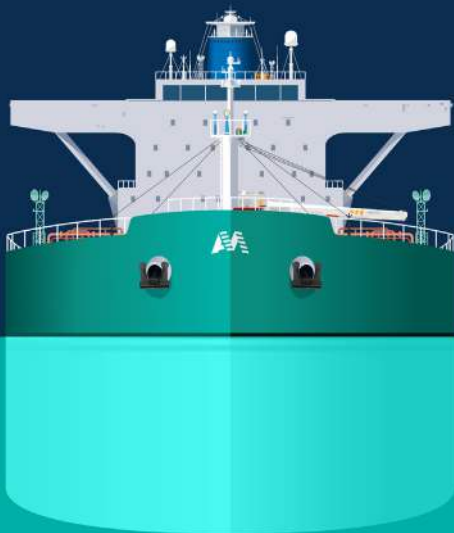


GET **READY** FOR 2020

**HOW TO OPTIMISE
FUEL SUPPLY SYSTEMS
WITH CUSTOMISED UPGRADES**



Introduction of new fuels requires a fuel supply system evaluation

It is likely that the fuel supply system for your ship's main and auxiliary engines was originally designed to run on fuel with different properties to fuels compliant with IMO 2020 and sulphur emissions control area (SECA) regulations. These regulations limit the sulphur content in all marine fuels to 0.5 percent globally and 0.1 percent in SECAs.

Furthermore, it may not have been designed for fuel changeover procedures.

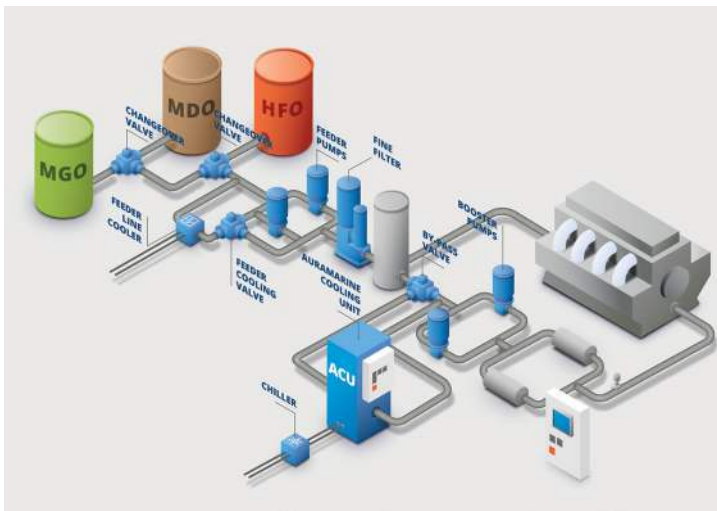
Maintaining the correct fuel viscosity, temperature and pressure at the engine inlet is crucial, regardless of the fuel in use or the complexity of a particular fuel supply system.

When introducing any new fuel, there are certain engineering and design modifications that should be carried out to ensure continuous and reliable operations.



The components in fuel supply and handling systems can be susceptible to leaks, clogging, thermal stresses, excessive wear and sensor malfunctions. Furthermore, they can be impacted by other instabilities caused by different fuel properties or incompatible fuel mixes. Diligent planning and modifications help to mitigate the risk of these events and keep operational costs as low as possible.

Whichever method or fuel type you choose for complying with 2020 regulations, Auramarine's experts are committed to ensuring that your post-2020 fuel system delivers the best operational safety and performance.



HFO and MDO/MGO operation:

- Cooling units
- Chilling units
- Fine filters
- AEP Emergency pump
- FuelSafe™ changeover system

Related components

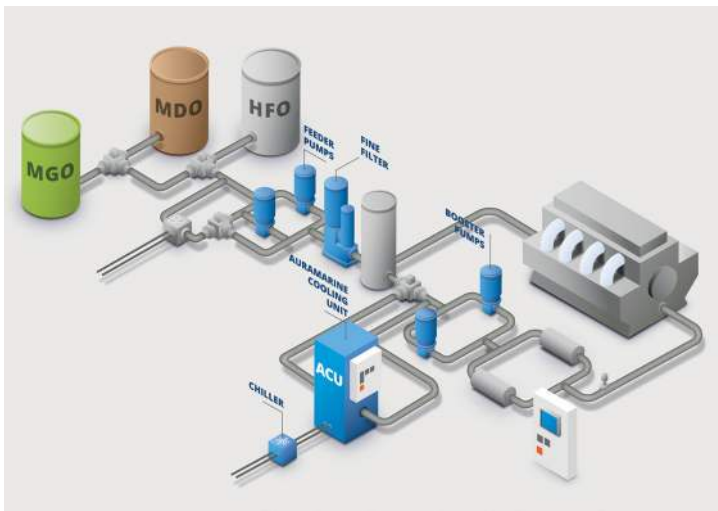
Coolers and in certain circumstances **chillers**, are needed to reach and maintain the correct marine diesel oil (MDO) and marine gas oil (MGO) viscosity for main and auxiliary engines.

