FPSO - FEARFULLY POOR SAFETY OFFSHORE

Anders Björkman - Heiwa Co. - European Agency for Safety at Sea - Beausoleil, France
http://heiwaco.tripod.com , email: anders.bjorkman@wanadoo.fr

SUMMARY

Most FPUs - Floating Production Units - are FPSOs - Floating Production Storage & Offloading units but you could also say that there is Fearfully Poor Safety Offshore!

An FPSO receives live crude from the sea floor, kills it in a topside production installation that sends the dead crude to storage tanks in the hull of the FPSO - the bottom side. Later the crude is offloaded to shuttle tankers at regular intervals.

The paper concerns itself with the access to and maintenance of the bottom and side structure of an FPSO hull - the cargo tanks. The FPSO is designed to spend 15-20 years offshore. It is generally based on seagoing oil tanker structure rules disregarding obvious differences.

An oil tanker spends almost half its time empty of cargo and hydrocarbon in ballast and will regularly visit ports, shipyards and dry docks for repairs and maintenance. Oil storage tanks can be accessed and inspected when the ship is gas free and empty in a safe haven.

An FPSO is completely different. It is always loading and is never empty in a safe haven.

But the same Rules apply.

The writer has many years experience of inspection, maintenance and repairs of FPSOs offshore worldwide. The paper describes simple means to improve safety and actually save money on FPSOs by implementing common sense that often contradicts present SOLAS and Class rules.

1. INTRODUCTION

An FPSO is always loading cargo, even while offloading, and is never empty in ballast and will never visit a port or shipyard for repairs and maintenance during its design contract life.

An oil storage tank on a FPSO can only be accessed and inspected when the unit is loaded and being loaded and is not in a gas free condition offshore. **In order to be able to safely access a storage tank on an FPSO you need an extremely reliable tank purging, gas freeing and isolation system unlike anything described by the SOLAS or Class rules for sea going oil tankers.** Many different - mostly unsafe - systems are in use with two to four lines for inert gas and air supply, hydrocarbon gas, air and mixtures of gases venting and with double valves isolation. If blinds are fitted, they may be of the wrong type and located in the wrong position, etc.

The first part of the paper describes an ultimate safe tank purging, gas freeing and isolation system recently developed by a major participant in the industry. You only need two lines and single valve isolation backed up by blinds in the right positions to handle all functions safely.

FPSOs are subject to Under Water In Lieu of Dry-docking, UWILD, surveys. The requirement is copied from the SOLAS/Class oil tanker rules. An oil tanker can be surveyed by an UWILD in port after 30 months in order to dry-dock at 60 months intervals, which is in order.

Without any serious thinking numerous UWILDs are applied to FPSOs for 20 years service offshore. The second part of the paper describes the futility of UWILDs of FPSOs offshore and proposes a better, safer and more economical system.

2. ACCESS TO CARGO TANKS ON FPSOs

In order to access a cargo tank on an FPSO it needs to be cleaned, purged and gas freed.

2.1 CARGO TANK CLEANING ON FPSOs

MARPOL provides some oil tanker minimum rules and requirements for tank cleaning using crude oil washing for FPSOs, while discharging in port, but they are generally used to prevent sludge and scale build up in the tanks and do not ensure sufficient cleanliness for access on an FPSO. Oil tankers normally water wash cargo tanks during ballast voyages. However, these are the only rules applied to FPSOs re tank cleaning. FPSOs evidently crude oil and water wash tanks while loading tanks and producing oil offshore.

The result is often that tanks are not clean or safe enough for access, reliable inspection, survey, scale/sludge removal and maintenance of, e.g. valves and other fittings.

The MARPOL rules mandate that you shall be able to check the cleaning while washing by, e.g. dipping via deck plugs, but this is not possible on an FPSO as you may release hydrocarbon gas that stops topside production. Mandatory dip plugs are thus not used on FPSOs.

The result of tank cleaning on an FPSO can only be checked afterwards when the tank is gas free! If the result is insufficient, you have to re-inert the tank and start washing again.

FPSOs may have difficulty to get rid of scale and sludge in the cargo tanks at off loadings. The result is a continuous build up of scale in the tanks that may obstruct stripping and making cleaning and gas freeing difficult.

With experience and well documented cleaning procedures such mishaps may be avoided.

2.2 ACCESSING CLEAN CARGO TANKS

This paper is however about accessing the clean tanks in order to make a reliable survey and inspection and to allow maintenance. The problem is simply that existing SOLAS rules are not clear enough to describe a simple, effective and reliable IG system to ensure, finally safe access into the tanks.

