Stricter limitations on sulphur emissions (SOx) will pose many challenges to ships operating in Emission Control Areas (ECAs). If not handled with care, switching from Heavy Fuel Oil to Marine Gas Oil can put equipment at risk and increase operational costs. DNV GL has developed a ship-specific Fuel Change-Over Calculator (FCO) to help shipowners and operators determine the ideal parameters for their vessel's fuel change-over. In addition, the new publication “Sulphur Limits 2015 – Guidelines to ensure Compliance” offers detailed advice on how to handle the procedure (see appendix).

Ships operating in an ECA will have to use fuel that does not contain more than 0.10% sulphur (MARPOL Annex VI) from 1st January onwards. Switching to Marine Gas Oil (MGO) is currently the most viable option for following the new threshold limit. The Fuel Change-Over Calculator can help to mitigate the risks associated with switching to Marine Gas oil (MGO). It accounts for variables such as a vessel's fuel system layout, any constraints on temperature and the variable sulphur content of fuels, as mixing occurs in the service system. It can significantly reduce the risk of human error during the preparation of the change-over procedure. The software uses a complex numerical simulation that is more accurate than previous linear models and delivers insight into the optimised lead time for the change-over process, its costs and the maximum hourly consumption to meet constraints, such as temperature. This kind of data ensures a cost-efficient, reliable fuel change-over and can also help demonstrate compliance for the respective authorities.

Switching from HFO to MGO during operation requires shipowners and operators to plan for several potential challenges. Accounting for the different operating temperatures of the two fuels is critical - otherwise you risk damaging the machinery. As HFO's and MGO's operating temperature differs by about 100 degrees Celsius, the change-over may cause a rapid fall in temperature and increase the danger of thermal shock to the equipment. Fuel systems also have to account for their difference in viscosity in order to avoid fuel pump failures and leakages. The fact that HFO and MGO are mixed in all ratios during the change-over procedure increases the risk of the fuels becoming incompatible. This may clog filters, causing the engine to shut down.

Shipowners and Operators need to take a measured, well informed and well documented approach to fuel switching. DNV GL is committed to supporting customers in achieving this. Along with detailed guidelines in the publication, the Fuel Change-Over Calculator’s analysis can serve as a basis for attaining compliance.
APPENDIX
SULPHUR LIMITS 2015
Guidelines to ensure compliance

CONTENTS

INTRODUCTION 03

REGULATORY BACKGROUND 04
  Applicable regulations 04
  Other regulations 04
  Emission Control Areas 05
  Work of European Commission on sulphur implementation 06

CHALLENGES OF FUEL CHANGE-OVER 07
  Description of fuel system 07
  Temperature 09
  Viscosity 09
  Lubricity 10
  Fuel incompatibilities 10
  Flashpoint 10
  Cylinder lubrication - acidity 10

MODIFICATIONS OF FUEL SYSTEM 11
  Storage tanks 11
  Service tanks 11

TRAINING 12

SUPPORT BY DNV GL 13
  Class services 13
  Approval of fuel system modifications 13
  Voluntary class notation ECA (SO₂) 13
  Witnessing of low sulphur fuel change-over and operations 13
  Advisory services 14
  Fuel Change-Over (FCO) Calculator 14
  Troubleshooting 14
  Training 14
  References 15
In 2015 shipping is taking a big step towards becoming greener. Stricter limitations on sulphur emissions (SO₂) in Emission Control Areas (ECA) will significantly reduce the industry’s footprint in terms of pollution from the 1st of January onwards. When ships pass through an ECA, their fuel oil will only be allowed to contain a maximum of 0.10% sulphur (MARPOL Annex VI). Vessels powered with heavy fuel oils will need to switch to using ultra-low sulphur marine gas oil (MGO), before they enter an ECA area and, of course, will switch back to HFO after they leave it.

Switching to MGO is currently the most viable option for following the new threshold limit. This may appear to be a simple task at first glance, but the change-over procedure actually requires significant attention from crews in terms of operating, as well as extensive preparation on board the ship before the 1st of January 2015. This brochure is designed to provide an overview of the regulatory background and point out the challenges the new rules could pose to shipowners and operators. Explaining relevant technical details, it describes which fuel change-over technologies can best help the industry fulfil the requirements and how we can support you in achieving compliance for your fleet.

