

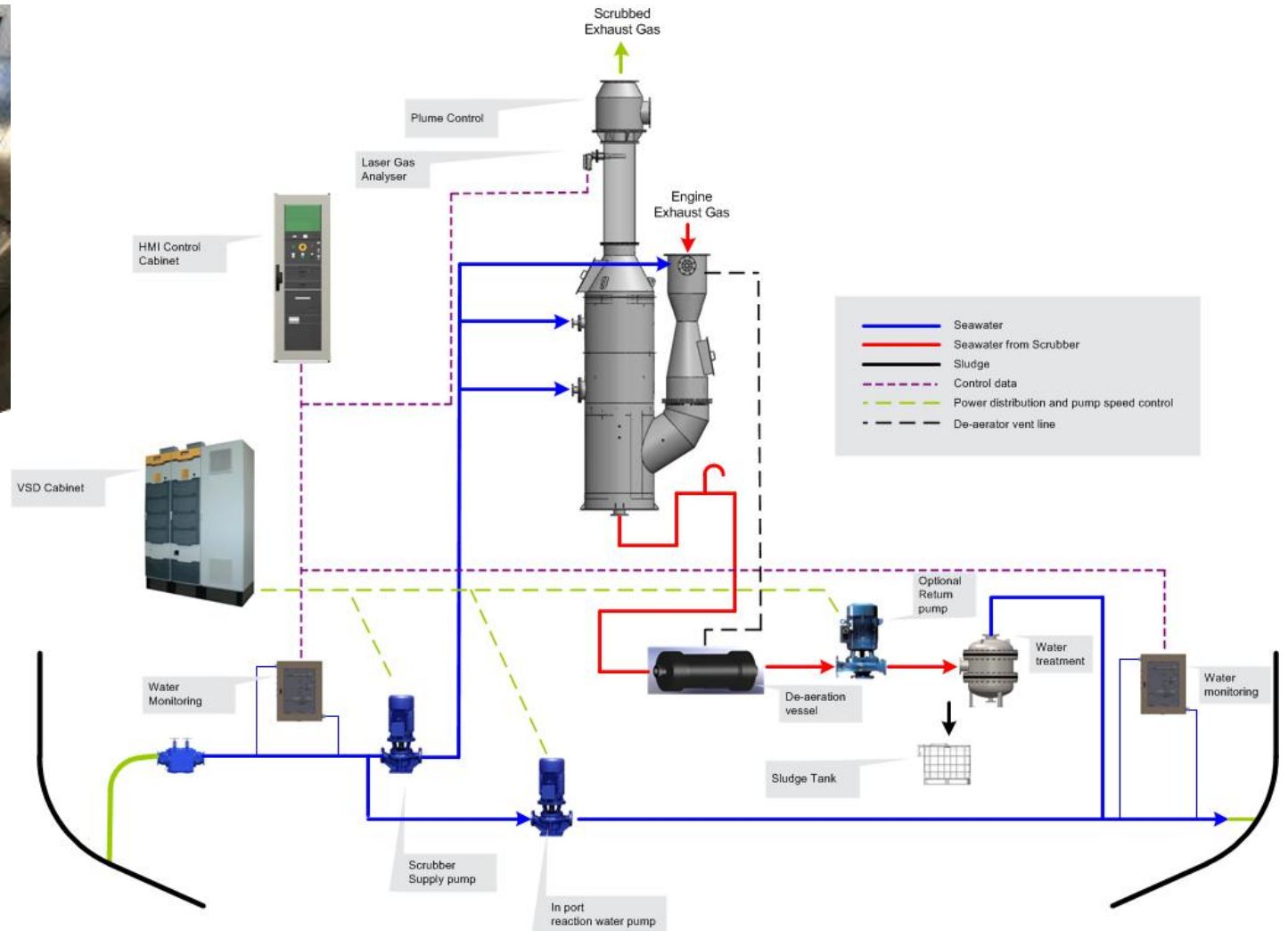
Scrubbing Technology - Update

SMM Hamburg, 2010



Scrubbing Technology - Update

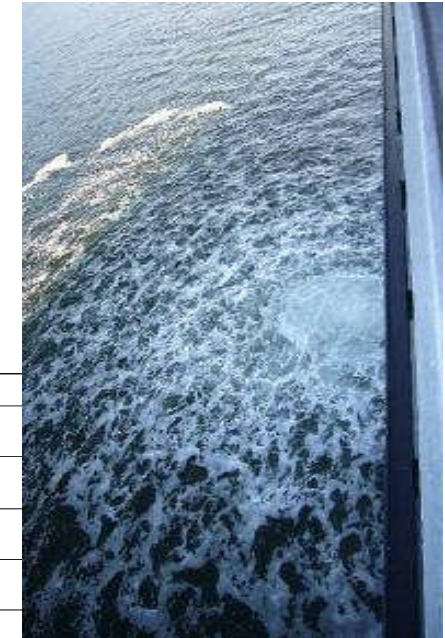
