Small Scale Pyrolysis Unit - Implementation in a Challenging Environment

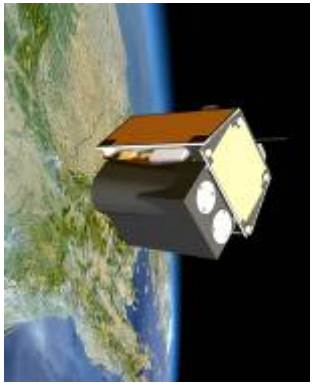
Presentation by Sean McCarthy
Business Development Manager – Energy & Environment

QinetiQ

www.QinetiQ.com

QinetiQ – Background

- Created in 2001 from the MOD's Defence Evaluation and Research Agency (DERA)
- 14,000 employees – 8,200 in the UK
- FY 2008/09 turnover £1.37 billion
- 40 UK sites with Farnborough Head Office
- Listed on the London Stock Exchange 2006
- MOD sold shareholding 2008 – QinetiQ truly independent
- Provide research, technical advice, technology solutions and services to customers in core markets of **Defence, Security, Energy & Environment**
- Working to transfer our expertise into civil markets



QinetiQ involvement in Waste and Energy

- Disposal of MoD munitions
- Waste water management
- Black bag waste minimisation
- Tyre disposal from MOD sites
- Plans for on site EfW
- Internal study for biomass heat
- Renewable R&D (wind, marine, Fuel Cells)

Static Kiln

Avocet Explosive Waste Incineration site (2 x rotary furnaces) .

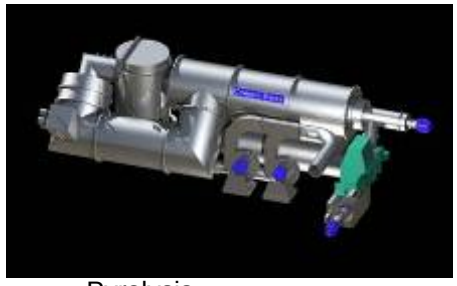
Fuel Cell
H Generator

Waste Sorting
Demonstration

Water treatment

Conventional Disposal

Marine Energy
Test Tanks



Pyrolysis
Waste Destruction

Waste water treatment systems

Development and retrofit of a
Membrane Bio Reactor to
HMS Grafton holding tanks

Selection of
water treatment Systems
for future vessels

Experienced gained on waste minimisation for Royal Navy

- QinetiQ evaluate COTS waste and energy technologies for MOD
- Provide improvements to create Type-Approved, Modified-COTS solutions for Royal Navy
- Identify technologies to achieve future limits for Marine Environmental Protection Committee (MEPC) and NATO working groups - set environmental discharge legislation.
- Selecting and designing waste management solutions for Submarines and surface vessels have unique challenges:
  - Limited amounts of oxygen available from electrolysers to sustain oxidative processing technologies.
  - Off-gases require dedicated abatement technologies - occupational exposure limits.
  - Space, weight and noise constraints are generally more stringent than land based installations
  - Need for stealthy operations – no discharge at sea

NATO and Royal Navy require "Environmentally Sound Ships"

- NATO ship operations constrained in international and territorial waters if ships lack appropriate shipboard waste-management systems to comply with waste-discharge limitations
- The "Special Areas" designated by MARPOL are particularly problematic for those NATO member nations that require their navy ships to comply with MARPOL Annex V discharge restrictions because virtually no solid-waste discharges are permitted in these areas.
- NATO strategy is to:
    - Design and operate ships to minimize air emissions, waste generation, and optimize waste management, and, where required,
    - Develop shipboard systems that will destroy or appropriately treat the wastes generated on board for effluent discharges and emissions that meet the standards of international legislation.

Variety of Waste Types from a RN Vessel

Food Waste

Clinical Waste

Sanitary Waste

Hazardous Waste

Solid Waste (*i.e.* Garbage):
(*i.e.* Plastic, metal, paper, cardboard, oily rags, glass)

Grey Water
(*i.e.* showers, laundry, etc.)

