



CIMAC CIRCLE Oslo 9. June 2005

FIELD EXPERIENCE
OF
2-STROKE LARGE BORE DIESEL ENGINES
BURNING FUEL OIL
WITH LOWER SULPHUR CONTENT

A.P.Møller
Denmark

ExxonMobil
USA
Denmark

Wärtsilä
Switzerland
Singapore

Test – Lower Sulphur Fuels – 2001-2002

- Why?

- Environmental

- Low Sulphur Fuels will become the NORM

- Very Limited Operational Experience

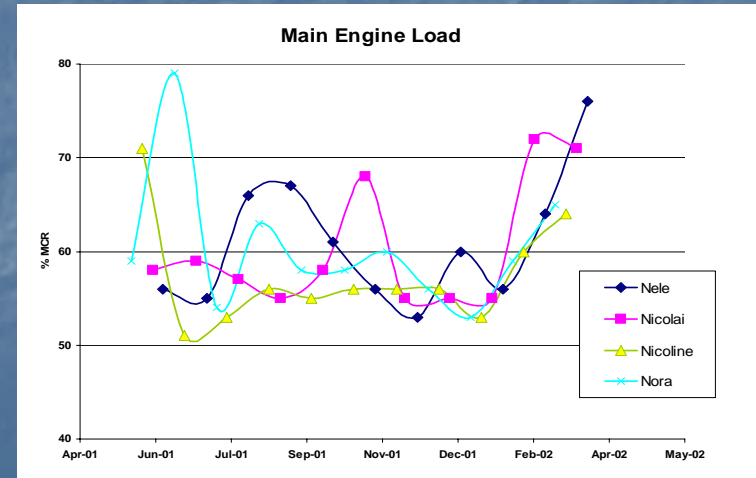
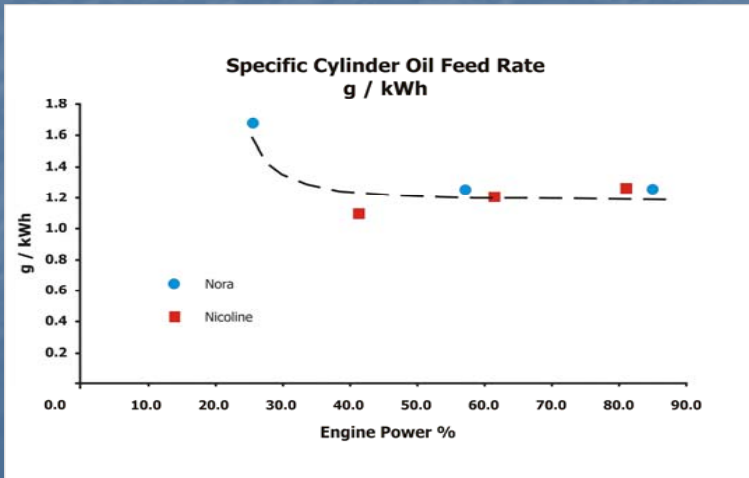
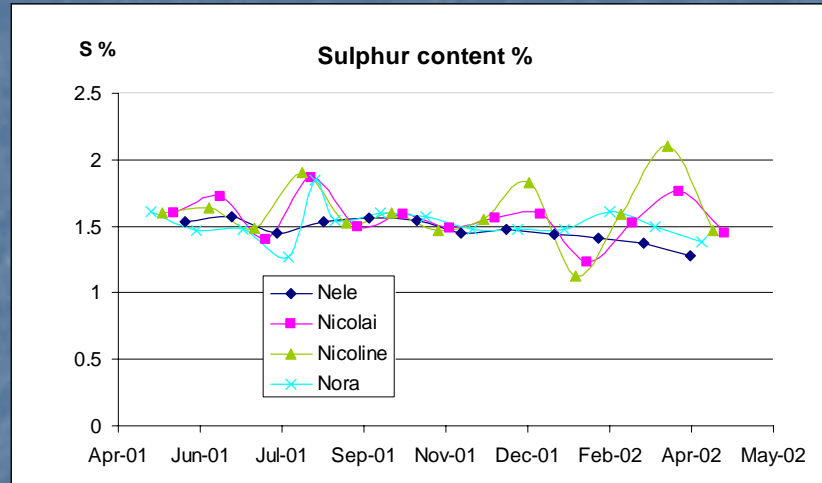
- Will specially formulated Cylinder Oils be required?
 - Will Wear Rates increase significantly?

