SOx - FUEL CHANGE MANUAL

Manual No. 01

IMO No. 1234567

Content

1. Ship Details

Ship's Name:	
Ship's Maiden Name (if applicable):	
GSM Phone:	
Inmarsat F - phone	
Inmarsat F - fax	
Inmarsat F - email	
Inmarsat C	
MMSI:	
Call Sign:	
IMO Number:	
Length over all [m]:	
Breadth overall [m]:	
Summer draught [m]:	
Gross Tonnage:	
Year built:	
Flag:	
Official No:	
Class:	
Port of registry:	

2. Owner Details

Owner:	
Operator:	
Address	
Tel:	
Fax:	
E-mail:	
Telex:	

3. Engine Details

ME	
Consumption:	
AE 1	
Consumption	
AE 2	
Consumption	
AE 3	
Consumption	
AE 4	
Consumption	

4. Consumption HFO

Average HFO	
Max	
Min	

5. Fuel System

5.1. Tanks - HFO m³

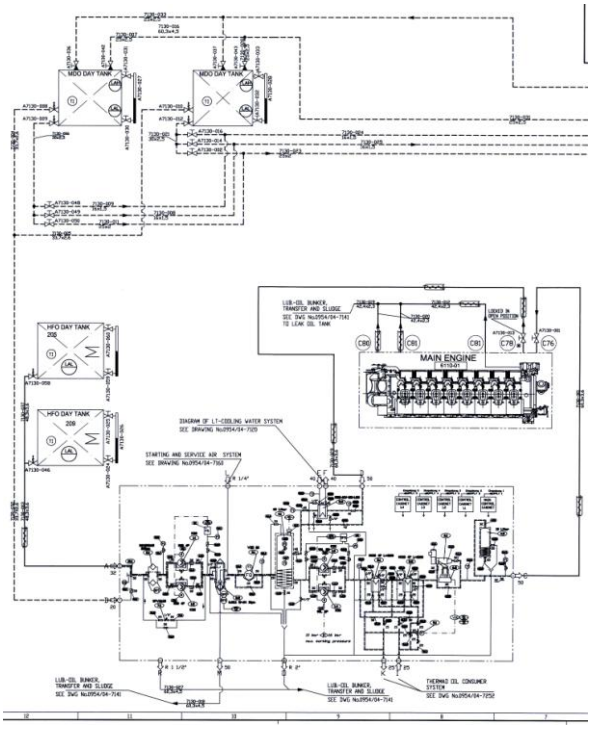
Tank Name	Code	100%	85%	Remark

5.2 Tanks – MDO m³

Tank Name	Code	100%	85%	Remark

5.3 Pump Capacities

5.4 Sketch



6. Backround & Future

MARPOL 73/78, Annex VI outlines international requirements for vessel air emissions and pollution prevention.

Under the terms of the convention, nations must require ships of their administration and foreign ships in their waters to comply with these international air pollution prevention regulations.

Upon entry into force of Annex VI to MARPOL on the 19 May 2005, the sulphur oxide (SOx) emissions from ships are controlled by setting a limit of 4.5% on the sulphur content of marine fuel oils. Further, a limit of 1.5% on the sulphur content of marine fuel oil is apply in designated SOx Emission Control Areas (SECAs).

SECAs
IMO has currently agreed on the designation of two SECA's, the first is the Baltic Sea and the second the North Sea with English Channel. It is expected that further SECA's will be designated and IMO has set forth certain criteria for designating such SECA's.

ECA (Emission Control Area)
ECA means to unite Sulphur Emission Control Areas (SECA) with incorporation of NOx emission as requirements.
So far Emission Control Area means an area where the adoption of special mandatory measures for emissions from ships is required to prevent, reduce and control air pollution from SOx, NOx, and particulate matter and its attendant adverse impacts on human health and the environment.
Emission Control Areas includes those listed in, or designated under regulations MARPOL ANNEX VI Reg. 13 and 14.

