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Sea Water Scrubbing
Presenter - Andy Osbourne

Faster Freight Cleaner Air Conference – Long Beach - February 2007

bp marine | Krystallon, a BP group company

Krystallon – BP/Kittiwake JV

- BP Group Company
- JV partner – Kittiwake, Littlehampton, UK
- Emissions solutions and energy security
- Six years of expertise & experience

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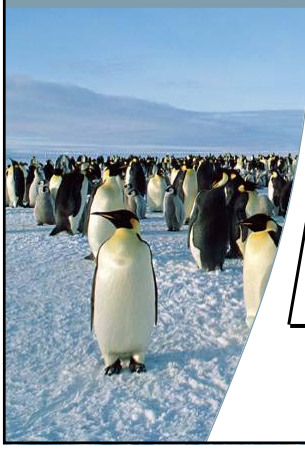
Marpol Annex VI – sulphur emissions



•19/05/05
•Worldwide 4.5%S limit
•Marpol BDN requirements

•21/11/07
•Channel & North Sea SECA

BLG 10 considering stricter limits & older engines intro from 2010 thro' 2015

July 2008 Amendments to Marpol Annex VI to MEPC 56

•19/05/06
•Baltic Sea SECA
•Scrubbers approved

Emissions trading

2006 | 2007 | 2008 | 2009 | 2010

Wash water criteria submitted to IMO

IMO

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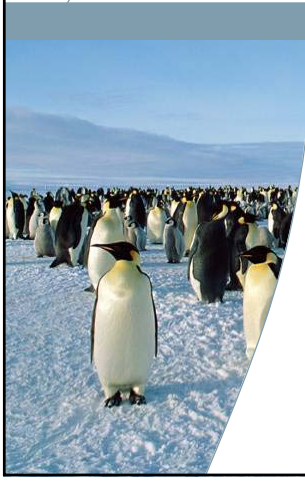
Sea Water Scrubbing Facts



SOME POWER PLANT INSTALLATIONS

•Shenzhen, China
•Guam
•Puerto Rico
•Longannet, Scotland, (approved by EU and Environmental Groups– sulphur into sea – equivalent to 40 super tankers in port at one time)
•Mongstad, Norway
•Tata, India
•Bankside & Battersea, London (1930s)
•Manjung, Malaysia 2,100MW (2003)

Total Sulphur in all fossil fuel

10microns

Sulphur in the ocean

1.7metres

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First fully functional commercial installation

1 MW Krystallon Sea Water Scrubber
Installed 18th December 2005
Zero sulphur emissions from start-up
85% Particulate removal

P&O Ferries - mv Pride of Kent

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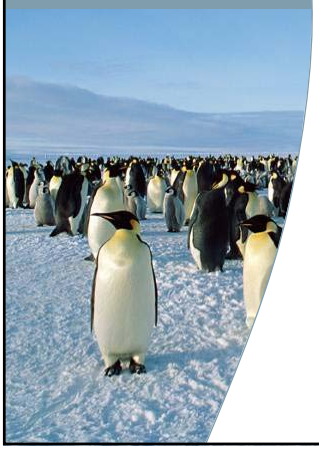
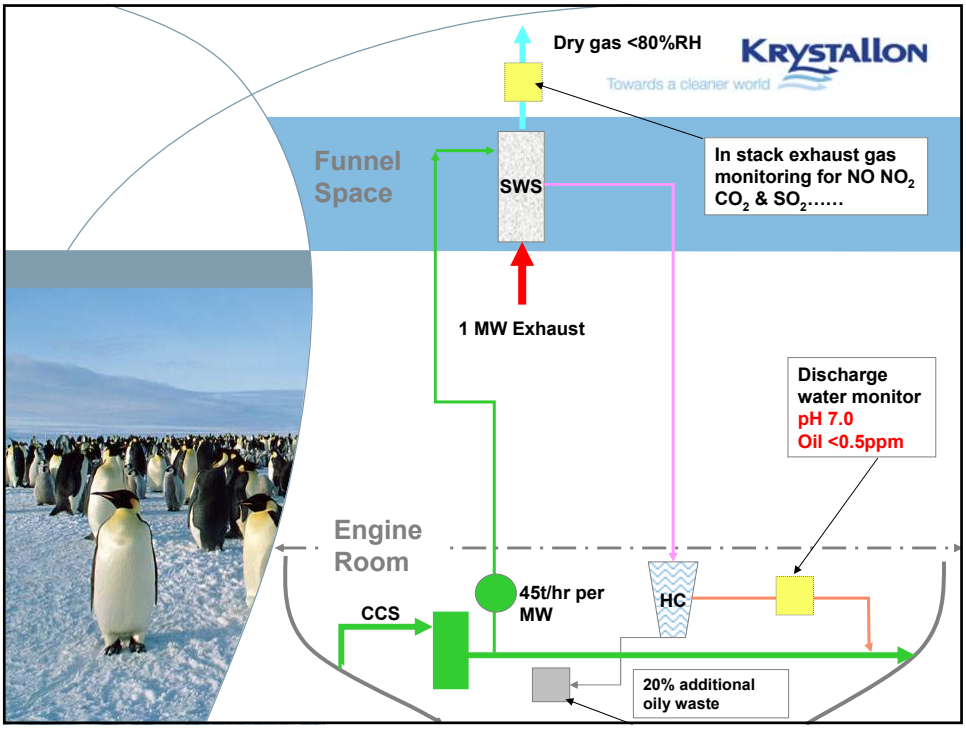
PofK Scrubber Performance – real data from working unit



