the risers. If you can imagine a little SPM (inaudible) shaking these steel risers to bits, it also gives a fatigue issue.

We have a salt fatigue issue and, in fact, one of the guys here is involved in that. (Inaudible) is around today so if you need to talk about fatigue, he's the man to talk to. That's another option of looking at it as another way of seeing how these things work.

The (inaudible) especially with the existing North Sea concept, so it's modified from North Sea practices. It decouples the riser motions. There aren't any built yet (inaudible) rational thinking. It's not actually been put into operation yet. It's one we're evaluating at the moment.

So a quick summary of how we see the issues piling up for us -- essentially OPEX, operating expenditure, capital expenditure, downtime, risk, and uncertainty. You can see that probably is a summary of how we (inaudible). The tandem obviously has a high OPEX. You've got to have very large tugs to hold the tanker in position with a stern current, whereas the SPM has very little OPEX. You just need one support vessel (inaudible) for operations of the well are just run on one support vessel of a much smaller size.

CAPEX, obviously, high and low, so you (inaudible) what's going to be selected, so from that you basically work a total cost ratio, see what the outcome is.

Thank you very much.

I've been asked to put on this lovely picture which is, I'm pleased to say, a Shell tanker.

MR. LEEMEIJER: Good morning. My background basically, as I said earlier, is operations. I've been involved in FPSOs since '89, five or six years offshore and the rest onshore, in both operations management and the projects.

We've spoken quite a bit about the hardware this morning. I'd like to focus today not on the hardware, nor on the various permutations that we've seen this morning employed in offloading and storing, but on another very important factor in the operation, that's the crew, and obviously their competency to do the job.

Regardless of the proven reliability, integral safety or ingenious designs of the systems, without a truly competent crew the possibility of a failure is always present. A typical example would be collisions between the shuttle tanker and the FPSO or near misses, especially involving DP Shell tankers which we have seen in the North Sea. I would say in all of these cases where the operator has opted for a sophisticated, expensive system there has been a problem with intervention by the crew or insufficient training of the crew and this has caused the problem. It's not been the systems.

It would be fair to say that it doesn't matter how fancy you make the system, if you don't train the crew to the same level as the equipment, you are going to have problems. It's similar again with the storage of the crude on board, same as the offloads. Again, the FPSO relies on the competency of the crew to avoid overstressing the vessel, overfilling the tanks. These are all manual operations. It doesn't matter how many fancy fail-safes you put in place, they can always be overridden by the people on board. For every fail-safe system the designer designs, creates, the human factor will find a way to shortcut it, avoid paperwork and find an easy way to do it. That's a reality of life.

The only way you can avoid this is to make sure that the crew are aware of their actions, and that's only through training and experience. So if the crew is not sufficiently trained or competent to be aware of the results of their actions, inevitably there will be accidents.

To date there are no competency standards that truly reflect the unique requirements of FPSOs. We've adopted marine systems, we've adopted production criteria, but a true universal FPSO competency standard is yet to be developed, and I believe this is a very important step that we have to take.

That's not to say that efforts are not underway by individual companies to address the situation. Their results, unfortunately, are invariably in-house results and are not transferrable within companies, so we need to look at this major problem and we need to address it urgently.

CAPTAIN SALOMONE: Thank you, John. We have completed the presentations of our three panelists and now it's up to the audience to start asking questions and, again, related to storage and offloading, present and future. So who's going to be the first one to ask a question?

QUESTIONS & ANSWERS

MR. HARRISON: Can you hear me?

CAPTAIN SALOMONE: Yes.

MR. HARRISON: This is with regard to a comment made by Ken McKenzie. He made reference to a Malaysia FSO that changed from alongside loading to tandem offloading. Can you tell us why? And was the FSO spread moored?

MR. MacKENZIE: Yes, I can. That was the FSO (inaudible). I spent almost three years on the project design and construction in Japan. It was a new-built installed in 1991, had turret mooring (inaudible) not a spread mooring.

The reason that the alongside offloading was selected was an operator preference. The area is quite benign most of the time. The reason that they changed to tandem offloading, when we built the ship we did run a pipe aft. We partially outfitted it for tandem in case we needed it in the future, and they found that alongside offloading in certain conditions, especially in the monsoon season in the South China Sea, the time to moor can be considerable and with the tandem offloading they became more efficient and they now use tandem pretty well exclusively.

MR. HARRISON: Thank you. Can I ask another question now?

CAPTAIN SALOMONE: Yes. Can you introduce yourself so that everybody will know.

MR. HARRISON: Yes. My name is Garth Harrison. I'm from Texaco.

The second question is just a clarification, I guess, for John Holmes from Shell. What sort of off-take particle size are you planning on the (inaudible) on the Bonga project?

CAPTAIN HOLMES: Currently 1 million barrels is the standard off-take possible. We're looking also at half million top-ups from other (inaudible).

MR. HARRISON: I see. Will these be dedicated or --

CAPTAIN HOLMES: The tankers obviously (inaudible) West African market.

MR. HARRISON: Thank you.

CAPTAIN SALOMONE: Thank you, Garth.

Next?

MR. HOWARD: I'm Don Howard with MMS. On all three of the systems you talked about, is there any use of vapor recovery on your shuttle tankers?

MR. MacKENZIE: The answer is no. BP Amoco has an FPSO in the North Sea, the Sea Recovery. In general most of them do not.

CAPTAIN HOLMES: I agree with that as well (inaudible).

MR. HOWARD: I had heard some talk that there may be some North Sea vapor recovery requirements coming or that several companies were looking at mixing that back into their fuel stream.

CAPTAIN HOLMES: That's correct. In fact, some work has been done with Shell on the operating tankers in the North Sea. The issue here is obviously you've got dedicated tankers around all the time in the North Sea which are going backwards and forwards. With vessels of opportunity, not many will be fitted or required to be fitted with vapor recovery, so potentially you've got, say, 80 percent of the vessels coming into your tanker in West Africa not having vapor recovery. But certainly the North Sea is heavily into vapor recovery. From the economics and the environmental side it also makes sense.

CAPTAIN SALOMONE: Thank you. Any other questions?

MR. FRAZER: I'm Ross Frazer with British-Borneo USA. John Holmes with Shell, would you go into a little more detail on the risk table you set up that described the two offloading and mooring systems and how Shell ended up finally making a decision on that, whether that risk table was where you started, was it halfway along, or was it at the end of the piece.