NOx
As a part of the revision of MARPOL Annex VI, IMO countries agreed to set stricter limits for NOx from ships too. MEPC of IMO agreed in 57th meeting that in the ECAs, NOx reduction from 17 gkWh-1 to 14.4 g/kWh is mandatory for engines constructed after 2011.
After 2016 only max of 3.4 gkWh-1 is allowed for new ships. This practically makes catalytic converters compulsory for ships sailing in NOx ECA areas, provided that low sulphur fuel can be produced at sufficient quantities.
It is noteworthy that IMO also requires modification of old engines built in 1990-2000, so that they conform to existing NOx limits of 17 gkWh-1.

Revised MARPOL Annex VI
The Baltic Sea and the North Sea will become ECA's upon entry into force of the revised MARPOL Annex VI. The MEPC agreed that two sessions of MEPC would be required to complete the necessary revisions to the Code.

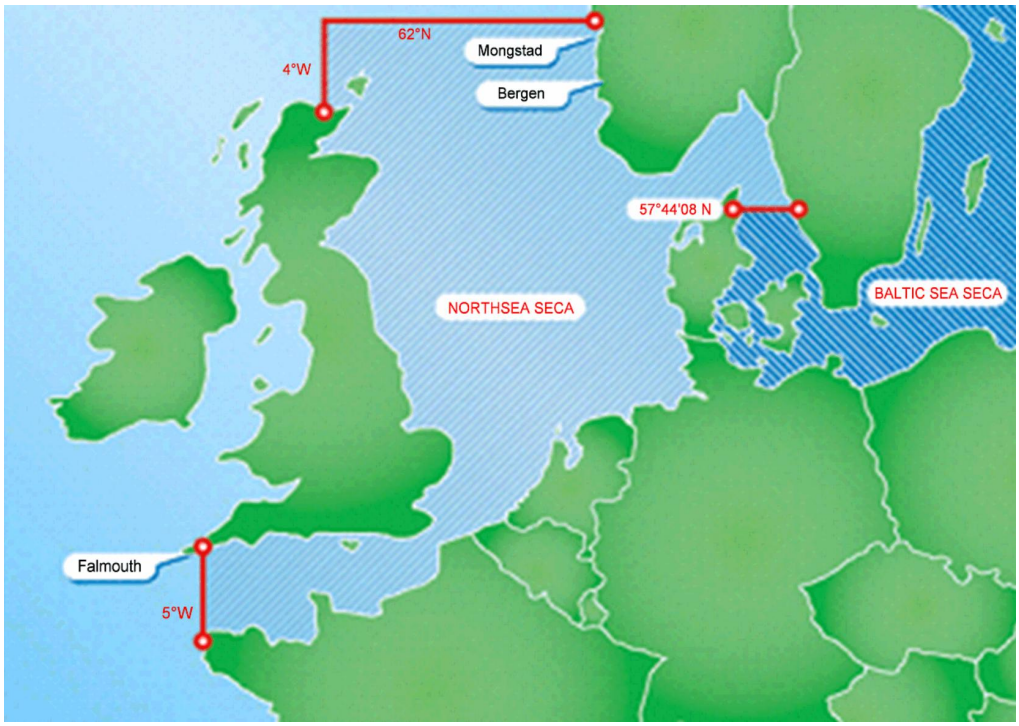
- Subsequently it was agreed to revise the entry into force date to 1 July 2010.
- Global limits reduced to 3.50% from the 1st January 2012.
- Global limit reduced to 0.50% from 1st January 2020, subject to a 2018 review.
- Global limit reduced to 0.50% by the 1st January 2025.
- Sulphur content in fuel oils reduced to 1.00% within an Emission Control Area (ECA) from the 1st July 2010.
- ECA Sulphur content limits reduced to 0.10% from the 1st January 2015.