The following parameters need to be taken into account:

**Temperature:** As the two fuels’ operating temperature differs by about 100 degrees, the change-over may cause a rapid fall in temperature and increase the danger of thermal shock to the equipment, if not handled with care.

**Viscosity / Lubricity:** HFO and MGO have very different consistencies. The fuel systems need to account for this difference in viscosity during operation, to avoid fuel pump failures and leakages. Lubricity is closely related to viscosity - if viscosity is too low, this may cause a lack of lubricity.

**Fuel incompatibilities:** HFO and MGO are mixed in all ratios during the change-over procedure. The fuels can become incompatible and clog filters, which may cause the engine to shut down.

**Cylinder lubrication – acidity:** Decreasing the sulphur content of fuel has an impact on its acidity. The amount of alkalizing cylinder oil needs to be adjusted to avoid excessive engine wear or even damage.

**Contamination:** Tanks formerly used for HFO need to be cleaned thoroughly before switching to MGO - otherwise there is a risk of fuel contamination and failing to comply with the SOx-regulation.

Complications can be avoided by preparing detailed guidelines for the fuel change-over, training crews to take a measured and careful approach to the procedure and by making informed decisions about the capabilities of your vessel. We are committed to helping customers meet the new IMO requirements without compromising on the safety and efficiency of the vessels. Using innovative software, such as the ship-specific fuel change-over calculator, we can supply you with the ideal parameters for the change-over procedures on board your vessels and train the crew to overcome challenges, prevent accidents and meet the new sulphur requirements.
APPLICABLE REGULATIONS

Figure 1 gives an overview of the scope of the sulphur regulation. It refers to the global sulphur limit as well as the stricter IMO regulations for Emission Control Areas. It also shows the limit for the sulphur content of fuels used on board ships during port stays in Europe; details can be found in the Directive 1999/32/EC, as amended by Directive 2012/33/EU.

Regarding ships operating in ECAs, IMO Revised MARPOL ANNEX VI, Regulation 14 (Sulphur Oxides (SOx) and Particulate Matter) reads (Consolidated Edition 2014):

While ships are operating within an Emission Control Area, the sulphur content of fuel oil used on board ships shall not exceed the following limits:

1.) 1.50% m/m prior to 1 July 2010;
2.) 1.00% m/m on and after 1 July 2010; and
3.) 0.10% m/m on and after 1 January 2015.
4.) Prior to 1st January 2020, the sulphur content of fuel oil referred to in paragraph 4 of this regulation shall not apply to ships operating in the North American area or the United States Caribbean Sea area defined in paragraph 3, built on or before 1st August 2011 that are powered by propulsion boilers that were not originally designed for continued operation on marine distillate fuel or natural gas.

This means that vessels using heavy fuel oil must have completed the change-over process and operate on ultra-low sulphur fuel upon entering an ECA. According to the Sulphur Directive 1999/32/EC (as amended by Directive 2012/33/EU), the maximum sulphur content of fuels used by ships at berth has not been allowed to exceed 0.10% by mass in EU ports since the 1st January 2010. However, it does not apply within European waters that lay outside ECAs, whenever ships are due to be at berth for less than two hours (according to published time tables). The requirement does not apply to ships that switch off all engines and use shore-based electricity while at berth.

OTHER REGULATIONS

Within the “Regulated California Waters” the regulation for the maximum sulphur content of fuels used by ships came into force on the 1st of January 2014. The sulphur content is not allowed to exceed 0.10% by mass in main engine(s), auxiliary engine(s) and auxiliary boiler(s). The term “Regulated California Waters” generally includes all areas within 24 nautical miles of the Californian coastline. Further details can be found in the California Code of Regulations 17 CCR, section 93118.2, the amendment from 2011 and the CARB Marine Notice 2011-2.
EMISSION CONTROL AREAS

According to MARPOL Annex VI, an Emission Control Area (ECA) is defined as follows: “An ECA is an area established by the IMO (International Maritime Organization), where the adoption of special mandatory measures for emissions from ships is required to prevent, reduce and control air pollution from nitrogen oxides (NOx) or sulphur oxides (SOx) and particulate matter or all three types of emissions and their adverse impacts on human health and the environment.”

