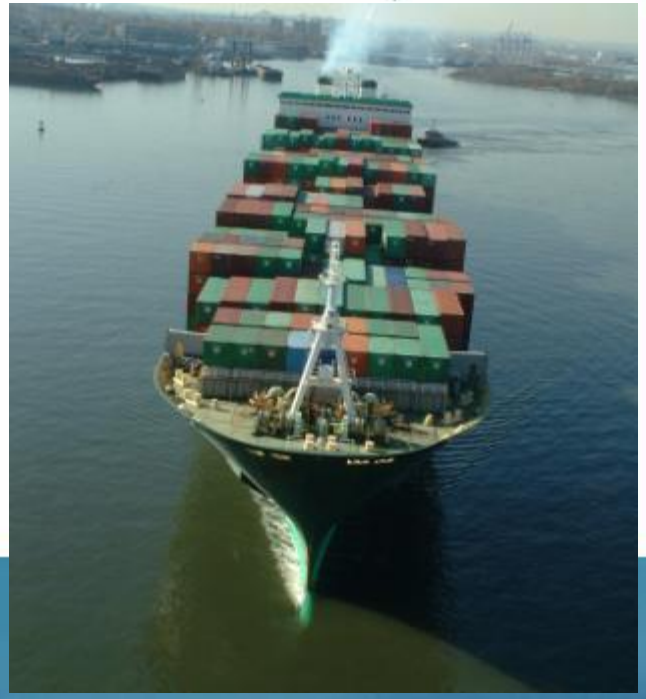
EMSA

European Maritime Safety Agency



Introduction to Sampling for CME

Globallast Regional Training Workshop on Compliance Monitoring and Enforcement of the BMW Convention.

16th March 2011

Brian Elliott

Senior Project Officer for Environmental Protection

Sampling for compliance to D-1 and D-2 Standard:

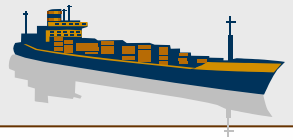
- Sampling in context with Port State Control;
- Philosophy of sampling;
- Ballast Water Systems
- Definitions
- Indicative Sampling
- Full Scale Sampling
- Work of the Correspondence Group
- Outstanding Issues

The Agency's main objective:

"to provide technical and scientific assistance to the European Commission and Member States in the proper development and implementation of EU legislation on maritime safety, pollution by ships and security on board ships"

- Improve cooperation with, and between, EU Member States in all key areas
- Ballast Water – Ballast Water Action Programme
  - Ratification, Regional Seas Conventions
  - EU Ballast Water Sampling Strategy, Convention and the EC Biocide Regs., Use of Risk Assessment
- Chair of the CG on Ballast Water Sampling at IMO.

Draft IMO Guidlines



Inspections

Initial Inspection

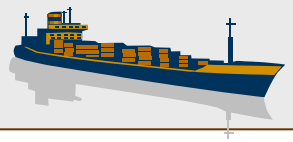
Clear grounds

More detailed inspection

- BWM Certificate
- Procedures on board according BWM Plan
- Type approval certificate for BWMS
- Ballast water record book
- Appointment of a Designated Officer

For ships non fitted with on board monitoring system the PSCO may udertake an indicative sampling

Draft IMO Guidlines

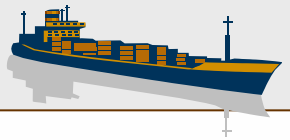


Inspections

- Initial Inspection
- Clear grounds
- More detailed inspection

- Absence of one of the above mentioned documents
- False entries in the WB Record book
- Personal not familiar with on board procedures
- Information from third parties
- Designated Officer not appointed

Draft IMO Guidlines



Inspections

Initial Inspection

Clear grounds

More detailed inspection

- Actions based on the analysis of the B.W. Management Plan
- Check of the duties of the Des. Officer
- Check of the record-keeping applied on board (if in compliance with the Convention)

Depending on the shortcomings detected the PSCO may require indicative or detailed, representative sample (and analysis)

History - Sampling for enforcement:

- BWM Convention – obligation to sample – large discharge
- Guidelines G2 - no common test – no common interpretation of results
- Agreed with commitment to further guidance – Sampling
- Protocols – included an Aide Memoire

EMSA's work:

- 1st Ballast Water Workshop - November 2008
- 2nd Ballast Water Workshop – Sampling – February 2010

EMSA asked to contribute this to IMO to use as a baseline for further work at BLG 15

Key Principles

- What exactly are we trying to sample?
  - Ideally BWTS that do not meet the D-2 Standard
- Issues and Problems
  - Focussing on the minuteness of the standard;
  - Issues forming Barriers;
  - Practical Issues, Indicative/Detailed Sampling
  - Representativeness/Homogeneity
  - Inherent accuracy
  - Logistics
  - Liability – undue delay – 'pseudo detention'; and
  - Cost – how many in reality? Access issues? Standby?
  - FSI Guidelines

Philosophy of Sampling

What are you trying to sample?

versus

What can you sample?

