Action code: WHEN CONVENIENT

Service experience with 2020-compliant fuels

Fuel equipment

SL2022-726/KNB
July 2022

Concerns

Owners and operators of MAN B&W two-stroke marine combustion engines.
Type: All MAN B&W engines.

Summary

This Service Letter focuses on the issues reported and observed in service and describes how to manage the downside effects.

Some of the effects introduced with 2020-compliant fuels, and which can influence the operation of main engine fuel equipment, are:

- Low viscosity
- Cavitation
- Time between overhaul (TBO)

Other relevant Service Letters:
SL2009-515
SL2014-593
SL2019-670
SL2019-681

Dear Sir or Madam

With the introduction of the global sulphur emission cap enforced worldwide since January 2020, the shipping industry has seen various new heavy fuel oil types, blends, and distillates for the marine market (in the following referred to as “fuel oils”).

Although MAN Energy Solutions assumed that new fuel oils could lead to failures, we have seen neither a significant nor a general increase in failing fuel injection equipment in service by the end of 2021.

However, we have received reports of a few incidents that have raised our awareness and, at present, we cannot exclude that new fuel oils, or new fuel oils in combination with ship operation, are affected by the introduction of the low-sulphur cap.

One particular challenge with the operation on new fuels is to ensure that fuel oil quality and specification complies with the engine specification at any time. The following pages offer some guidance and recommendations based on our observations over the past years.

If you have any questions or inquiries regarding this Service Letter, contact our Operation Department at Operation2S@man-es.com

Yours faithfully

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Contents

In the following, we present some of the effects introduced with 2020-compliant fuels. The first section (p. 2) adresses low-viscosity-related issues, the second section (pp. 3-8) looks at cavitation in fuel equipment, and the last section (pp. 9-13) gives guidelines on how to prevent cavitation by ensuring correct adjustment of pressure regulating valves in the fuel supply system.

Low viscosity

Handling of low-viscosity fuel oil on board can be a challenge when taking into account that the main engine requires min. 2 cSt. Sometimes it may be necessary to cool the fuel oil.

It is well known that cavitation is more prone to occur in very low viscosity fluids, and it is therefore important that fuel oil treatment system operation can match the specific fuel in use. Special attention must be paid to change-over scenarios where improper operation of the fuel oil treatment system can lead to unintended high fuel oil temperatures and, consequently, very low viscosities. The fuel oil condition met by the main engine must always comply with MAN Energy Solutions specifications, according to ISO 8217.

This was addressed in our service letter SL2009-515 issued in 2009, and we recommend revisiting this service letter and pay special attention to the recommendations.

Fuel atomising nozzles

Some vessels have reported cracks in fuel nozzles after switching to a 2020-compliant fuel. Fig. 1 shows a nozzle tip with a crack. This is most dominant for engines of higher Mark number due to the higher efficiency.
The reason why this has become an issue is related to the higher delta temperature between the max. temperature for the nozzle during combustion and the cooling effect from the injected fuel.

HFO typically has a temperature of 130 to 140 degrees Celsius whereas the fuels of today may have a viscosity that does not require heating. On the contrary, some new fuel types may need to be cooled in order to ensure a minimum of 2 cSt at engine inlet.

In some cases, this increased temperature difference may challenge the lifetime of the nozzle and thus reduce the specified time between overhaul (TBO).

Fig. 1: Crack found on the tip of a nozzle

Cavitation

In general, cavitation can occur in both the high-pressure pipes from the fuel booster to the fuel valve and internally in the fuel valves. Fig. 4 shows an overview of the fuel equipment investigated.

We recommend inspecting the fuel equipment when convenient within the next 12 months. This is particular important if the new fuel oils used on board since 2020 have different characteristics compared to the fuel oils used prior to 2020.

In the following, various examples of cavitation are shown and described.

High-pressure pipes
We have received a few reports of cavitation in the high-pressure pipes for engines operating only or mainly on distillate or ULSFO, see Fig. 3.

The same observation has been made for engines which operated on HFO until the introduction of the global sulphur emission cap enforced since January 2020.

In most cases, the pipe cavitation seems to have progressed slowly and is often detected when overhauling/exchanging the fuel valves.

However, it cannot be excluded that the cavitation was initiated only by the use of new fuel oils.

If the high-pressure pipe cone suffers severe cavitation damage that leads to a high-pressure fuel oil leakage and, therefore, erosion damage, this may ultimately lead to damage on the top cover mating surface between the top cover and the high-pressure pipe.

Fuel pump – fuel booster
Cavitation damage has not been reported for the fuel pump or fuel booster, see Fig. 4.

Plug screw in top cover/distributor block
Crack formation around the plug screw in the top cover has been reported in a few cases. The root cause has been identified to be a loose plug behind the plug screw.

The loose plug would “hammer” against the plug screw at every injection, and thus stress the threads in the top cover and initiate a crack at the thread in the top cover. Cavitation on the plug may lead to loose plugs.

A repair kit consisting of new plugs and tools for overhauling the mating seat in the top cover can be ordered from PrimeServ, see Fig. 5.