The SOLAS IG system may protect the tanks against fire, but if the deck pipe system is dangerous when you try to gas free the tank, then something is wrong.

There are many instances that leaking valves in approved IG systems prevent proper purging, may cause flammable gas leaks when gas freeing and do not ensure safety against gas leaks when inside the tank. The result is that unit staff spades all lines under a Permit to Work system just in order to get into the tank.

My conclusion is that the situation is unsatisfactory but that there is a simple solution. Develop an industry standard for FPSO inert gas systems to fulfil basic standard functions apart from fire protection!

We start with a short repetition how the tanks are protected by its IG system in the first place.

3. THE IG SYSTEM

The basic principle of the inert gas system is to provide a non-flammable atmosphere within the cargo tanks, without contaminating the cargo. Inert gas must always be available in sufficient volume and pressure to suit all cargo operating conditions.

The system has three basic groups of equipment:

(1) **A processing plant** to produce, clean and cool the combustion or flue gases into suitable inert gas, and deliver it under a minimum pressure, by means of dedicated fans, for use in the cargo tanks. The requirements of the processing plant including its instrumentation, referred to as the IG plant, is in general exactly the same as for conventional oil tankers and per the SOLAS rules.

(2) Two non-return devices; **a water-filled deck seal and a SDNR valve in one line**. The water filled deck seal acts as the main separation between the IG plant in a safe zone and the deck pipe system in the hazardous zone. The deck seal is a particular non-return system, in addition to the mechanical non-return valve fitted, that prevents the back flow of hydrocarbon gas from the cargo tanks to the combustion chamber or engine room, thus avoiding a potentially hazardous condition in the safe zone. The requirements of the deck seal are in general exactly the same as for conventional oil tankers and per the SOLAS/FSS rules.

Only one line - for IG or air - should be allowed between the IG plant and the deck pipe distribution system. Systems with double deck seals in parallel lines should be avoided on FPSOs. And evidently any system without deck seals, e.g with separate line to provide air for gas freeing should not be allowed at all as hydrocarbon gas can leak back into the safe area.

(3) **A deck pipe distribution** system to provide direct the flow of inert gas into the appropriate cargo tanks at the required time (see figure 1). This distribution system is also used for venting the tanks via main vent risers and many other functions unique to FPSOs. The mandatory requirements of the deck pipe distribution system including its instrumentation and sample points are generally based on SOLAS oil tanker rules but must be adapted with great care to FPSOs.

3.1 DEFINITIONS

FPSOs are manned by many persons with top side process background and not of a marine background, who are not familiar with the terms used in the marine field. Some are thus repeated here:

Venting means emission and/or release of inert gas mixed with flammable vapours from the cargo tanks via a vent outlet in a specified location

Purging means replacing flammable vapours in a cargo tank by clean inert gas to obtain a non-flammable tank atmosphere.

Gas freeing means replacing the non-flammable atmosphere in a cargo tank by fresh air

Inerting means filling a gas free tank with inert gas

Topping up means adding inert gas to a tank to maintain minimum tank gas pressure

IG	inert gas
HC	hydrocarbon gas
TTBE	tank to be entered

3.2 DECK PIPE DISTRIBUTION SYSTEM – GENERAL - THE IDEAL SYSTEM

The objective should be to have minimum number of lines, valves and blinds requiring minimum operations to fulfil all functions in sections 4.2 - 4.9 below.

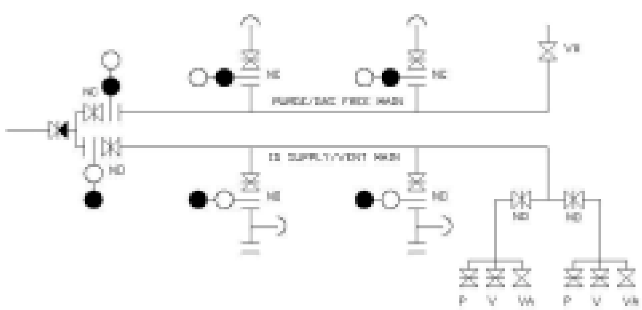

Figure 1 – FPSO basic layout IG deck pipe distribution system

The inert gas is distributed to the cargo tanks by two main deck lines or headers with branch pipes to each tank. See schematic figure 1 above. Oil tankers have only one line. Each header includes a spectacle blind and a main isolating valve fitted after the common non-return valve downstream of the deck seal. Each cargo tank branch pipe includes only one isolating valve and a spectacle blind.

The valves should be easy to maintain butterfly or flap valves adapted for low pressure service (<1 bar).