Black Water
(*i.e.* Sewage)

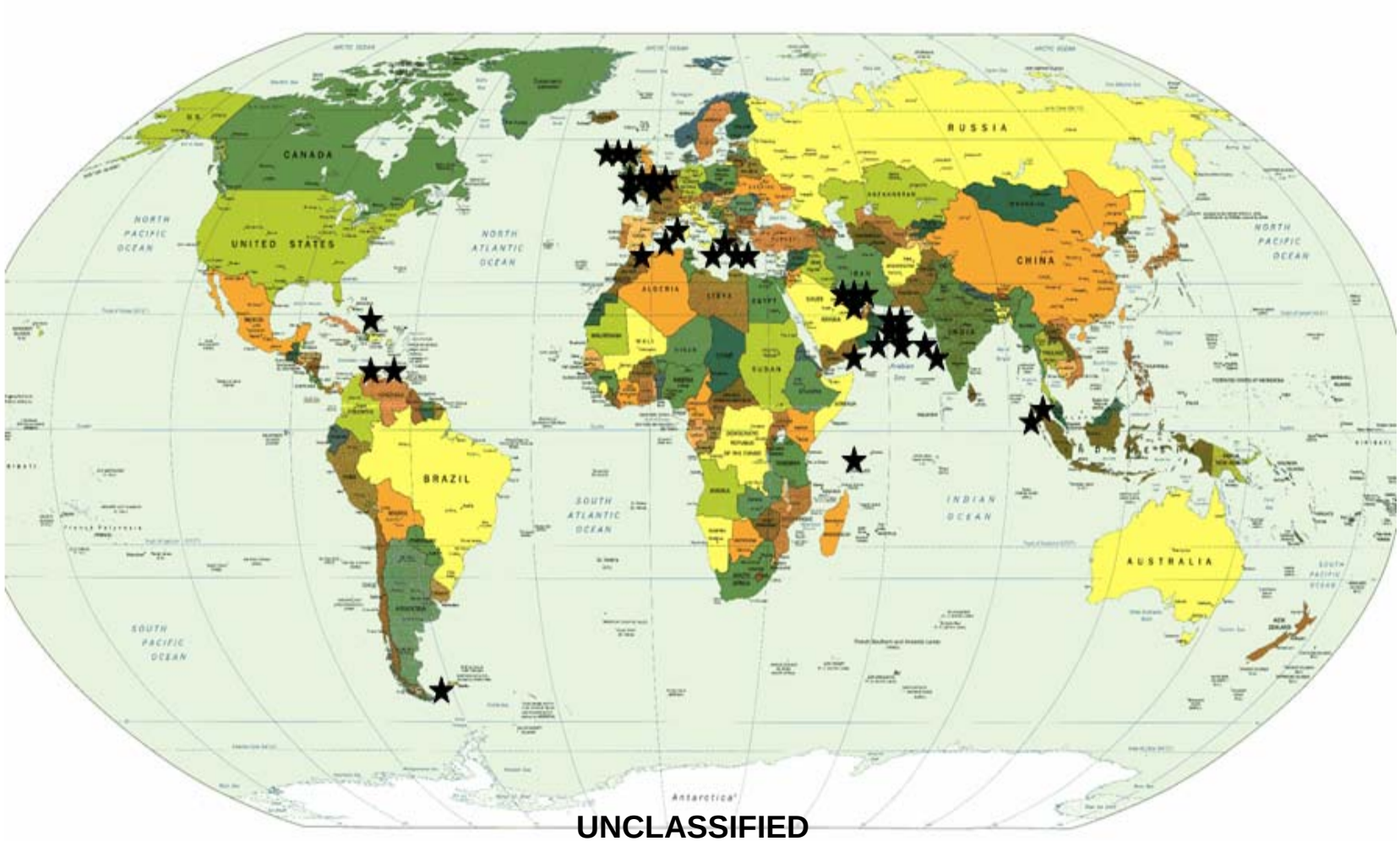
Ballast Water

Bilge Water

Waste Management Drivers for the RN

- Comply with legislation - Environmental independence (IMO and NATO)
- Increase time at sea between waste off-load at port
- Help to reduce the cost of off-loading wastes in ports
  - 'Duty of Care'
- 2002 NATO policy - Defence Against Terrorism
  - Restrict ease of use of bowsers
- Reduce drudgery
- Reduce on-board stowage
- Improve health and safety
- Cost (Capital & TLC)
- Waste Management Policy:
  - Re-use ⇒ Recycle ⇒ Storage ⇒ Treatment