Fig. 2: Inspection of the high-pressure pipe end/seat reveals a crack – no special equipment required

Fig. 3: An endoscope was used to inspect for damage inside the high-pressure pipe

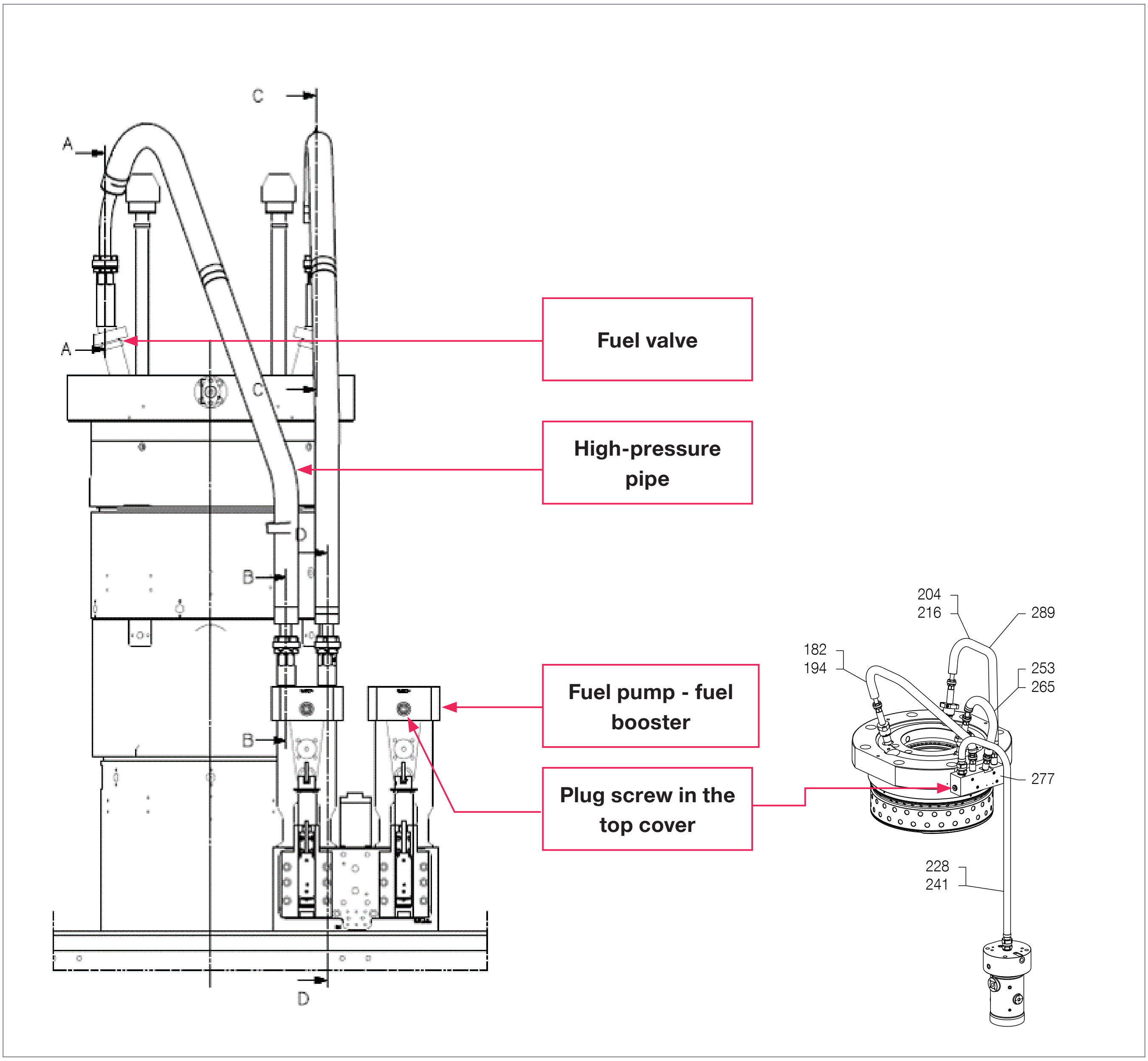
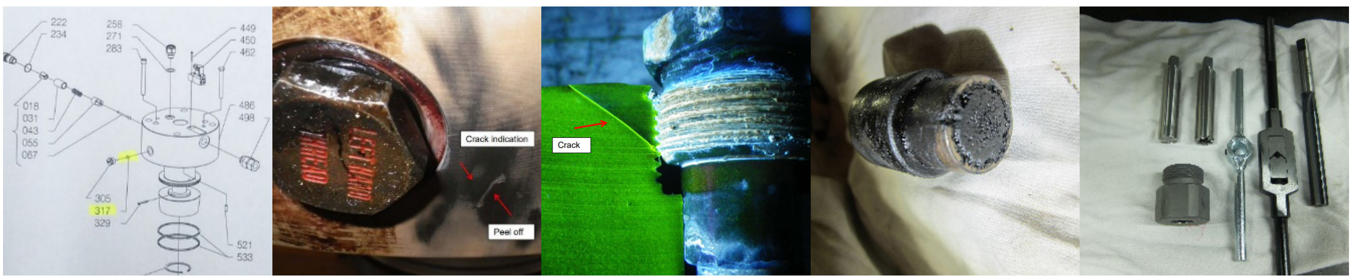


Fig. 4: Fuel injection equipment



Top cover plate | Crack indication | Cross section | Plug | Repair kit

Fig. 5: Crack indication around the plug screw in the top cover, top cover plate and repair kit

