

# ■ imaros

Final conference

## Project background

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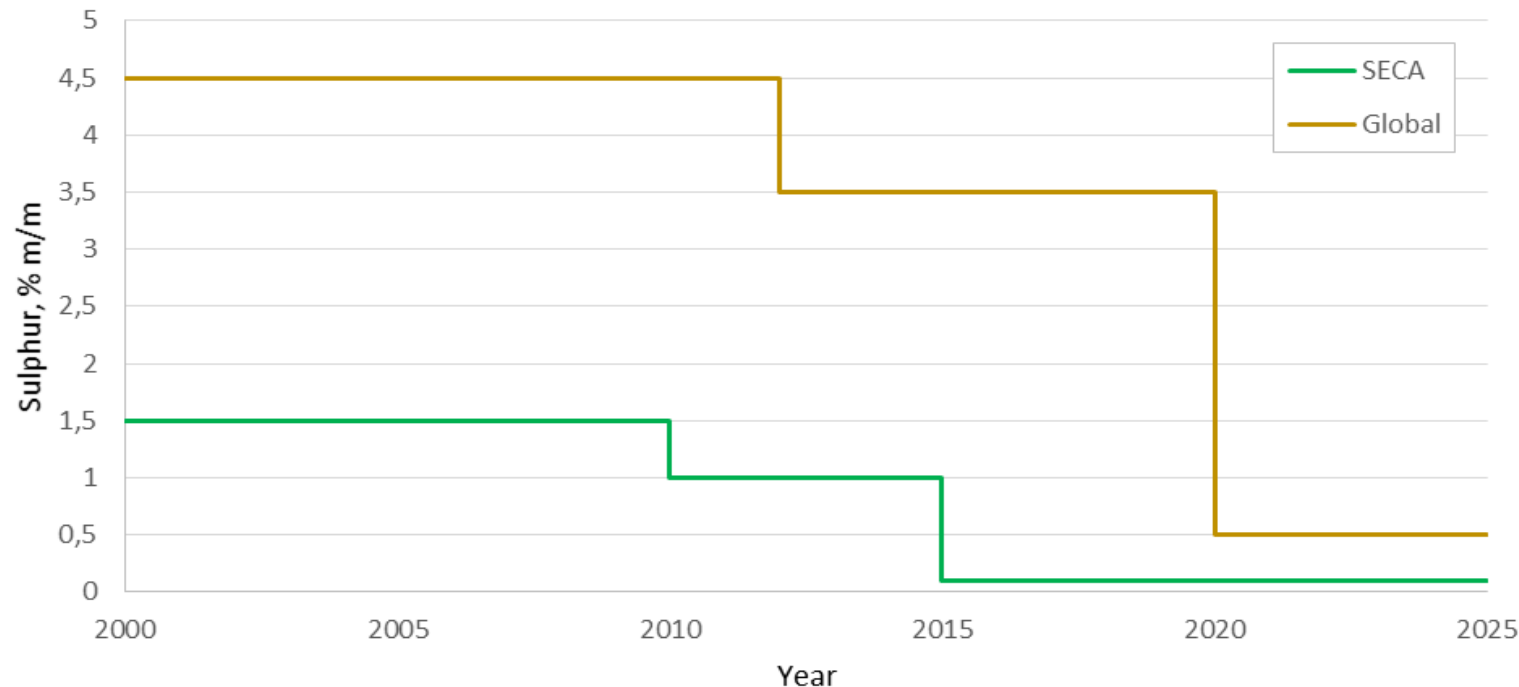
On 1<sup>st</sup> January 2015, new requirements on the sulphur content of ships' fuels took effect, laid down in Annex VI of the IMO MARPOL Convention.

Within the **Sulphur Emission Control Areas (SECAs)** ships must use fuels with a maximum sulphur content of 0.10% – or adopt alternative solutions resulting in an equivalent effect.



Emission Control Areas, figure from DNV





Limits on the sulphur content of fuel to be used inside and outside SOx Emission Control Areas (SECA). Alternatively, approved abatement methods must be applied.

# Compliance options



Figure: 

- New fuel types on the market – designed to meet the new regulations
- Lack of knowledge how spills of these fuels behave:
  - chemical and physical properties
  - toxicity
  - best methods for response

## New generation fuel oils

- **Ultra low sulphur fuel oils – ULSFO**
- **Very low sulphur fuel oils – VLSFO**
- ECA fuels
- Hybrid fuel oils
- ...