The Maritime Challenge – A snapshot of the Fleet deployment from 2005



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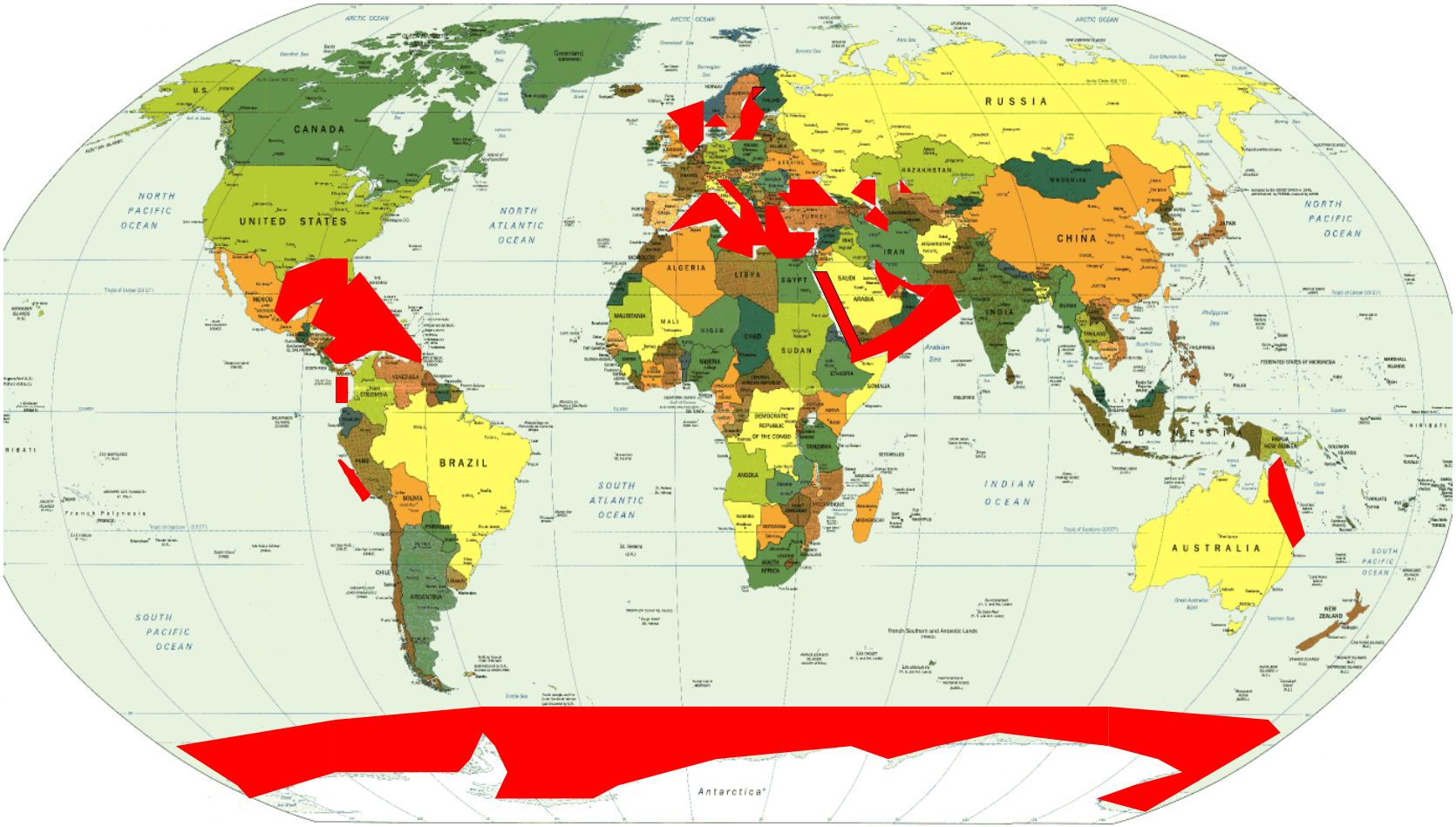
Imagine the world in 2010 – Legislation is tightening in key operating areas