Emission Control Areas will include those listed in, or designated under, regulations 13 [Nitrogen Oxides] and 14 [Sulphur Oxides and Particulate Matter] of the MARPOL Annex VI. Figure 2 shows the ECA zones that have been established up to now (November 2014). They are part of the ECA control regime as applicable for Regulation 14. As this document addresses the sulphur emissions, the ECAs are only being regarded in their function as Sulphur Emission Control Areas (SECAs). No distinctions in respect to NOx emissions and their limitations are made in this brochure.

According MARPOL Annex VI, the following four SECAs are currently applicable:

- SECA Baltic Sea (effective date 2006-05-16)
- SECA North Sea (effective date 2007-11-22)
- SECA North America (effective date 2012-08-01)
- SECA United States Caribbean Sea (effective date 2014-01-01)
WORK OF EUROPEAN COMMISSION ON SULPHUR IMPLEMENTATION

The European Commission (EC) has established the “European Sustainable Shipping Forum” (ESSF), which brings together Member States and maritime industry stakeholders. ESSF will enable a structural dialogue and provide a forum for exchanging best practices and coordination between all stakeholders, discussing practical issues that shipping companies could encounter during the implementation process, particularly those that arise during the transition-phase before the new standard comes into force. The ESSF has established several groups that deal with very specific topics, including a group that focuses on LNG as ship fuel, a scrubber group and a group that focuses on the implementation of the Sulphur Directive.

The implementation group addresses issues such as sampling procedures. It looks into defining what is necessary in terms of sampling and supporting documentation (i.e., for fuel change-over procedures, bunker delivery notes, tank sounding records and logbooks), sampling points, the analysis stage, possible deficiencies, reporting of inspection and actions based on the identified deficiencies and penalties. This information will support Member States and Port State Control (PSC) in implementing the new sulphur directive.

Here are some of the things that shipowners and operators should be aware of:

- Representative fuel samples taken by PSC should be forwarded in clean properly marked and sealed bottles to a laboratory for testing. The laboratory should be accredited according to the ISO 17025 standard to ensure reliable and correct results. The sampling frequency is currently still being discussed, but member states will probably have to check 10% of all individual ships calling at EU-ports for compliance with the EU sulphur directive.

- Another important issue is to raise awareness for fuel switching and sulphur control inspection. Training sessions for inspectors and crews are currently being developed and will be offered from various parties. Along with publications, they can help you and your crew learn about the potential safety risks of the fuel change-over procedure.

- Port state control personnel also need to be qualified. Only PSC personnel with enough knowledge about fuel systems, machinery and fuel sampling will carry out the on board inspections. Common minimum standards for the training procedures are currently under discussion.

- “Remote Sensors” or “in situ” SOx emission monitoring are being discussed as options for checking compliance with the regulation. So called “sniffers”, installed in planes or fixed on bridges or harbour entries are capable of indicating that the “right” fuel is used while the exhaust plume of the ship is passing the sniffer. This could help PSC target their sampling better and increase the number of ships that are checked for compliance with the sulphur directive in their port. Ports in Sweden, Denmark, Germany and the Netherlands have already confirmed that they will use this type of “sniffer” technology. However, this will not replace on board fuel sampling, as Port State Control is legally obliged to rely only on on board fuel sampling.
CHALLENGES OF FUEL CHANGE-OVER

Switching from one type of fuel to another is a delicate operation that has many potential pitfalls. Therefore, vessels trading between areas with different sulphur limitations need to have detailed change-over procedures readily available on board the ship. The crew needs to be well trained and aware of any risks associated with the change-over – otherwise they risk engine failure, power loss or even blackout.