# Classification ISO 8217 Fuel Standards (2017)

## Requirements for Marine Distillate Fuels

## Requirements for Marine Residual Fuels

Characteristic	Unit	Limit	Category ISO-F-					
			DMX	DMA	DFA	DMZ	DFZ	DMB
Kinematic viscosity at 40 °C	mm <sup>2</sup> /s <sup>a</sup>	Max	5,500	6,000	6,000	6,000	11,00	
		Min	1,400	2,000	3,000	2,000		
Density at 15 °C	kg/m <sup>3</sup>	Max	-	890,0	890,0	900,0		
Cetane index	-	Min	45	40	40	35		
Sulfur <sup>b</sup>	mass %	Max	1,00	1,00	1,00	1,50		
Flash point	°C	Min	43,0	60,0	60,0	60,0		
Hydrogen sulfide	mg/kg	Max	2,00	2,00	2,00	2,00		
Acid number	mg KOH/g	Max	0,5	0,5	0,5	0,5		
Total sediment by hot filtration	mass %	Max	-	-	-	0,10 <sup>c</sup>		
Oxidation stability	g/m <sup>3</sup>	Max	25	25	25	25 <sup>d</sup>		
Fatty acid methyl ester (FAME) <sup>e</sup>	volume %	Max	-	-	7,0	-	7,0	
Carbon residue – Micro method on the 10 % volume distillation residue	mass %	Max	0,30	0,30	0,30	-		
Carbon residue – Micro method	mass %	Max	-	-	-	0,30		
Cloud point <sup>f</sup>	winter	°C	Max -16	report	report	-		
	summer	°C	Max -16	-	-	-		
Cold filter plugging point <sup>f</sup>	winter	°C	Max -	report	report	-		
	summer	°C	Max -	-	-	-		
Pour point (upper) <sup>f</sup>	winter	°C	Max -	-6	-6	0		
	summer	°C	Max -	0	0	6		
Appearance				Clear and Bright <sup>g</sup>				

Characteristic	Unit	Limit	Category ISO-F-				Category ISO-F-							
			RMA	RMB	RMD	RME	RMG			RMK				
			10	30	80	180	180	380	500	700	380	500	700	
Kinematic viscosity at 50 °C	mm <sup>2</sup> /s <sup>a</sup>	Max	10,00	30,00	80,00	180,0	180,0	380,0	500,0	700,0	380,0	500,0	700,0	
Density at 15 °C	kg/m <sup>3</sup>	Max	920,0	960,0	975,0	991,0	991,0			1010,0				
CCAI	-	Max	850	860	860	860	870			870				
Sulfur <sup>b</sup>	mass %	Max	Statutory requirements											
Flash point	°C	Min	60,0	60,0	60,0	60,0	60,0			60,0				
Hydrogen sulfide	mg/kg	Max	2,00	2,00	2,00	2,00	2,00			2,00				
Acid number <sup>c</sup>	mg KOH/g	Max	2,5	2,5	2,5	2,5	2,5			2,5				
Total sediment – Aged	mass %	Max	0,10	0,10	0,10	0,10	0,10			0,10				
Carbon residue – Micro method	mass %	Max	2,50	10,00	14,00	15,00	18,00			20,00				
Pour point (upper) <sup>d</sup>	winter	°C	Max 0	0	30	30	30			30				
	summer	°C	Max 6	6	30	30	30			30				
Water	volume %	Max	0,30	0,50	0,50	0,50	0,50			0,50				
Ash	mass %	Max	0,040	0,070	0,070	0,070	0,100			0,150				
Vanadium	mg/kg	Max	50	150	150	150	350			450				
Sodium	mg/kg	Max	50	100	100	50	100			100				
Aluminium plus silicon	mg/kg	Max	25	40	40	50	60			60				
Used lubricating oil (ULO):			Calcium > 30 and zinc > 15						or					
- Calcium and zinc; or Calcium and phosphorus	mg/kg	-	Calcium > 30 and phosphorus > 15											

ULSDO / ADO  
( < 10 ppm )  
( 0.001%S )

MGO  
=  
DMA

MDO  
=  
DMB

"New generation LSFOs:

- ULSFO: < 0.1 % S
- VLSFO: < 0.5 % S

"Traditional" HFOs:  
( IFO-180 / 380 )

VHFOs:  
IFO-500 / 700

Wide spectre. Do not fit into one specific grade



- Previous NCA – project

<https://www.kystverket.no/Beredskap/forskning-og-utvikling/diesel--og-hybridoljer/forskningsresultater/>

- 2 case studies:
  - Makassar Highway – incident (Sweden)
  - Flinterstar – incident (Belgium)



NCA /SINTEF project to gain knowledge on spills of distillate fuel oils and new generation low sulphur fuel oils, especially in cold climate.