A **fuel pump's** ability to accommodate specific fuels should be evaluated. Upgrades may be necessary to guarantee pumping capacity and lubricity. Fuel transfer and circulation pumps with higher thresholds for leaks or blockages, caused by the varying lubricity of fuels, will also improve long-term cost-efficiency and operational availability.

Fuel filters should be able to remove cat fines and alert operators about frequent back-flush cycles or clogging.

A **fuel changeover system**, such as Auramarine's FuelSafe™, safeguards the operation of the main and auxiliary engines during changeovers between different sulphur-content fuels. It combines the changeover with automated cooling and viscosity control, optimising and controlling fuel changeovers.

FuelSafe™ also supports scrubber operations. When approaching ports with zero discharge of wash water effluent, operators may need to switch off the scrubbers and switch between different fuels. The fuel changeover system may also need to be engaged if the scrubber malfunctions.



MDO/MGO operation

- Cooling units
- Chilling units
- Fine filters
- AEP Emergency pump

Related components

Regardless of whether the engines run on MGO or 0.5% sulphur content MDO, a feeder-booster unit, equipped with a **cooler**, or if needed a **chiller**, will maintain any operational pattern from an economical and operational perspective.

It is essential that the coolers or chillers are properly dimensioned, engineered and tailored to meet the needs of your specific fuel system. Certain cooling control optimisations should be carried out for peak performance.

We highly recommend a **review of all feeder-booster units** to define the necessary steps to manage a lower lubricity fuel. Upgrades to ensure pumping capacity and lubricity may be required for the continuous operational reliability of the fuel supply system.



FuelSafe™ fuel changeover system

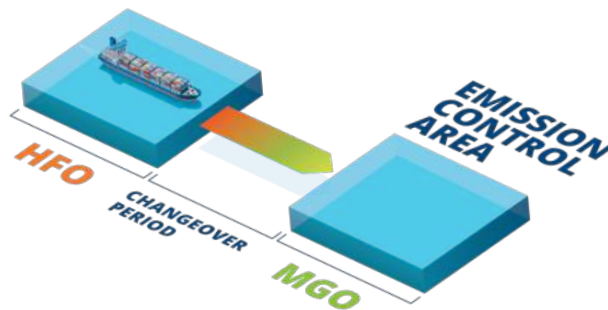
Fuels with a wide range of properties can be used in diesel engines if these properties can be adequately controlled by the fuel handling system during the changeover process.

In a manually controlled fuel changeover system, the main challenge is that it is almost impossible to simultaneously keep the fuel temperature change rate, a maximum rate of 2°C/min, low enough and the viscosity high enough ($\geq 2\text{cSt}$) at the engine inlets.

- Injection pressure losses caused by too low a viscosity may result in difficulties during start-up and low-load operations
- Too low a viscosity reduces the fuel's effectiveness as a lubricant, which can lead to malfunctions of fuel pumps and other machinery with moving parts in the fuel circulation system
- Interruptions in fuel supply during the changeover process can lead to reduced engine power or loss of propulsion

Auramarine's FuelSafe™ fuel changeover solution meets all these challenges. Systems typically include an **Auramarine Fuel Selector (AFS)** and an **Auramarine Cooler Unit (ACU)**, as well as a set of key components.

Changeover is initiated at the push of a button and all necessary steps are automatically controlled. It is suitable for various engine loads, fuel consumption rates and fuel system volumes; the minimum required engine load during changeover is 33%.



