Group A
Cargoes that may liquefy

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Consultant Scientist

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- Reactive

Consulting
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Poll: Which of the following is nickel ore?

A.  
B.  
C.  
D. None of the above
Poll: Which of the following is nickel ore?

A. ★

B. 

C. 

D. None of the above
Group A consists of cargoes which may liquefy if shipped at a moisture content in excess of their transportable moisture limit.
**Liquefaction** is a phenomenon in which a soil-like material is abruptly transformed from a solid dry state to an almost fluid state.

**Moisture Content** is the portion of water, expressed as a percentage of the total wet mass of a sample.

**Flow Moisture Point** is the moisture content at which a flow state develops.

**Transportable Moisture Limit** is calculated as 90% of the Flow Moisture Point.
Poll: Which of the following may be prone to liquefaction?

A. 

B. 

C. 

D.
Poll: Which of the following may be prone to liquefaction?

A.  
B.  
C.  
D.
The IMSBC Code

Responsibility of the Shipper

- Provide the Master with a signed certificate of TML and MC, each issued by an entity recognised by the Competent Authority of the port of loading. [Sec 4.3.2]

- Establish procedures for sampling, testing and controlling moisture content to ensure the moisture content is less than the TML when the cargo is on board the ship [Sec 4.3.3]

- Facilitate access to stockpiles for the purpose of inspection, sampling and subsequent testing by the ship’s nominated representative [Sec 4.4.3]
Left: In its solid state the particles are held together by friction. 

Right: External agitation can increase water pressure inherent within the material, pushing particles apart.

Image: http://www.ama.org.uk/2014/06/challenges-of-mineral-bulk-shipping/#.WKPeBm997IV
Mineral Ores & Concentrates

The cargo can shift in one direction with the ship’s rolling and not return to the centre.

Further rolling can cause permanent listing.
Group A Cargoes

Unprocessed ores
- Nickel ore
- Iron ore fines
- Fluorspar
- Certain types of bauxite

Mineral concentrates
- Pb concentrate / ore residue
- Mn concentrate
- Zn concentrate / sinter / sludge
How is the cargo tested?

Flow Table Test

- Generally suitable for max grain size of 1 mm, may also be applicable up to 7 mm
- Flow characteristics under impact or cyclic forces of the flow table
- Plastic deformation or an increase in diameter by more than 3 mm

Image: http://underwater.iis.u-tokyo.ac.jp/research/bulk/bulk-chp1-e.html
How is the cargo tested?

Penetration Test

- Generally suitable to a top size of 25 mm
- Vertical vibration
- Penetration of a bit exceeding 50 mm indicates MC is greater than FMP

Image: http://underwater.iis.u-tokyo.ac.jp/research/bulk/bulk-chp1-e.html
How is the cargo tested?

Modified Proctor-Fagerberg Test

- Generally suitable to a top size of 5 mm; should not be used for coal or other porous material
- Compaction test at varying MC
- TML is equal to the critical MC at a certain level of saturation
How is the cargo tested?

Can Test
Poll: Which of the following passed a can test?

A. 
B. 

C. Both  
D. None
Poll: Which of the following passed a can test?

A. 

B. ★

C. Both

D. None
Certificates

Flow Moisture Point/Transportable Moisture Limit

- To be established at regular intervals at source or whenever changes have occurred to the material.
- Should be available before the ship arrives in port, and reluctance to provide this at an early stage usually indicates that it may not be available.

Moisture Content

- Cargo sampled as close as possible to time of loading or if it has been wet by rain, snow or spray.
- Certificate given to Master before loading commences.
- Maximum 7 days old.

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Case Studies

Nickel Ore

Bauxite

Iron Ore Fines
Nickel ore
The six (7) main areas for loading Nickel Ore:

- Surigao
- Tubay
- Santa Cruz
- Tawi-Tawi
- Narra
- Rio Tuba
- Davao

Image: Pandiman Philippines Inc
Open cast mine

Loading into barges
Limited access to the nominated cargo
## Cargo Declaration: FMP/TML/MC

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cargo Declaration</th>
<th>Independent Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMP</td>
<td>40.10 %</td>
<td>34.28 %</td>
</tr>
<tr>
<td>TML</td>
<td>36.09 %</td>
<td>30.85 %</td>
</tr>
<tr>
<td>MC</td>
<td>34.45 %</td>
<td>37.88 %</td>
</tr>
</tbody>
</table>
How is testing carried out on site?
How is testing carried out on site?

- Inadequate facilities
- Incorrect interpretation of the IMSBC Codes
- Incorrect moisture declaration (due to time or rain)
- Unsatisfactory sampling techniques

Interpretation of results
The point at which FMP is reached is way beyond that which is found acceptable at independent labs.
Mining in the Philippines: Current situation

Philippines to shut half of mines, mostly nickel, in environmental clampdown

Philippines to shut mines, suspend others as clampdown deepens
Bauxite

Loading bauxite in Malaysia
BAUXITE

Description
A brownish-yellow clay-like and earthy mineral. Moisture content: 0% to 10%. Insoluble in water.