The spectacle blinds should be of the 3/4 bolts type that can be operated open/close/open in less than one minute and fitted adjacent/be interlocked to the valve, so that the blind can only be closed, when the valve is closed.

The blinds shall be located on the "hydrocarbon gas free side" of the valve in order to be swung without hydrocarbon leakage.

This means that all blinds connected to the IG supply and HV vent main are located on the cargo tank or deck seal sides and all blinds connected to the Purge/Gas free main is located adjacent to the header.

The blinds on the IG Supply/HC vent main are normally locked open (NO) and the blinds on the Purge/Gas free main are normally locked closed (NC). An interlock system ensures that the two branch valves/blinds serving the same cargo tank cannot be closed simultaneously. **This is to prevent accidental total isolation of the tank to ensure that over or under pressure damaging the tank cannot take place.**

One main - the **IG supply/HC vent main** - is generally used only for

(a) IG supply when offloading and

(b) venting HC when loading and purging.

The IG Supply/HC vent main branch line connections to the tank shall be located opposite to the Purge/Gas free branch line connection to the tank.

The other main - the **Purge/Gas free main** - is generally only used for

(c) IG supply when purging and

(d) fresh air supply when gas freeing and

(e) IG supply when re-inerting a tank

The Purge/Gas free main branch line connections to the tank must be located to ensure a free flow to the bottom of the tank and opposite to the IG Supply/HC vent man branch line connection ensure effective purging and gas freeing by dilution.

The **Purge/Gas free** main shall also be used for IG supply and tank venting, when the IG supply and HC vent main is out of service for maintenance.

HC shall not be permitted into the Purge/Gas free main under any circumstances except in the redundancy case 4.8 below. If you find HC in the Purge/Gas free main, you know that something is wrong!

The deck mains also provide other functions:

1. P/V protection of the tanks

2. permitting ullage gas transfer when transferring cargo between tanks by gravity

3. providing inert gas to void spaces and ballast tanks in the cargo tank area using portable hoses.

The total system shall allow a defined time for personnel entry to a tank for maintenance between offloads. The time should include all preparation such as cleaning, purging, gas freeing and re-inerting. It is recommended that the time to purge any tank is to be verified by a dilution study.

Pressure-vacuum breakers are fitted on each main line to prevent over-under pressure in the cargo tanks. They consist of one liquid P-V breaker or equivalent and two mechanical vacuum valves per main line.

The deck piping system shall be so designed as to prevent the accumulation of cargo in the pipelines under all conditions. Particular attention is to be given to the effect of large trim and list when a branch line inlet may be located below the highest point of the tank.

Arrangements shall be provided to enable the Purge/Gas free main to be connected to an external supply of inert gas.

Pressure gauges *inside* the cargo tanks are considered part of the deck pipe distribution system.

Instrumentation and sample points shall be provided as follows:

1. One pressure indicator/transmitter between deck seal and main isolating valves,

2. Two pressure transmitters in each main header after the main isolating valve, one of which is also a local indicator, also providing various low/high pressure alarms in the CCR. One pressure gauge is located at each riser. All pressure gauges are to be combined with a sample point for 0_2 and HC sampling.

3. One pressure transmitter inside each cargo tank providing various low/high pressure alarms in the CCR.

One or two **main vent stack/riser** is fitted to the IG Supply/HC vent main. *These vent stack are located so that venting and purging is possible at any side port or starboard of the unit, while loading, purging, gas freeing, accessing and re-inerting a tank.*

The vent stack is fitted with a purge valve (P) and two high velocity vent valves. One high velocity vent valve (V) is remote controlled from the CCR. The other high velocity vent valve (VA) is automatic.

The vent stack should be fitted with a manually activated nitrogen snuffing system to be used in case of ignition of the gases venting from any of the pressure release or purge valves.

An **auxiliary vent stack** is also arranged on the Purge/Gas free main with only one high velocity vent valve (VA), only to be used when the main stack is isolated for maintenance. A snuffing system is fitted also on this stack.

3.3 SOLAS AND IMO REQUIREMENTS

It must be remembered that the SOLAS rules are based on trading oil tanker practice, i.e. loading and discharging take place in port and the cargo is rarely handled during the voyage. Purging, gas freeing and re-inerting of cargo tanks on oil tankers then generally take place with the tanker in ballast, i.e. with no cargo aboard.

FPSO cargo operations are completely different - the unit is continuously loading with intermittent partial offloads at sea and transfer of cargo between tanks may take place.

Purging, gas freeing and re-inerting of an empty cargo tank take place while loading other tanks and with cargo aboard

The IG plant and cargo tank pipe vent system design shall comply with the basic rules in SOLAS Chapter II-2: Regulation 5.5.1.1 and Chapter 15 of the FSS Code (Resolution MSC.98(73)). The rules are scattered around in various sections and publications as described below.