- SOx reduction > 99%
- NOx reduction < 5%
- Particulate reduction ~ 85%
- Within diesel engine backpressure envelope
- Water discharge already to IMO guidelines (from Environmental Impact Assessment by Terramare Inst + Newcastle University)
- Installed during normal drydock periods
- No unplanned stoppage since installation (ten months trouble free operation)
- Zero crew intervention


Dry gas <80%RH
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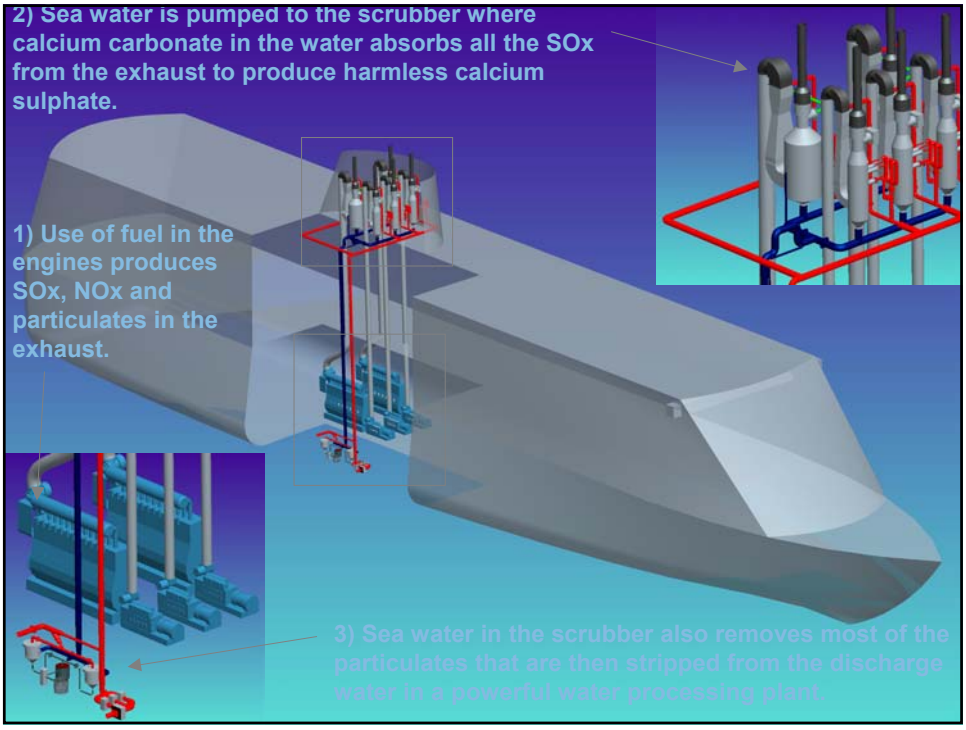
Funnel Space
SWS
In stack exhaust gas monitoring for NO NO_2 CO_2 & SO_2……
1 MW Exhaust
Discharge water monitor
pH 7.0
Oil <0.5ppm
Engine Room
CCS
45t/hr per MW
HC
20% additional oily waste


2) Sea water is pumped to the scrubber where calcium carbonate in the water absorbs all the SOx from the exhaust to produce harmless calcium sulphate.
1) Use of fuel in the engines produces SOx, NOx and particulates in the exhaust.
3) Sea water in the scrubber also removes most of the particulates that are then stripped from the discharge water in a powerful water processing plant.