CAPTAIN HOLMES: Sure. During the preliminary design studies we also looked at what we were going to do with regard to offloading. The main problem is (inaudible) risk. I'm sure you're aware that putting risk in financial terms (inaudible) is very difficult. We had various studies done by DMV, the (inaudible) which indicated that the tandem offloading is a factor of four times more risky than is the standard SPM. That doesn't mean that the risk isn't manageable, so you can put that in cost terms to mitigate that risk and to get it back down to what we call (inaudible).

So we really drew this up as more of an indication for ourselves of how we perceived the risk. Obviously risk can be managed and all these other issues can be managed. The CAPEX is fairly obvious. You can work out CAPEX and OPEX fairly easily from existing projects.

The downtime is another issue. At the moment we have stern current in Bonga so the downtime potentially is quite high with regard to the availability for berthing, and that obviously is mitigated when you've got SPMs, so in theory you have a higher downtime on tandem. You can relate downtime to production, just directly translate that, so that comes out as a cost item.

So really this is like a summary table of how we set about looking at the total cost of ownership, looking at it in financial terms, and trying to equate risk in finance terms as well. And certainly it's very difficult -- I mean, it's very generic to say low, medium or high, and some of it will change, obviously, as we get evaluations.

UNIDENTIFIED SPEAKER: Was this at the beginning of your evaluation or --

CAPTAIN HOLMES: Yes, it was. It was right at the very beginning. We sat down and worked (inaudible) idea of the whole operation, said "what do we see as the major risks?" "What are the ones we don't have to concentrate on?" and then set about mitigating those risks with regard to how we could control the situation.

MR. FOLKERS: Joe Folkers of Ameron International.

With a million-barrel offloading, could you comment on the rate at which the offloading occurs and if there's any advantage to one offloading method based on either the capacity or the rate that the offloading is attempted.

CAPTAIN HOLMES: Obviously that's another consideration in your availability figures. The offloading we want to achieve in 24 hours, which roughly gives you an offloading rate of about seven and a half thousand cubic feet. In order to achieve that for a long distance, you have to

have a very high pressure output from the FPSO if you're using an SPM. That's the reason why we went to the two 22-inch pipes.

Tandem is fairly straighforward. You can achieve seven and a half thousand through one 20-inch hose, two (inaudible), so that's fairly simple to do. The issue comes when we're dealing with long distances and high pressures.

MR. MacKENZIE: If I may just add, I've been working on Texaco's (inaudible) FPSO since October last year and it's quite similar to Shell Bonga, 2 million barrels. They have an offloading terminal. The floating rate is 45,000 barrels per hour and it will be tubed through two lines. We haven't firmed up the size yet but it's quite similar to what Shell is doing at Bonga.

MR. EGGERS: Good morning. I'm Dave Eggers from Mentor Subsea. This is a question for John Holmes of Shell. What do you believe Shell's philosophy will be for basically shuttling the oil in the Gulf of Mexico? Do you feel that you're going to be utilizing your oil shuttle tankers and, if so, can you explain what the CAPEX impact would be if it's a Jones Act tanker, shuttle, U.S. built, or would that tend you to go into maybe the tanker of opportunity because of that reason?

CAPTAIN HOLMES: That's quite an (inaudible) question. Can I sort of start by saying basically my expertise relies on Bonga at the moment from previous worldwide operations. I think that's one of the issues, obviously burning issues, of the Jones Act. I've been very little involved in the Gulf of Mexico so it wouldn't probably be appropriate for me to comment on what's going on, so, I'm sorry, but it's outside of my present scope.

MR. EGGERS: Could one of the other panelists maybe answer the question?

CAPTAIN SALOMONE: I don't think that the panelists here are ready to answer that question. Unfortunately, not all of us are involved in future FPSOs in the Gulf of Mexico right now, so that's going to be a very good one but definitely something we will think about. Thank you very much anyway for the question.

Next one?

MR. AMBROSE: Raymond Ambrose, American Eagle Tankers. This question is directed to any one member of the panel. In the offloadings in West Africa and you use vessels of opportunity, taking into consideration the local weather conditions, does the horsepower of the tanker of opportunity ever come into consideration? You've mentioned stern currents so that would mean (inaudible) it would require certain horsepower, so could any one of you address that question, please. And I pose this question because in the U.S. Gulf they've started using ATBs, so that would be a factor. Thank you.

MR. LEEMEIJER: Yes. Normally there is a stipulation (inaudible) for any vessels you use to hold the shuttle tanker on station, depending again on the size of the shuttle tanker. So that's incorporated in terminal regulations that are formulated for the field. This also comes into the -- it raises the point of using vessels of opportunity and that brings in the factor of the crew on board not being conversant with the terminal where they're arriving at. It does make for better competency to use dedicated vessels.

CAPTAIN HOLMES: We also looked at this issue and it's a burning issue (inaudible). One of the issues we had to look at was the -- not necessarily the power of the vessel, but also the strength of the towing apparatus on the vessel of opportunity. You can imagine you've got potentially vessels 20 years old coming into a West African port with unknown strength

(inaudible). If you start putting 120 tons on a set of mooring bits, you'd probably end up (inaudible). That's not an ideal situation.

We've actually done studies that ran simulation work to look at the mooring of the tanker using stern current and the current indication is that we will be probably limiting the berthing criteria so that we don't get the range of forces on the tanker, but also we'll probably be using vessels of 120 to 140 (inaudible), 80 or 90 tons.

CAPTAIN SALOMONE: Thank you, John. Another question.

MS. COGHLAN: Mr. Leemeijer, you were talking about how many collisions (inaudible) that were in the North Sea. Can you tell me how many, what kinds of damage resulted, if there were any regulations or preventative measures that resulted because of those?

MR. LEEMEIJER: I think John is digging out some figures on that issue here, but basically -- the damage was very minor, basically because of the designs of the vessels, ship-shaped vessels, and the areas that were in contact were not susceptible or would not cause major damage to the vessel or cause any loss of stability to the vessel.

There were no spills of oil involved in these collisions, so it was very minor damage in that respect. Of course, it was serious in what could have happened if things had got worse.

Each one of these incidents was investigated by the HEC and other authorities and there have been quite a few forums by the industry there to come up with regulations to try and overcome these problems, but this is still ongoing.