- Laboratory and mesoscale tests at SINTEF laboratory
- Basin tests at NCA test facility
- Testing at 2 °C and 13 °C

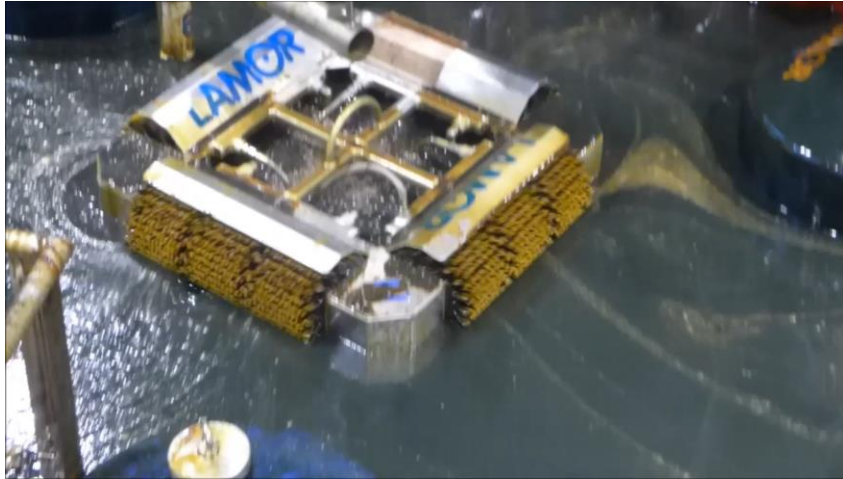


Oil sample	Initial analysis	Extended analysis	Skimmer tests
Marine Gas Oil 1000 ppm S	X		
Marine Gas Oil 500 ppm S	X	X	X
Gas Oil 10 ppm S	X	X	
«Rotterdam diesel»	X	(X)	
«Krasnoselsk»	X		
Wide Range Gasoil (WRG)	X	X	X
Heavy Distillate Marine ECA 50 (HDME 50 )	X	X	X
Ultra Low Sulphur Fuel Oil (ULSFO)	X	X	X

# Physical properties of distillate and hybrid fuel oils

Oil type	Residue	Evaporation (vol. %)	Residue (wt. %)	Density (g/ml)	Flash point (°C)	Pour point (°C)	Viscosity (mPa·s) 2°C (10 s <sup>-1</sup> )	Viscosity (mPa·s) 13°C (10 s <sup>-1</sup> )	Viscosity (mPa·s) 50°C (*40°C)
<b>HDME 50</b>	Fresh	0	100	0.903	186	12	11002	1005	36
<b>ULSFO</b>	Fresh	0	100	0.872	75	24	13106	4300	11
	250°C+	14.6	86	0.878	112	30	77782	33169	-
<b>Rotterdam Diesel</b>	Fresh	0	100	0.885	82.5	<-36	43	12	5.4*
	250°C+	6.1	94	0.887	110.5	-27	56	14	-
<b>MGO 500 ppm S</b>	Fresh	0	100	0.852	62.5	<-36	8	3	3.7
	250°C+	30.6	70.8	0.868	110	<-36	20	12	-
<b>GO 10 ppm S</b>	Fresh	0	100	0.833	71.5	<-36	5	0	2.1
	250°C+	59.5	41.2	0.846	107.5	-33	10	7	-
<b>WRG</b>	Fresh	0	100	0.886	115.5	-24	179	59	12.6/ 17.4*

## Brush skimmer in HDME 50 (0 °C)





## Brush skimmer / adhesion band skimmer in ULSFO (0 °C)



- Two very different 0.1 % S fuels
- Need to gather more experience:
  - Better knowledge of the different products available?
  - Field experiences?
  - Further tests and analysis?
- NCA engaged in new projects on the topic:
  - National projects (SINTEF, oil on water trails)
  - Arctic council project
  - Co-funding ITOPF R&D award project
  - European Project - IMAROS

- Planning
- Meetings & workshops
- Financial management
- Reporting

WP1: Project management



- Overview of frequently encountered new 0,1 % and 0,5% S products
- Sample collection and selection for WP 3 and 4

WP2: Compilation of knowledge



- Chemical composition and physical properties:
  - Oil weathering
  - Behaviour in the environment
  - Oil spill identification
  - Modelling

WP3: Chemical characterisation



- Testing of response methods and equipment:
  - Mechanical recovery
  - Dispersants
  - *In situ* burning
  - Shoreline clean-up

WP4: Response options



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