Test – Lower Sulphur Fuels

- Where?
 - Fuel availability
 - Limit fuel requirements
 - Ease of Inspection
 - Confidentiality
- N-Class Container vessels (2200 teu)
 - Wärtsilä Sulzer 7RTA84CU
 - MCR 38,570 bhp @ 102rpm
- Tanjung Pelepas to New Zealand
 - Four week cycle



Conditions



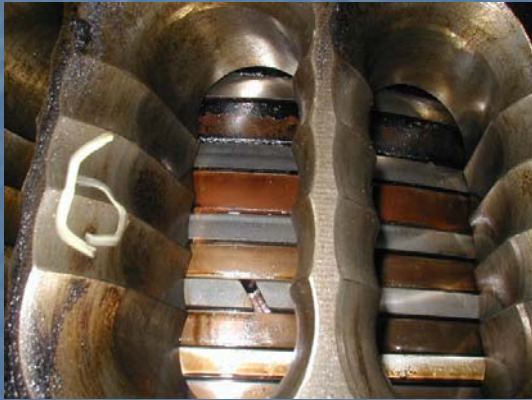
Test – Lower Sulphur Fuels

■ Evaluation

- Port Inspections
- Replicas
- Deposits
- Scrape Down
- Wear Measurements



Port Inspection / Overhaul



Replicas

Nicoline Maersk
20.03.2002

Main Engine Hours:
11887hr

Cylinder Liner #4F

300mm below TDC



Healthy Results

Nicoline Maersk
20.03.2002

Main Engine Hours:
11887hr

Cylinder Liner #4P

10mm below TDC