Functional requirements in addition to SOLAS/FSS rules must therefore be applied with this difference in mind.

The IG plant *fire safety* requirements are listed in Chapter 15 the IMO Code for Fire Safety Systems (the FSS Code).

The cargo tank *vent pipe system requirements* are listed in SOLAS Chapter II-2: Regulation 4.5.3 (*Cargo tank venting*), Regulation 4.5.5.3 (*General requirements*), Regulation 4.5.6 (*Inerting, purging and gas-freeing*), Regulation 4.5.7 (*Gas measurement*), Regulation 11.6

(*Protection of cargo tank structure against pressure or vacuum in tankers*) and Regulation 16 (*Operations*).

Reg. 11.6.4 specifies that the pressure relief capacity to be at least 1.25 times the maximum loading rate without exceeding the cargo tank maximum design pressure.

Reg. 11.6.3.4.2 specifies that the vacuum relief capacity for each tank shall be sufficient to handle the cargo pump capacity, in case the inert gas blowers fail and at the same time prevent a vacuum exceeding 700 mm WG in each tank.

SOLAS and IMO / MSC / Circ. 677, cf. IMO Gas Rules 3.9.11 specify a maximum allowable gas velocity in the inert gas- und venting piping not to exceed 40 m/s.

IMO / MSC / Circ. 677.2.5.1 for determining the size of devices to avoid inadmissible pressure or vacuum in cargo tanks during offloading or discharging, calculations of pressure losses should be carried out.

Further requirements are listed in Chapter 15 of the FSS Code.

FSS Chapter 15 2.3.2.4 rules that means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations when the cargo tanks are isolated from the inert gas mains. The industry informal standard is that cargo tanks cannot be isolated from the inert gas vent main at all unless the tank is gas free and then vents to open air.

FSS Chapter 15 has no requirements for overpressure and vacuum of the main headers themselves. Industry standard is to fit a P/V breaker or equivalent and vacuum breakers on the main headers to fulfil the SOLAS II-2, reg 11.6.4 pressure relief capacity and the reg. 11.6.3.4.2 vacuum relief capacity.

There are no SOLAS requirements about gas leak detection, cargo transfer, etc. as these problems are not relevant on oil tankers.

There are no SOLAS requirements that the system shall actually be able to carry out all the functions 4.2-4.8 below.

3.4 PARTICULAR DESIGN REQUIREMENT - CARGO TRANSFER

As FPSOs may transfer oil by gravity from one cargo tank to another while at the same time loading operations continue, the following design criteria to size the deck vent branch pipes should be complied with:

Any cargo tank is assumed 98% full and maximum amount of the cargo is transferred by gravity to other tanks that are empty. The transfer takes place via the *stripping* suction of the full tank, the bottom cargo pipe system and via the normal suction of the empty tanks. The transfer stops when all tanks are level.

The time of cargo transfer by gravity shall be established (using Bernoulli theory).

During the cargo transfer the tank ullage atmosphere of the tank being filled is transferred to the tank being emptied via the deck pipe distribution system. Temporarily the tank being filled will experience an increased gas pressure and the tank being emptied will experience a reduced pressure.

The pressure in the tank(s) being filled shall not exceed 0.24 bar during transfer

The (under) pressure in the tank being emptied shall not be less than -0.07 bar during transfer.

During the gas transfer the velocity in the branch pipes shall not exceed 40 m/s.

4. OPERATIONAL REQUIREMENTS

The SOLAS Operation and control requirements are given in the FSS Code Chapter 15 - 2.4. However it is strongly recommended that the particular functional requirements of an IG system on an FPSO are included in future rules.

The particular requirements on an FPSO are outlined below. The procedures to be followed in the event of a fault or failure of the inert gas system to provide IG shall also be included in the Operational instructions.

4.1 DECK PIPE DISTRIBUTION SYSTEM - PARTICULAR FUNCTIONS

The inert gas and cargo tank venting system shall be designed for continuous and simultaneous performance of the various functions in 4.2 - 4.8 below albeit that purging and gas freeing do not take place while offloading and when part of system is disconnected for maintenance. All functions are carried out while normal cargo production takes place. Operating blinds shall generally be done without hydrocarbon leakage.