Those ships using separate fuel and entering or leaving an ECA shall carry a written procedure showing how the fuel oil change-over is to be done, allowing sufficient time for the fuel oil service system to be fully flushed of all fuel oils exceeding the applicable sulphur content prior entry into ECA. The volume of low sulphur fuel oils in each tank as well as the date, time, and position of the ship when any fuel-oil-change-over operation is completed prior to the entry into an ECA or commenced after exit from such an area, shall be recorded.

Summary - EU and other requirements

2007	1st January	CARB	Max 0.5% sulphur within 24 miles of California shore
	11th August	EU	North Sea and English Channel SECA enters into force
	22nd Nov	IMO	North Sea and English Channel SECA enters into force
2008	1st January	EU	Max 0.1% sulphur for marine gas oils
2010	1st January	EU	Max 0.1% sulphur bunker fuel in use at EU berths
		EU	Max 0.1% sulphur in all EU inland waterways
		CARB	Max 0.1% sulphur within 24 miles of California shore
2012	1st January	EU	Max 0.1% sulphur bunker fuel in use by Greek ferries at Greek ports

SECA Areas



-Baltic Sea
-North Sea

- East of 5 West – English Channel
- East of 4 West – North Sea
- South of 62 North
- 57.44.08 North – Baltic Sea

7. Change-over procedures

Change-over between heavy fuel oil grades is standard practice and so is changeover from heavy fuel oil to marine diesel oil in connection with e.g. dry-dockings.

Change-over from heavy fuel oil to marine gas oil is however completely different and clearly not common standard. If gas oil is mixed in while the fuel temperature is still very high, there is a high probability of gassing in the fuel oil service system with subsequent loss of power.

It should be acknowledged that the frequency and timing of such change-over may increase and become far more essential upon entry into force of SECA's.

Additionally, the time, ship's positions at the start and completion of change-over to and from 1.5% fuel oil must be recorded in a logbook (e.g. ER log. book), together with details of the tanks involved and fuel used. It can be anticipated that the same will be applicable with respect to the EU proposal upon entry into force.

Following description of procedure, how it is possible to keep set limits of Sulphur with entrance in SECA(s).

7.1. Company's General Standard

Generally 3 days before passing western borderline of SECA / EU the nearly empty Settling Tank should be drained in one of both possible Storage Tanks (HFO Storage Tk. 3 PS or STB).

Afterwards the Settling Tank can be filled with LSF, must be rest 2 days and can be switched to consumption via Purifier. One drained Day Tank will be filled from both with the cleaned LSF and aftwards the second one. During this time the second Settling Tanks will be cleaned and filled with LSF, where the fuel has to be rest 2 days too.

In ECR all tank indicators for LSF/ HSF to be marked accordingly. Further all HSF Tanks to be closed permanently and marked accordingly in the ECR, too.

After leaving the SECA / EU area the fuel system can be switched back to normal HFO.

7.2 Flow-Through Method

Flow through process is useful to estimate parameters of SOx change and means to pump three times the mass / capacity LSF into the relevant service tank to get an exchange rate with HSF of more than 95%.

The Flow-through Method is known for instance from IMO Res.A.868(20) for Ballast Water Management and requests there the same to change at least three times of tank volume, giving an exchange of 95%.

7.3 Beneficial Calculation

If there is an fuel system with may be double settling- and service tanks, no specific calculation or extended manual will be necessary.
In other cases, for instance fuel change by means of blended LSFO & HFSO, a calculation will be provide reliable information and can optimize costs.

8. Calculation according 7.3

8.1. Boundary Conditions

- Ideal blending of fuel
- Constant fuel consumption of machinery
- Constant fuel delivery to service tank
- Constant filling level service tank
- Filling of settling tank starts at 0%. Tank is filled up to 85%
- Fuel contents in piping and fuel system unconsidered
- Temperatures and viscosity unconsidered

8.2. Sample conditions

- Pump transfer: Vin
- LSF from HFO Storage Tk. 3 PS
- LSF in HFO Settling Tk. 1
- HSF in HFO Daytank 1 VTank
- HSF consumption = LSF admixtion
- LSF Clsf
- HSF Chsf
- Concentration to be calculated Ct

8.3. Sample – Sulphur Concentration after dt and as function of ME consumption

1.) Input:

- Sulphur of LSF-HFO: Sulphur concentration of LSF – Fuel
- Sulphur of HSF-HFO: Sulphur concentration of HSF – Fuel
- Capacity of Day TK: Capacity of Tk or Tanks were fuels will be mixed
- Exchange Rate: Equal ME consumption.
- Time after start LSF mix:

2.) Question:

- Which Sulphur concentration after dt and in consideration of ME fuel consumption ?