- Cannot sample the ballast water that has been discharged already.
- Sample ballast water as it is being discharged.
- Cannot make assumptions for ballast water still to be discharged.
- Representativeness
  - whole discharge (spikes, first 5 minutes)
    - whole of the discharge
    - whole of the discharge at that specific time: iso-kinetic

Philosophy of Sampling II

- Statistics of Sampling:

$$n = \frac{N\, z_{\alpha/2}^2\, P(-P)}{(N-1)\, e^2 + z_{\alpha/2}^2\, P(-P)}$$

⇧ Heterogeneity ⇧ No of Samples

ballast water (m^3)	% for Sampling	No of 1m^3 samples
5,000	65.7%	3,288
10,000	48.9%	4,899
50,000	16%	8,056
100,000	8.7%	8,762
150,000	6%	9,026

- Expense and time it takes – Undue Delay
- Cost?

Philosophy of Sampling III

- Statistics of Sampling:
  - ICAS – 46 providing organisms are in each one;
  - D-2 Standard – very low levels;
  - very difficult to test;
  – sample error at least +/- 3; and,
  - experimental error.
- EMSA looked at practicability:
  - 2 projects;
  - graduated - indicative and detailed testing; and,
  - developed a sampling system to identify a BWTS working at a level well above the D-2 Standard.
- Who Samples? – Indicative Sampling = PSC
  - Detailed Sampling = to be decided


LIFT

Definitions I

- INDICATIVE ANALYSIS - A[n indirect or direct] measurement [of a sample] taken in accordance with Annex 1, Part 1 or Part 2 of the G2 guidelines of ballast water discharge [to establish whether a ship is potentially compliant or non-compliant with D-2 [and may be followed by detailed analysis if deemed necessary]. An indicative analysis may either be an:]
  - indirect ([biological], chemical, or physical parameter, O2, Cl, [ATP, DNA, chl] etc.
    - does not provide a value comparable to the D-2 standard.
  - direct (concentration of organisms), but imprecise measurement.
    - with a large confidence interval and/or high detection limits
    - or no precision and low detection limit.

Definitions II

- DETAILED ANALYSIS - A measurement of a [representative] sample of ballast water discharge which:
  - .1 may be used to determine whether [a BWMS] [a ship] [the sample] is either marginally (e.g. by two or three times) or significantly (e.g. by an order of magnitude) failing to meet the [limits given in the] D-2 standard.
  - .2 provides a direct measurement related to the D-2 standard (number of organisms per volume) and is of sufficient quality and quantity to provide a precise measurement of organism concentration (+/- [X] organism per volume) [and size];
  - .3 uses a measurement method with an adequate detection limit for the purpose for which it is being applied (minimum detection limit of [X] organisms per volume).

Testing for compliance to the D1 Standard

- Indicative
  - Physical parameters
    - Salinity
- Detailed
  - Organism species
    - Oceanic or coastal

Indicative Testing for compliance to the D2 Standard

Organisms less than 50 and greater than or equal to 10 micrometres in minimum dimension

8 methods considered

Organisms greater than or equal to 50 micrometres in minimum dimension

6 methods considered

Methods for bacteria analysis

11 methods

Indicative Testing for compliance to the D2 Standard

Organisms less than 50 and greater than or equal to 10 µm in minimum dimension

1). Presence/absence methods (no viability, no counts)

e.g. DNA, ATP, "traditional" Chl *a* methods deliver results in less than 60 minutes

2). Viability and counts

Flow cameras (less than 60 minutes, not portable, viability stain needed)