CAPTAIN HOLMES: There's a report out by IMCA, which is International Marine Contractors Association, which looked at collisions in the North Sea or FPSO incidents in the North Sea in the last five years. In the last year, to the best of my knowledge, there were three such incidents, mainly involved DP drive-ons. Again it comes back to the issue of the competency of the crew. There's a lot of work going on by the OCRNF at the moment. (Inaudible) but the IMCA has got all those figures.

MR. MacKENZIE: The history of spills from FSOs/FPSOs is quite low. It's under 10,000 barrels.

CAPTAIN SALOMONE: Under 10,000 barrels in how many years?

MR. MacKENZIE: Since they've been in operation.

CAPTAIN SALOMONE: Next question?

UNIDENTIFIED SPEAKER: My name is (inaudible). First a question. Do you find it kind of a trade-off between the policy of using available tankers to do the offloading compared to dedicated tankers, dedicated crews, compared to the discussion about highly trained people involved in these operations?

MR. LEEMEIJER: I think it's a case of what fits the circumstances and the location, to be realistic. In West Africa where you have larger hull tanks, usually in fairly benign waters, and a different scenario as far as your loading, it would be, I would say, acceptable there to use trade tankers. The situation and the conditions are much more favorable in that respect.

In the North Sea, where you've got far rougher conditions environmentally, there it's obvious the route has been taken to use dedicated vessels and DPs for that very purpose. I think the

Gulf of Mexico is another one that has to be looked at closely and then make a decision as to which is the most favorable route to take.

CAPTAIN HOLMES: Looking at the West African market, obviously you've got vessels of opportunity there so therefore it's cheaper to ship the oil, but again it comes down to the same risk. If you know what the risk is then you may find you can manage that risk.

UNIDENTIFIED SPEAKER: Just one comment about the (inaudible) and the experiences we have had with tandem offloading in the North Sea. Operational-wise, of course, education and experience of operators is one item and the (inaudible) doing these operations is also another thing. And there have been ongoing a lot of development in the last couple of years, so definitely some of the experiences we had in the early days of tandem offloading is related to the development of SPM offloading over to tandem offloading, and the last couple of years there's been a lot of development and investigations and effort made to improve this special offloading equation compared to SPM offloading operations.

CAPTAIN SALOMONE: Thank you. I think the tandem offloading is becoming more and more popular, but again it depends a lot on the environmental conditions and probably with the North Sea, the environment, the conditions there are very harsh, it's not the best the way to go, but again in West Africa it's becoming more and more popular.

Next question?

MR. HARRISON: I'm Garth Harrison, Texaco. Again in West African operations with tankers of opportunity, do you use berthing masters or mooring masters to moor or tandem moor or even buoy moor or do you use the master of the ship?

CAPTAIN HOLMES: We alway use the pilots. You'd never let a master of a vessel berth on a tandem, especially a tandem on the FPSO. You need local experience, you need a high degree of experience, and you'd never let a master of a ship do that.

MR. HARRISON: How do you recruit these mooring masters?

CAPTAIN HOLMES: Basically by ensuring training. A lot of simulation work goes into it and also it's a series of -- they will be basically ex-masters in the Shell system. You take ex-masters or chief officers who have mooring experience, train them up, send them to other postings to get experience and watch what the operation is and then going on from there. So it's an ongoing training period. My own period was about a year of training.

MR. HARRISON: So it is using Shell mariners to --

CAPTAIN HOLMES: Generally speaking, we would have Shell mariners.

MR. HARRISON: -- train as mooring masters for these locations?

CAPTAIN HOLMES: That's right.

CAPTAIN SALOMONE: If I may, I can answer also in this regard. Chevron is using their own mooring masters. We have highly trained professionals that are providing (inaudible) master service in West Africa, in Papua New Guinea, Australia, Thailand, and we think that it's very important for the success of the offloading operations to have highly skilled mooring masters.

They are not only doing the mooring operation but they are there also to make sure that the offloading is performed in a way that the vessel will be loaded in the fastest time possible in the

safest way possible, and normally we send two mooring masters on board in order to coordinate and to make sure that the operations will be completed safely. The mooring master becomes the loading master for the period (inaudible) becomes the mooring master in the interface between the offloading vessel and the terminal.

MR. HARRISON: And do you have a mooring team as such with people to go on and supervise the connection of the hose and the connection and disconnection of the mooring hawser and such?

MR. LEEMEIJER: Yes. (Inaudible) SBM has a similar policy. They have a mooring team that goes on board, supervises the (inaudible). They also audit the vessel to make sure that it complies with the terminal regulations before they start the offloading. And I'm sure that's the same for all the other operations here.

CAPTAIN SALOMONE: Yes, definitely. The buoy master is the one that's responsible for the hose connections and he organizes the vessel crew and gives instructions to the officer in charge.

Another question?

MR. KINT: I don't have a question, but I have some information which the audience may be interested in. My name is Thyl Kint. I'm with BHP Petroleum. Since 1987 we've operated six FPSOs in Australia in a climate very much like the Gulf of Mexico. We've had over 400 offloadings, 220 of them have been with the (inaudible) and over that period we have effectively two near misses and one minor spill.

One of the near misses was mentioned yesterday, really -- sorry, I need to say all these offloadings are all tandem. And one of the near misses was mentioned yesterday when we had a tsunami that came and sent our shuttle tankers surfing. Act of God, can't do anything about that. But all safety equipment effectively worked, was shut in, quick disconnect. The only near miss we had was in the early days when we did not use hold-back tugs. We once had a jackknife situation, which pretty much was lack of training.

And the only spill event which we had in over 400, and it consisted of probably less than 10 barrels that entered the sea, was when the butterfly valve on the tanker's side had an uncontrolled shutdown which overpressured the hose which then the quick disconnect coupling burst and we had some uncontrolled discharge, but again the shutdown was quickly -- and that's pretty much -- I think for 400 offloadings is pretty much significant experience. That's the experience we've had in an environment which is not unlike the one that exists here.

CAPTAIN SALOMONE: Thank you for sharing your experience.

CAPTAIN HOLMES: It's good to hear that experience. I don't think we should really get hung up on whether it's tandem or SPM offloading, but I think each individual field has to make its own decision based on the criteria, and certainly the (inaudible) conditions in one area can be totally different in another, hence the reason to go for either tandem or SPM. And if you witness some waves that are colinear and everything is pointing in the same direction, tandem is very effective. If it isn't, then obviously SPM is more effective.