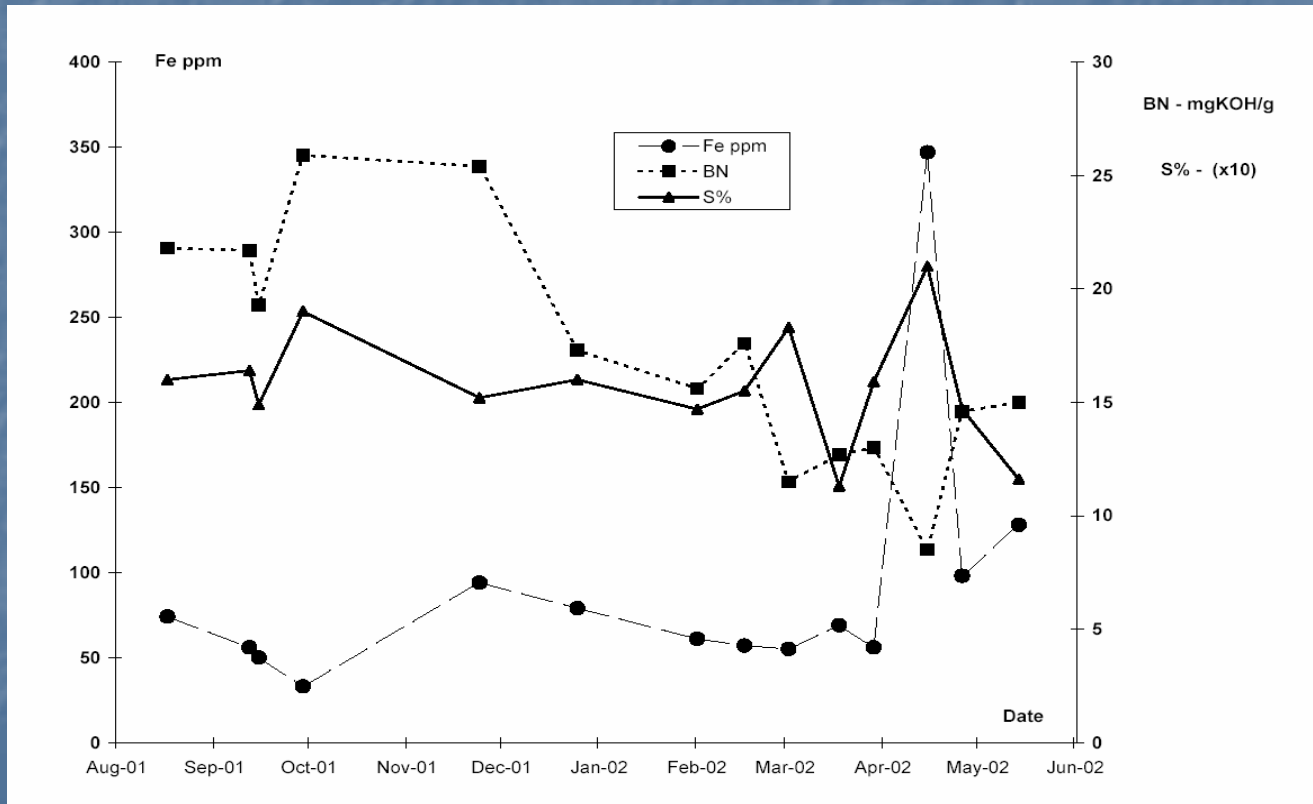
Micro-abrasion

Cat. Fines

Scrape Down Samples



Nicoline Maersk



Deposits

- Hard Deposits not seen
- Deposit Range 8B to 2H



Hardness Scale

9B 8B 7B 6B 5B 4B 3B 2B B HB F H 2H 3H 4H 5H 6H 7H 8H 9H



Softer

Harder

Deposits

Nicoline Maersk - Piston Land Deposits, Piston #4			
Piston Land	Thickness, Microns		Hardness
	Average	Maximum	
No. 1 (Crown Land)	621	2850	HB - 3H
No. 2	3	9	
No. 3	2	6	
No. 4	5	44	
No. 5	1	5	

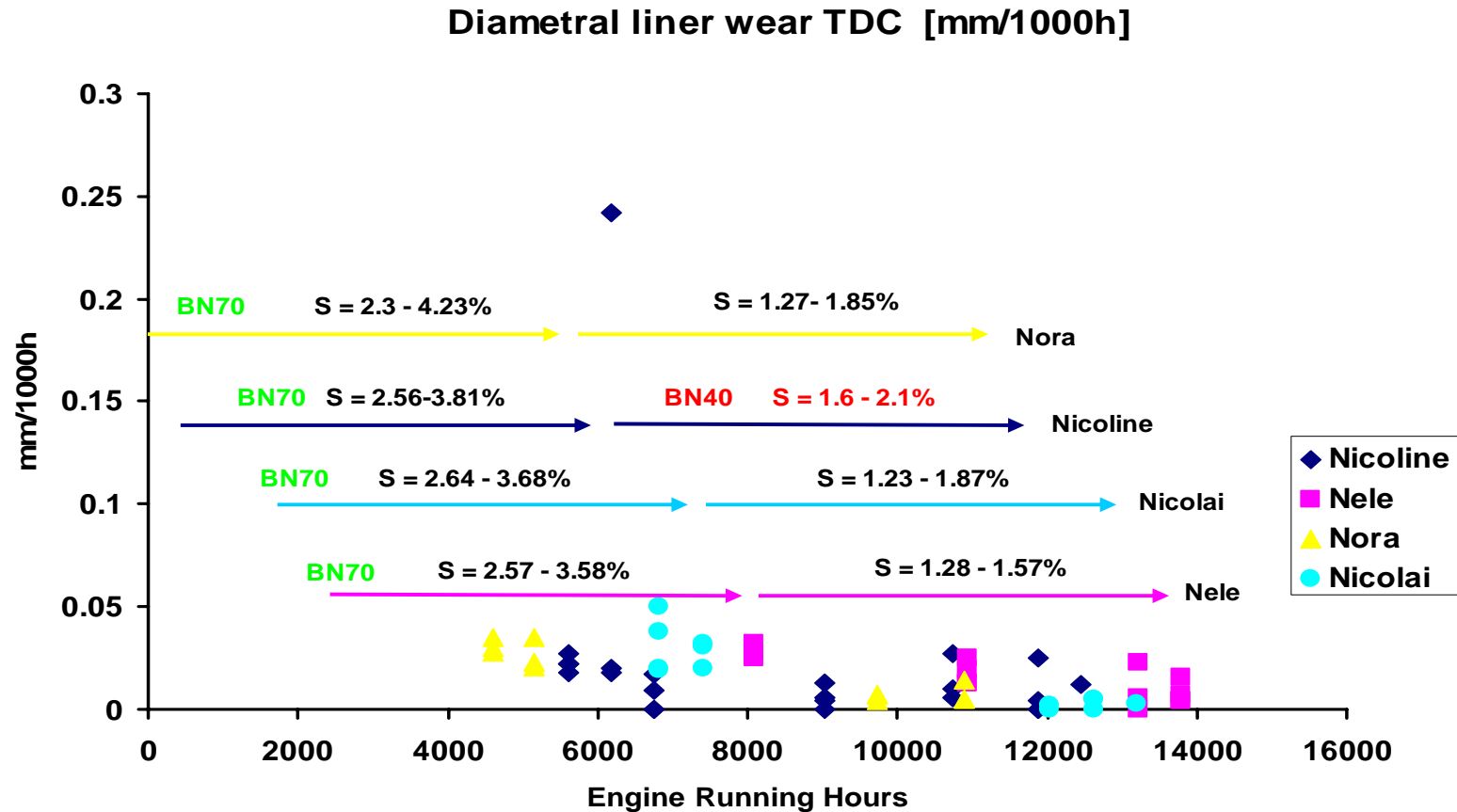
Nicoline Maersk - Ring Groove Deposits, Piston #4			
Ring Groove	Thickness, Microns		Hardness
	Average	Maximum	
No. 1	10	24	B
No. 2	234 (1)	1081 (1)	7B
No. 3	11	20	<8B
No. 4	7	13	
No. 5	5	54	<8B