The cargo tank inert gas supply and venting system installed on the main deck provides the following functions 4.2 - 4.8:

(In below figures of the *electronic* copy of this paper **BLUE** lines are gas free and contain fresh air, **GREEN** lines contain inert gas, IG, and **RED** lines contain hydrocarbon gas, HC (flammable vapours mixed with inert gas). **VIOLET** lines indicate closed valves/blinds. In the *printed* copy of this paper the **colours** are not shown but the gas content of the mains ar various functions are also shown in the text. Electronic copy - with colours - of the paper is available from the author at above email address).

4.2 CONTROLLED VENTING OF HYDROCARBON GAS IN THE CARGO TANKS

Venting HC is to open atmosphere via the main riser during any operation below and without interrupting topside operations.

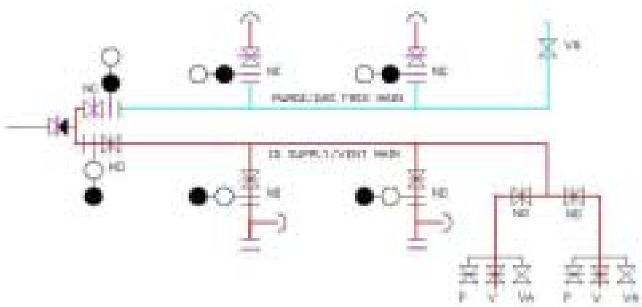

Figure 2 - FPSO cargo tank venting through IG Vent main and risers P+S. IG Supply/Vent main contains HC, Purge/Gas free main contains air.

Venting of HC P or S takes place when the gas pressure in the tank reaches a certain level and ceases when a set lower pressure is reached. The amount of gas and frequency of venting depend on the type of crude oil and the loading rate.

4.3 FILLING CARGO TANK ULLAGE SPACES WITH INERT GAS WHILE OFFLOADING

This function is to replace the liquid being discharged with clean IG in order to maintain cargo tank pressure. The IG fans can be set up to activate when the pressure falls below a preset (adjustable) level.

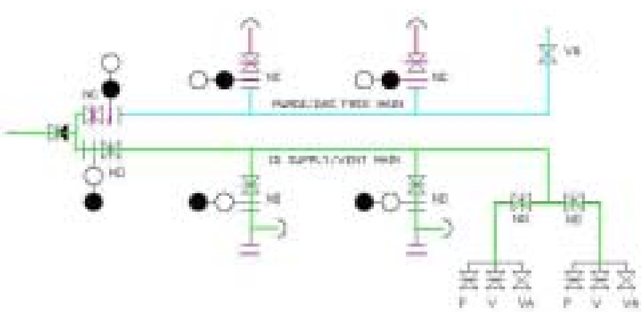

Figure 3 - FPSO – cargo tank IG topping up while discharging via IG Supply main. IG Supply/Vent main contains IG. Purge/Gas free main contains air.

IG is supplied to all tanks via the IG Supply/HC vent main.

It should be noted that, when venting and filling cargo tank ullage spaces with IG while offloading, the Purge/gas free main is completely gas free.

4.4 PURGING EMPTY CARGO TANKS OF HYDROCARBON GAS BY INERT GAS

This means generally purging one cargo tank to be entered, TTBE, at a time, while simultaneously loading and venting other cargo tanks. Purging does not take place during offloading. Venting during purging is via the main vent riser P or S. The purging is generally by dilution of the tank atmosphere with inert gas provided to the tank via the Purge/Gas freeing main at maximum 40 m/s. Tanks with complicated structure, e.g. wash bulkheads preventing effective dilution, may have extra inert gas inlets for purging.

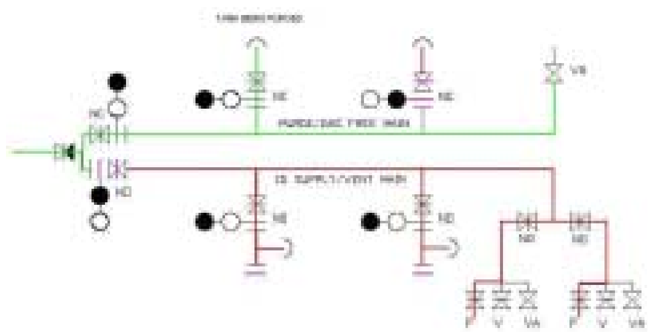

Figure 4 - FPSO cargo tank purging with IG supply via Purge main and venting P+S via Vent main. IG Supply/Vent main contains HC, Purge/Gas free main contains IG.

In order to purge a tank you close the IG Supply/HC vent header main valve/blind, open the Purge/Gas free header main valve/blind, purge the header with IG and open the valve/blind of the TTBE and supply IG. No HC should leak out at any blind operations. The gases are vented through the purge valve on the riser. The amount of gas vented is evidently the same as the IG supplied for purging, i.e. quite a large amount that can blow back on the top side and cause gas alarms.