One reason why difficulties may occur is the fact that the two fuels have totally different properties. While HFO and low-sulphur HFO are similar (although different HFO batches should not be mixed on board or stored within one tank), this is not at all the case for HFO and marine gas oil (MGO). MGO and HFO differ in:

- Colour
- Density
- Temperature
- Viscosity
- Calorific value
- Acidity

As a result, these fuels tend to be incompatible when a certain mixing ratio is reached. To complete the change-over successfully, therefore, requires crews to prepare it in advance.

The exact sulphur content has a major impact on the related calculation; the closer the MGO sulphur content gets to the limit of 0.10%, the longer it will take to complete the change-over. A fuel that exceeds the limit for contained sulphur of 0.10% by mass, according to the bunker delivery note, should not be accepted for bunkering.

After discussing the fuel system in general, the next chapter will examine the following challenges in more detail: Temperature change during the fuel switch, fuel incompatibilities, lower viscosity, lubricity, acidity and changed flashpoint.

DESCRIPTION OF THE FUEL SYSTEM

As the fuel system is very complex, we will only focus on the relevant parts for the fuel change-over procedure. The change-over mainly occurs in the area between the service tanks, the main engine (ME) and the auxiliary engines (AE) inlet.

In principle, the service system is the supply and return line to and from the engines and their additional components – see the blue area in Figure 3 for illustration. There are also fuel systems that have a service system as well as two booster units for both ME and AE. In this case the corresponding fuel change-over from HFO to MGO has to be performed in both service systems.

In the following section the case of a fuel system containing a combined ME / AE service system is examined. Figure 3 shows an example for a combined ME / AE service system and two separate service tanks: one tank for HFO and one tank for MGO. The drawing is simplified and only shows basic components. Some parts of the fuel system, such as the viscosimeter and the filters are missing.

The fuel oil originating from the service tanks is pumped into the service system through a three-way valve. The fuel oil passes the fuel pumps before the supply is split into two service lines; one goes to the main engine and another goes to the auxiliary engine(s). Other fuel oil systems with a separated ME and AE fuel oil circuit work in a similar way.

Not all the fuel oil from the service lines is used for combustion and the remaining oil is transferred to the return line. In the return part of the service system, the flow from the main and auxiliary engines is gathered and is pumped back to the supply lines past the venting or the mixing tank and heated to achieve the required viscosity. This circuit will be used to explain the change-over procedure and the challenges it creates.
Before entering an ECA, single fuel ships have to change-over from the cheaper HFO to MGO containing a sulphur level that doesn’t exceed 0.10% by mass. The fuel change-over procedure is started by shutting down the flow from the HFO service tank with the three-way valve and supplying the necessary volume from the MGO service tank instead.

The piping of the service system is assumed as a closed circuit, which is filled up completely with circulating fuel oil. During the change-over process, the fuel in the service system will be continuously diluted by MGO. The time for reaching a sulphur level of 0.10% can vary drastically, depending on the current machinery fuel oil consumption, the volume of the service system and the sulphur levels in fuels. See section 6 for more information on a DNV GL fuel change-over calculator.

Figure 3: Schematic diagram of the relevant components of the fuel service system
**TEMPERATURE**

The operating temperature gradient between HFO and MGO is typically around 100°C and can be up to 120°C, assuming a standard operating temperature of 35°C for MGO and 135°C for most highly viscous HFO grades. During the change-over procedure from hot HFO to cold MGO, the temperature of the injection equipment changes accordingly - creating potential hazards. Since the volume of the engine’s service system is relatively small, the change-over may cause a rapid fall in temperature and increase the risk of thermal shock (thermal expansion or contraction) to the injection components. Thermal shocks can lead to insufficient clearance and may cause the pump plungers (and fuel valves) to scuff, stick, or even seize. Engine manufacturers recommend a maximum temperature change of 2°C per minute. Keeping the temperature change below this threshold is a challenge in itself. The most important parameters for the procedure are the engine’s fuel consumption rate and the temperature difference of both fuels at the beginning of the change-over. It is possible to meet the 2°C/min restriction by reducing the engine load and the temperature difference of both fuels. But temperature management must be handled with care, since HFO becomes very viscous when it is too cold and high temperatures can cause the MGO’s viscosity value to be too low. Both cases can cause damage to the injection equipment.