NOTE: (1) Deposits concentrated in FP - Aft quadrant

Nicoline Maersk - Ring Top and Back Deposits, Piston #4						
Ring	Ring Top Deposits (1)			Ring Back Deposits		
	Thickness, Microns		Hardness	Thickness, Microns		Hardness
	Average	Maximum		Average	Maximum	
No. 1	2	3		5	7	B - 2H
No. 2	29	44		215 (2)	1013 (2)	<8B - HB
No. 3	8	12		6	9	
No. 4	3	7		5	12	
No. 5	0.5	1		1	2	

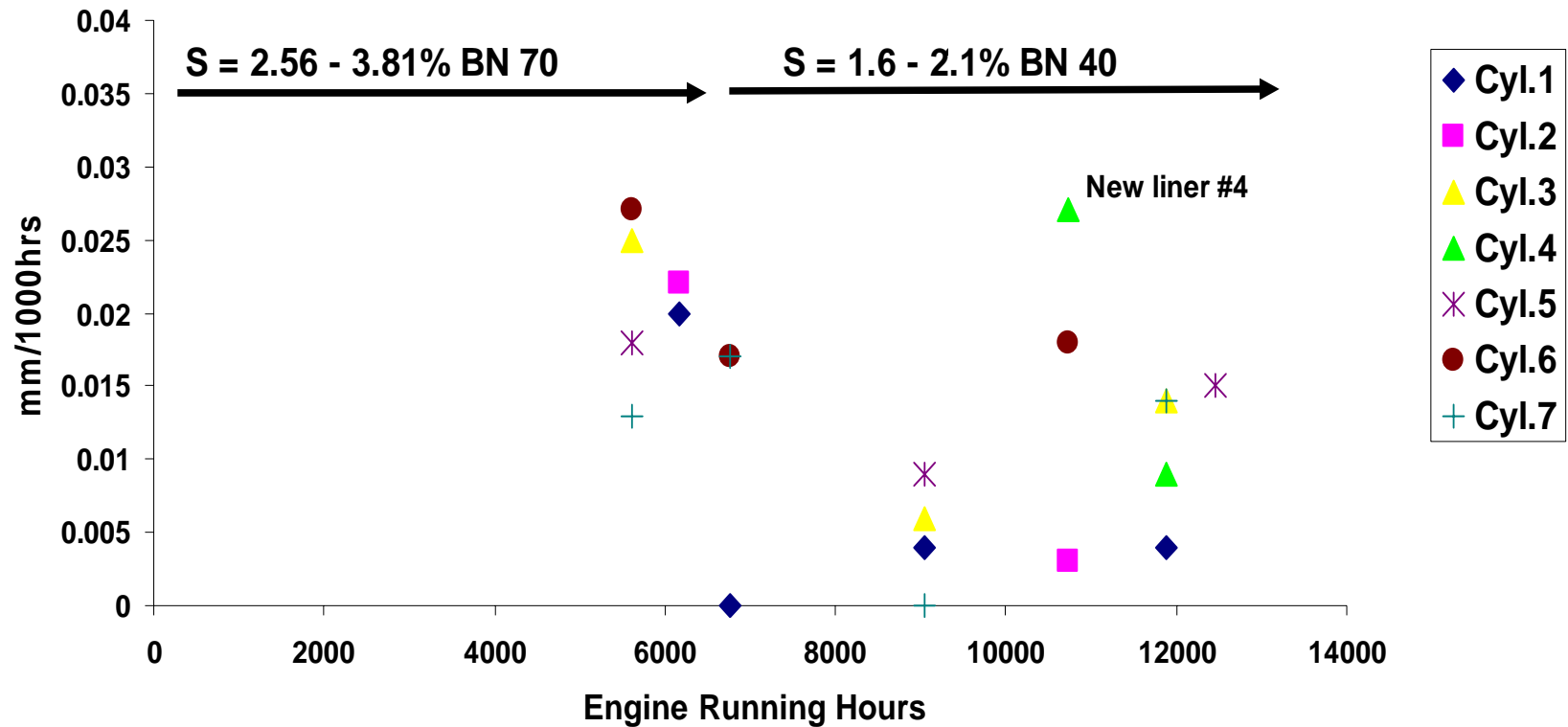
NOTE: (1) All piston rings free; no sticking or sluggishness
 (2) 1 spot of significant deposit near gap