It should be noted that leaks of HC into the Purge/Gas free main from loaded tanks are not possible in the proposed system preventing proper purging.

Purging a TTBE stops, when there is less than 2% HC in the tank. Then starting gas freeing with air is safe.

4.5 GAS FREEING A PURGED TANK OF INERT GAS BY FRESH AIR

This function - gas freeing a TTBE - takes place simultaneously with loading and venting other cargo tanks. The inert gas from the TTBE shall be discharged overboard (over the side down to one meter above waterline) via a hose temporarily connected to the tank and the fresh air supply shall either be by portable fans fitted on the tank or by the inert gas fixed fans via the Purge/Gas freeing main. Gas freeing does not take place during offloading. Venting the other tanks during gas freeing of a TTBE should be possible via the main risers P+S.

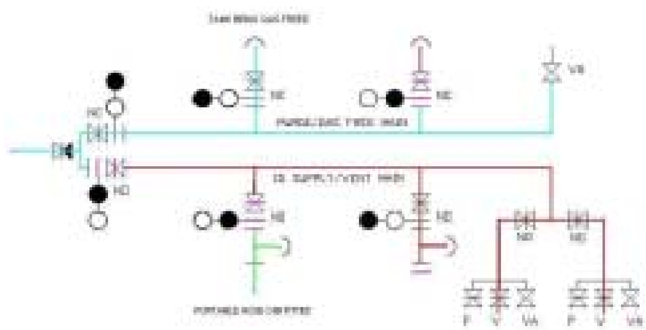

Figure 5 - FPSO cargo tank gas freeing with air supply via Purge main. IG Supply/Vent main contains HC, Purge/Gas free main contains air. IG is vented out via portable hose. Other tanks vent via IG vent main.

Before the gas freeing of a TTBE commences, you close the TTBE vent branch line valve, reduce IG pressure and close the blind and remove a flange on the TTBE and fit a hose overboard. Air is supplied to the tank via the Purge/Gas free main and the inert gas of the TTBE escapes via the hose. No HC will leak out during these operations.

Again it is not possible that HC leaks into the TTBE via leaking valves in the deck pipe system.

4.6 POSITIVE ISOLATION FROM THE SYSTEM BY SPECTACLE FLANGES OF A TTBE

When a cargo tank is to be entered, all vent and/or inert gas connections to the tank shall be closed by permanently fitted spectacle flanges that are easy to operate/swing without hydrocarbon gas leakage.

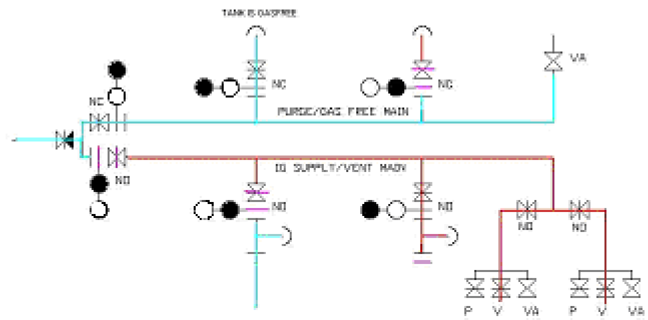

Figure 6 - FPSO gas free cargo tank isolation during access. IG Supply/Vent main contains HC, Purge/Gas free main contains air.

As seen in figure 6 above isolation of a TTBE during access relies on all branch line valves/blinds of the Purge/Gas free main to cargo tanks full of HC remain locked closed.

In order to close the Purge/gas free branch valve/blind of the TTBE itself, the interlock system must be over-ridden., as the TTBE IG supply/HV vent branch line is closed.

4.7 RE-INERTING GAS FREE TANK WITH INERT GAS

The air in the TTBE is vented overboard via the hose already fitted for gas freeing and the inert gas supply is from the system. Re-inerting does not take place during offloading. Venting of other cargo tanks during re-inerting a TTBE should be possible via the main vent riser.

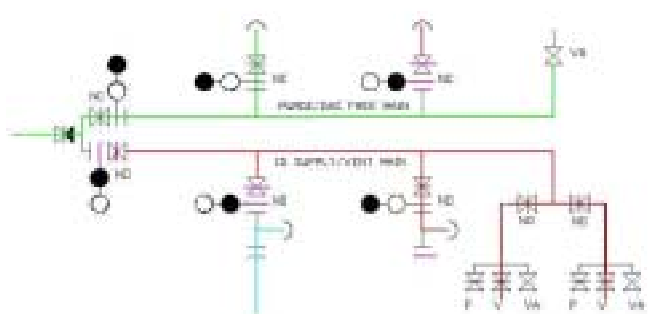

Figure 7 - Re-interting a cargo tank after access. IG Supply/Vent main contains HC, Purge/Gas free main contains IG. Air is vented out via a portable hose.