Performing the change-over at very low engine loads is also not advisable, because this prolongs the time in which the two fuels mix in the service system and increases the risk of asphaltene precipitation, filter blocking and, therefore, power loss, or even engine shut down. In short, these constraints require a measured approach to fuel change-over – aiming for a reasonable change-over time.

**VISCOSITY**

HFO and MGO differ significantly in terms of viscosity, as shown in Figure 4. The main reason for this is their different chemical composition: HFO contains molecules with much longer chains than MGO. This also causes the net calorific value of the distillates to be slightly larger than those of the residues (about 2-7%). They have a density difference of approximately 8%.

In general, HFO-capable engine equipment requires a viscosity of 10 – 20 centistokes (cSt) for operation. Residual fuels usually need to be heated up to 135°C to meet the required viscosity. In contrast, distillate fuels have a significantly lower viscosity, which typically lies within the range of 2 up to 11 cSt. The lower value of 2 cSt at 40°C is cited in most manufacturer recommendations, as this minimum viscosity is required to ensure a uniform lubricating film between the moving components of the injection equipment. If the viscosity is too low, the corresponding equipment can be affected in the following ways:

- Fuel pump seizures and premature wear off
- Increased leakage in fuel pumps, engine mounted pumps as well as fuel handling pumps.

We therefore advise clients to look for fuel bunker specifications with sufficiently high viscosity, in order to compensate for the subsequent rise of temperature in the fuel system (e.g., DMZ grade according to fuel specification ISO 8217).

![Figure 4: temperature related viscosities of the respective fuels](Source: Operation on Low-Sulphur Fuels, MAN B&W Two-stroke Engines, Homepage of MAN Diesel & Turbo, September 2014)
**LUBRICITY**

The lubricity of distillate fuels might be lower compared to residual fuels. Several components, such as the pump plunger, may experience insufficient lubrication when using ultra-low sulphur fuel. Sulphur is known as an additive component for increasing the lubricity. The automotive industry has decreased its sulphur content to nearly zero in the past decade. Their experiences have shown that a sulphur content of less than 50 ppm can cause lubricity problems (note that 1000 ppm corresponds to 0.10%). The automotive industry deals with this problem by adding other lubricants and subsequently carrying out lubricity tests to fulfil the requirements of the automotive fuel standard DIN EN590.

**FLASHPOINT**

Due to explosion risks related to the use of highly volatile fuels on board ships, IMO has banned the use of fuels with a flashpoint lower than 60°C. Some studies do exist, indicating that the ultra-low sulphur fuel oils often have a flashpoint lower than 60 degrees. These fuel oils should not be used on board and should be handled in accordance with the instructions from the Flag Administration and Class Society. Please note that the flashpoint is part of the Bunker Delivery Note and should be always checked when bunkering.

**FUEL INCOMPATIBILITIES**

The two different fuels will inevitably be mixed in all ratios during the process of fuel change-over. This bears the potential risk of incompatibility of residual fuel and ultra-low sulphur distillates. Adding distillate fuels to residuals can cause the asphaltenes contained in the residual fuel to precipitate as heavy sludge and clog up the filters. In some cases, this may cut off the fuel supply to the engine completely and cause the engine to shut down. Generally, we don’t recommend returning the fuel mix into the ultra-low sulphur service tank.

In order to prevent the incidents described above, we recommend carrying out compatibility tests for the respective fuels before they are bunkered. Corresponding test kits are commercially available and can be used manually on board. Of course, there is also the option of handing in fuel samples to an independent land based laboratory – but this would cause a considerable time lag between taking the samples and receiving the results.

**CYLINDER LUBRICATION – ACIDITY**

The cylinder oils are chosen in such a way that their alkalinity neutralizes any corrosive acidic sulphur in the fuel. However, when a fuel’s sulphur content decreases, it produces less acidic sulphur. An excessive alkaline content in the cylinder lubricant typically leads to polished or scuffed liner wear, while an insufficient alkaline content causes cold corrosion. Hence, when the fuel’s sulphur content is lowered, the alkalinity of the lubrication oil should be lowered accordingly, either by adjusting the feed rate and / or by using a cylinder lubricant of different BN quality. The change-over of cylinder lubricant is not a time-critical issue, but it is of utmost importance when operating on distillates for a longer period with very low sulphur content.
MODIFICATIONS OF FUEL SYSTEM

The equipment manufacturer should be consulted when someone is trying to ascertain whether the single components are able to operate with MGO and sulphur content of less than 0.10% by mass, or if any modifications are necessary. This applies to all oil-fired components, such as main engine(s), auxiliary engine(s) and boilers, but also to corresponding components, such as filters and pumps. This chapter provides guidance regarding modifications that may have to be carried out on certain parts of the fuel system.