CAPTAIN SALOMONE: Next?

UNIDENTIFIED SPEAKER: If the panel can't answer this question, perhaps someone from the audience could. My question is directed to the FPSO operations in the U.S. Gulf. You

mentioned mooring masters or pilots to supervise the maneuvers of either the dedicated shuttle tanker or vessel of opportunity. Yesterday we heard from the Coast Guard that U.S. citizens will have to be employed on the FPSOs. Will this also apply to the mooring masters and pilots?

Presently in the U.S. Gulf for standard lightering operations the mooring masters or pilots that are used are not necessarily U.S. citizens. They are persons from any country who are qualified as master mariners and good pilots with experience.

I'd appreciate it if someone could throw some light on this. Thank you.

CAPTAIN SALOMONE: Is there anyone in the audience that is able to answer this question?

(No response.)

CAPTAIN SALOMONE: Well, I think that if we follow the example of the lightering masters that are working right now in the Gulf of Mexico, most likely the buoy masters that will berth export tankers at an FPSO in the Gulf of Mexico can be of any nationality, as long as they will be highly qualified to do the job.

Next question?

MR. CRAGER: Bruce Crager with Oceaneering. A question for any of the panelists regarding design of quick disconnects and emergency disconnects, both for the hawser and the hose, and then what experience you've had where that's actually been put into effect in the field where you've had a quick disconnect.

CAPTAIN HOLMES: We've looked at quick disconnects with an SPM and tandem. Certainly we favor the use of marine breakaway couplings (inaudible), be they double closure systems or single closure systems. They've proved very effective in use through all our terminals, this is Shell terminals throughout the world, and certainly for a minimal cost you get maximum protection of the operating system.

We've also looked at the use of double (inaudible) hoses which we're very much in favor of as another production. It's almost like a belt and braces situation. We'd rather have two relatively cheap systems to protect against pollution.

Quick release on the hoses, again that's another issue. We've looked at those for tandem. For SPM it's not quite so clear because obviously you can withstand more forces on the SPM than you can on the tandem because of the weathervaning aspects, but, yes, I think they're both essential systems and certainly stuff that we've looked at.

MR. LEEMEIJER: I concur with that. The SPM uses dry brakes and quick connects on the hoses. We've had no problems with these units over the years. They've always operated successfully when tested on the quick connects. The dry brakes, when they have broken, have (inaudible) so they're two very useful units.

MR. MacKENZIE: I agree with the panel. The North Sea DP shuttle tankers have quick disconnectand they work very effectively.

CAPTAIN SALOMONE: Thank you.

Next question?

MR. WARD: Skip Ward with the OTRC. You heard yesterday we're doing this preferred risk analysis for FPSOs with other deep water systems and the transportation system is one of the major differences between FPSOs and the others. We're trying to use the available data from the Gulf of Mexico on lightering as much as possible to characterize the shuttle tankering from FPSOs. Could you all compare and contrast the similarities and differences between the lightering operations as they're going on in the Gulf now and with the FPSO shuttle, what offtake would be just in terms of operations and risks and similarities and differences? Thank you.

MR. MacKENZIE: I think it is a similar operation. As I said before, the difference is with the lightering operation both vessels are moving. With tandem or side-by-side, whenever offloading they're fixed, but it is a similar operation and the lightering operation has been very successful in the Gulf of Mexico for many years.

CAPTAIN SALOMONE: I will add just that you'll need to have dedicated expertise on both. That doesn't matter whether it's going to be lightering or tandem, you have to have the expertise for lightering and you have to have the expertise for tandem. They're similar, but they're different, and it's important that the people that are going to perform those operations have the necessary training, exposure, operating experience. So again, yes, there are similarities but still there are some important differences that should be highlighted when you talk about putting there the right experienced people for doing the job. Thank you.

Next?

MR. GRECCO: Mike Grecco with Unocal. One of the driving factors on the size of the FPSOs is the amount of storage required. I realize this is sensitive to the environment, (inaudible) shelf dangers, production rates, things of that nature. Have any of the panelists looked at the Gulf of Mexico environment and come up with, I guess, just kind of a ballpark days of storage that might be needed on an FPSO for the Gulf of Mexico?

MR. MacKENZIE: Mike, I've looked at (inaudible). There's several things to consider when you size an FPSO. One is the production rate, and probably any FPSO that would be installed in the Gulf of Mexico will have a high production rate. If it's 200,000, 250,000, whatever, barrels a day, you'd have to account for that. You also have to have -- if you're going to leave anything in the FPSO after you offload, you also have to have several days buffer storage because we do have a pretty benign environment. Assuming that all the crude is brought into the U.S. and not exported, you should be able to do it with two to three days buffer, assuming you've got at least two shuttle tankers.

The parcel size is quite small because I believe the maximum refineries can accept in the U.S. is 500,000 barrels. With this large production rate, that means you will have to do a lot of offloading, but I noticed the model the MMS had yesterday I believe was a million-barrel storage capacity. That may or may not be big enough.

CAPTAIN SALOMONE: Thank you, Ken.

Next one?

MR. LOCH: Ken Loch with Enron North America. I'll address my question to Ken. What effects do you think long-term shutdown due to loop current might have and how much detail would you go into in terms of potentially affecting storage requirements or looking at damage to wells due to long-term shutting?

MR. MacKENZIE: Before you go, I need you to repeat part of that question again. I think it was a several-parter.

MR. LOCH: The basic question is the greater potential impact of long-term loop current in an area on an FPSO than a pipe (inaudible) system and in terms of doing engineering, how far back, how much detail would you get into in considering -- you also have lost production, you've got a risk cost potential of even not being able to bring wells back onto full production after multiple long-term shutdowns. How much detail, how far back would you go in your assessment of that risk?

CAPTAIN HOLMES: I think you're right in pointing out that there is obviously a trade-off with the current situation, but again it all comes out in your total cost of ownership under those scenarios. You've really got to trade off whether you can afford to shut wells in. That comes back to the previous question also, the size of storage you're going to achieve and the amount of off-takes or the number of off-takes. There's obviously a trade-off between the side and the cost of construction of the FPSO (inaudible).