See how Auramarine's
FuelSafe™ system
works (YouTube):





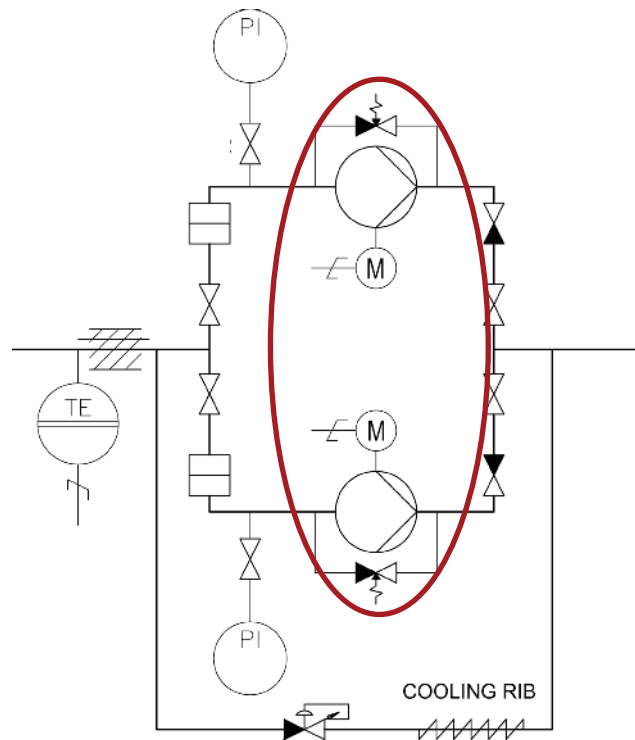
Pumping system compatibility check and upgrades

The different properties of low sulphur fuels compared with traditional fuels means that a professional pump compatibility check should be carried out before any new type of fuel can be successfully introduced into the system.

Low sulphur fuel oil is characterised by low lubricity and viscosity. These properties can affect the fuel pumping system, causing leaks and the excessive wear of moving parts.

Upgrades may be necessary to ensure adequate pumping capacity and lubricity for main and auxiliary engines. Auramarine can carry out the fuel pump compatibility check for you. If an upgrade is required, we will deliver the necessary parts, carry out the assembly, and test the pump's function and performance. Additional cooling arrangements may be necessary.

For screw pumps, the correct clearances and dimensioning are important for maintaining the required pumping capacity. Pumps should be inspected for signs of wear and tear, including checking the condition of gaskets. Rotor screw dimensions should also be evaluated to ensure lubricity compatibility in relation to any new fuel.





Control optimisation for improved system performance

Fuel heating and cooling

For any fuel system to be able to remain fully functional and adaptable to different fuel types and qualities, control optimisation for existing heaters and coolers is sometimes needed.

For example, the coolers installed on board a ship when it was originally built, may not still be able to cope with the requirements of new fuels.

Optimisation ensures that the cooling/heating process works without any issues and is properly adapted to any fuel system upgrade. This is especially important with current fuel mixes, where uncertain or unclear properties are being introduced.

Auramarine offers a **review of your existing heater and cooler systems** from an engineering and system process perspective, recommends the necessary improvements and if needed, carries out the modifications.



The variety of heating and cooling arrangements on board ships means that Auramarine's control optimisation systems are always tailored to fit each specific existing system design. This ensures the best possible performance.

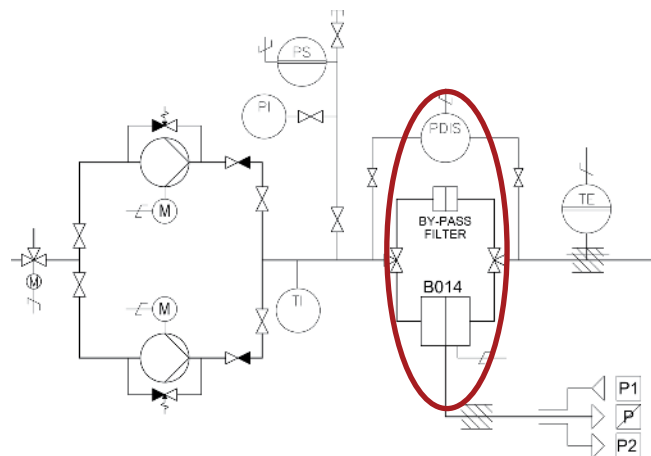
Early detection of system failures

Control optimisation can also enhance troubleshooting capabilities. Properly optimised systems can detect system failures or deficiencies at an early stage, preventing malfunctions or instabilities in fuel supply. Optional features include, for example, viscosity and temperature control with signals to ECR and fuel consumption signalling (mA or pulse).



Filtration upgrades for enhanced engine protection

Filters mitigate the risk of new types of fuels that can cause excessive component wear and tear for the engine components. However, different fuels can require a change in filter replacement intervals; sometimes these can be shorter than previously required.