We recommend installing cooler or chiller units in the fuel supply or returning line to prevent the distillate fuel oil from being heated above e.g. 40°C. Cooling will ensure higher viscosity and thereby reduce the risk of low viscosity lubrication on the components involved. Modifications within the fuel system fall under the scope of approval by a classification society and should therefore be communicated to the respective departments.

STORAGE TANKS

As a passage through an Emission Control Area can last for a longer period of time, shipowners are advised to carefully consider whether their ship is equipped with sufficient storage capacity for the ultra-low sulphur MGO. One of the greatest challenges is contamination. A tank which was formerly used to carry HFO needs to be professionally cleaned in order to prevent any contamination with bunkered MGO later on. A storage tank may also be divided into two different tanks, one containing HFO and the other containing MGO - good insulation is needed to ensure the MGO is prevented from heating. In both cases, a contamination with residues can still occur, especially during the first bunkering of MGO in the cleaned tank and this would lead to non-compliance. To avoid contamination with HFO, you should handle the following components with care:

- Bunker and transfer pipes
- Air and overflow system (ensure that fuel mix is prevented from returning to MGO storage tank)
- Sounding devices and / or level indicators
- Tank heating to be disconnected or modified
- Necessary update of trim and stability booklet due to different properties

SERVICE TANKS

According to SOLAS Chapter II-1/26.11, the service tank is supposed to have a sufficient capacity for 8 hours of normal operation. Shipowners need to ensure that an MGO service tank is separated from the heated HFO service or settling tanks and that the tank heating is disconnected or, at least, not in operation to avoid a possible fire hazard or risking supplying fuel with a too low a viscosity to the engine. The fuel oil transfer piping from the storage to the service tanks (including the pumps) needs to be separated. This is necessary to avoid possible contamination of MGO with HFO, resulting in potential non-compliance.

The return piping may be a further contamination hazard. If you use return flow, we recommend that any fuel mix should be lead back from the service system into the HFO service tank. If a return flow to the MGO tank is installed, you must ensure that the return line is filled with pure MGO. It is not recommended to use the return flow to the MGO service tank when a mixture of MGO and HFO may occur.
We advise shipowners and/or operators to develop sound fuel change-over procedures in order to cope with the challenges discussed above. The manuals should/will be kept in the ship documentation so that operational personal can follow the instructions as soon as they are used for on board compliance documentation - as they will be checked by PSC, as well. A detailed system inspection and maintenance plan can help prevent an accelerated wear off of the equipment.

Approaching January 2015, you need to train your staff comprehensively, in order to raise awareness for the challenges that the fuel change-over procedures can pose. Crews should receive regular training sessions to keep up to date during the implementation period.
Keeping up to date and with the ongoing changes in environmental legislation is a challenge, since new proposals for legislation come up all the time and the IMO is quicker to implement them into new policies today. With its longstanding maritime expertise in both regulatory affairs and technical innovation, DNV GL is helping our customers to overcome the challenges posed by the Emission Control Areas. This kind of support can help mitigate the risks associated with difficult fuel change-over procedures and prevent costly incidents, as well as lapses in the quality of a shipowner’s service.

**CLASS SERVICES**

**Approval of fuel system modifications**
Any changes or modifications to approved systems normally require class approval, see also page 11.

**Voluntary class notation ECA (SO₂)**
DNV GL has developed a voluntary class notation ECA (SO₂), which sets a standard for designing fuel oil systems as well as the modifications that are required for machinery components to enable the consumption of low sulphur and low viscosity marine distillate fuel oils (marine gas oil). The class notation can be granted to both new and existing ships.