Fuel valve

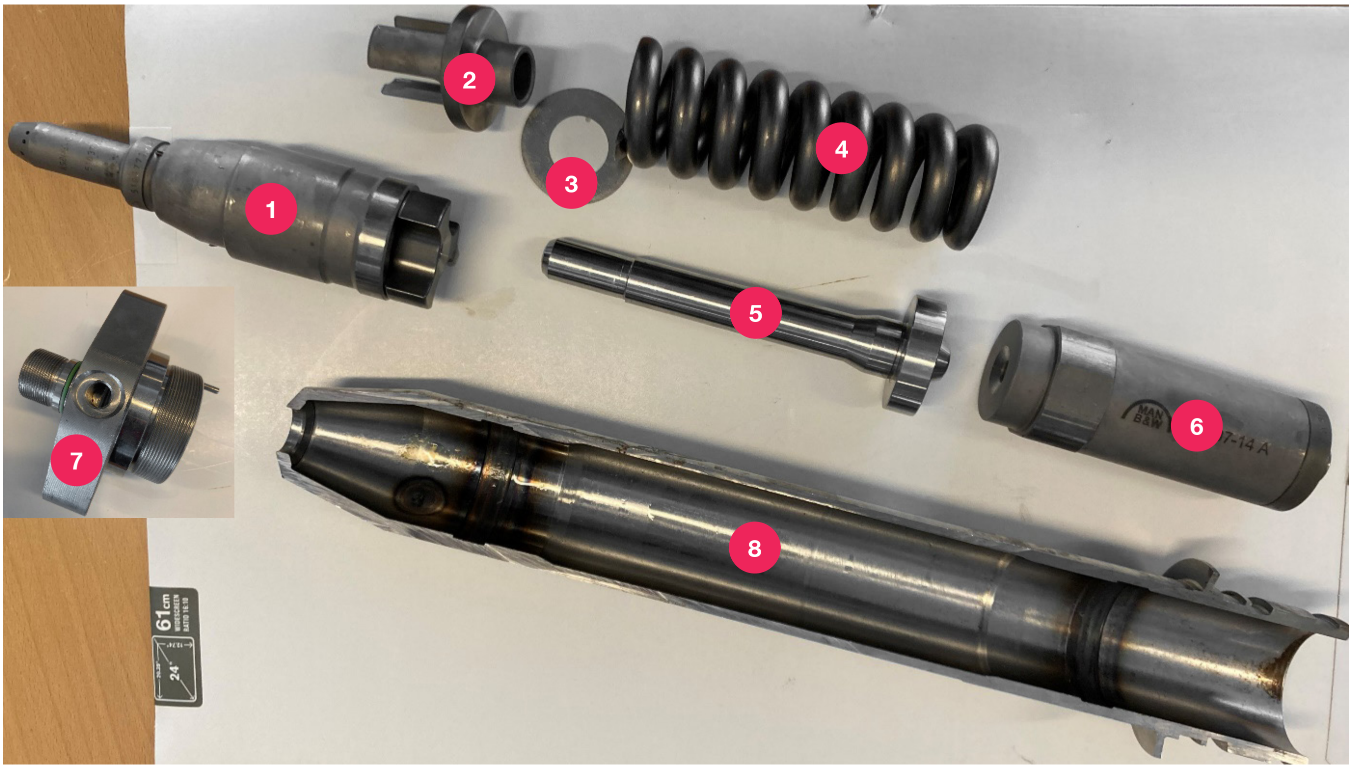


Fig. 6: 1. Spindle guide 2. Foot 3. Shim 4. Spring 5. Thrust spindle pipe 6. Non-return valve 7. Fuel valve head 8. Holder/body

Fuel injection valves may also show signs of cavitation on the internal parts shown in Fig. 6, and as illustraded in Figs. 7–17.

Fuel valve head (pos. 7)

Cavitation has been found inside the fuel valve head, see Figs. 7 and 8.

Fig. 7: Cavitation found inside fuel valve head – towards non-return valve

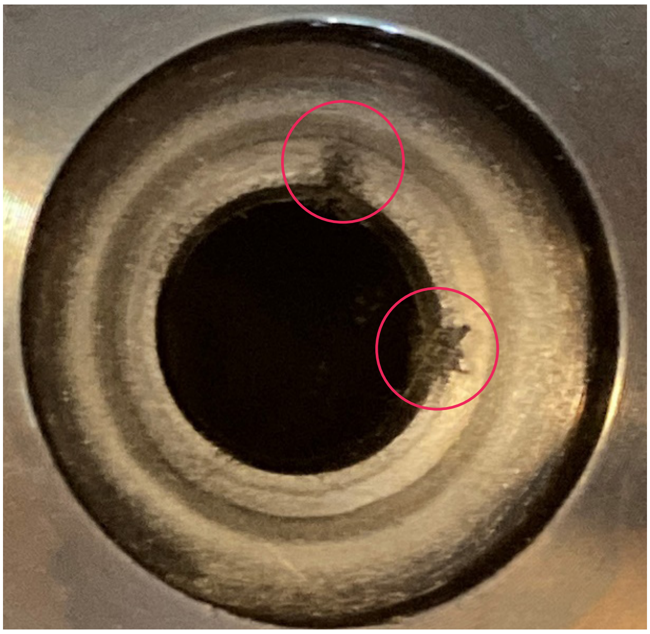


Fig. 8: Close-up of cavitation damage

Non-return valve (pos. 6)

For quite some years now, the standard design on our medium and small-bore engines (50, 60 and 70 bores) has been a type where the non-return valve and thrust spindle pipe are designed as one unit. This design has shown clear superiority over the two-part design used on our large-bore engines. For this reason, we have introduced a similar one-unit type and tested it for 8,000 hours of service on a G95ME-C engine, and the results were very promising, see Fig. 9.

Whereas cavitation is rarely found on the upper end of the non-return valve (Fig. 10), cavitation has been found on the lower end (Fig. 11).