Auramarine filtration upgrades ensure that with the right filters in place, ships have better control over replacement schedules and that engine manufacturers' latest guidelines are followed.

To provide adequate engine protection, we recommend replacing existing filters with fine filters. Another possibility is to add a second (fine) filter in front of the engine. The suitability of each option depends on the system's current arrangement on board, as well as the engine manufacturer's latest recommendations.

Suggested steps:

- an analysis of your current system arrangements to ensure compliance with engine manufacturer's recommendations
- suggestions for the best possible technical options to prevent potential damage from cat fines. In certain cases, the existing system has restrictions that call for a re-evaluation of the whole fuel handling process due to space constraints or control system issues
- modification design, including upgraded specifications (with filters starting from six microns)
- selection of quality components
- support with incorporating modified items into your existing control systems



Engineering and design modifications

1. Engineering preview

When modifications and technical interventions are made to existing fuel systems, an expert engineering preview should be conducted.

Auramarine's engineers can review a ship's existing fuel supply system design and assess what kind of solutions would best serve the ship in the future.



2. Design and parts lists

Auramarine has a knowledgeable and experienced in-house engineering team, specialising in fuel supply system processes, and expertly capable of developing engineering modifications. We deliver the design details for any new set-up and submit the drawings and parts list for production and component deliveries.

3. Technical consultation and documentation for class approvals

We can also provide technical consultation and submit updated drawings and documentation ready for class approval.





Case: Additional cooling capacity

Original status: the system is running on HFO. No cooling is needed.

Challenge: cooling capacity requirements increase with the introduction of low viscosity fuels. When using MGO or other low-viscosity fuels, to ensure the correct viscosity at the engine inlet, set by manufacturers, cooling units are required. In contrast, HFO meets the same viscosity requirements at temperatures approximately 100°C higher, therefore cooling capacity is not required.

Solution: an additional auxiliary cooling unit for using MGO/MDO.

Benefits: maintains the correct temperature and therefore continuously keeps fuel viscosity within the limits specified by the engine manufacturer.

Auramarine cooling unit technical data

MGO fuel standard:	ISO8217:2017 DMA (2-6cSt at 40°C)
Unit controller cooling mode temperature set point factory setting:	40°C (unless otherwise specified in project specific data)
Cooling media:	Sea-water or LT water*
Unit controller temperature ramp factory setting:	2°C / min
Control voltage:	230 VAC, internally transformed
Supply voltage:	230V/380V/400V/440V/450V/480V/690V 50/60Hz
Design pressure max.:	Oil side 16 bar, water side 10 bar
Design temperature:	100°C (maximum operating temperature)
Maximum dimensions:	1500 x 1900 x 580 mm
Maximum weight:	approx 550 kg



Engineering and design modifications

Case: Additional cooling arrangement for feeder pump circulation

Original status: during a port stay, the pressure from the feeder circulation ensures that there is sufficient pressure and readiness for engine startup in the booster circulation. With practically no fuel consumption, the fuel temperature in the feeder circulation is prone to rise.

Challenge: when running on HFO, the temperature rise in the feeder circulation has not been an issue, but when using MGO it is critical to maintain a low enough temperature to avoid pump problems.

Solution: an additional cooling arrangement for feeder pump circulation will maintain the correct MGO temperature.

Benefits: risks for pump problems will be mitigated while maintaining the correct booster circulation pressure and readiness for problem-free engine startup.

Case: Additional MGO boosters/ feeders

Original status: one fuel supply unit supplying fuel to both main and auxiliary engines.

Challenges: in situations where in port a ship runs on auxiliary engine (MGO) only and there is therefore no need to supply fuel to main engine **OR** the ship transfers fully to MGO use only.

Solutions:

- the installation of an additional MGO fuel supply unit to enable the functional change of any of the ship's engines to run on MGO
- the installation of an additional, new auxiliary engine dedicated for MGO operation
- the modification of an existing HFO unit; removing heaters and steam piping, replacing them with a cooler if there is no existing cooling capacity on board

Benefits: these are relatively easy solutions because no heaters, steam piping, viscometers, automatic filters or insulation methods are needed. They are also cost-efficient because it is not necessary to move the existing fuel supply unit. The most cost-efficient solution depends on the ship's engine and fuel supply system specifications and its operating profile. Contact Auramarine for more detailed calculations.