Cylinder Liner Wear

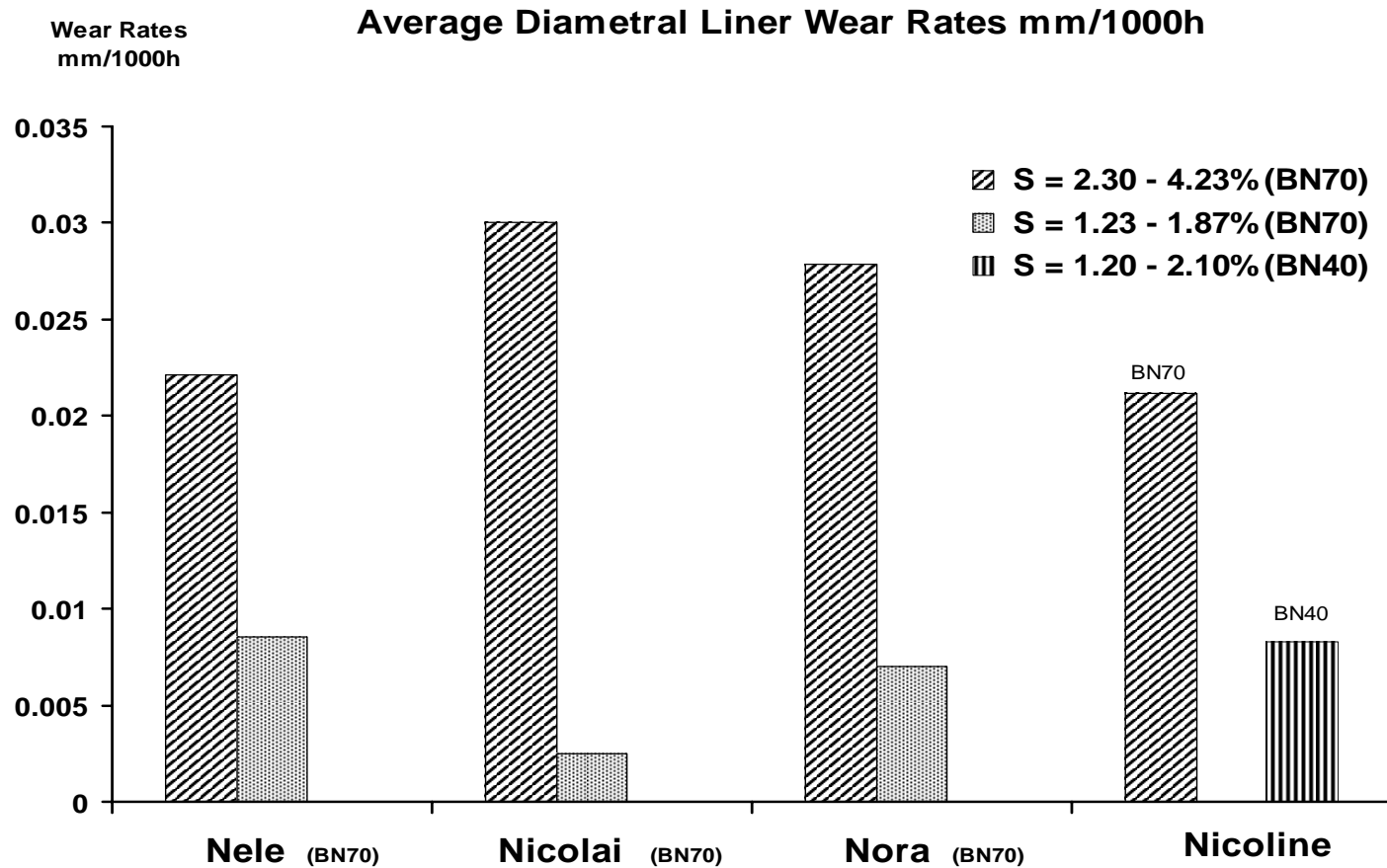


Cylinder Liner Wear