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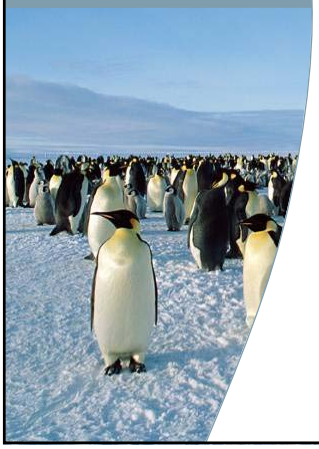
Waste production



- The water treatment plant will typically produce approximately 20% of the vessels usual oily waste.
- This waste will go into the vessels normal oily waste sludge tank and will be disposed of in exactly the same manner.
- IMO already classifies this waste as “oily waste”
- It is **not** classed as hazardous waste

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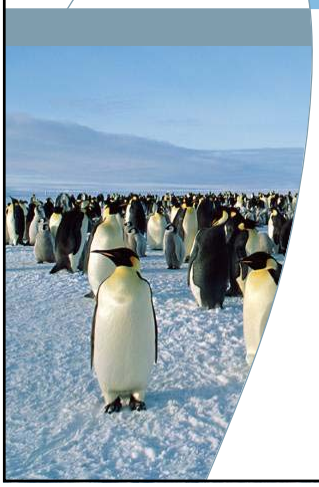
Design developments (Krystallon)



- Currently able to provide scrubbing to 12MW
- Commercial units now being installed
- Design being evaluated to 15 – 25MW (end 2007)
- Range 25MW to 50MW probably 2008
- Web based emissions monitoring

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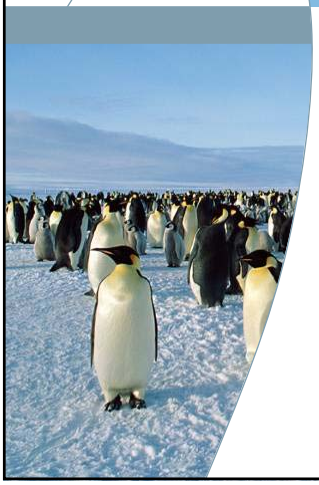
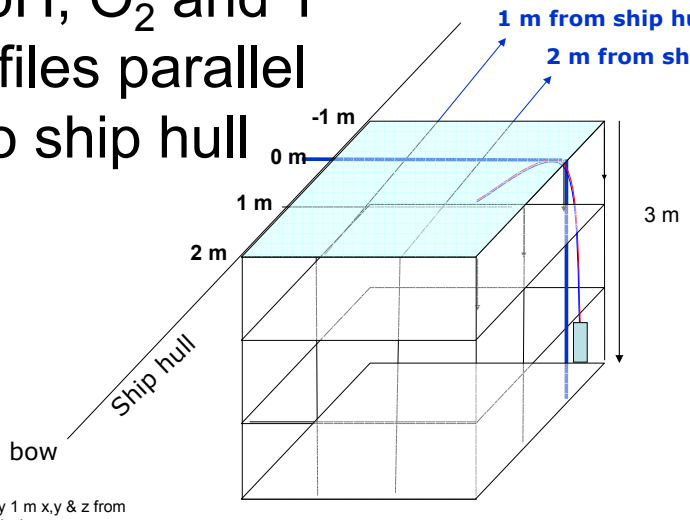
Performance Monitoring