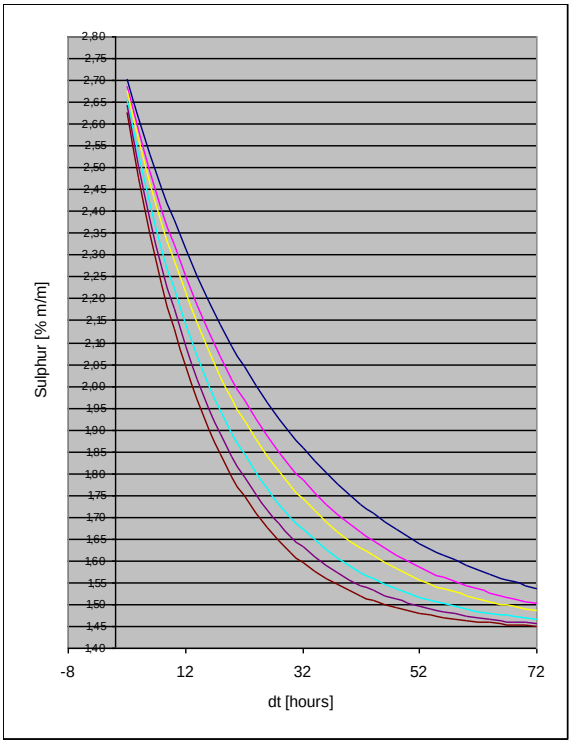
3.) XLS Sheet – Single Value

1. Basics for calculation of Ct - single value					
Sulphur of LSF-HFO	Clsf	1,40	%	0,043756406	EXP
Sulphur of HSF-HFO	Chsf	2,70	%	1,3	Chsf-Clsf
Capacity of Day TK / average fuel level	Vtank	25,30	mto (85%)	1,4	Clsf
Exchange Rate	Vin	1,58	mto/h	**1,456883327**	**Ct = Desired Sulphur for t**
Time after start LSF mix	t	50,00	h		

4.) XLS Sheet – Table

2. Table of Ct calculation - ME consumption in 5 mto steps							
Sulphur after t/h and Vin of:	**Vin**	**1,25**	**1,46**	**1,60**	**1,88**	**2,08**	**2,29**
t	**2**	2,58	2,56	2,55	2,52	2,50	2,48
	4	2,47	2,43	2,41	2,37	2,34	2,30
	6	2,37	2,32	2,29	2,23	2,19	2,15
	8	2,28	2,22	2,18	2,12	2,07	2,03
	10	2,19	2,13	2,09	2,02	1,97	1,93
	12	2,12	2,05	2,01	1,93	1,88	1,84
	14	2,05	1,98	1,94	1,86	1,81	1,77

5.) Graph



8.4. Sample – Lead Time calculation

1.) Input:

- Sulphur of LSF-HFO: Sulphur concentration of LSF – Fuel
- Sulphur of HSF-HFO: Sulphur concentration of HSF – Fuel
- Capacity of Day TK: Capacity of Tk or Tanks were fuels will be mixed
- Exchange Rate: Equal ME consumption.
- Desired Sulphur concentration for dt

2.) Question:

- Which time is necessary to reduce Sulphur concentration to desired amount, depending from selected HSF to LSF and in consideration of ME consumption (Exchange Rate).