The basic technology



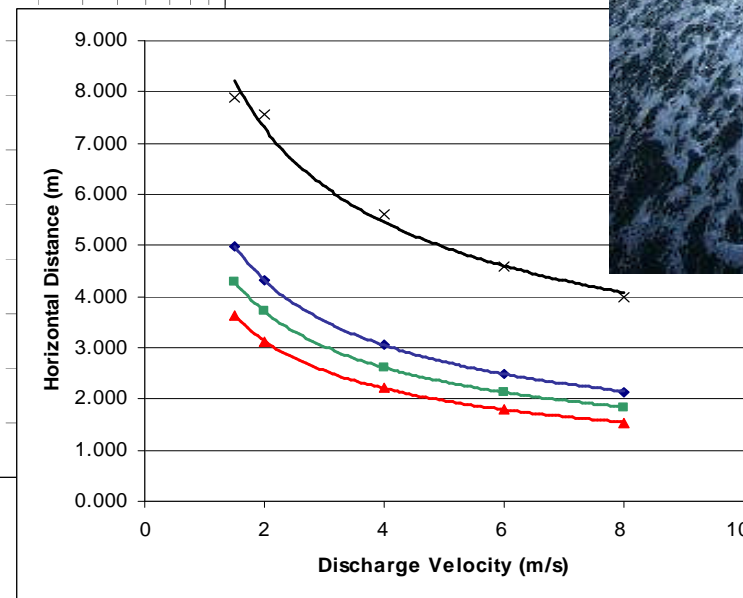
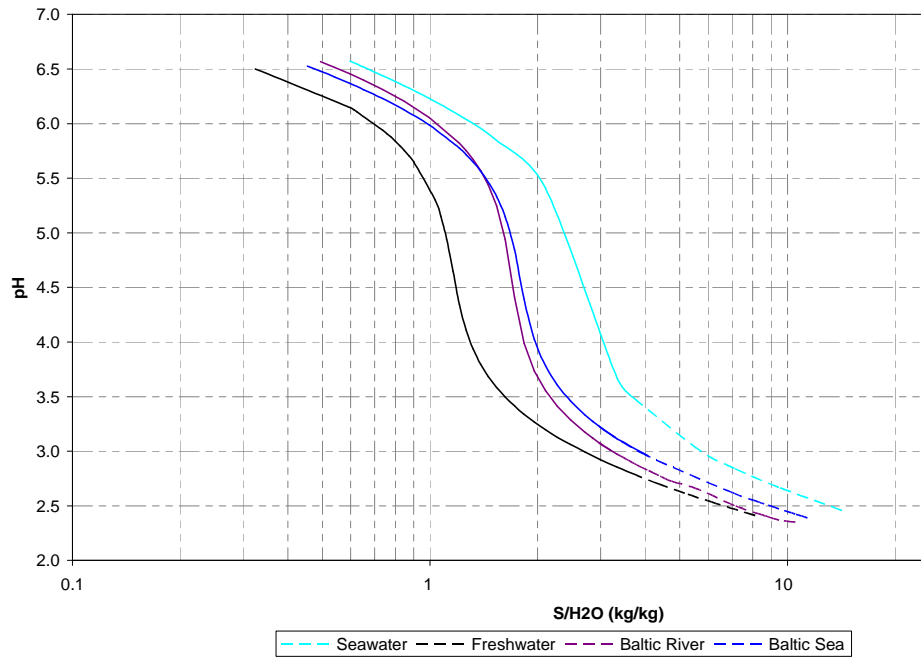
Scrubbing Technology - Update