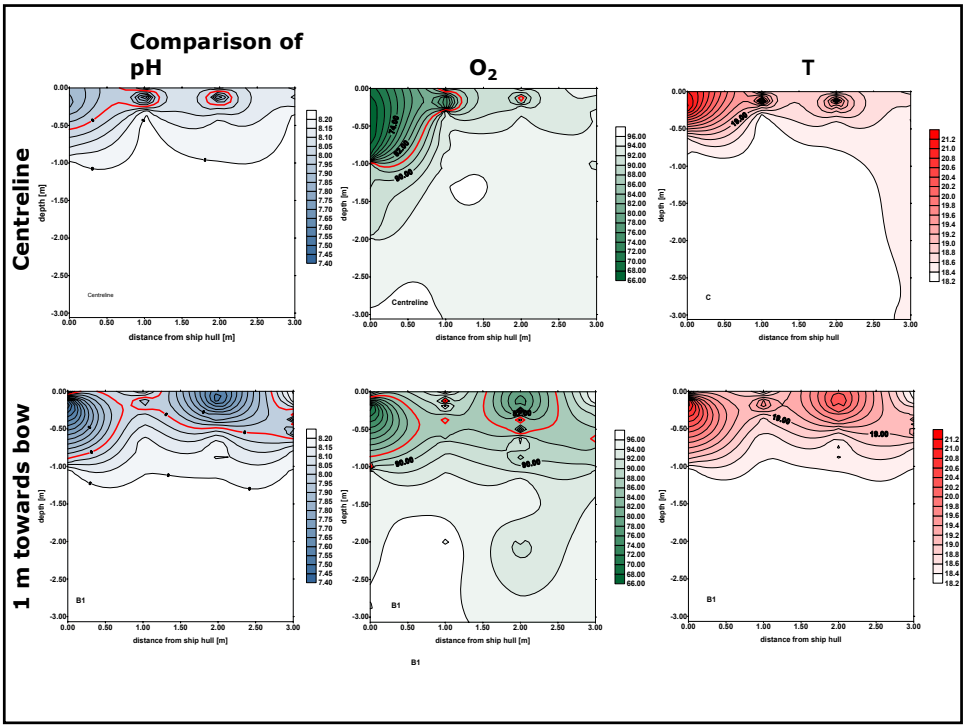


- **Continuous monitoring** of
- SO2,
- CO2,
- NO
- NO2
- Linked to GPS for ship positioning and data availability
- Assessment of oil monitor capabilities with sensitivity in the region of ppbillion for water discharge!

Sampling grid for pH, O_2 and T profiles parallel to ship hull



Sampling every 1 m x,y & z from centreline of discharge



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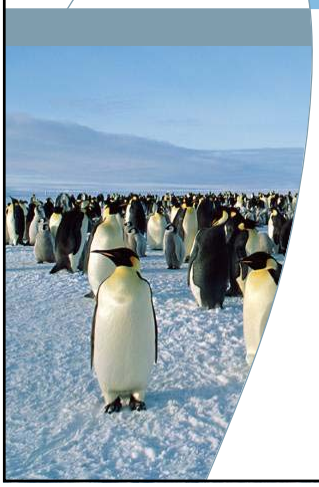
Some options for compliance



- Cold ironing
  - High investment, transfer of pollution
  - Niche solution & possibly regret investment
  - Doesn't address out-of-port running (3 mile limit)
  - Most operators look for other options
- Use only diesel oil
  - High cost, tank size
  - Convenient, lower maintenance, no fuel changeover
  - Diesel to HSFO differential gives very quick payback for scrubbers
- Use 1.5% sulphur fuel
  - Higher cost, availability, tank segregation, fuel changeover
  - Flexible option, little investment
- Blend fuel prior to use
  - Investment, maintenance, verification, reliability
  - Flexible option, low cost
  - Most operators not confident of 100% compliance
- Install abatement technology
  - Investment cost
  - Lowest cost fuel, emissions credits, use in port
- Join an emissions trading group (not yet an option)
  - Provides an assured means of achieving compliance, choice and lowest cost options for the ship operator
- Trade to different or unregulated port !!

difficult

Ease of compliance

easier

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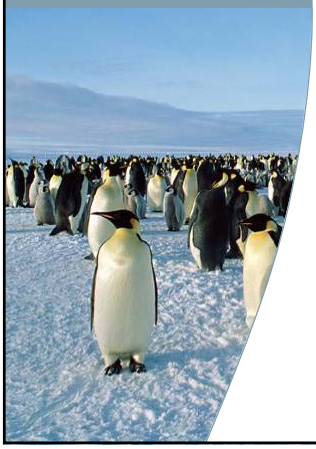
Some advantages operators have observed so far during discussion.



