Deck oil spill containment and control - “unsafe” safety systems?

Introduction

CHIRP Maritime recently received a report relating to “unsafe” safety systems. The report was quite lengthy, and without losing too much of the impact, it proved to be too long for publication in *Maritime FEEDBACK*. The report was ship-type specific, but the concept of unsafe safety systems could be applied anywhere within the maritime sector and thus the topic was felt worthy of further promulgation as an Insight article.

The reporter has recently retired following a career of 58 years in the marine industry. During that time the reporter observed, experienced, and was made aware of several safety systems which could be deemed to be “unsafe”, and wanted to share some of this experience with interested parties in order to identify lessons that could be learned.

One example is systems fitted in most oil tankers for dealing with oil spills on deck, which are usually located as follows;

- port and starboard at the aft end of the main deck - these systems are designed to contain and deal with major oil spills on deck due to cargo pipe failure etc.
- similar systems to deal with drainage of cargo manifold drip trays both on the port and starboard side. Any oil leaks at the manifold, such as those caused by gasket failure, would initially be contained within the manifold drip trays and then drained to an adjacent cargo tank.

Problem identified

The reporter was initially made aware of a problem as a Superintendent of oil tankers. Ship’s staff on various vessels were asked by either a Port State Control or a Vetting Inspector to open the oil spill dump valve located at the aft end of the main deck. Occasionally, and much to everyone’s surprise, opening this valve resulted in oil leaking “out” onto the deck. Subsequently, investigations were conducted into the system design to discover why this was happening.

The systems fitted at the aft end of the main deck are simple “U” tubes which are located in the vessel’s slop tanks as shown in figure 1.

Midship systems which allow manifold drip trays to be drained to adjacent cargo tanks also use simple “U” tubes, or similar devices which work on the same principle

For the “U” tubes to work as designed, the open end of the “U” tube in the slop tank or the cargo tank must not be submerged below the level of oil in the tank. When the “U” tube systems were first introduced, the usual practice was for slop tanks to remain virtually empty. Slop tanks were only used for tank cleaning to allow for in-service cargo tank inspections or in preparation for drydocking. Therefore, the oil spill drainage system to the slop tank was always ready for use.

More recent practice is to use the slop tanks as cargo tanks, and they are usually filled to their maximum capacity in order to maximise cargo capacity for the voyage. This means however that the “U” tube system cannot work, and the pipework right up to the underside of the deck oil spill dump valve, (see figure 3), is now under cargo pressure as shown in figure 2. The problem becomes more evident under high inert gas pressure. Thus, opening this deck oil spill dump valve, when the slop tanks are filled with cargo, invariably results in oil leaking out onto the main deck.

“U” tube operation as per design – an example

- the location of the “U” tube within the slop tank is determined by the maximum allowable inert gas pressure and the magnitude of the deck camber.
- the maximum inert gas pressure in the slop tank is 1,647 mm of oil with a specific gravity of 0.85.
- on a VLCC, the deck camber can be in the order of 1,000 mm
- the open end of the “U” tube must be located approximately 2,400 mm below the bottom of the deck oil spill dump valve
- initially the “U” tube pipework has to be filled with a suitable fluid (such as hydraulic oil). This should be poured in from the open dump valve until oil starts overflowing from the open-ended pipe into the slop tank.
- the “U” tube system will then work as designed, both when the slop tank is empty or filled to a level below the “safe level” as indicated in figure 1.
- any main deck oil spill, which is collected and contained at the aft end of the main deck, can now be safely drained from main deck into the slop tank when the deck oil spill dump valve is opened.