Operating Experiences

- ▶ **Pride of Kent scrubber operational for >30,000hrs.**
- ▶ **Zaandam scrubber operational for >4,000hrs**

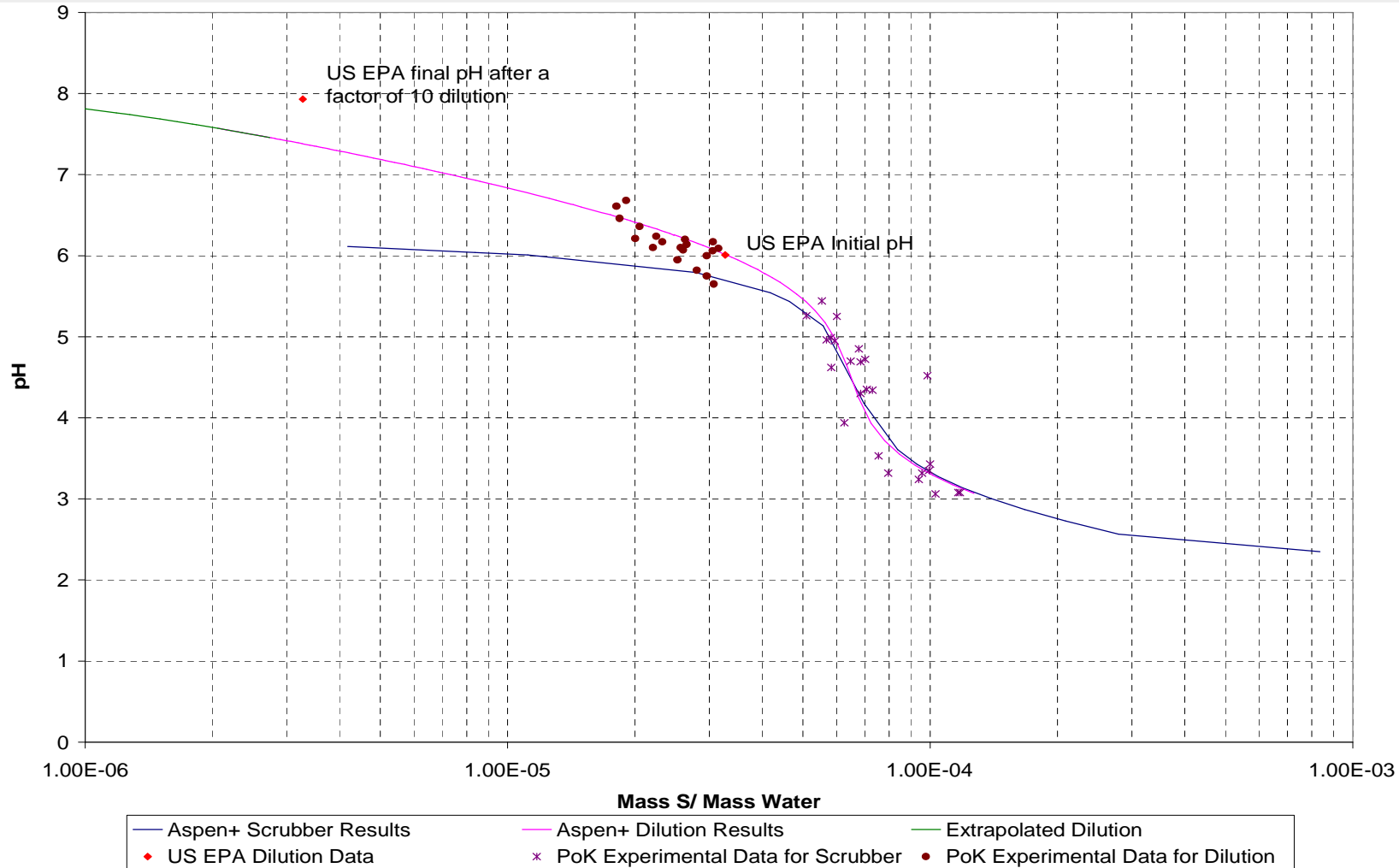


Sulphur Absorption Curves



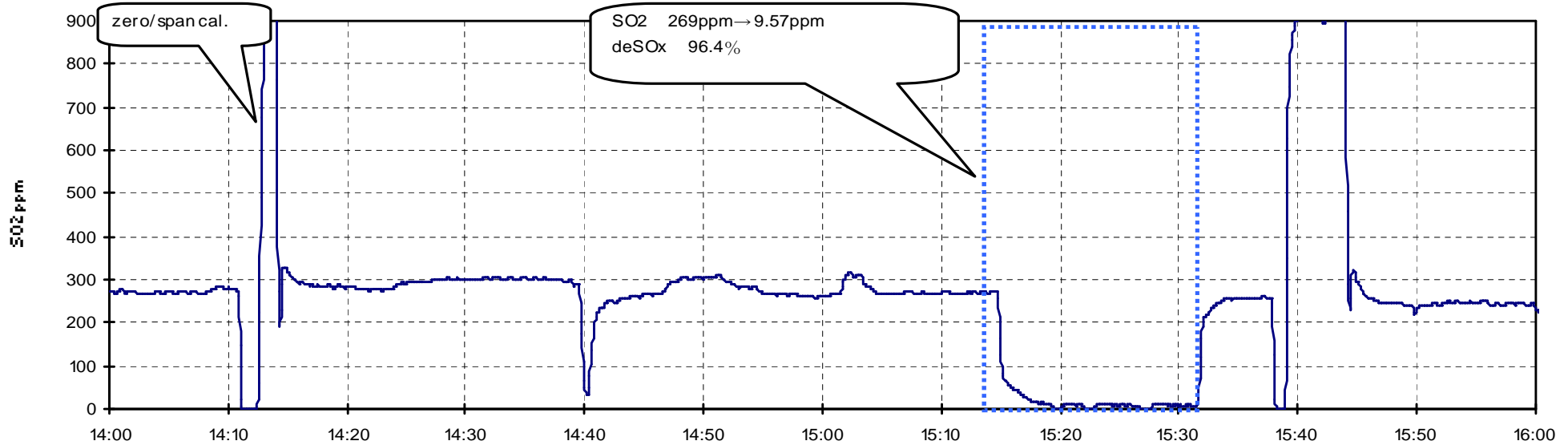
Scrubbing Technology - Update

Operating Experiences

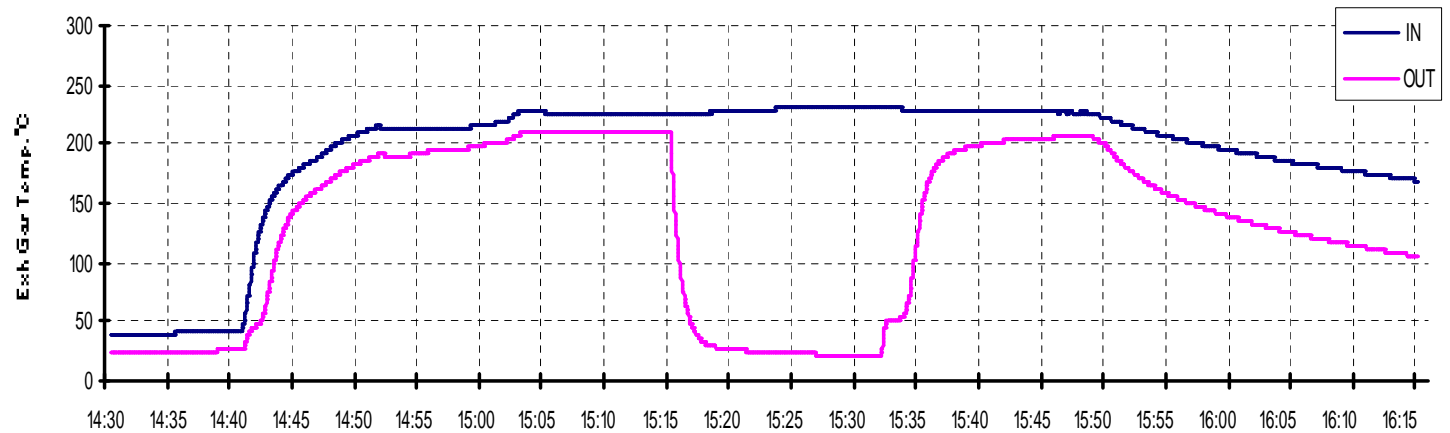


Scrubbing Technology - Update

Operating Experiences

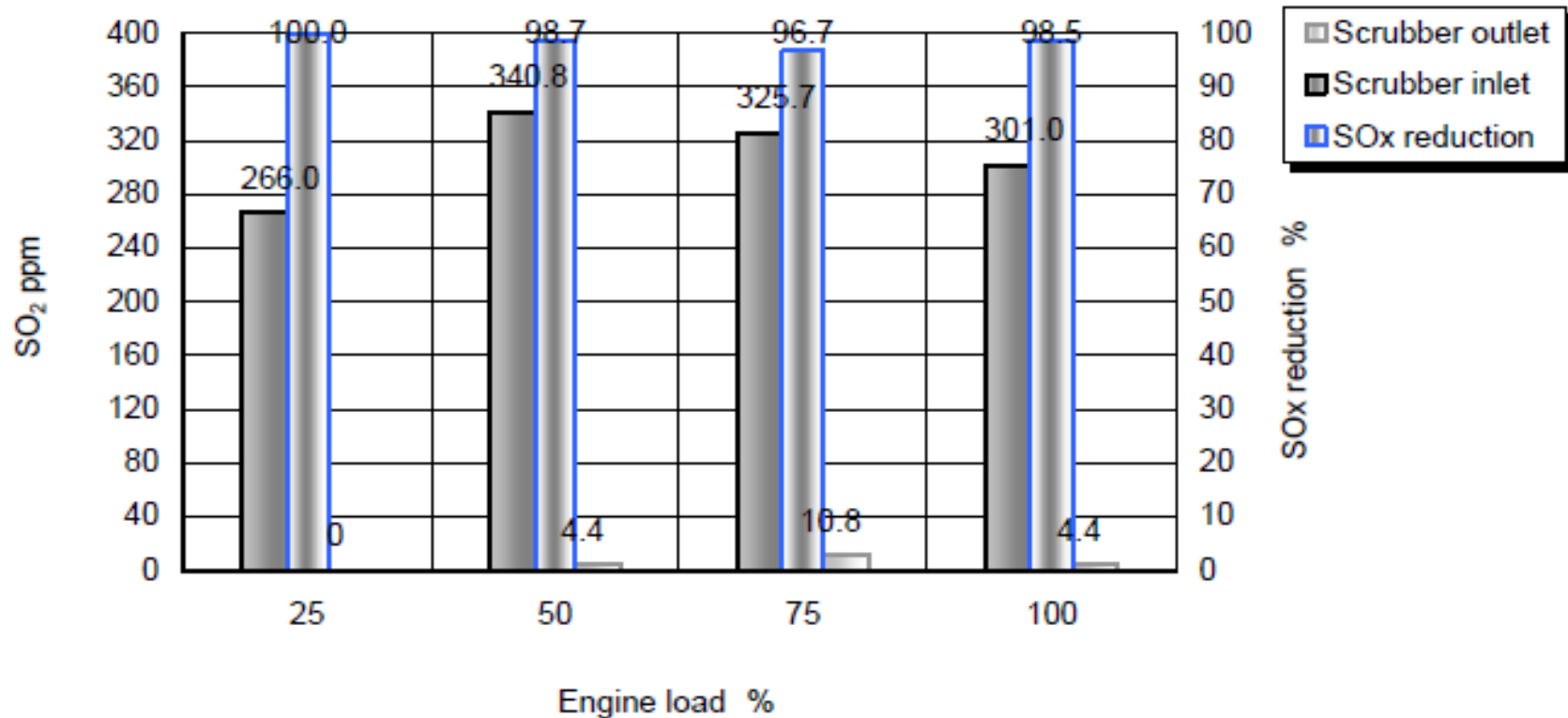


Print outs showing
SO₂ removal and