Thrust spindle pipe (pos.5)

Cavitation has been reported on the mating face at the top position towards the non-return valve, especially for 80, 90 and 95-bore engine fuel valves, see Fig. 12. In severe cases, the cavitation will intersect the circular sealing area and bypass the injection pressure. Cavitation occurs also in more rare cases at the lower end, see Fig. 13.

We have not received any reports of cavitation at this lower end position for 50, 60 and 70-bore engine designs.

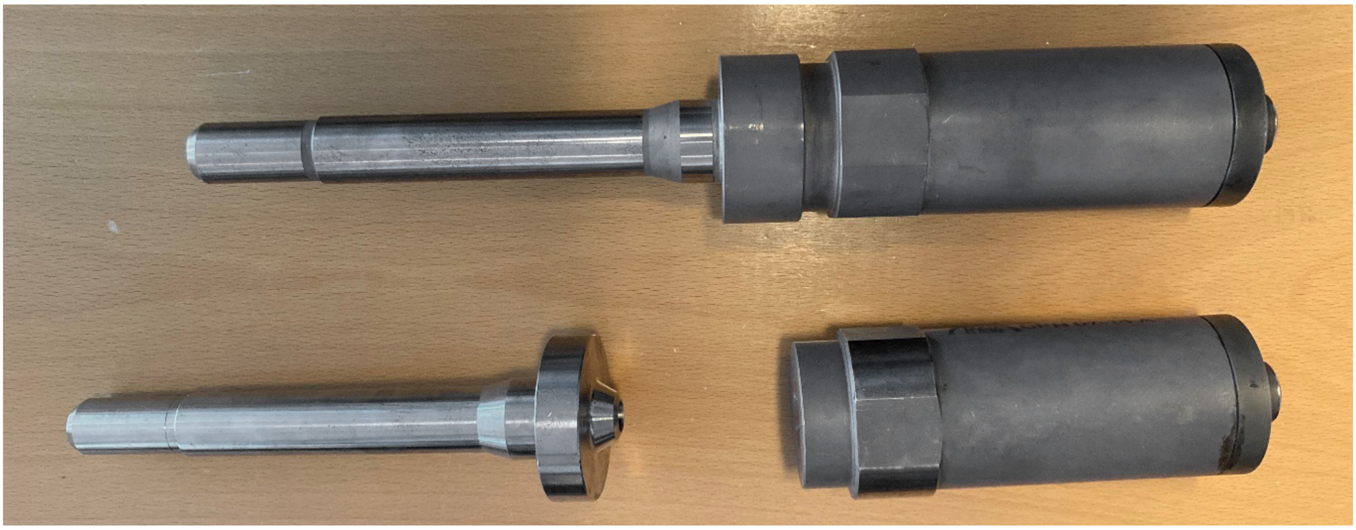


Fig. 9: Non-return valve and thrust spindle pipe vs. combined non-return valve and thrust spindle pipe

Fig. 10: Cavitation is rarely found at upper end of the non-return valve – towards the fuel valve head – here found in fully functional condition without cavitation

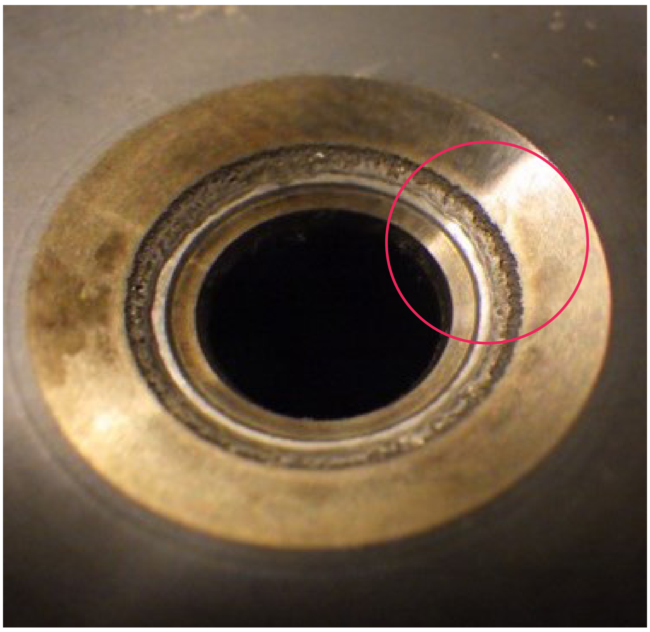


Fig. 11: Close-up of cavitation damage found at lower end of non-return valve – towards thrust spindle pipe

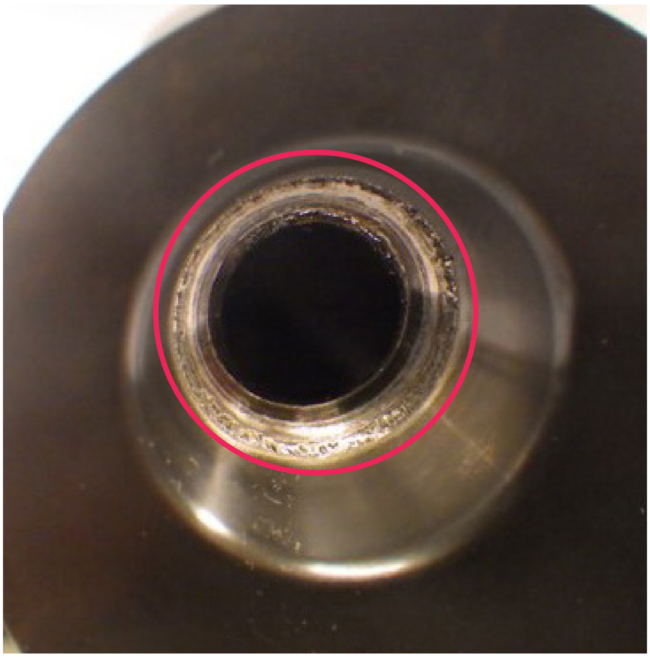


Fig. 12: Cavitation found on upper end of thrust spindle pipe – towards non-return valve