Best compromise: Pulse Amplitude Modulated (PAM) Fluorometer

portable, easy to use, low expertise needed

Viability in less than 10 minutes

No counts, but biomass and Chl *a* indication

Pulse Amplitude Modulated (PAM) Fluorometer

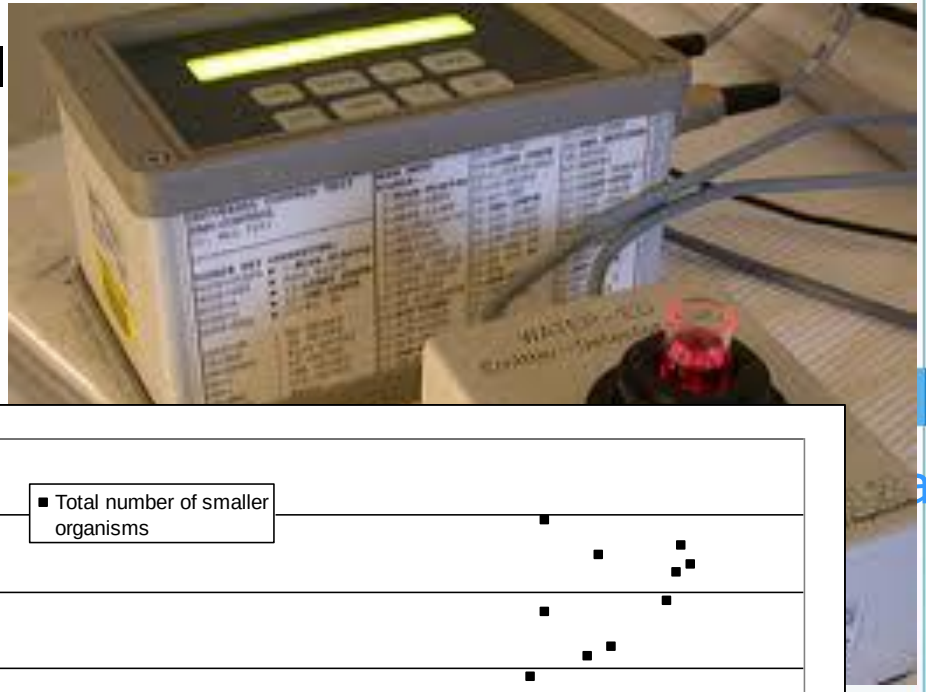
Fast assessment of the overall photosynthetic state

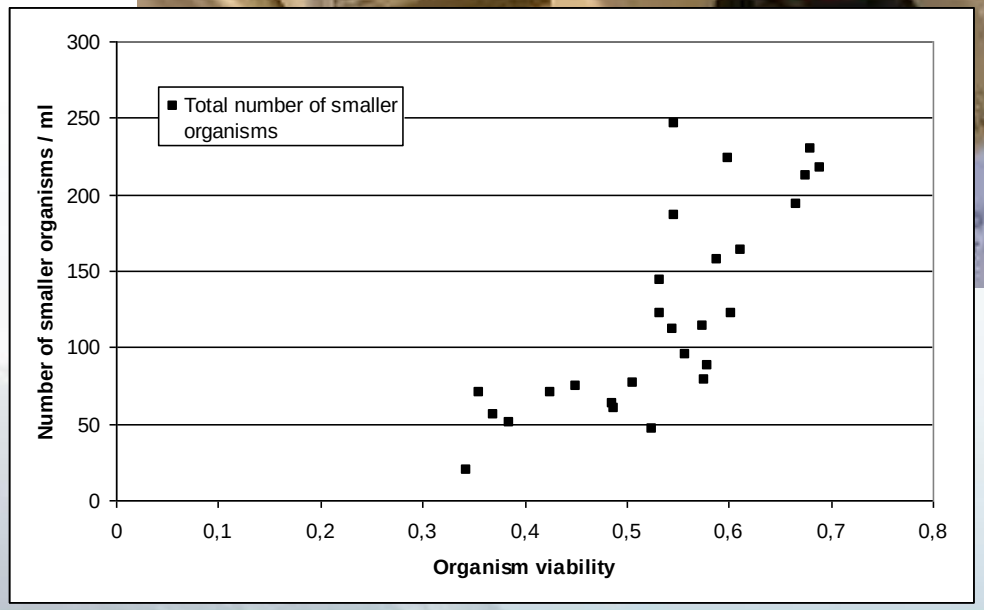
PAM measures phytoplankton biomass and viability

No direct counts

Results show a relation of biomass and viability measurements with organism numbers

Suitable tool to show clear grounds that D-2 was not met





Indicative Testing for compliance to the D2 Standard

Organisms greater than or equal to 50 µm in minimum dimension

1). Presence/absence methods (no viability, no counts)

e.g. DNA, ATP methods deliver results in less than 60 minutes

2). Counts (no viabilty)

Hand-held flow cameras (less than 30 minutes)

Best compromise: Stereomicroscopy (counts & viability)

portable, easy to use, high expertise needed

results in less than 40 minutes

or, Visual (>1000 microns)

Indicative Testing for compliance to the D2 Standard

D-2 Bacteria

1). Presence/absence methods (no cfu and/or counts)