**Witnessing of low sulphur fuel change-over and operations**
Though not required by Classification, ship operators may be asked to provide a statement confirming the vessel’s capability to operate on ultra-low sulphur fuel, the effectiveness of fuel change-over procedures, or both. This can be the case with charter parties for example. In such situations DNV GL may issue a document in the form of a witness statement, after an on board attendance has shown that the machinery can be operated on ultra-low sulphur fuel and/or the fuel change-over has been witnessed. See also Recommended Practice (RP-D202).

Contact your Key Account Manager / Business Development Manager or request via: Date@dnvgl.com

Please contact your local service station.
ADVISORY SERVICES

Fuel Change-Over (FCO) Calculator
DNV GL provides a ship-specific FCO Calculator application, which is Microsoft Windows-based. It uses a complex numerical simulation of the fuel change-over process to calculate an optimal change-over period and is more effective in reducing costs than previous simulation models. The fuel change-over calculator takes the following issues into account:

- Specific fuel system layout
- Continuously variable sulphur content of fuels
- Continuously variable fuel oil consumption
- Continuously variable temperature of fuels
- Return flow from service system to service tank
- Constraints on temperature
- Price of respective fuels.

And the following results are calculated:

- The optimized lead time for the change-over process
- A warning if the temperature limit is exceeded
- The amount of MGO used for the change-over procedure and the associated costs
- Maximum hourly consumption to meet constraints

Please contact:
systems-engineering@dnvgl.com

Troubleshooting
If incidents damage the fuel systems and other related systems, DNV GL can help alleviate the problem. We have a wide range of experience with trouble shooting, both on a design level and on board the ship. DNV GL engineers can help customers to find root causes for the problem and recommend modifications to reduce future damages in terms of costs and/or even off-hire.

Contact your Key Account Manager or request via:
Date@dnvgl.com

Training
The DNV GL’s Maritime Academy offers training courses on the challenges of fuel switching in ECAs for 2015, which discusses the issues relating to the change-over in detail.

Air pollution from ships in practise
The course objective is to gain advanced knowledge about exhaust emission legislation, abatement technology and alternative fuels.

Focus points
- Principles of pollutant formation in engines
- Revised MARPOL Annex VI and NOx Technical Code 2008
- Conversion of ships in operation (Approved Methods)
- Latest technical developments in exhaust after-treatment
- Impact of restricted use of high sulphur fuel oil (HSFO) & alternative fuels
- Emission measurement techniques
- On board surveys
- GHG issues: Energy Efficiency Operational Indicator (EEOI), Energy Efficiency Design Index (EEDI)
Low sulphur fuel – basics and experience
Participants will gain detailed knowledge for managing the international requirements regarding sulphur reduction for ship newbuildings and ships in service.

Focus points
■ Keeping the ship in line with new international requirements while maintaining safe and profitable operational conditions and avoiding damage to machinery
■ Avoiding fines and port state detentions by knowing the actual regulations
■ Being able to design, construct and inspect a ship according to the latest international regulations

Gas as ship fuel
The course will give the participants an overview about the current developments in the field of gas as ship fuel.

Focus points
■ Properties of liquefied gases
■ Applicable rules and regulations
■ Tank and pipe systems and ventilation
■ Safety-related aspects of a gas fuelled propulsion system
■ Ship type considerations

The Maritime Academy web-page
www.dnvgl.com/maritime-academy provides more information about the course. You can contact the academy under the following email address:
academy.maritime@dnvgl.com

References
Recommended practices:
Driven by its purpose of safeguarding life, property and the environment, DNV GL enables organisations to advance the safety and sustainability of their business. DNV GL provides classification and technical assurance along with software and independent expert advisory services to the maritime, oil & gas and energy industries.

It also provides certification services to customers across a wide range of industries. Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, DNV GL empowers its customers’ decisions and actions with trust and confidence. The company continuously invests in research and collaborative innovation to provide customers and society with operational and technological foresight. DNV GL, whose origins go back to 1864, operates globally in more than 100 countries with its 16,000 professionals dedicated to helping their customers make the world safer, smarter and greener.