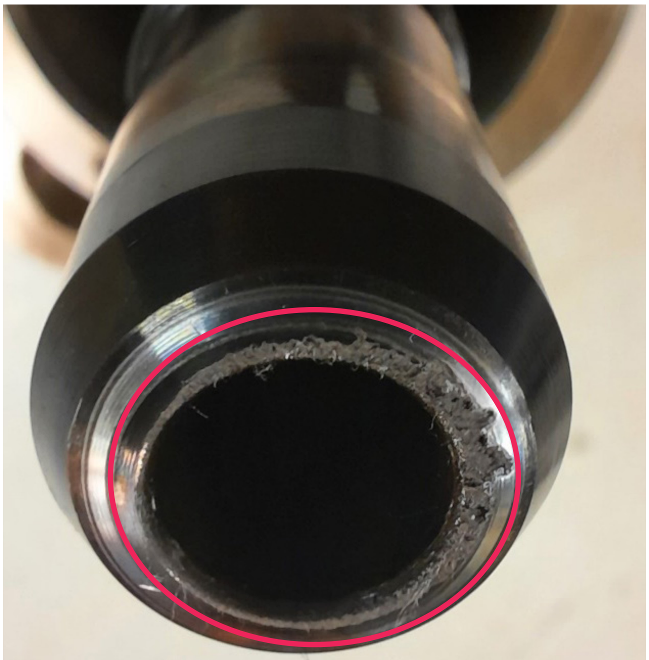


Fig. 13: Cavitation found on lower end of thrust spindle pipe – towards spindle guide

Countermeasure:
Introduction of the combined one-unit non-return valve for the 80, 90 and 95-bore engines. Cavitation is avoided by omitting of the mating sealing surfaces.

Spring (pos. 4)

In a few cases, cavitation has been found on the inner diameter of the spring coils, see Fig. 14. Cavitation marks might also be found on the thrust spindle pipe, see Fig. 15.

This type of cavitation occurs when the circulation pressure is too low for the fuel circulating loop, and it is mainly related to an incorrect pressure setting or a worn out “pressure holding valve”.

Fig. 14: Cavitation found on spring

Fig. 15: Cavitation found similarly on cylindrical part of thrust spindle pipe

Spindle guide (pos. 1)

We have seen very few cases of cavitation on the spindle guide. The cavitation has been found on the mating face towards the thrust spindle pipe, see Fig. 16. In such cases, cavitation was also found on the position for the thrust spindle pipe. Fig. 17 shows an example purely cometic cavitation.

Fig. 16: Cavitation found on thrust piece in spindle guide

Fig. 17: Cavitation marks are considered to be merely cosmetic

Fuel valves must always be properly maintained and correctly installed.

Fuel valve spring housing

The spring housing is a wear part that secures the correct tightening force in the engine. If it is not up to acceptable standard, this may have a huge impact on the operation of the fuel valve and the lifetime of internal components.

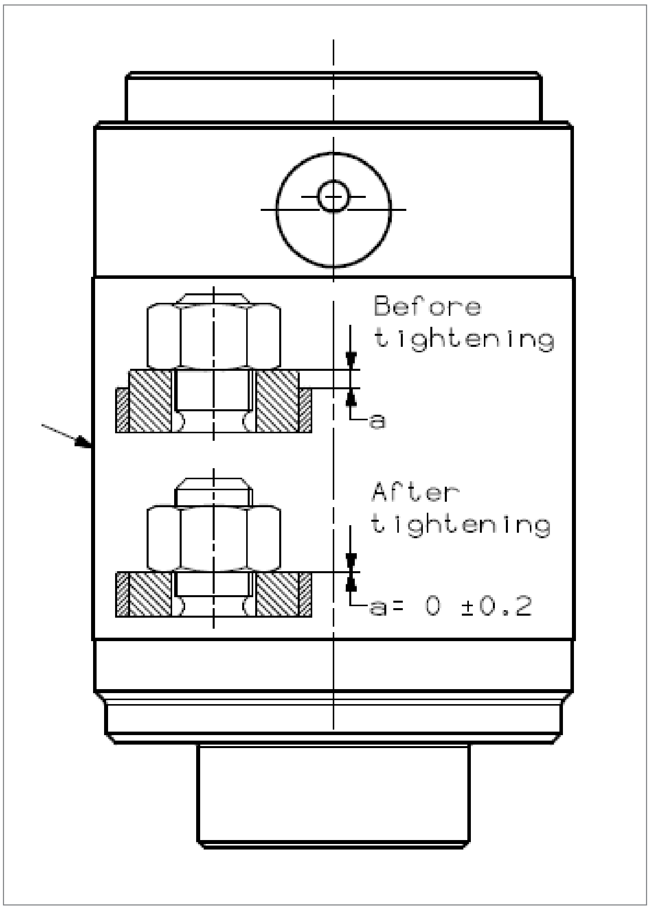


Fig. 18: Spring housing

Fuel oil circulation system

Correct supply and circulation pressures are important to prevent cavitation in the fuel supply system. Fig. 19 shows a fuel oil system with highlighted pressure regulation valves.