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HMS OCEAN Technology Development Programme

2008 – Technology Readiness Level 6/7
2009 - Technology Readiness Level 9

- 2007
  - Marinisation Programme, Factory Acceptance Test, NATO Maritime Environmental Protection Committee
- 2008
  - Jan/ Feb – Dismantle & Ship
  - Feb/ Mar/ Apr – Install, align, cold commission
  - Jun/ Jul – STW, Hot Commission, Harbour Acceptance Test
  - Aug – Sea Acceptance Test
- 2008/09
  - 1 year minor trial

Challenges

- Environmental legislation and policy compliant
- Confined space – 3 x 7m with 1.8m headroom
- Heat build up
- Offgas abatement – WID comparable
- Understanding rates of all liquid and solid waste accumulation on various RN ships and finding waste management solutions that meet size footprint and logistical demands.
- Working with industry to adapt commercially-available systems to the RN.
- Trialling such systems with authentic waste streams at QinetiQ's land based test site, typically up to 45-days.
- Recommending / Implementing design changes.
- Re-trialling improved design and proposing further recommendations for ship installation to the designated OEM.

Royal Navy Specifications

- 24/7 one man operation
- Continual waste feed and char removal
- Minimum operator training required
- Latest proven COTS technologies
- Energy efficiency - Self sustaining thermal process with potential for energy recovery
- Modular design
- Handle mixed waste streams including plastic, cardboard, paper, metal cans, glass, medical and sanitary, liquid oil, sewage sludge and food waste
- No waste segregation
- Char generated removed by an automatic process

Approach

- ST150 uses pyrolysis to produce char and syngas.
- Gasification of the char bed releases additional energy and decreases the volume of the char
- syngas is combusted in the oxidiser, an exothermic reaction,
- excess heat is used to heat the pyrolysis chamber to temperatures of 900 - 1100oC.
- Sufficient heat is generated to both make the process self-sustaining and export heat as energy if required
- Feed system designed to accept waste as presented by user e.g. manual load, hopper load
- Char system designed to decant into container of user choice e.g. 25 litre pale, 55 gallon drum or skip
- Energy recovery as direct heat, or heat converted to electricity
- Exhaust abatement systems to meet local / national legislation - ST150 already meets MARPOL as standard

Technical Specifications

- Dimensions - 11m x 2.9m x 1.8m high
- Throughput – 120kg per hour (500kW)
- Char – 25 litres per 100kg of raw waste
- Electrical – 3 phase to user requirements
- Fresh Water – Min 7barG, 280 to 400kg/hr
- Combustion Air – Ambient, 550 to 700 Nm3/hr
- Compressed Air supply – 7 barG, 80 to 100 Nm3/hr
- Shock cooling exhaust to prevent formation of dioxins / furans
- Diesel – Typically 40 litres (max 100 litres) per 24hrs dependant upon calorific value of waste
- Automatic control system – maintains performance across all waste stream processing modes

Future

- Carrier Vessel Future CVF – include sludge oil and sewage
- Deployable Pytec system
  - Military – Forward Operating Bases
  - Humanitarian Aid Camps
  - Gated Communities
  - Retail Parks
  - Island Communities
  - Cruise Liners
- Pyrolysis char - Carbon Sequestration

PyTEC
Deployable Pyrolysis Waste Destruction with Energy Reclamation

- 2x 20ft ISO containers “helicopter portable”
- Processes multiple waste streams
  - Mixed domestic including glass and tin (220 lb /hr)
  - Food
  - Medical and sanitary
  - Oil and fuel
- Automatic control system – maintains performance across all waste stream processing modes
- Separate skid mounted blast cooler as thermal engine condenser allows system to run in waste only mode