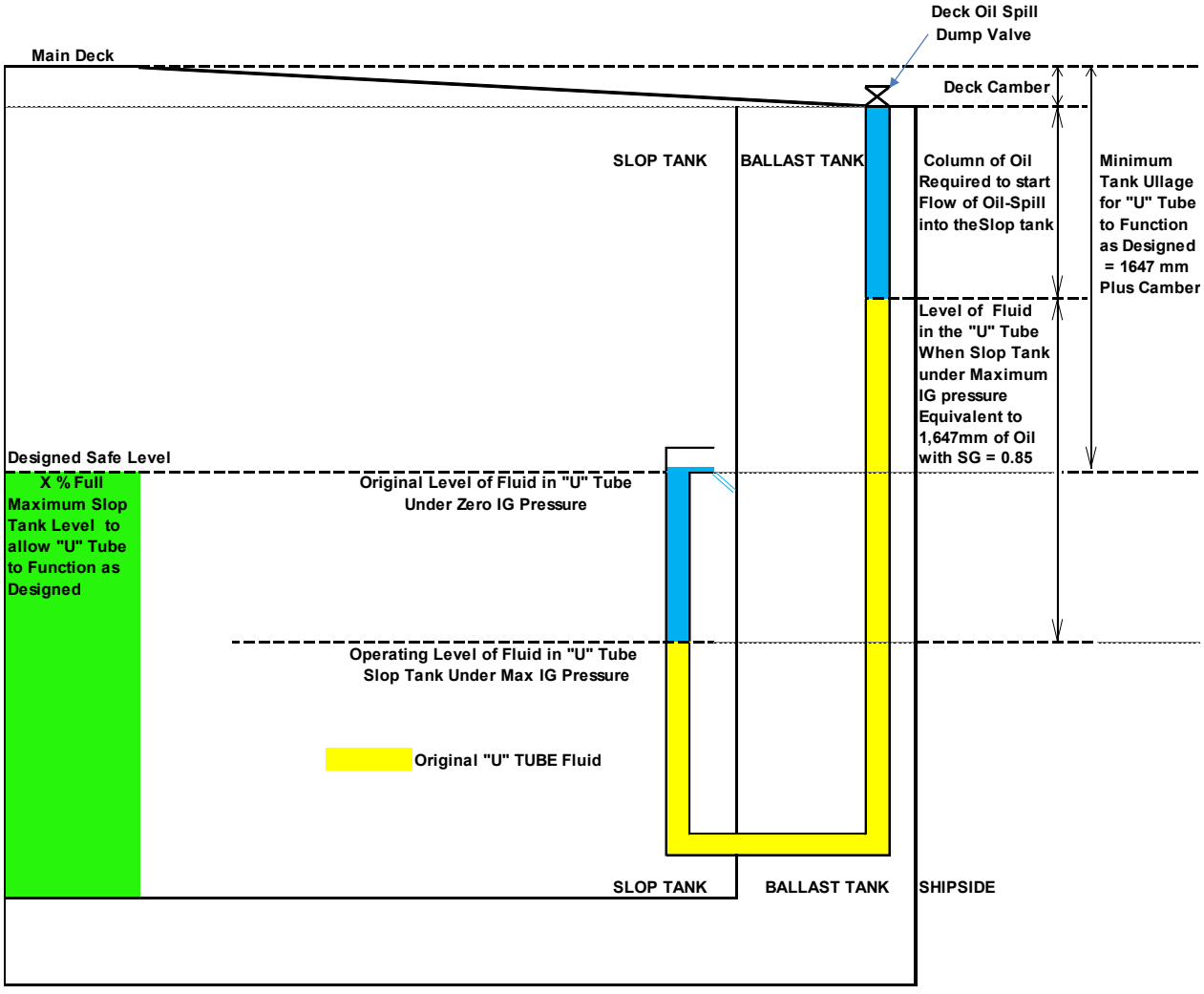

Figure 1 “U” tube arrangement

Situation when slop tank is filled with cargo

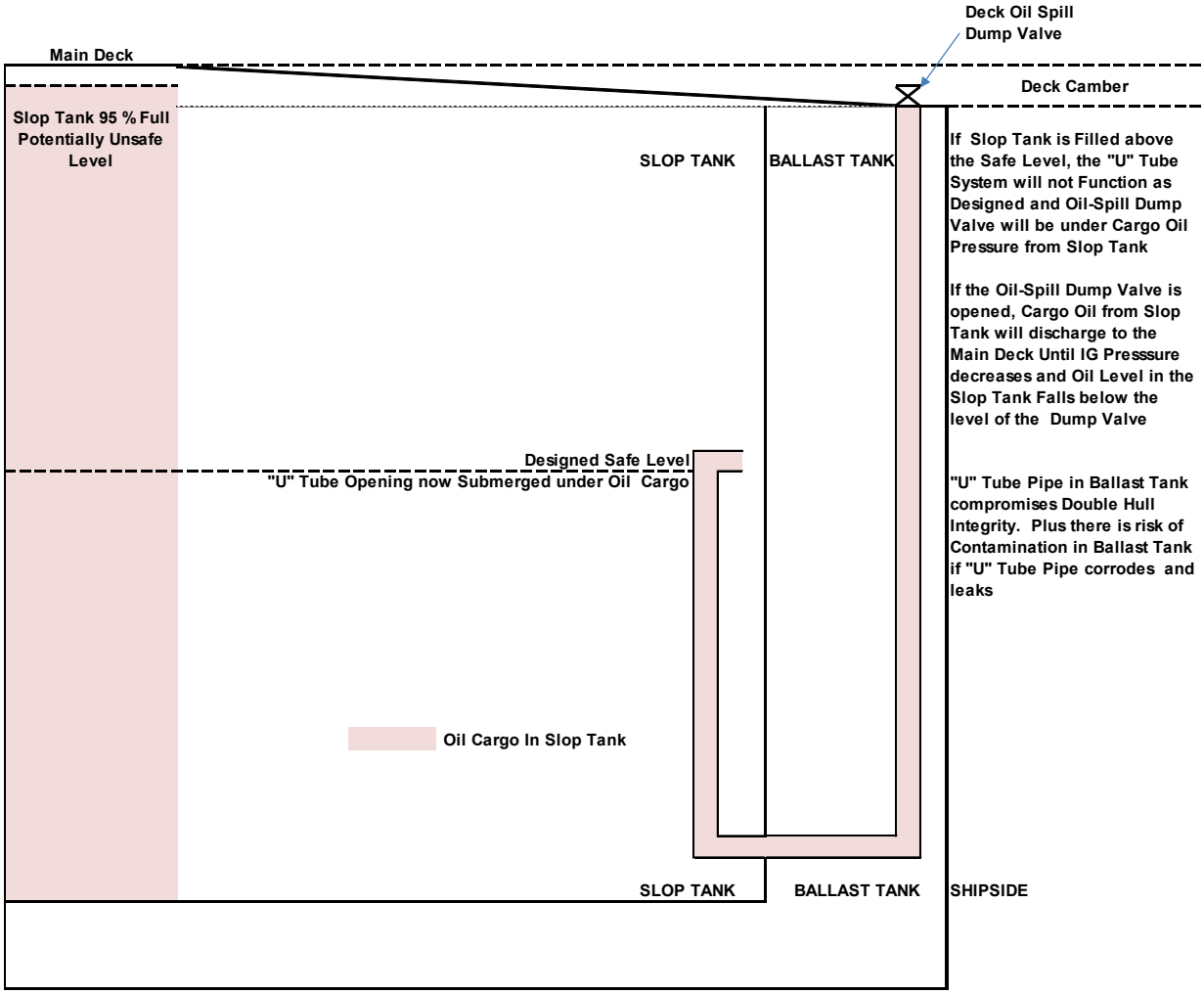

Figure 2 – Dump valve under pressure

As can be seen in figure 2 the oil spill dump valve will be under oil pressure whenever the slop tank is filled to any level above the safe level. This is due to the inert gas pressure in the tank and the head of oil in the slop tank. Opening the oil spill dump valve under these conditions **will** result in oil being discharged onto the maindeck. If the oil spill dump valve is not closed immediately, oil will continue to be discharged onto deck until the following conditions prevail:

- the inert gas pressure decreases to a value low enough to stop overcoming the head of oil in the “U” tube pipework. This will depend on the actual level of oil in the slop tank. Additionally, the decrease of inert gas pressure will be a slow process unless the inert gas supply line to the slop tank is shut immediately.
- if the slop tank is filled to maximum capacity, the cargo oil will be above the level of the oil spill dump valve. This means that, even if the inert gas pressure is zero, there will be an outflow of oil to deck until the level of oil in slop tank falls and reduces the head to zero.