This really comes back to my previous comment. You need to look at the whole system in totality rather than just in isolation and go on previous experience. Each field might be totally different with regard to characteristics of oil, whether you can afford to shut in the wells. Some may have to.

Another thing to consider is the maintenance of the FPSO. If it's going to be on location for 20 years, then you're going to have to allow some sort of down time on that.

MR. LEEMEIJER: I think also these comments on up times achieved indicates that even with 99 percent up times that these factors are always carefully looked at. The offloadings themselves have not impacted our production when employing an FPSO. It's not a cause for concern in that respect.

MR. MacKENZIE: I think the key here is getting the size right in the first place. You have to design for the maximum expected production rate. You may only have that production rate for a few years but for those few years you have to have the size right, and I guess it can't be too big but it sure can be too small.

MR. WILSON: My name is Brett Wilson. I work for ExxonMobil Upstream Research Company and I run a high speed currents research project, and we would look at FPSOs as one of the better systems to put out in a high speed current area, mainly because you have a minimal cross-sectional area, and we don't anticipate any problems with being able to moor a vessel like that in a high speed current area, especially like the loop current where it's highly sheared. You know, if you're drilling and you have a loop current come by, that's another problem, but if you don't have a cylindrical riser running through the water that you haven't been able to design for (inaudible), we don't think that's a problem. We don't see why you'd shut down.

CAPTAIN SALOMONE: Thank you.

Next question?

MR. GRECCO: Mike Grecco from Unocal again. At the OTC this year a gentleman from Petrobras got up and described in one of their FPSOs the capability to take -- call it raw production, and put it in one of the tanks on the tanker if they had a system upset and then they could fix the upset and process that raw crude, so to speak, raw production, at a later time when the system came

up. Could the panelists comment on this? How common is this practice and is it something we can maybe look forward to using?

MR. LEEMEIJER: It's not common practice but, again, it depends entirely on the crude itself, whether it's possible, gas content, et cetera, but it is looked at where there is maybe some repairs required, and then you could possibly look at putting (inaudible) crude in the tanks. But, again, it's entirely up to the constituents of the crude itself whether you can actually achieve that or not.

CAPTAIN HOLMES: That's a good point as well. You're always going to get some situation where you may need to load crude in the tanks and certain ones we've designed have that facility. There's also the possibility of taking excessive water from the topsides to basically get you through a bad situation where you need to process the water. Again, tank protection, component protection, painting, is essential in that situation. The current systems which (inaudible) the slop tanks on standard tankers, in my opinion, are not sufficient to do the job. Slop tanks are made for trading tankers. They tend to be much smaller, defined by (inaudible) and they are not sufficient for FPSOs. We've tended to go with much larger slop tanks which can hold a greater percentage of water.

MR. MacKENZIE: There are FPSOs that have tanks designated off-spec crude. It's often more than off-spec crude, but it has been done and it's still being done.

CAPTAIN SALOMONE: Next question? It's 10:00 clock and we are supposed to have another half an hour but --

MR. LEE: I have a question. This is Craig Lee from ABS. Do you know how you operate -- I'm interested in knowing about the operation in environmental conditions. How do you operate when the typhoon coming and after you shut down what environmental condition (inaudible)? Do you have on-board system to carry you? What condition you shut down and stop the offloading and the loading?

The other question is because the FPSO is permanently onsite, in trying to avoid dry-docking so every five year you need inspection and during inspection onsite do you clean -- how do you clean the tanker in doing inspection, okay? Answer the question.

MR. LEEMEIJER: I'm quite sure we could fill up the next half hour. The first point on weather, we always closely track any named storms or any major storms in the area. There will be parameters in the regulations for the terminal, as we call it, the FPSO, disconnect parameters where production would stop, and then there would be a controlled disconnect, if it is a disconnectible unit, of course. That depends entirely on installations out there. But all these regulations, all these operational procedures, are very carefully laid down to guide the OIM or the vessel's master on when to stop production and when to prepare for abandonment of the well. So this is very carefully controlled.

Just skipping on and then I'll let the other guys talk about their experiences, I'll go on to inspections. Normally you would carry out your special surveys on a rolling scenario. So you would do your surveys continuously through the five-year period. You wouldn't wait until (inaudible) and bring the whole vessel out of operation. So one of the important factors with the design of the vessel is to make sure you have effective isolation between tanks, acceptable isolation to allow a tank washing and an entry for inspection of those vessels whilst maintaining production to the other tanks.

That is one of the highest criteria when doing the design of the -- not just the product lines but also the inert gas (inaudible) systems on the tanks themselves. This allows you to do your inspections on a rolling basis. It allows access to any tank at any time, and that's very important. That's one of the major factors that will keep an FPSO out there continuously, is the ability to inspect any tank at any time during the period without halting production.

CAPTAIN HOLMES: Yeah. Coming up to your environmental conditions, during the initial design of an FPSO you'll be looking at all the meteorological data you have. Certainly you'll be talking more information, if possible. First it would be designed to withstand a hundred-year storm, which is the standard criteria that's used for putting vessels on location. So you'd already have a good idea of what the maximum forces are you would need to (inaudible).

The second issue is obviously the stability of the vessel with regard to storms, and again that's part of the hull construction (inaudible) and damage stability like any normal trading tanker.

Coming on to the tank trading issue, I agree with the other panelists saying that essentially the difference between a trading tanker and an FPSO is that the trading tanker has the luxury of carrying water around the world and being empty, whereas the FPSO is live. That's the biggest danger. You have to ensure very accurate isolation between your live systems and your overall passive, dead systems, and that is (inaudible) and very hard to control. It's very important, obviously, to keep things like inert gas wells separated, taking sections of pipeline and (inaudible) them so you've got physical separation, and also removing sections of pipe and (inaudible) them off to make sure there's no potential hydrocarbons going into the tank.

You would do it on a regular basis and it's a rolling cycle of doing the inspections, so you don't need to have the vessel in dry-dock. In fact, the classification societies are happy with this scenario.

MR. MacKENZIE: Regarding shutdowns in typhoons, hurricanes, I've had personal experience. I spent three years working for Unocal on their FSO (inaudible) in the Gulf of Thailand. This was a reconversion. The FSO was installed originally, converted in 1981 and it was in service until we took it out to a shipyard in 1996 and did a reconversion, live extension, et cetera. It was an alongside offloading originally, by the way, and we converted to tandem at that time. But that FSO, I believe it's the world's oldest, was built originally in Germany in 1957 and we life-extended it for another 15 years, so it will be a record.