All methods to determine cfu require incubation time of 24 - 72 hours

2). Counts (no viabilty)

None – as need incubation time

Best compromise: If at all - Hand-held fluorometer

monitors enzymes produced in the target bacteria

portable, easy to use, low expertise needed

presence/absence in < 10 mins to 4 hours

semiquantitative, i.e. high reading = high bacteria

Indicative Testing for compliance to the D2 Standard

- Start with one method to evaluate one organism group in D-2
- Take adequate sample – identified in prep for PSC and depends on methodology and reasoning
- Should this show presence or high numbers, take result as indication of a failed treatment system
- Should this show absence or low numbers, continue with second (and third) D-2 organism group to confirm results
- The easiest to start with may be the analysis for phytoplankton (PAM), followed by bacteria (hand-held fluorometer) and zooplankton (stereomicroscope)

Detailed Testing for compliance to the D2 Standard

Sampling depends on needs

- often dictated by courts

Seen that "Statistical representativeness" is not at the present time viable

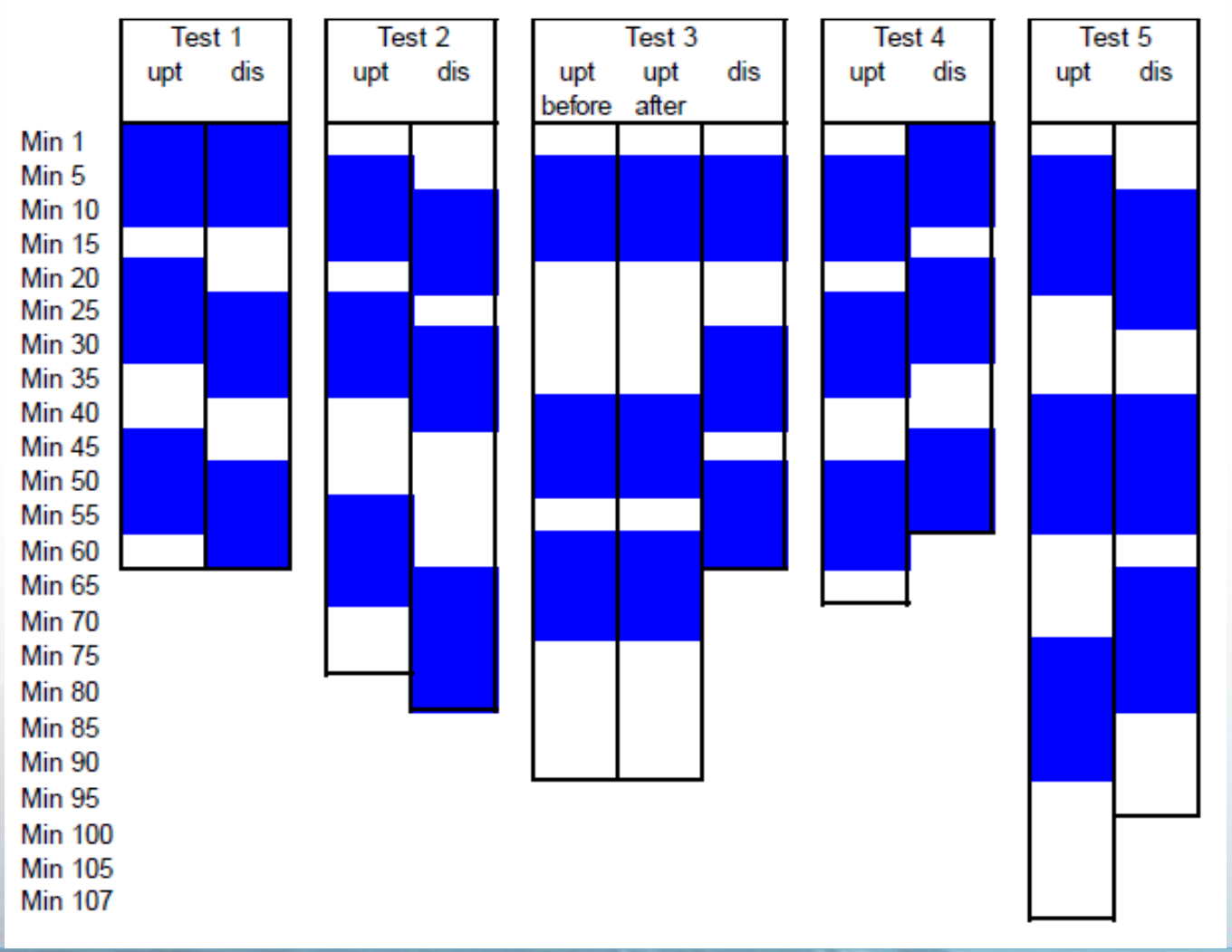
Have to define what want to proove

EMSA Proposal

Test to identify a system that is working at a level 2 or 3 orders of magnitude above the D-2 Standard -