This is why the deck oil spill dump valve must always be secured in the “shut” position

Rules and regulations

When initially investigating which Rules/Regulations covered the installation and operation of the “U” tube systems, no information could be found in SOLAS, Classification Society rules or OPA/90. It is however possible that in the subsequent years Class rules governing these “U” tube systems have been developed.

Although when investigating the problem, it was not a Class requirement to fit such systems, it was a requirement of one of the oil majors. An employee in the vetting department of that oil major was contacted and it was confirmed the “U” tube system was originally designed on the assumption that slop tanks would be empty. It was also mentioned that the original operating philosophy was for the oil spill dump valve to be left in the “open” position during cargo operations. This meant that, in the event of a major oil spill on deck, no human action would be needed to drain the oil spill to the slop tank.

Deck oil-spill dump valve

Figure 3 – Deck oil spill dump valve.

The diagram above shows a very basic “plate type” valve located close to the ship’s side. On most vessels this valve is locked “shut” and secured as shown above or provided with a chain & padlock to prevent unauthorised or accidental operation. Warning notices to prevent operation may also be found posted next to this valve.

The pipework connected to this valve passes through the ballast tank and then via a bulkhead penetration piece into the slop tank. This valve is the only separation between oil in the slop tank and the open deck - it is under oil pressure whenever the slop tank is filled with cargo.

Classification societies do not currently appear to request overhaul, inspection, or proof of operation of this valve during the vessel’s class survey cycle.

Alternative pumping arrangements

It was noted that some owners/managers are aware of the problem with the “U” tube system when slop tanks are filled with cargo. In addition to locking the oil spill dump valve in the “shut” position, many prudent owners/managers have fitted alternative pumping arrangements for deck oil spills on their vessels (see Figures 4, 5 & 6).

Figure 4 - Aft end Wilden pumping arrangement

Figure 5 - Wilden pump discharge connection to slop tank

Figure 6 - Midship pumping arrangement at manifold

Compared to the properly engineered midship pumping system shown in figure 6, the portable air driven Wilden pump usually fitted at the aft end of the main deck appears to be a makeshift system.

These alternative pumping arrangements are apparently accepted, as an alternative to the “U” tube system for dealing with deck oil spills, by Class, Flag State and oil major vetting inspectors. Without specific knowledge of the submission of such systems for approval it is difficult to comment on the approval process.

In summary the following arrangements have been observed on a variety of oil tankers

(a) portable Wilden pump used aft plus properly engineered system amidships.
(b) portable Wilden pump used at both aft and amidships locations.
(c) portable Wilden pump used aft and nothing fitted amidships.
(d) No alternative pumping system fitted.

Typical newbuilding manifold drainage arrangement without pumping system

As shown in figure 7, many oil tankers are not fitted with alternative pumping arrangements at the time of delivery from a newbuilding yard. Therefore, Class surveyors, oil major vetting inspectors, and Port State Control inspectors will periodically inspect many oil tankers, some with and some without an alternative pumping arrangement.

Figure 7 – Typical new build with no manifold drainage pumping arrangement

Action or comment (if any) by inspectors regarding oil tankers which are not fitted with alternative pumping arrangements has apparently not resulted in effective change to vetting procedures in order to mitigate the risk.

As per the design of these systems, the “U” tube needs to be filled with a suitable oil in order to function. It could be reasonably expected that this would be done at delivery from the new building yard and periodically during the life of the vessel. New building commissioning and test procedures dealing with initial filling of these “U” tubes do not appear to be in place. It is true to say that many shipyards will build to a certain specification, and it is not uncommon for owners to specify “latest SOLAS standard” and, for tankers, “latest vetting requirements”.