But UNOCAL's practice in the Gulf of Thailand is to de-man the platforms in a typhoon, shut down, in some cases shut in production, but not to de-man the FSO. They usually leave the OIM, the safety officer, several other people on board, and there have been some heavy typhoons in the Gulf of Thailand. Normally it's a very nice place, but the FSO has survived all of them and there are rare occasions where the OIM reported rolling up to 40 degrees. A lot of things got broken inside, but nothing major. As I said, it's still there, still in good shape.

On tank cleaning, if I may, just a couple of notes. On a new-built FSO/FPSO, tank flexibility is very important. You will have to enter the tanks at some time during the FSO/FPSO's lifetime for inspection, whatever, maybe repair, and the more tanks you have the better you are. The fewer tanks you have gives you less flexibility.

CAPTAIN SALOMONE: Great. Thanks a lot.

MR. WILSON: Brett Wilson from ExxonMobil again. I'm on the comparative risk assessment team as well. I have a question that's not really storage and offloading related but you

may have some information on it, and that's the number of incidents you've had with supply boat collisions, any fatalities, injuries, you know, collisions that would break through the structure of the hull, that kind of thing.

CAPTAIN HOLMES: Certainly the database is available. OCI managed to keep a database on collisions and certainly IMCA also did the same stuff, but there have been incidents. They tend to be very low collision impacts, mainly just working alongside. Developments such as the fantail laser have helped remove these incidents. They tend to be low energy impacts. The FPSO is designed to withstand the standard -- I think it's 12 (inaudible) of impact, and likewise the supply vessels will have sufficient (inaudible). So anything tends to be more of a gentle nudge rather than a major collision.

That aside, also you need to make sure that the major collision is also assessed and whether that's a likelihood, that's obviously going to be dependent on the location. If you're situated in the middle of a shipping lane, obviously you're going to have more risk than if you're in the middle of nowhere.

MR. LEEMEIJER: I agree with John. Of course, there's various types of use of supply vessels. North Sea is typically DP vessels standing some way off the FPSO due to the weather, and longer-reach cranes, et cetera, which reduces the risk of impact. When you tend to get into more benign waters, then you tend to use maybe not so sophisticated units, but then normally you'd (inaudible) by using Yokohama fins, et cetera, to reduce the chance of an impact against the hull. But, as John says, yes, you get some minor nudges, but as far as major damage, I've not seen anything in the last 10 or 12 years of that nature.

MR. MacKENZIE: The FSO (inaudible) in the 15-plus years it was out there never had a fatality, never had a major incident from a supply boat, but it really did tear up the paint on the side of the ship. That was really about the worst thing that happened to it.

MR. WHEELER: Todd Wheeler, BP Amoco Shipping. Two questions, one for the panel in general. Can you talk about the design parameters and the operational experience with submerged turret loading?

And one for Captain Holmes. I'm curious why you used a steel continuous riser as opposed to flexible hose from your FPSO to the buoy.

CAPTAIN HOLMES: Let's take the second part first. It's sort of a question of fatigue life and cost again. If you use flexible risers there's a cost associated with that. Steel material is cheaper. If you can crack fatigue issue then it's not an issue. Certainly we feel we've done enough work to get the fatigue correct. Flexible hose you've got to replace every seven years, eight years. Again there's an increased cost involved in that and there is virtually no difference in the safety factor.

We don't (inaudible) submerged turret loading. It's probably best -- I can see a gentleman sitting right in the back, Jens Kaalstad of APL, who is probably more able to answer on submerged turret loadings (inaudible).

Maybe I could get you to answer that question.

MR. KAALSTAD: I'm Jens Kaalstad with APL. We provide the (inaudible) or submerged loading. Although I will give a presentation during the (inaudible) turrets Section No. 3 and (inaudible) introduction to the FPSO disconnect (inaudible) will address the STL, but the

experience with is, I would say, exceptional. The Heidrun development is the phenomenon we're most proud of. We have two SDL systems in the Heidrun field producing 250,000 barrels of oil per day. Total tankers are dedicated as three shuttle tankers (inaudible). That means that every three to four days we need to have a new shuttle tanker connected to an STL buoy, and to date since 1995 we've had more than 430 loadings and it has been 100 percent availability at all times from that system.

We have been conducting up in 5.7 meter significant seas. We've been producing from the rate of 230,000 barrels directly from the SPL into the shuttle tanker. In 13 1/2 meter significant seas, the production has gone on as normal, so basically 100 percent availability. It's been in excess of most pipelines systems. I'm trying to say that the STL has been a remarkable loading system. Thank you.

MR. MacKENZIE: Todd, if I may just add to John's comment on steel catenary risers versus flexible pipe, I have Texaco's (inaudible) which is, as I said, similar to Bonga. To achieve the flow rates that we require, they don't use flexible pipe because they haven't made a lot of it large enough in diameter to achieve the (inaudible).

CAPTAIN SALOMONE: Next one?

MR. MACK: My name is Ron Mack from FMS SOFEC. In our discussion we're supposed to be talking about storage and offloading. I wonder whether maybe we should talk about the absence of storage and offloading. It seems to me that the major difference between FPSOs and TLPs and spars would be the ability to have storage and offloading on the vessel.

If we were to take storage and offloading off the vessel and use possibly just a converted single-hull tanker and use it only as a productions platform with export to the sea flooring into a pipeline, I guess I have two questions then. How would the operators in the room possibly view that as a development option? Does it appear to be attractive and competitive with TLPs and spars?

And then secondly, if we were to take storage and offloading off the vessel, how does the MMS and Coast Guard possibly view that and would there be any barriers to using this technology?

MR. LEEMEIJER: That's a (inaudible) that's been used in the North Sea on a couple of occasions where the FPSO has been tied to a pipeline for export. The advantage, of course, is if there's any problem with the pipeline then you can continue production into the storage vessels. If you do that, then the second half of your question is now void because you're still using the vessel for storage, so that, to me, would be the advantage of using the vessel, is that you've got options.

If you use it purely for the topsides, then I would not say that you gain any great advantage over other systems, but if you allow storage into those tanks, if there is a problem with your export system then, yes, it has great advantages.