Therefore, correct functioning and adjustment of pressure regulating valves in the fuel supply system is essential to ensure sufficient circulation of the fuel during engine standstill and to ensure a sufficient fuel flow during engine operation.

More information about the pressure regulating valves and their adustment can be found in Table 1.

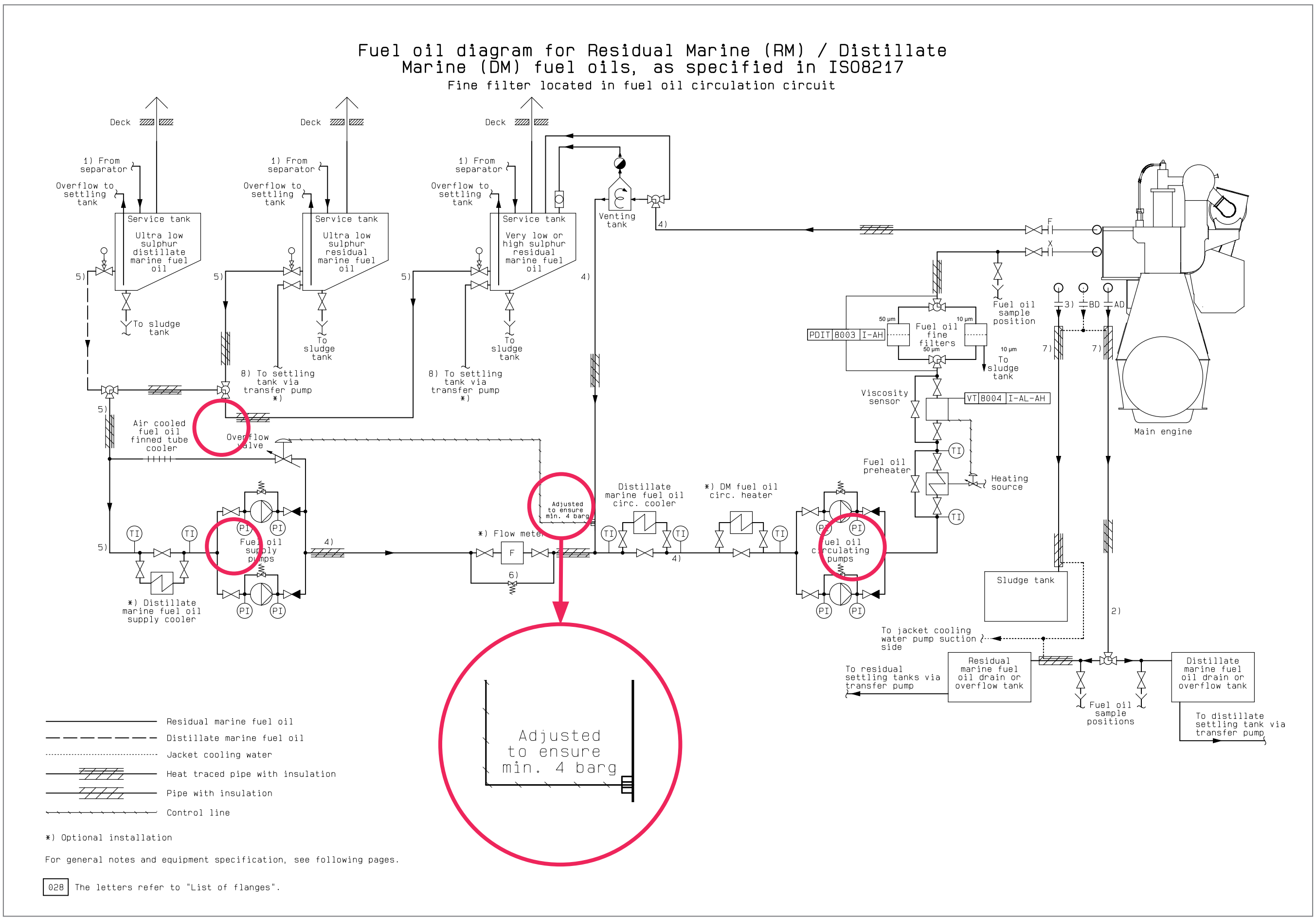


Fig. 19: Fuel oil system

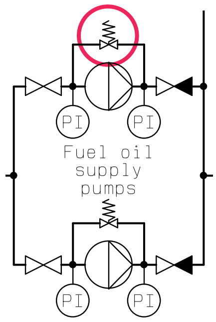
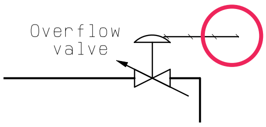
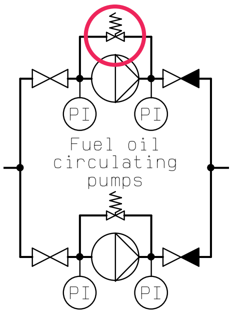
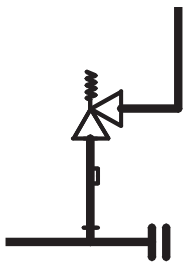
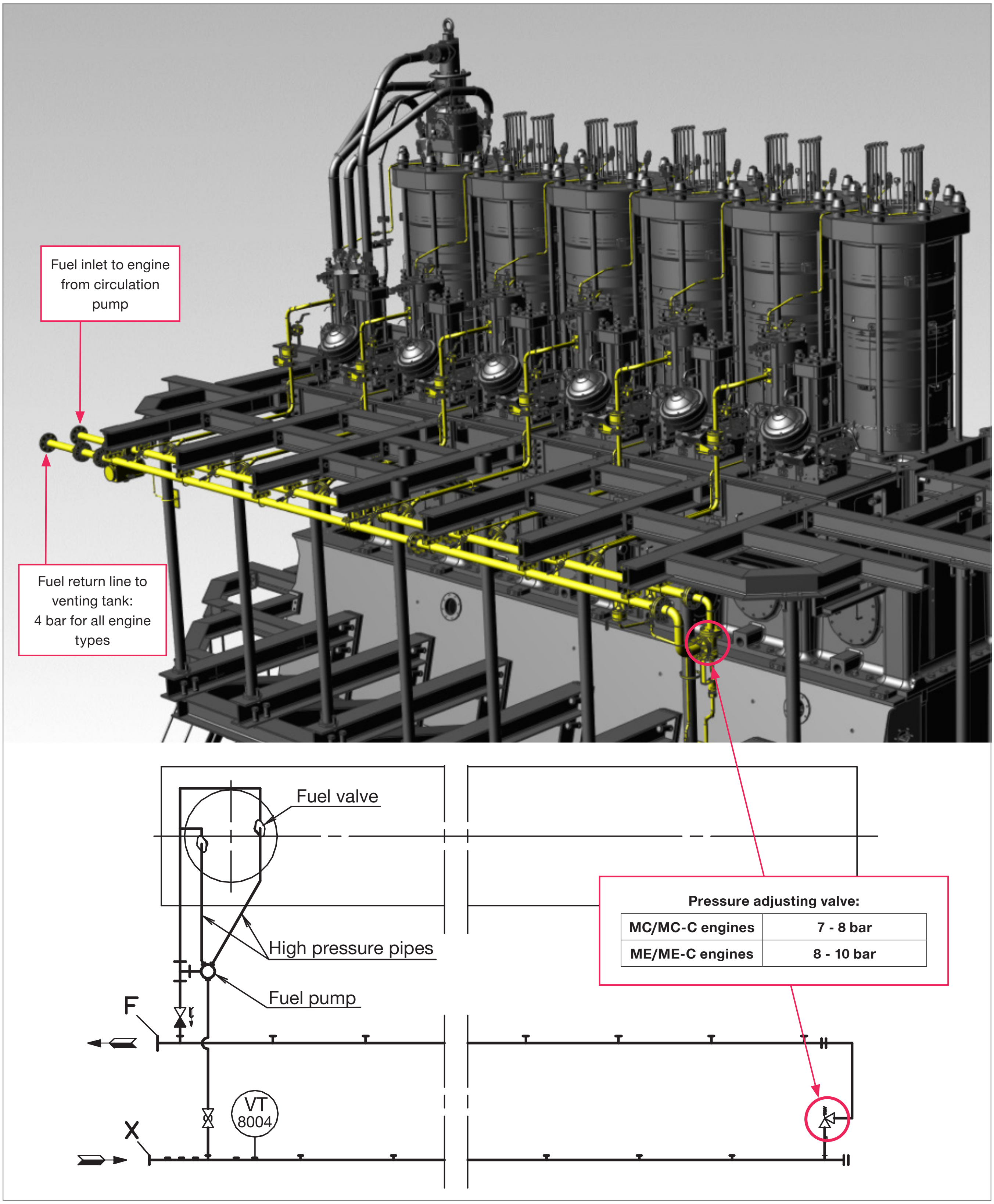
	**Fuel oil supply pumps:** Two screw pumps in parallel (one in standby mode) An internal safety/bypass valve is built in (red circle) to prevent damage to the pump housing. Do not adjust this safety valve, as it is preset by the maker. Make sure that it is set correctly according to maker's specification.	Fig. 19.
	**Pressure regulating valve - Overflow valve:** The valve is a proportional type valve designed to measure the pressure from the venting tank to the circulation pumps (but before heater/cooler, etc.). A pressure of 4 bar must be obtained.	Fig. 19.
	**Fuel oil circulation pumps:** Two screw pumps in parallel (one in standby mode) An internal safety/bypass valve is built in (red circle) to prevent damage to the pump housing. Do not adjust this safety valve, it is preset by the maker. Make sure that it is set correctly according to maker's specification – typically 16 bar.	Fig. 19.