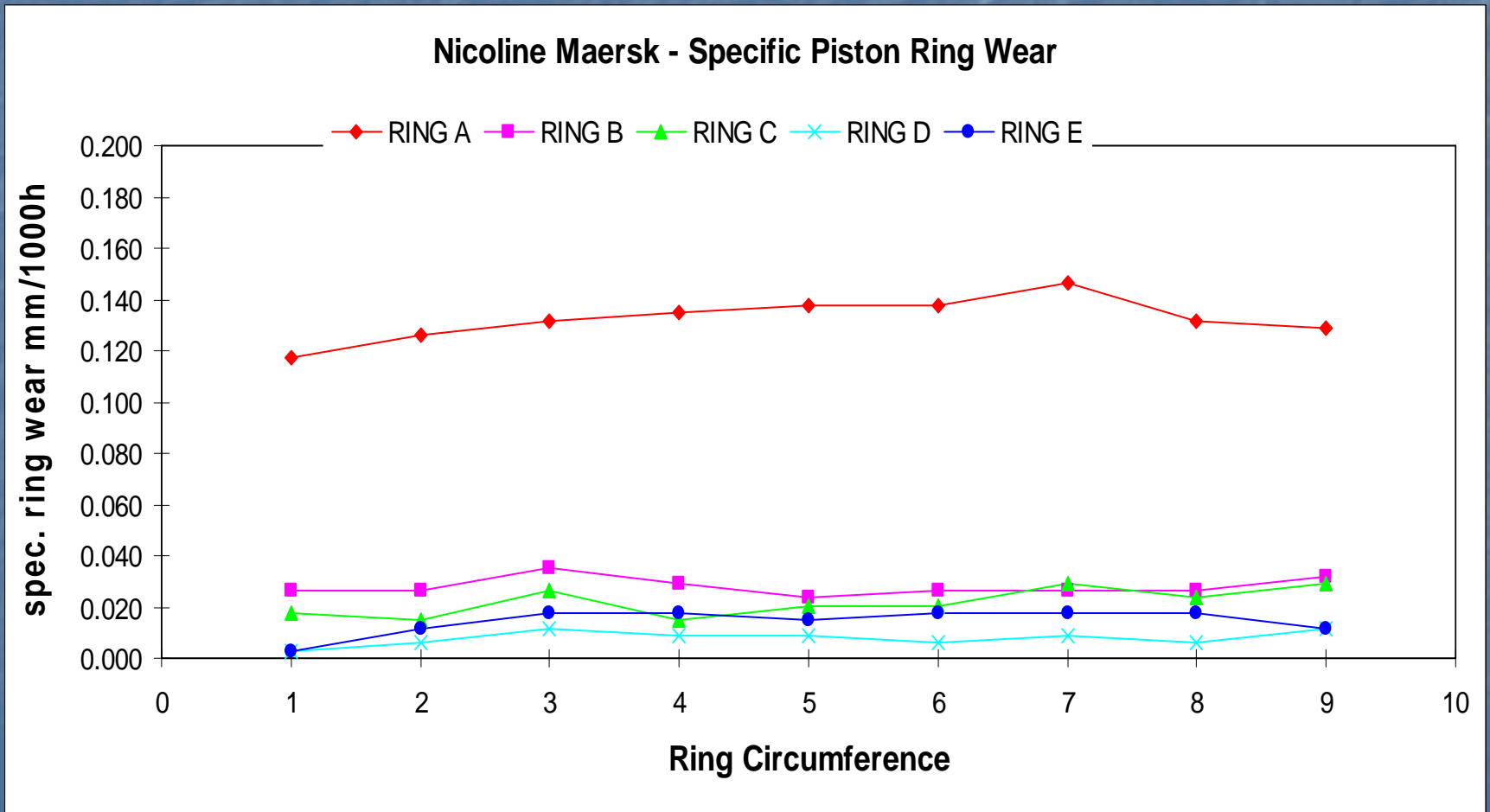
Nicoline Maersk - Diametral Liner Wear TDC [mm/1000hrs]