- 9 or 11 per cubic metre
- <100 or 1000 per cubic meter

Sequential Flow Sampling



Sequential Flow Sampling

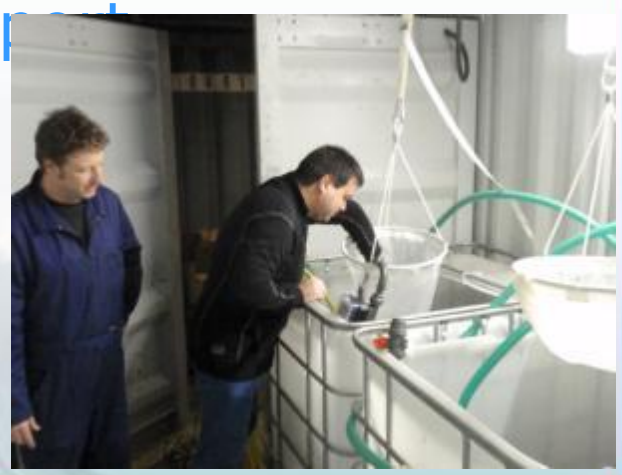
2 to 3 Samples: beginning, middle, and end

- but +/- 10 minutes from the beginning/end.

For organisms > 50 microns; 350 – 500 litres of sample filtered and concentrated to ca. 100 ml

For organisms < 50 and > 10 microns; 5 litres of continuous drip sample during sampling, subsample of ca. 60 ml for transp

For bacteria; 1 litre separated from the 5 litre continuous drip sample



Analysing Samples for Compliance

Organisms less than 50 and greater than or equal to 10 micrometres in minimum dimension - Detailed Stereomicroscopy

Organisms greater than or equal to 50 micrometres in minimum dimension. - Optical Cytometry – with stains

Methods for bacteria analysis

International/National Bacteriological Analysis Methods

Statistical Analysis

Test depending on distribution of data

- Average testing
  – normal distribution, 1 sample student t test – very unlikely
  - un-normal, 1 sample wilcoxon test

- Instantaneous testing
  - 1 sample Poisson Rate test

Issues for Guidance:

- what to do when a vessel indicates that they have a problem with their BWTS prior to entering a port;
- how "clear grounds" can be identified;
- for when a pSc office suspects there is something amiss, but needs sampling to prove "clear grounds";
- management options for the vessel once a discharge has been stopped;
- how to undertake indicative analysis and representative sampling;
- preparations needed before sampling,
- going on board to sample;
- the actual sampling procedures;
- sample handling, transport, chain of custody procedures;
- analysis procedures.

Potential Options for Management following discovery of Clear Grounds that the Ship is not meeting the BWM Convention's Requirements;

- Option A – remain where it is until the deficiency is rectified;
- Option B - move to a safe anchorage if the location of the ship is unsuitable (i.e. the berth is needed by the port) and fix;
- Option C - leave port to rectify the deficiency in another location.
- Option D - arrange for treatment of the ballast water discharge to the D-2 Standard using a mobile [, or another ship's] BWMS. The BWMS used should also comply with the BWM Convention, be type approved and have the appropriate approved documentation;
- Option E - arrange for delivery of the ballast water to a land based treatment facility;
- Option F - arrange for the discharge of ballast water from the ship into another ship, for treatment or delivery onshore [or into another ship that requires ballast water];
- Option G – retain ballast water on the ship and limit further cargo handling,
- Option H – allow the ship to return to the point of origin to discharge its ballast water; or
- [Option J - Exchange their ballast water at least 50nm off the coast in water at least 200m deep, or in a pre-designated ballast water exchange area].

Other Prevalent Issues:

Next MEPC Review: The availability of Ballast Water Treatment Systems for larger vessels (i.e those with a ballast water capacity of greater than 5000m^3);

Wait and see nature of ship-owners:

1) Problems with finding retrofitting crews/facilities;
2) Significant development of retrofitting capability;

Re-emergence of calls for Port Reception Facilities for Ballast Water;

Emergence of Other Methods – flow through, no ballast ships;

Problems for specific types of ships (dredgers, heavy lift vessels);

Scaling of UV Systems

Thank you

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