IG is supplied to the TTBE via the Purge/gas free header and the air in the TTBE is vented out through the hose. When the TTBE is inerted, the hose is removed and the flange is closed. Then the IG Supply/HV vent branch line valve and blind are opened and the Purge/gas free branch line valve and blind are closed.

4.8 REDUNDANCY

Functions 4.2- controlled venting - and 4.3- IG supply when discharging - shall be provided when part of system is disconnected for maintenance. This basically means that you shall still be able to vent while loading, to fill any cargo tank with inert gas while unloading and maintain protection with the IG supply/HC vent main out of service. Consequently purging and gas freeing are not possible when one main line is out of service.

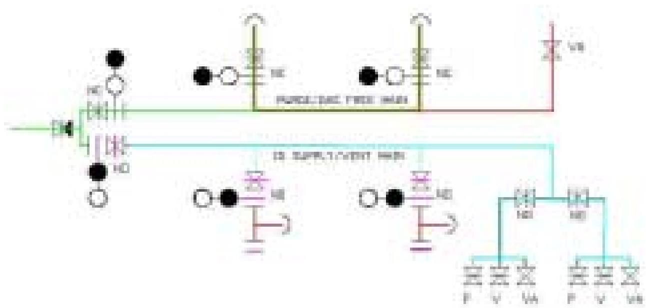

Figure 8 - Redundancy. IG Supply/Vent main contains air, Purge/Gas free main contains HC or IG. Tank access is evidently not possible.

To operate the valves/blinds for the redundancy case, all NC valves/blinds are opened and all NO valves are closed, and this can generally be done without HC leakage. Then the Purge/gas freeing main is used for HC venting via its only vent riser. To return to normal operations, NO valves open, NC valves closed, may cause HC leaks as then all blinds are located on the 'wrong' side of the valves.

4.9 RISER VALVES OVERHAUL

You shall be able to overhaul the riser valves while loading and venting.

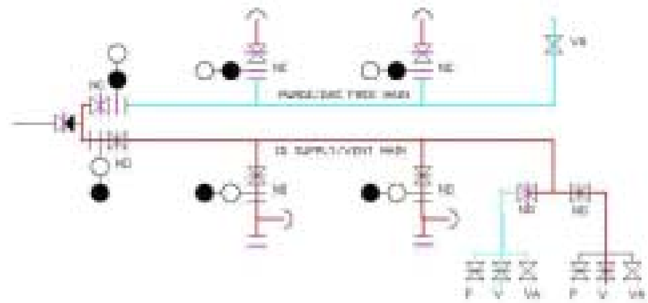

Figure 9 - Riser valves overhaul. IG Supply/Vent main contains HC, Purge/Gas free main contains air.

In order to overhaul the riser valves you close the isolation valve in the riser branch. These valves are interlocked, i.e. only one can be closed at any time

4.10 SUMMARY OF FUNCTIONS OF A SAFE IG SYSTEM ON AN FPSO

All functions, operations and maintenance are minimal in above system that should become IMO regulatory minimum for FPSOs.

A minimum number of valves and blinds are operated at every function. The risk of dangerous hydrocarbon gas leaks is eliminated.

It is possible to replace any valve with minimum or no leakage of hydrocarbon or flammable vapours.

Before any system is approved by the Administration it should of course be tested and commissioned under the supervision of the Administration.

5. UWILDs of FPSOs and FSOs

FPSOs and FSOs are subject to UWILD (Under Water Inspection In Lieu of Dry-docking) surveys at 30 months intervals according to ABS rules. The purpose is an external inspection of the underwater hull including the sea chests by diver and video recording supervised by Class.

The reason for the UWILD for FPSO and FSO seems to be historical Class oil tanker rules requiring dry dock (or UWILD) every 30 months just being copied without any further logic to FPSO/FSO surveys.

Oil tankers normally dry-dock every 30 months (or sometimes every 60 months with an intermediate UWILD) to renew the anti-fouling paint system and to overhaul and check propeller shafts and seals and rudder bearings and supports and at the same time you take the opportunity to check the shell plates and sea valves and to clean sea chests.

Evidently the above does not apply to FPSOs without propellers and rudders but with ICCP system to protect the external hull from corrosion.

An FPSO does not renew its anti-fouling paint system during the contract period. Most FPSOs are not even fitted with an anti-fouling paint system.