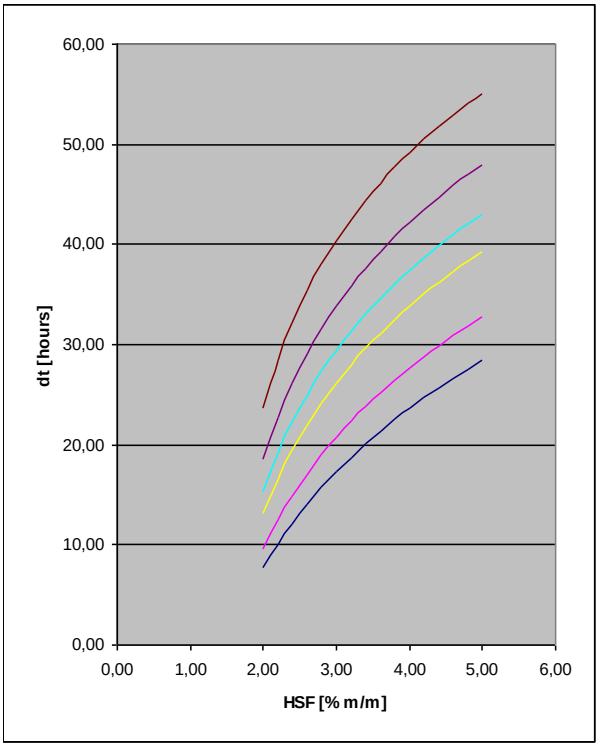
3.) XLS Sheet – Single Value

3. Basics for Lead Time calculation - single value					
Sulphur of LSF-HFO	Clsf	1,4	%	-2,890371758	ln
Sulphur of HSF-HFO	Chsf	3,2	%	4,7	V
Capacity of Day TK - average fuel level	Vtank	18,8	mto (85%)		
Exchange Rate	Vin	4	mto/h	**13,58474726**	**Time after start LSF mix (h)**
Ct = Desired Sulphur concentr. for t		1,5	%		

4.) XLS Sheet – Table

4. Lead Time Tables							
Time to reduce Sulphur (%)	LSF %	0,50	0,75	1,00	1,10	1,20	1,30
HSF %	2,00	1,91	2,40	3,26	3,81	4,61	5,89
	2,20	2,49	3,10	4,11	4,75	5,66	7,07
Ct = req sulphur conc	2,40	3,02	3,71	4,84	5,54	6,52	8,01
1,5	2,60	3,49	4,24	5,47	6,21	7,24	8,80
	2,80	3,91	4,73	6,02	6,80	7,87	9,47
	3,00	4,31	5,16	6,52	7,32	8,42	10,06
	3,20	4,67	5,56	6,96	7,79	8,92	10,58
	3,40	5,00	5,93	7,37	8,22	9,36	11,05

5.) Graph



8.5. Sample – LSF consumption

1.) Input:
- Time interval of LSF use – dt: Time after starting of HSF / LSF mix
- LSF intake: Amount of LSF transfer in day tank – equal ME consumption per hour, in case of constant tank level
- ME consumption per day
- ME consumption per hour

2.) Question:
- How many LSF will be burned until exceeding set limit of Sulphur concentration.

3.) XLS Sheet – Single Value

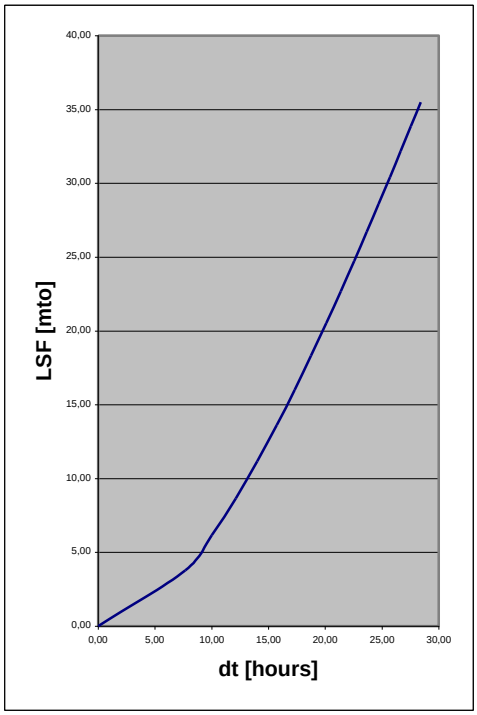
5. Basics for LSF consumption - single value						
Time interval of LSF use		dt	55,00	h	0,101097825	EXP
LSF intake		Vl	1,58	mto/h	87,08333333	ME*t
ME consumption per day		Vd	38,00	mto/d		
ME consumption per hour		Vin	1,58	mto/h	**78,27939774**	**LSF consumption for dt**