CAPTAIN HOLMES: I certainly can support that as well, but the thought of putting any flow of oil into a single hull, I couldn't possibly support that.

MR. MacKENZIE: Yeah, I agree with the panelists. Whether it's double hull or double sided, no question, it should be one or the other.

CAPTAIN SALOMONE: Thank you. Do we have another one?

MR. WILSON: I hate to come up here again, but I think the answer to the first part of Ron's question is based on the fact that he's dealing with surface wellheads or subsea wellheads, if that's what's going to drive that decision, but if you're got a subsea wellhead development system you may find that an FPU, and that's basically an FPSO with no S is very -- you could find that it's very attractive.

Now the second part, how the Coast Guard and regulatory societies -- that was the second part of your question -- that's one that would be worthy of some answer if we can get one.

MR. HOWARD: Don Howard with MMS. We would treat it no differently than we would treat a TLP or a spar. I'm not sure on the Coast Guard's point of view.

MR. GUEGEL: Anthony Guegel with Offshore Data Services. Those are interesting questions and that kind of leads to what I was going to ask both the panel and the audience. What's the potential or likelihood of production spar platforms with storage capability, either in the Gulf of Mexico or anywhere else in the world, and what special considerations, if any, have to be given to offloading from such a platform?

CAPTAIN HOLMES: We show a couple of experiences with spar buoys, some of it's good and some of it's bad. We're currently looking at the (inaudible) in the Gulf as subsea as some storage and, again, we work very closely with the Coast Guard and the MMS to develop the criteria that needs to be built around that. Essentially I believe it's going to be double-sided and double bottom but the insides will be single, so essentially it's looking at a risk and seeing what the risk is. But I agree there needs to be some sort of common ground on this where we can eventually have sort of a fundamental approach which is pragmatic rather than just laying down blanket rules.

CAPTAIN SALOMONE: Any other questions?

Yes, there's another one here.

MR. KERSHAW: Clarence Kershaw, MMS. There was some talk yesterday about pressurization of the tanks on the FPSOs, during offloading they pull the vacuum on the tank. I assume that there are makeup valves on the tanks to keep the pressure on them. My question is, is offloading a manual operation or is it automated? Are there pressure controls on the tanks to automatically shut down the pumps while you're pumping? Are there liquid level controls in the tankers which will tie into the pumps?

MR. LEEMEIJER: I think there's so many FPSOs operating in the world and so many various systems that you could probably say yes to all of those and probably no to most of them as well.

Invariably, the normal scenario for venting and purging tanks is on a common rail system with an inert gas riser and purge riser with all tanks tied into that single system to allow equalization of the inert gas across all the tanks whilst discharging, and that is the normal practice.

There have been some problems with pressurization on tanks on FPSOs and these have not been due to (inaudible) and they have been due to operational problems, the crew, as I said earlier, bypassing laid-down procedures. The big lesson learned from that was to try and make the systems more fail-safe and I think you'll find the latest systems have overcome that problem of manual intervention causing problems.

Most off-takes are a mixture of automatic and manual. (Inaudible) tanks invariably is a manually-controlled operation, but you do have safeguards, pressurization of lines and

disconnection criteria that will automatically shut down the discharge. So there are safeguards but there is a lot of manual work involved in systems for discharge, yes.

CAPTAIN HOLMES: I would agree with that as well. There's no more incidents on FPSOs than there are on trading tankers. In fact, it's probably the other way around. There's pressurization of tanks on trading tankers probably more frequently than FPSOs.

The big issue with the FPSOs, you've potentially got mixes of hydrocarbon gas and fresh air and that's what you're trying to avoid. And in some cases you have three headers -- you have a clean header, a dirty header, clean IG, dirty IG, the dirty IG containing hydrocarbons, the clean IG not containing hydrocarbons.

Coming back to discharge, leaking in the receiving tanker, i.e., the off-take tanker, can normally only be done with dedicated shuttle tankers that have (inaudible) connections between the stern of the vessel and the bow of the off-take tanker, and that way you can have emergency stops. Another way of clearing it is to have remote control radios with a code and a shutdown signal which the loading master -- and again it comes back to the experience of the loading master -- on board, being able to shut down the pumps on the FPSO. And, again, that would be linked into a series of controlled shutdowns rather than just (inaudible).

Certainly as time goes on systems are getting more complex. Again it comes back to the experience and the operating qualifications of the people on board, but it's becoming more and more fail-safe.

MR. MacKENZIE: The system can be designed to be fail-safe. It's usually an operator problem. The majority of FPSOs use a tanker (inaudible) level-gauging system which includes high level alarms in the tanks, whereas you can't really overload and overpressurize them.

CAPTAIN SALOMONE: Next question? We have another ten minutes.

MR. KERSHAW: They mentioned a figure yesterday of 40,000 barrels per hour when they were offloading the FPSO. What method is used and what's the best method to use to measure the oil when you're transferring that large amount? Can you measure it through a meter accurately or is it better to use a tank gauge? What's the best method?

CAPTAIN HOLMES: Obviously the best method is to meter it, but a lot of states in the world will not accept metering (inaudible) of the oil, so consequently you'll have to go back to manual dipping of the tanks. But certainly metering is a common feature. Other tankers obviously you won't have the metering skids so you'll have to go back to dipping tanks and (inaudible) but modern tankers have the skids.

MR. LEEMEIJER: Yes, I agree with that. It's a bit of horses for courses. It depends on (inaudible) requirements for the crude itself, and again whether it's acceptable and where you're selling the crude, whether you're selling at the terminal or the FPSO or whether it's being sold to refineries, so all these factors have to be weighed up as to whether you install a metering skid, strap on metering which involves back pressure on the systems or whether you rely on tank gaging systems. So again it's purely horses for courses on this one.

MR. KINT: I'd like to add some comments on the metering. Thyl Kint with BHP. On our earlier FPSOs we invested heavily in very sophisticated metering systems to put on our FPSOs and we have pretty much totally abandoned that system because we always sell our crude when it

comes off the FPSOs and we have yet to find a buyer that believes any of the numbers we generate ourselves.

MR. KINT: So we now install cheap measuring systems just to have a rough record and then we have very well-honed practices of arguing with pieces of papers and dipping tanks and a good piece of bargaining and finally they go away, and generally that's how it's been. Maybe it will change sometime but we're not there yet.

CAPTAIN SALOMONE: The next one will be the last one because we could like to dedicate the last five minutes to (inaudible).