- The ability to continue to burn HSFO and fully comply whilst operating in SECA or controlled area.
- No exposure to potential future difficulties on low sulphur fuel availability.
- No logistical or engineering difficulties with regard to burning different fuel or using different lube oil.
- Environmental responsibility – publicly taking “green” stance
- Zero operational maintenance. Turn it on and forget about it ! No crew training or intervention.
- Early positioning on achieving emissions credits.
- Partnered with large trading and proactive environmental BP parent group.

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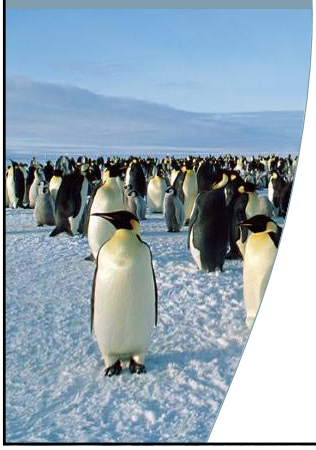
Current status of scrubbers



- Krystallon - Successful current working installation (100% sulphur removal + PM 85% by mass)
- Others – bench testing and some onboard-type testing – results variable. (Effectiveness from 30% to 50%)
- Actively quoting and now engaged in commercial negotiation. (including funding options)
- Ferry industry affected (potentially) the most – Funding is an issue.
- Huge global interest in realistic and cost effective alternative to low sulphur fuels and cold ironing. West Coast of the USA now expressing large interest.
- Active participation in various legislative input (including scrubbing input as well as wash water discharge criteria) .
- Working with BP parent company to facilitate wider offer linked to fuel supply and trading options.

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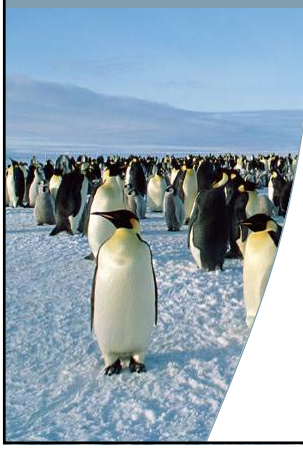
Particulates – the next legislation??



- ARB – USA. Current Auxiliary already effective in January 2007. This has PM limit as well as SOx and NOx.
- Port Authorities in USA (West Coast – Long Beach and Los Angeles) introducing 0.5% sulphur rule also – but with ACP (Alternative Compliance Plan) to effect required levels.
- Other US regulatory bodies also now looking at PM emissions in addition to sulphur
- Lower sulphur fuels will not be the answer for PM emission>Cold ironing (Shore Power) in port – but what in monitored zone??

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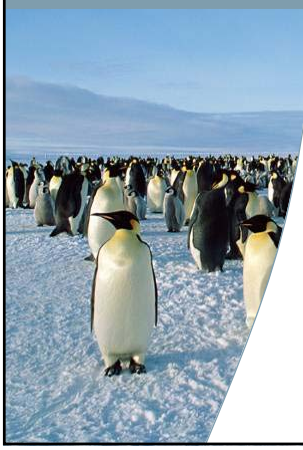
Current Cost of Scrubbers



- **<u>Dependent upon vessel type and utilisation</u>**
- Cruise Lines (high use and high utilisation) = $30 per tonne over 3 year period (3 year payback)
- Ferries - $40 - $45 per tonne over 3 years.
  (Offsetting will potentially halve this number)
- Current high to low fuel diffs quoted from $15 up to $40 per tonne.
- Payback on Auxiliaries versus diesel = 6 months !!

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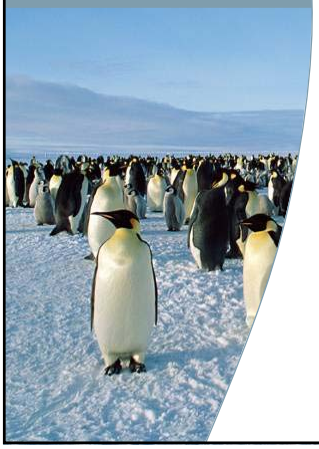

THANK-YOU