Exhaust Gas
Temperatures



Scrubbing Technology - Update

Operating Experiences



Scrubbing Technology - Update

Collected Sludge

PM Generated : 60 – 120mg/Nm³

Equates to : 0.1kg/hr.MW

Actual collected: 0.02-0.05kg/hr.MW

Composition: 0 – 93% Sediment

Disposal: Dockside Pickup

Disposal Cost: €150 – €400/t
= €0.15 – €0.4/kg

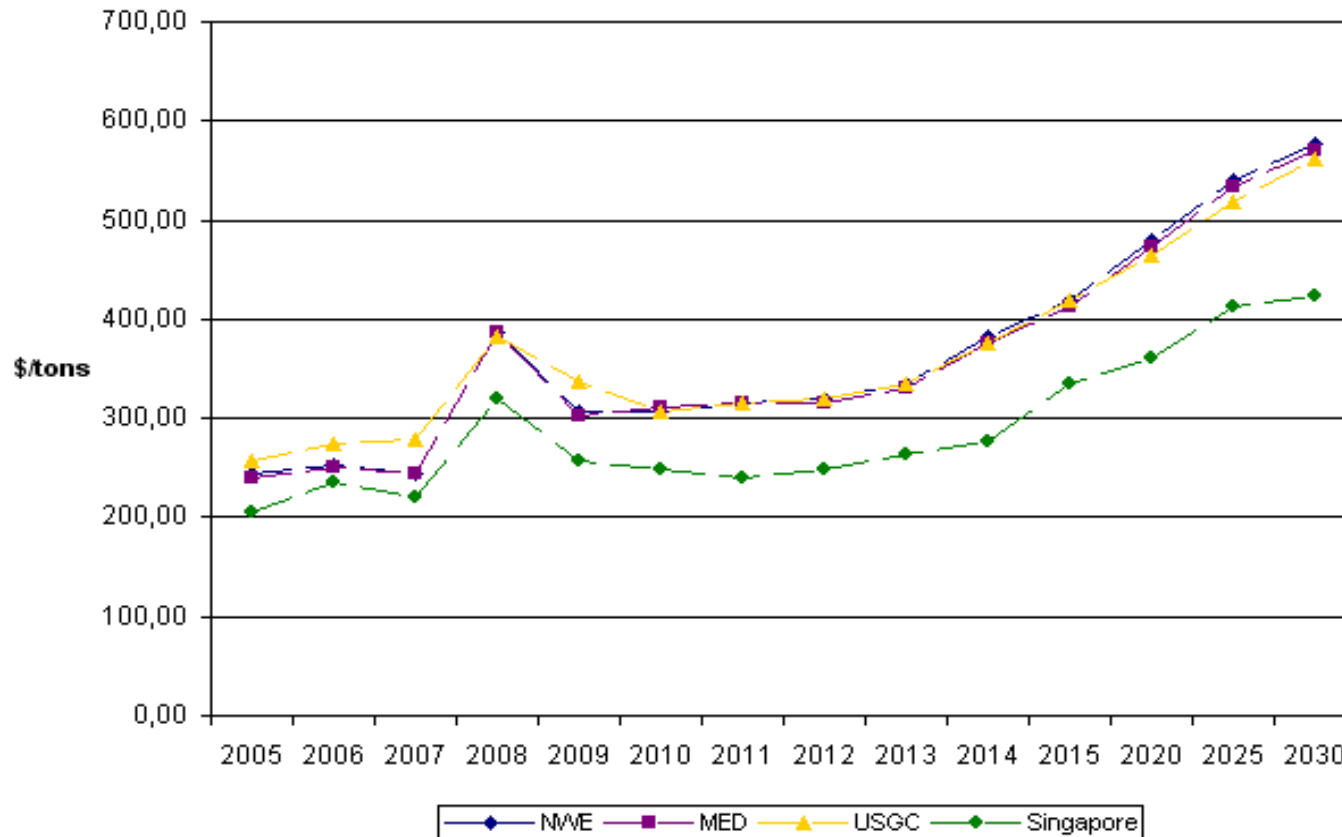
For 4,000hrs, = € 25/MW



Scrubbing Technology - Update

Legislation – The effect on the bunker fuels market