Cylinder Liner Wear



Piston Ring Wear



Conclusions of the Trial

- Liner Wear - improved
- Both BN40 and BN70 satisfactory at 1.5% Sulphur
- BN40 upper limit 1.5%

- BN70 lower limit yet to be determined

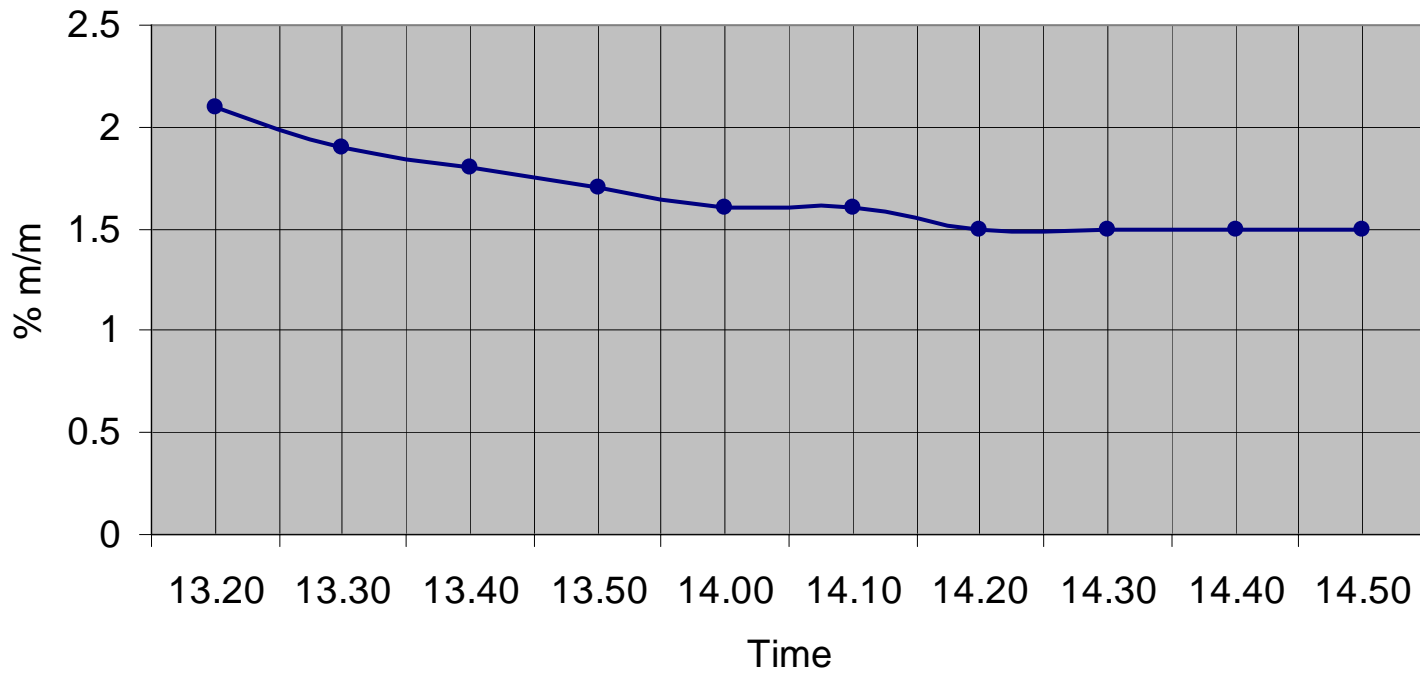
- Catalytic fines
- Scrape Downs

Low Sulphur Fuel Handling Trial

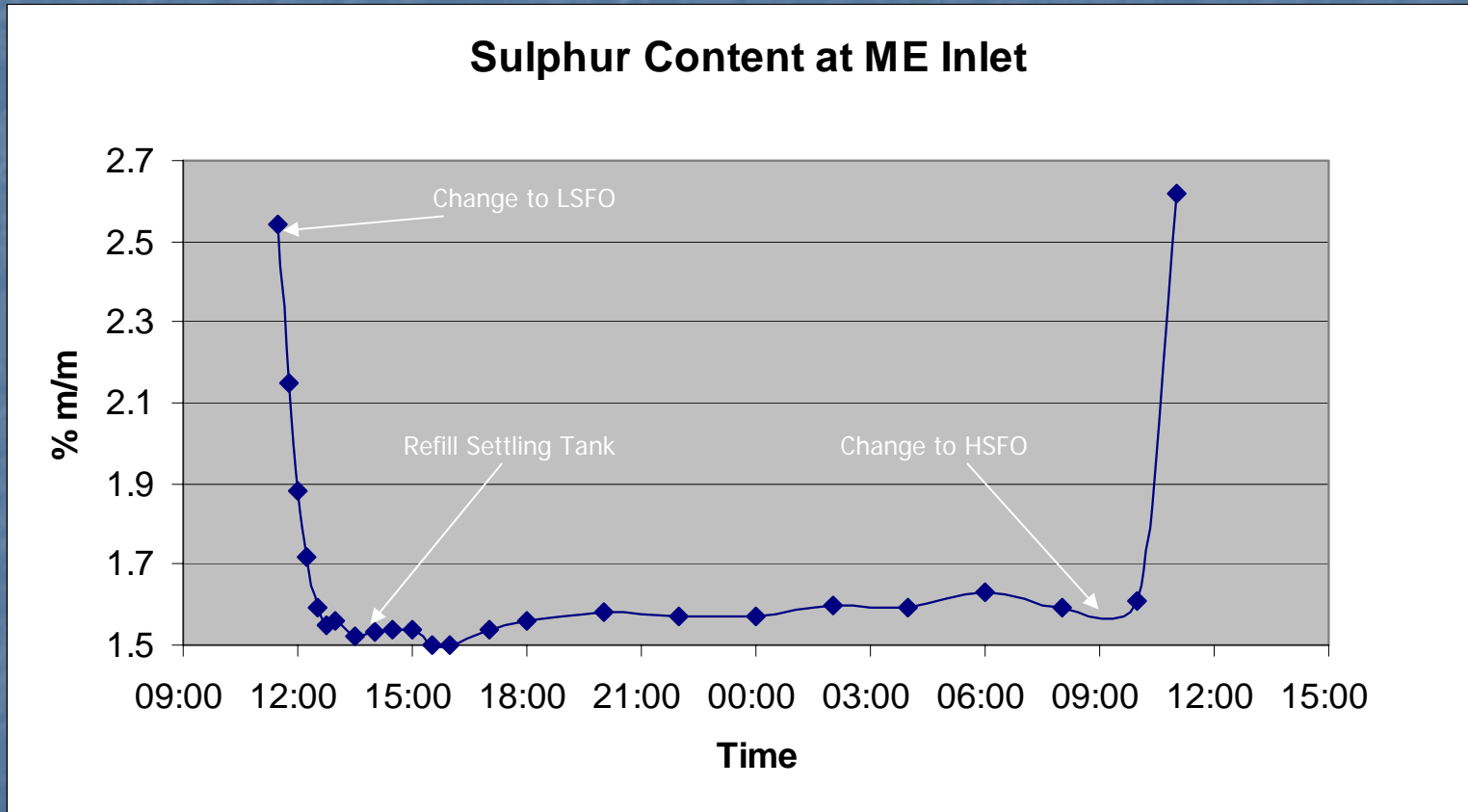
- Hi and Lo Sulphur Fuel Vessels
- Handling on-board
- Additional Settling / Service Tank(s)

Low Sulphur Fuel Handling (Test 1)

Sulphur Content at M/E inlet



Low Sulphur Fuel Handling (Test 2)



Low Sulphur Fuel Handling Trial

- Change-over Time dependent on tank arrangement
- Clean LSFO Tanks
 - <1% of HSFO (2.8% Sulphur) mixed with LSFO (1.49% Sulphur) will exceed limit

Thank You