UWILD is costly (> $200 000:-) and of little benefit.

Present experience of UWILDs of any FPSO is in my opinion that they do not provide much or any useful information.

Defects have never been found that cannot be found from inside. Barnacles and growth cover the underwater hull and you cannot see much on the video recordings except the barnacles ... and some fish.

Conditions to do UWILD are difficult and dangerous due to waves, swell and currents.

The industry standard to inspect and survey (incl. UTM) the underwater hull plating and sea chests should be from inside when cargo tanks are being accessed.

The industry standard should be to check every 30 months and UTM every 60 months every plate panel between web frames and bottom longitudinal frames including the coating in the tank body - from inside.

Ballast tanks, void and manned spaces should be inspected more frequently.

Tightness and functioning of sea valves is also checked easier from inside. To overhaul a sea valve you can close the sea chest by a cover fitted by divers and at same time clean the sea chest. This is much less costly than UWILD and can be done when required.

Tight (or passing) sea valves are best checked from inside and can be overhauled as required without UWILD.

Therefore it is strongly recommended that the administrations cancel the UWILD requirement from its rules for FPSOs.

All UWILD requirements can in fact be done and fulfilled from inside, when the tanks and spaces are surveyed and inspected.

Total annual savings for the industry may be of order $ 50 M per year.

Sometimes the mooring system is also a Class item subject to underwater survey done at the time of UWILD.

The industry should consider removing the mooring system of an FPSO as a Class item.

The reason is two-fold. First the underwater survey does not provide much useful information except that it looks OK.

Second the mooring system is designed with a long life and redundancy and sometimes a monitoring system is fitted and any defect can be attended to after it occurs. The Owner can of course check the mooring system itself when pulling new risers, etc.

However the Owners should not abandon underwater examination as such but it should be carried out under its own control when required on a case by case study.

Compact, light weight and easy to use ROVs (Remote Operated Vehicles) with video camera and light and 200 meters cables for underwater work are today available at very low prices (< US$ 5000:-) and **each unit or its shore base could be equipped with an ROV for use on the units when needed.**

6. CONCLUSIONS

Oil tanker SOLAS rules for cargo protection using IG and Class UWILD rules have been applied to FPSOs without further thought and the result is quite discouraging.

As sea going oil tankers are completely different from moored FPSOs offshore, you cannot just copy/paste same rules to apply to these two different vessel types.

SOLAS IG rules are very good for oil tankers but insufficient for FPSOs. In fact different interpretations and applications of the SOLAS IG rules for FPSOs have resulted in numerous different systems of FPSOs, some of which are quite unsafe. This paper has described the relevant functions of an IG system on an FPSO and described the simplest system to fulfil these functions and requirements. This system could be the base of an industry standard.

The result should then be easy access cargo tanks at high safety when reliable surveys can take place. Hopefully this paper will encourage the IMO to amend its rules.

Class UWILD rules mandate that FPSOs shall be inspected by divers from outside every 30 months. As FPSOs are not protected by any anti-fouling system (but an anti corrosion system) very little is visible from outside, except barnacles and sea weed (and fishes). It is evidently much easier to inspect the hull from inside.

Hopefully the IACS will sometime in the future adopt the proposal that FPSO hulls simply inspected from inside and that the UWILD requirement for FPSOs hull is scrapped.

7. ACKNOWLEDGEMENTS

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8. AUTHORS BIOGRAPHY

Mr **Anders Björkman** graduated from Chalmers University of Technology in 1969 with an M.Sc. in Naval Architecture and Marine Engineering. He spent a year in the Royal Navy, e.g. with planning conversions of ferries and other ships into minelayers and has worked for Lloyd's Register as a class surveyor, for Scandinavian Underwriters Agency as an underwriter's surveyor, for Mediterranean Average Adjusting Co. as average adjuster and for twenty years as group naval architect for V.Ships. 1989 and onwards Mr Björkman has assisted the El Salam shipping company, Cairo, Egypt to be the leading roro-passenger shipping company in the Red Sea and lately the Mediterranean with today 16 roro-passenger ships transporting > 1 000 000 persons annually. Since 2002 Mr. Björkman has assisted SBM Offshore Inc. with structural condition monitoring and maintenance of a large fleet of FPSOs.

Mr Björkman has developed the **Coulombi Egg** oil tanker system, which is the only alternative design system to double hull tankers according to Marpol I/13F(5) approved by the IMO in 1997. It is the only ship/tanker design purely developed according to damage statistics and FSA and spills much less oil than any tanker.

Mr Björkman has made written contributions about ship's safety and works today as a reputable ship safety consultant.