Gasoil/HSFO Differential



Source: Report "Outlook for Marine Bunkers and Fuel Oil to 2025" from January 2009 by Robin Meech, Marine and Energy Consulting Limited

Scrubbing Technology - Update

Payback periods

Payback period by fuel consumption, time spent in ECAs and fuel price differential

**12,500 tonnes annual fuel usage
(assuming \$2,5m total scrubber cost)**

		Fuel price differential	20 \$/t	50 \$/t	100 \$/t	200 \$/t	500 \$/t
Proportion of time spent in ECAs	5.0%		200 yrs	80 yrs	40yrs	20 yrs	8.0 yrs
	25.0%		40 yrs	16 yrs	8.0 yrs	4.0 yrs	1.6 yrs
	50.0%		20 yrs	8.0 yrs	4.0 yrs	2.0 yrs	9.6 mths
	100.0%		10 yrs	4.0 yrs	2.0 yrs	1.0 yrs	4.8 mths

**30,000 tonnes annual fuel usage
(assuming \$3m total scrubber cost)**

		Fuel price differential	20 \$/t	50 \$/t	100 \$/t	200 \$/t	500 \$/t
Proportion of time spent in ECAs	5.0%		100 yrs	40 yrs	20 yrs	10 yrs	4.0 yrs
	25.0%		20 yrs	8.0 yrs	4.0 yrs	2.0 yrs	9.6 mths
	50.0%		10 yrs	4.0 yrs	2.0 yrs	1.0 yrs	4.8 mths
	100.0%		5.0 yrs	2.0 yrs	1.0 yrs	6.0 mths	2.4 mths

**30,000 tonnes annual fuel usage
assuming \$4m total scrubber cost)**

		Fuel price differential	20 \$/t	50 \$/t	100 \$/t	200 \$/t	500 \$/t
Proportion of time spent in ECAs	5.0%		133.3 yrs	53.3 yrs	26.7 yrs	13.3 yrs	5.3 yrs
	25.0%		26.7 yrs	10.7 yrs	5.3 yrs	2.7 yrs	1.1 yrs
	50.0%		13.3 yrs	5.3 yrs	2.7 yrs	1.3 yrs	6.4 mths
	100.0%		6.7 yrs	2.7 yrs	1.3 yrs	8.0 mths	3.2 mths