Inherent risks with “U” tube systems

It may be assumed that the slop tanks and cargo tanks, in which the “U” tubes are fitted, are often filled with cargo up to 95% capacity. This gives rise to the following risks, both real and potential;

Aft Systems

- opening the oil spill dump valve will result in oil leaking onto deck
- any major deck oil spill cannot be drained to the slop tank unless an alternative pumping arrangement is provided.
- if there were a minor collision at the ship’s side close to this valve, there is a danger that the simple “plate type” valve would distort and pop open allowing oil to leak onto the deck. Since the damaged valve could not be closed, there could be a significant oil leak to the deck.
- a major collision could result in shearing the “U” tube pipe within the ballast tank. This could result in serious oil contamination in the ballast tank.
- the integrity of double hull design is impaired by a pipe, which is under cargo oil pressure, being contained within the ballast tank and close to the ship’s side.
- corrosion and leakage of the “U” tube pipework in the ballast tank could lead to oil contamination of the ballast tank.
- in some vessels a non-return valve has been fitted the “U” tube pipework at the bulkhead penetration piece in the ballast tank. Essentially, this is an acknowledgement and acceptance that the function of the “U” tube, which is in itself a non-return system, is rendered ineffective due to filling the slop tanks with cargo.

Mid-ship systems

- the manifold drip tray “U” tube drainage system will not work.
- in the event of an oil leak at the manifold, the drip trays can only be drained if an alternative pumping arrangement is provided.

- the drainage pipework for the main deck cargo lines is usually connected to the manifold drip tray “U” e drainage system. Therefore, drainage of main deck lines can be impaired when the relevant cargo tank is full.
- it is also possible for oil to migrate from one cargo tank to another via these main deck line drains. Some owners have fitted non-return valves in the drainage pipework system for the main deck cargo lines to prevent cross contamination when loading more than one grade of cargo.
- This is another example of an acknowledgement and acceptance that the “U” tube systems are rendered ineffective by maximum filling of the relevant cargo tanks

Summary

- The deck oil spill drainage “U” tube systems fitted in most oil tankers appears to be a vetting requirement and not a Class requirement

- These deck oil spill drainage “U” tube systems will be rendered ineffective when the tanks in which they are located are filled with cargo.

- This appears to be common knowledge among owners, managers, Flag State, classification society and vetting inspectors

- Some owners/managers have fitted alternative pumping systems, which apparently have been approved by the relevant authorities

- The “approved” alternative pumping systems show great variation in design & effectiveness.

- Other owners/managers have not fitted any alternative pumping systems in their vessels.

- Class surveyors and vetting inspectors do not appear to make any comment regarding oil tankers which are not fitted with an alternative pumping system.

- Some owners have fitted non-return valves to try to mitigate the problems caused by the ineffective “U” tube systems.

- The “U” tube pipework in the ballast tanks will be under oil pressure and this affects the integrity of a double hull design.

- When slop tanks are cleaned / gas freed for drydocking there is a possibility of some cargo oil remaining trapped in the “U” tube pipework. If this pipework is not drained and flushed through, a hidden risk during drydock repairs is created.

Conclusions

The commercial requirement to fill slop tanks and all cargo tanks to maximum level needs to be acknowledged and accepted by all parties.

In view of this, the ineffective “U” tube systems are a definite safety/pollution risk.

Consideration should be given to removing “U” tube systems already fitted in existing oil tankers. Likewise, consideration should be given to not fitting “U” tube systems in new vessels.

Until the “U” tube systems are removed from existing oil tankers, the slop tanks and the cargo tanks in which the “U” tubes are fitted should only be filled to a level which ensures the open end of the “U” tube is not submerged. This would necessitate a tank ullage of about 3,000 mm.

To deal with main deck oil spills, all oil tankers should be fitted with properly engineered and Class approved pumping systems at both the aft end of the main deck and amidships in way of manifold drip trays.

CHIRP Comment

Although this is a type-specific issue, the concept of “unsafe” safe systems may be applied across many areas within the maritime sector. In the case quoted, it would seem that a good idea has become set in stone and not engineered out when circumstances changed. This is also true in many other cases.

It should be highlighted that the oil industry states that they are aware of the risk and “manage” it. Within the marine sector tankers are one of the few ship types that self-regulate through a highly effective vetting system. Even so, as this example shows, one should never be complacent. One of the more widely used methods currently employed for deck oil spill containment is using Wilden pump(s) at the after end of the main deck to pump to designated spill containers. This is excellent for minor spills but would be impractical for a major event such as a pipeline failure.

The reporter has highlighted an important issue. Since there are lessons that can be learned, the first step is for new vessels and human-centred design to effectively engineer out the problem and provide a solution.