	**Pressure adjusting valve:** The valve is a proportional type valve that will give a certain pressure deviation from the setpoint throughout the load span of the engine. Incorrect setting of the built-in safety valves in the supply/circulation pump can lead to uncontrolled flow from outlet to inlet at the pump itself. This may lead to fuel pressure pulsation in the circulating system as the engine starts to consume fuel oil.	Fig. 20.

Table 1: Pressure regulating valves and adjustments

Fig. 20 shows in more detail where the pressure adjusting valve is located in the circulation system close to the engine inlet. Furthermore, the figure gives the different settings depending on engine type.



Pressure adjusting valve:	
MC/MC-C engines	7 - 8 bar
ME/ME-C engines	8 - 10 bar

Fig. 20: Fuel circulation on the engine

Common fuel supply systems, covering both main engine and gensets, may be more exposed to cavitation as it is more difficult to ensure correct supply and circulation pressures at all times under all conditions.

Fig. 21 highlights item 10 between the inlet and outlet of the main engine. The bypass line with overflow valve, item 10, serves the purpose of bypassing the main engine if, for instance, the main engine fuel oil system needs a major overhaul. During this bypass, the overflow valve takes over the function of the internal overflow valve of the main engine.

During normal operation of main engine and gensets, the shut-off valve in the bypass line (below item 10) must be closed. Otherwise, the two overflow valves will be in series and act against each other!