Engineering and design modifications

Case: Emergency pump units

Original status: a ship's fuel supply system is equipped with the necessary number of fuel pumps to meet current rules and regulations.

Challenge: in the case of a blackout, which cuts off the electricity supply to the fuel pump motors, there is a risk of fuel supply failure

Solution: a separate Auramarine air-driven emergency pump, which operates using a pressure accumulator or electricity from the emergency circuit. An electrically operated version, with its own dedicated battery power source, is also available.

Benefits: ensures instant pump availability in blackout situations. The solenoid valve engages automatically during a power failure when the voltage in the circuit drops. Following this, the emergency pump immediately starts to supply fuel to the engine(s).

Auramarine emergency pump technical data

MDO viscosity range:	2 -20 cSt
Control voltage:	230 V AC / 110 V AC / 24 V DC
Control method:	Normally open (NO) / Normally close (NC)
Design temperature:	60°C (maximum operating temperature)
Design pressure:	10 bar
Test pressure:	15 bar
Working pressure:	6 bar
Pressurised air:	Max. 10,3 or 30 bar
Min. FO viscosity for pump:	1.4 cSt
MDO Flow (@ 2cSt, 6 bar):	1,18 / 1,58 / 2,71 / 3,73
MDO Flow (@ 6cSt, 6 bar):	1,32 / 1,80 / 2,95 / 4,09
MDO Flow (@ 20cSt, 6 bar):	1,43 / 1,98 / 3,15 / 4,39
Air motor:	Nominal power 1,25 kW, 3000 r/min, 7 bar, IEC D71, IM V1
Instrument air consumption:	55~110 m3/h
AEP Unit dimensions (mm):	W350xH790xL850
AEP Unit dry weight:	~100 kg



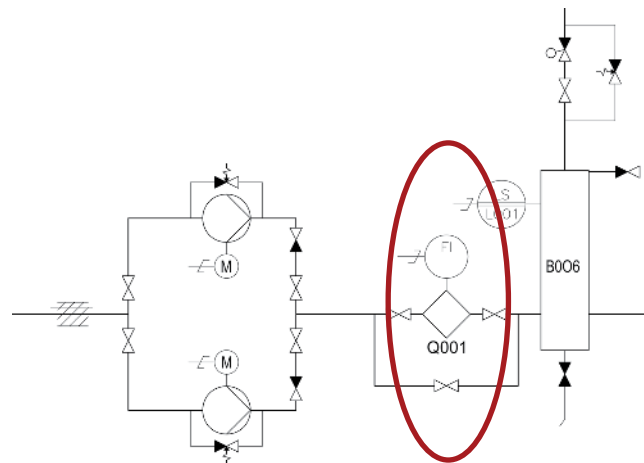
Upgrades

for fuel measurements and reporting

Measuring and documenting the consumption of fuel on board a vessel has become increasingly necessary to improve efficiency and to keep the fuel costs in control. Also, compliance with the EU MRV and IMO data collection regulations requires accurate fuel consumption measuring.

Fuel consumption measuring can also bring benefits in fuel changeover situations.

Auramarine fuel handling systems incorporate numerous flow meters. If existing flow meters are becoming outdated and new flow meters are being considered to enable real-time measurements on board with higher degrees of accuracy, we can help you select the most suitable arrangement.



Flow meter upgrade options:

- Replacement of volumetric with mass flow meters
- Upgrade of existing volumetric flow meters
- Separate flow meters for each fuel type in use



Project management support

The technical departments of shipowners and management companies are currently occupied with preparations to ensure their vessels comply with the 2020 regulations. Auramarine is ready to relieve this workload and support fuel supply system transition to 2020 compliance.

- We offer a comprehensive **technical review** of your ship's or fleet's fuel supply system to determine the best possible adaptation of existing on-board fuel supply systems to handle the new fuels. If needed, this can include technical meetings with Auramarine's product specialists.
- Auramarine can also **update technical drawings** for class approval.
- Once the necessary steps have been identified, **project schedules** are matched with upcoming ship or fleet maintenance schedules. Early contact is advised.
- A project may involve initial service engineer visits, installation supervision and/or start-up and commissioning.



- Component delivery times are scheduled to match each ship's drydock or repair schedule. This is subject to a timely order submission.

Both individual ships and especially a series of ships, which will gain from economies of scale, benefit from Auramarine fuel supply system project management services.

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- 1. Fuel supply system evaluation**
- 2. Design and modifications**
- 3. Safe and efficient operations**

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