UNIDENTIFIED SPEAKER: Following up on that metering -- this is K Mart here, we have a sale on Aisle 3. No.

On the measurement of water, that would be a shake out and how accurate is that? Do you normally (inaudible) or is it proportional to the tank?

MR. LEEMEIJER: Again it depends on what system you're using for your measuring. If you have a metering system you would have a representative sampling system that would take samples throughout the off-take and then you would take your samples and then establish the water content from that. If you don't have a metering system, then you would go (inaudible) MMC tanks that would give you an interface on the amount of water in the tanks and establish it that way, checking at the end of the off-takes what was left in the tanks as far as water content, so it depends entirely on what system you're using.

CAPTAIN HOLMES: I agree also. (Inaudible) before you discharge anyway to get rid of the water and also when you're crude oil washing, you don't want to have wet crude when (inaudible) so again you de-bottom the tanks to reduce the chance of picking up water.

MR. MacKENZIE: Most FPSOs have export-quality tanks, at least they try to have them. Hopefully the water is -- sluice water is gone over the side and all you're exporting is crude. At least that's the plan.

CAPTAIN SALOMONE: Skip?

MR. WARD: I wanted to take just five minutes or so. John Leemeijer brought up the idea of need for training. A lot of the discussions yesterday and today as well have emphasized the importance of crew competency and I'd like to just try to capture some ideas from the audience here that we can include in the proceedings on the attributes of a universal training system.

MR. LEEMEIJER: Sure. Generally, as I said earlier, traditionally we've taken marine -- practice in marine standards for competency and then we've tried to mold them into production standards, and unfortunately production standards have not been as developed as the marine standards because of the shortness of time in comparison.

Several companies have attempted a competency assessment system. Certainly in the North Sea this is becoming a requirement for the oil companies, to demonstrate that you have the competency assessment system in place, and the regulatory authorities as well would like to see this operating.

The biggest hurdle is to make it an industry-wide and industry-acceptable level or standard, such that anybody transferring from one company to the other can have his competency accepted rather than starting from scratch with a new system. This has not evolved yet, I believe, unless

somebody knows something about it that I don't. If anybody's got any comments (inaudible). Like I said, it's a biggie and we certainly need to address it.

MR. CRAGER: John, what is the basis, STCW? Is that the lowest -- the only thing we've got right now?

MR. LEEMEIJER: STCW, yes, for the marine crews. Of course you have (inaudible), also standard certificates recognized in the trading nations for officers on board vessels. That's the basis of the marine crew. Production is more difficult and because of the shortness of time in development there is not a standard that can be assessed on the production side. That's the one that needs to be addressed urgently, especially if we're moving to the Gulf of Mexico and we're looking at using U.S. crews, then certainly we need to get these guys on board at a very early stage of the projects and bring them in and start training them on other installations around the world so that when we come to the Gulf of Mexico we have competent people that we can assess on an ongoing basis.

That's the other important point, is continuous assessment, which is happening now by various companies in the North Sea whereby when a person comes into the system you interview them, you analyze and you do a practical demonstration of their competency in the early stages. You identify the areas where they're weak and you then put them into a training program and bring them up. You then reassess them on an ongoing basis to make sure that they are still competent and that they are learning, and it's very time-consuming, very costly, but a very worthwhile exercise, and it gives you a lot of comfort to know that guys out there actually know what they're doing and they haven't just got a piece of paper that they've waved in front of somebody.

CAPTAIN HOLMES: Just to give you an idea of time scale, on Bonga, which is coming on-line in 2003, that's the latest press release, we are doing training matrixes already and we've already started training crews. It is a long process but it's something you need to get on board straight away, and I can't stress highly enough the importance of training.

CAPTAIN SALOMONE: I would like to add that on our (inaudible) the operators were on board since the very beginning of the projects. They went through all the project and when they started operating they were already exposed to the majority of the problems and the issues they would have to face during the operations. Even if they didn't have operational experience, they did have experience during the construction phase of the LPGF, so we gave very, very much importance to the training of our operators on board the facility.

MR. MILLS: Peter Mills of the UK Health & Safety Executive. If I could just remind the audience and the panel of something I brought up yesterday, the Code of the United Kingdom Operators Association. We're just about to kick off a joint industry project (inaudible) offshore petroleum training organization for marine competency and training, so there's one initiative that's about to take off that all the major UK oil companies (inaudible) are involved with, so I thought that was an important initiative to take.

MR. LEEMEIJER: That's quite right, Tommy. I'm not going to denigrate it, but one of the problems with the code is its exclusivity of who it asked to join, and some of the smaller operators, we are virtually on the fringe of it, and whilst we're invited to some of the meetings, we're not actually members of the (inaudible) so they hang down from high on some occasions.

MR. MILLS: I believe it's becoming more open. It does need to become a more democratic process.

MR. LEEMEIJER: You're right.

Just one final thing. When you're working in a (inaudible) area, West Africa, for instance, or Far East Asia, there is usually a requirement to use nationals on board the vessel. Quite often they don't have a training program of any shape or nature themselves and in most circumstances it's important to bring on -- you almost have a shadow crew arrangement where you have to train up the nationals in line with using possibly TCNs, country nationals, to train them.

Again, you have to recognize very early on the accomodation requirements alone on board to carry almost two crews for some period until you're confident that the nationals can take over the running of the FPSO, and this isn't (inaudible). Recently it's involved (inaudible) and we were training these guys for two years in Malaysia before we went offshore and then we were using Filipino operators and they're operating together now in that field. So it's a long, hard haul to get everything in place.

MR. MacKENZIE: In the early '90s I was involved with (inaudible) a new field which was offshore Sable Island off Nova Scotia, Canada. It included two platforms, an FPSO (inaudible), an SPM and a dedicated North Sea style shuttle tanker.

The Nova Scotia government dictated that the crew shall be Canadians and that was fine; however, there weren't any that had any training, so initially the crew, all the officers, the chief engineer, et cetera, were Norwegians. It was almost two years before they were all replaced with Canadians, so I just want to let you know it takes time. Even though these were very good mariners, they have no FPSO or shuttle tanker training and that takes time to learn.

CAPTAIN SALOMONE: I think that's pretty much all and we conclude the question and answer. Thank you very much for attending this session and hope to see you at the next one. Thank you very much.