4.) XLS Sheet – Table

	6. LSF Consumption Tables in mto						
	LSF %	0,50	0,75	1,00	1,10	1,20	1,30
	HSF %						
Table showing LSF tons	2,00	2,43	3,73	6,48	8,56	11,90	17,93
necessary to change from	2,20	4,00	5,93	9,78	12,54	16,80	24,07
HSF to LSF concentration	2,40	5,65	8,15	12,92	16,21	21,14	29,27
	2,60	7,32	10,32	15,86	19,57	25,00	33,74
	2,80	8,97	12,42	18,60	22,64	28,46	37,65
	3,00	10,59	14,42	21,14	25,45	31,58	41,12
	3,20	12,16	16,33	23,51	28,04	34,42	44,23

In LSF consumption table used dt values are from Lead Time Table!

5.) Graph



8.6. Summary

The XLS calculation should be used to get information about necessary time and LSF amount necessary for safe approach to SECA border.

1) Determine ETA for next port and average fuel consumption
2) Determine sulphur concentrations of HSF and LSF
3) Calculate necessary lead time to SECA border for actual HSF and LSF concentration
4) Calculate roughly estimated LSF consumption / bunker.
5) Keep records about the SECA passing in/out bound

Keep in mind that details of fuel oil changeover procedures from HSFO to LSFO, and vice versa, need to be recorded as required by Regulation 14(6) of Annex VI. The volume of LSFO in each tank, as well as the date, time, and the position of the ship when any fuel changeover operation is completed, is to be recorded in log books, i.e. the engine room log book. It should be noted that non compliance while operating inside the SECA is a detainable deficiency and it is the ship owner's responsibility to document that the fuel oil burned within the SECA has net sulphur content below 1.5%.

9. PSC - Questionaire

As result of latest Port State Controls and External ISM Audits it is necessary to point out the importance of available procedure for Fuel Change before entering SECA.

SOx and Fuel Oil Quality - Bunker Delivery Notes

- Bunker Delivery Notes contain information specified in Appendix V to Annex VI
- Sulphur content of not more than 4.5 % m/m
- Kept aboard for 3 years after bunker delivery

SOx and Fuel Oil Quality - Bunker Samples

- Each sample not less than 400 ml for each delivery
- Sealed
- Uniquely identified
- Location (including facility), date & method drawn
- Marked with the delivery date
- Marked with the name of the bunker facility
- Marked with the vessel's name and IMO number
- Signed by the fuel supplier's representative and the Master or Officer in charge
- Marked with the bunker grade
- Onboard storage at cool/ambient temperature and not stored in direct sunlight or in an accommodation space
- Sample retained for a minimum of 12 months

Sulphur Emission Control Areas (SECA) Baltic Sea / North Sea

- If separate fuel tanks are used – verify that "high" & "low" sulphur fuels cannot be blended/mixed
- Verify unauthorized inter-connection of "high" & "low" sulphur fuel piping
- Approved exhaust gas cleaning system (if installed)
- Verify logs to ensure date, time, position, of fuel change over was documented
  - Verify bunker delivery notes to verify 1.5% m/m sulphur fuel was delivered
  - Verify that fuel system was sufficiently flushed of fuel exceeding 1.5% m/m before entering SECA
  - Sulphur content consumed in SECA does not exceed 1.5% m/m