Characteristics

<table>
<thead>
<tr>
<th>Angle of Repose</th>
<th>Bulk Density (kg/m³)</th>
<th>Stowage Factor (m³/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>1,190 to 1,389</td>
<td>0.72 to 0.84</td>
</tr>
<tr>
<td>Size</td>
<td>Class</td>
<td>Group</td>
</tr>
<tr>
<td>70% to 90% lumps;</td>
<td>Not Applicable</td>
<td>C</td>
</tr>
<tr>
<td>2.5 mm to 500 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10% to 30% powder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Extract from IMSBC 2016 Edition
## Group A or Group C?

<table>
<thead>
<tr>
<th></th>
<th>Flow Moisture Point (FMP) %</th>
<th>Transportable Moisture Limit (TML) %</th>
<th>Moisture Content (MC) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory A*</td>
<td>15.9</td>
<td>14.3</td>
<td>17.0</td>
</tr>
<tr>
<td>Laboratory B*</td>
<td>15.4</td>
<td>13.8</td>
<td>17.04</td>
</tr>
</tbody>
</table>

* Owners and Charterers appointed their own preferred laboratory

### Extract from cargo declaration

- **Total Moisture**: 8%
- **Sulphur**: NIL
- **Size**: 2 mm - 75 mm
- **Physical Properties:**
  - **Transportable Moisture Limit**: 10%
Group A or Group C?

Extract from a cargo declaration for Bauxite

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow moisture point (FMP)</td>
<td>20.54</td>
</tr>
<tr>
<td>Transportable moisture limit (TML = 90% x FMP)</td>
<td>18.48</td>
</tr>
</tbody>
</table>

Moisture in the test portions just above FMP:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture in the test portions just below FMP</td>
<td>20.77</td>
</tr>
<tr>
<td>Tamping pressure used or simulated conditions attempted</td>
<td>116 Kpa</td>
</tr>
<tr>
<td>Sieve aperture size +7 mm, size fraction</td>
<td>20.21</td>
</tr>
<tr>
<td>Sieve aperture size -7 mm used for test purposes</td>
<td>79.79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size-Above 25mm%</th>
<th>Size-25mm to 7mm%</th>
<th>Size-7mm to 1mm%</th>
<th>Size-Below 1mm%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.02</td>
<td>17.20</td>
<td>18.18</td>
<td>61.60</td>
</tr>
</tbody>
</table>
Iron Ore Fines
IRON ORE FINES

The provisions of this schedule shall apply to iron ore cargoes containing both:

.1 10% or more fine particles less than 1 mm ($D_{10} \leq 1 \text{ mm}$); and
.2 50% or more particles less than 10 mm ($D_{50} \leq 10 \text{ mm}$).

Notwithstanding the above provision, iron ore fines where the total geothite content is 35% or more by mass may be carried in accordance with the individual schedule for “IRON ORE”, provided the master receives from the shipper a declaration of the geothite content of the cargo which has been determined according to internationally accepted standard procedures.

Characteristics

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<tr>
<th>Angle of Repose</th>
<th>Bulk Density (kg/m$^3$)</th>
<th>Stowage Factor (m$^3$/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>1,500 to 3,500</td>
<td>0.29 to 0.67</td>
</tr>
<tr>
<td>Size</td>
<td>Class</td>
<td>Group</td>
</tr>
<tr>
<td>10% or more of fine</td>
<td>Not Applicable</td>
<td>A</td>
</tr>
<tr>
<td>particles less than 1 mm</td>
<td>and 50% or more of</td>
<td></td>
</tr>
<tr>
<td>and 50% or more of</td>
<td>particles less than 10 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Which test to use?

- Penetration Test
- Modified Proctor-Fagerberg Test

<table>
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<tr>
<th>Parameters</th>
<th>Penetration Test</th>
<th>Modified Proctor-Fagerberg Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>TML</td>
<td>8.9 %</td>
<td>10.7 %</td>
</tr>
</tbody>
</table>
Exposed stockpiles

Loading wet cargo
Risk and loss prevention

- Check the shipper’s cargo declaration and stated moisture content.
- Request for new moisture content tests to be carried out, if rainfall occurred in the days prior loading.
- Ensure any document seeking confirmation that the cargo is safe to carry is signed by the shipper, not the master or his appointed surveyor.
- Check cargo to be loaded in each barge or stockpile for excessive water content.
Risk and loss prevention

- Should there be any concerns or doubts about the moisture levels in the nominated cargoes, further advice and assistance can be obtained from an independent reputable cargo expert.
- Moisture testing can be carried out on site.
Developments in the Code

- Clarification of duties of the Shipper; access to stockpiles.

- New Schedules for Group A cargoes
  - Alumina Hydrate
  - Clinker Ash, Wet
  - Ilmenite (Upgraded)
  - Nickel Ore
  - Sand, Heavy Mineral

- Revised schedule for iron ores, and an individual schedule for iron ore fines.
Summary

- Ensure that proper IMBSC Code Documentation, including shipper’s declaration and certificate of moisture content, is provided in advance of loading.

- Master should ensure that he is fully satisfied with the condition of the cargo before accepting it for loading; and that all conditions in accordance with the IMSBC Code are duly met at all times.

- Loading should be stopped if there is a possible problem, and expert help sought.
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Thank You!

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