PAYBACK PERIOD

	>15 years
	5-15 years
	<5 years

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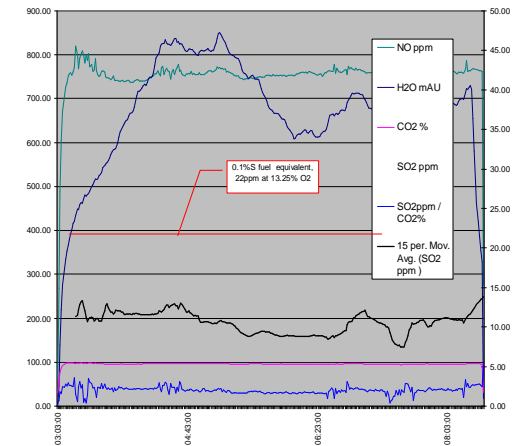
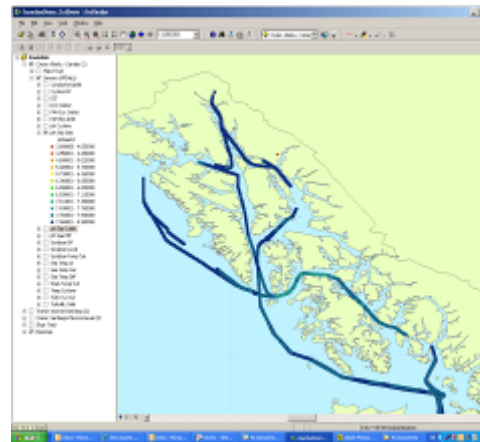
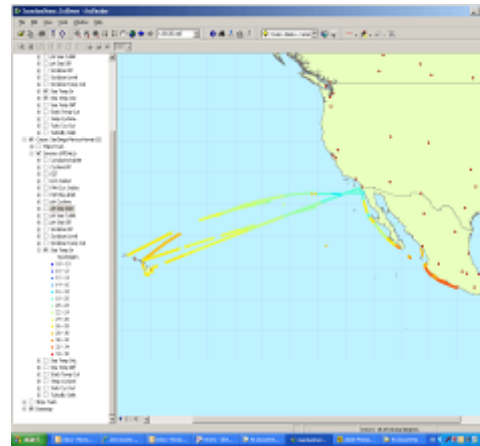
Approvals and environmental compliance

Approved under Scheme B of IMO Annex VI Regulation 14 - Sea Water Scrubbing Guidelines and MEPC 184(59) and compliant with CFR 40 Part 110.3, and NPDES (2.2.26 Exhaust Gas Systems) for Wash Water

Remote reporting of performance and GPS position with secure data storage

3 detailed EIA

- **Water interchange & Toxicology**
- **Plume modeling**
- **Physical measurement and verification**



Scrubbing Technology - Update

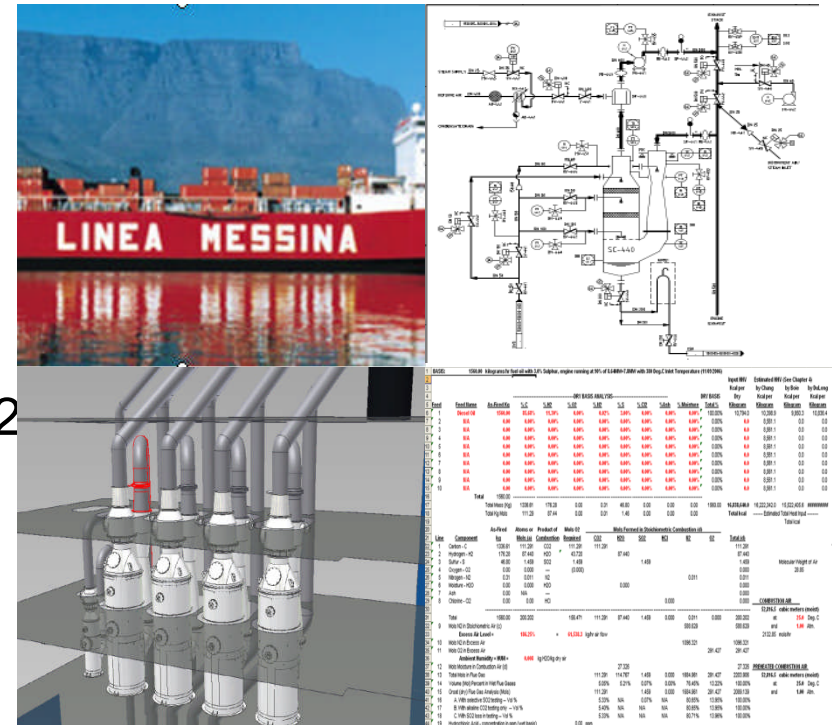
SMM Hamburg, 2010

Vessel : DSME Hull 4465/66/67/68
 Size of SWS : 4 x 2 MW auxiliary
 1 x 1 MW boiler

Installation type : New build

Delivery : January 2011 January 2012
 July 2011 June 2012

Performance :
 98% SO_x Removal
 60-80% PM Removal
 Up to 4,5% sulphur fuel



Prepared for main engine scrubbing

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