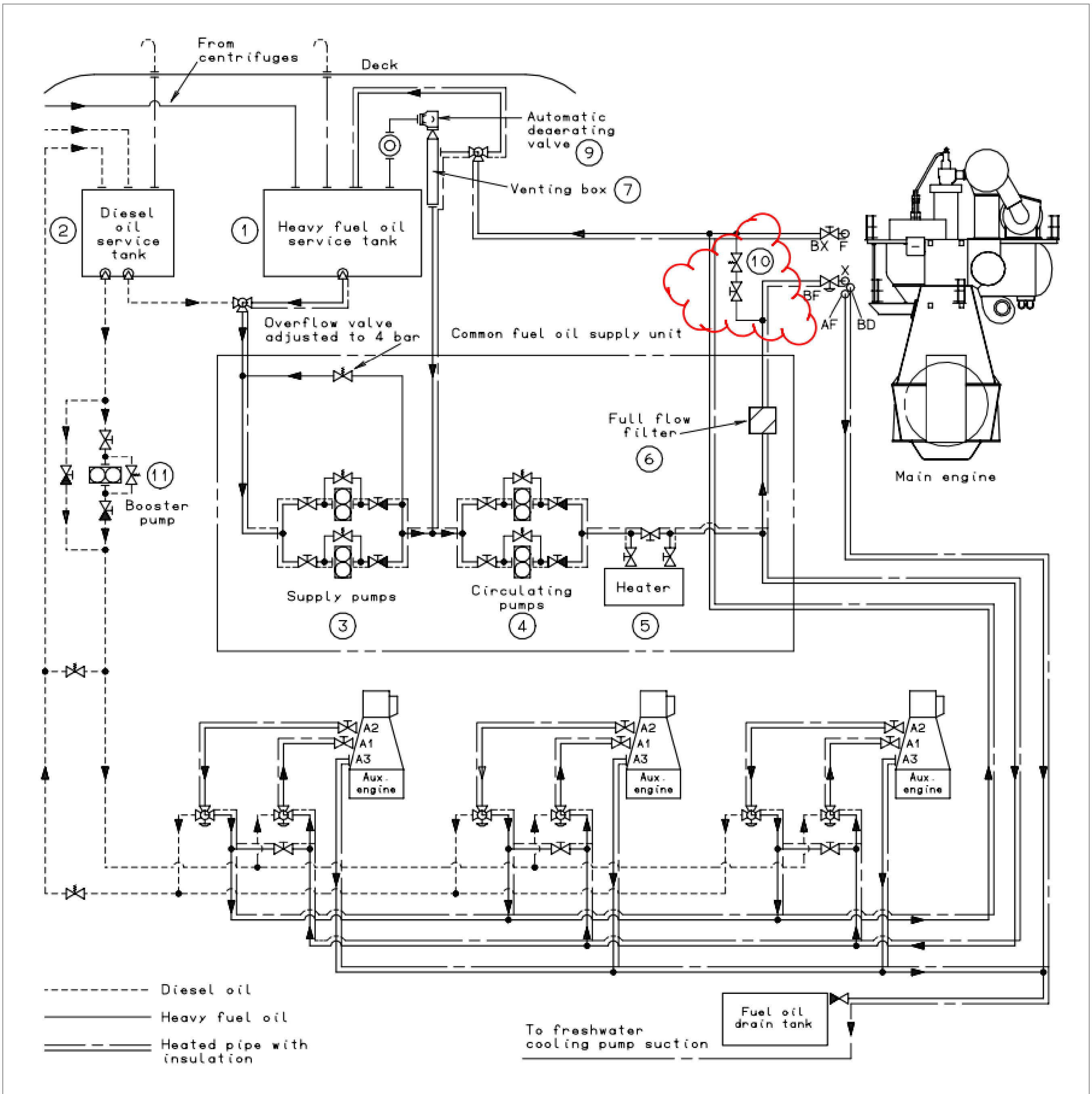


Fig. 21: Common fuel oil system for main engine and auxiliary engines

Similarly, the common supply system for two main engines will be affected.

As shown in Table 2, we recommend keeping:
- The supply pressure at 4 bar (must be measured at the string from the venting tank to cope with internal resistance from filters, viscorator, flowmeter, etc.)
- The circulation pressure as high as possible for the engine type

Supply pressure	Circulating pressure
4 bar	~10 bar
Measured at the string from the venting tank	As close to 10 bar as possible for ME engine types

Table 2

Ensure that:
- The overflow valve at the supply loop works well and is correctly maintained (in case of problems with the function, consider exchanging the valve with a good quality valve from an acknowledged supplier).
- The pressure adjusting valve at the circulation loop for main engine works well and is correctly maintained and adjusted.

Summary & closing remarks

Design update

As a countermeasure, the new combined non-return valve with integrated spindle pipe will soon be introduced as a standard spare part for 80, 90 and 95-bore engines with conventional fuel valves (interchangeable with the existing two-part design of the non-return valve and thrust spindle pipe).

Recommendations

To minimise the impact of downside effects influencing the TBO, we recommend the following:
- At all times, the fuel oil condition met by the main engine must comply with MAN Energy Solutions specifications, according to ISO 8217.
- The operation of the fuel oil treatment system must match the specific fuel in use.
- Keep focus on maintenance.
- Maintain and ensure that the fuel supply and circulation system is working properly.
- Carry out inspections for cavitation in the fuel system.
- Consider introducing shorter inspection intervals.
- Ensure that the necessary spare parts are available on board.

For questions regarding spare parts, contact PrimeServ at Primeserv-cph@man-es.com