IRON ORE FINES

RISK OF CARRIAGE BY SEA

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INTRODUCTION

- Iron ore fines are a product of the screening of iron ore

- They are used to produce sinter or pellets in the steel industry

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INTRODUCTION

International Maritime Solid Bulk Cargo Code (IMSBC Code), Chapter VII, Group “C”.

Definition - Section 1.7.14 - “Group C consists of cargoes which are neither liable to liquefy (Group A) nor to possess chemical hazards (Group B).”Iron ore is classed as group “C”.

However Iron ore sinter feed and pellet feed are classed as Group A.

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INTRODUCTION

If documentation states cargo is iron ore fines the Master may interpret cargo as fines from iron ore, a Group “C” cargo.

Knowledge of section 7.2.1 of the Code is required. This states that cargoes with a certain amount of moisture and small particles may liquefy.

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INTRODUCTION

How many Masters would read and understand the Code in such detail when they are presented with the cargo for loading.

Iron ore fines should be included as a separate entry in the IMSBC Code, classed as a Group “A” cargo, cargoes which may liquefy.

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INTRODUCTION

SOLAS Chapter VI, “Carriage of cargoes” Regulation 2 would require information to be provided to the Master before loading.

A certificate would be required quoting;

- Transportable Moisture Limit (TML) of cargo
- Moisture content of cargo to be loaded

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INTRODUCTION

SOLAS Chapter VI, Regulation 2, section 2.2;

“..... In the case of a concentrate or other cargo that may liquefy, additional information in the form of a certificate on the moisture content of the cargo and its transportable moisture limit.”

Unfortunately the Master does not always receive this information.

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MINING

- India is the World's 4th largest iron ore producer
- In 2008 India produced an estimated 200 million tonnes of iron ore

MINING

A high grade ore can have an iron yield of 60%.

Large lumps as mined are crushed to approx 300mm.

They are then further crushed to 6 – 40mm for shipment.

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MINING

Fines below 6mm can be further crushed and sold as sinter feed or formed with a binder into pellets.

An iron ore crushing unit

BENEFICIATION

Many ores with iron content below 60% may undergo a benficiation process.

This removes impurities, gangue such as sand and calcite ,thereby raising the iron content of the ore.

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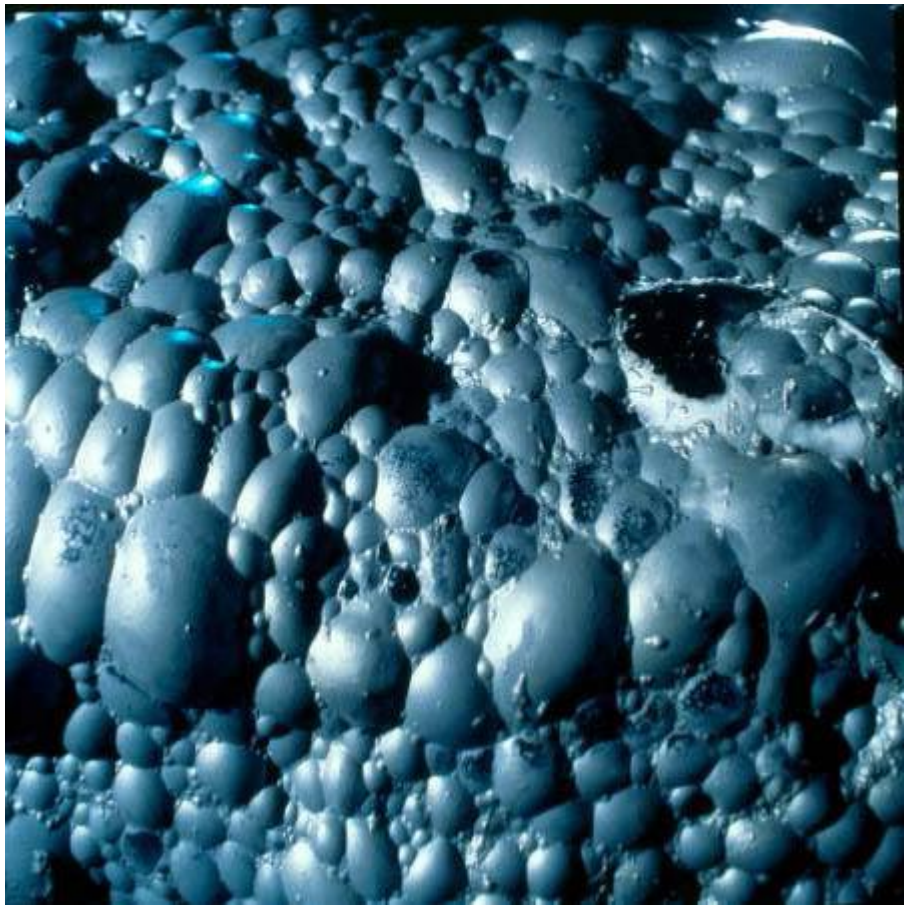
BENEFICIATION

This may be through a wet process, froth flotation, which leaves the ore in a wet state.



BENEFICIATION

The enriched fines may be sold as sinter feed or pellet feed.

Sinter feed is too fine to be fed to a furnace. It is agglomerated by heating in a sinter plant which causes the fine material to bond together into larger lumps.

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BENEFICIATION

Pellet feed is crushed, mixed with a binder and water and rolled into pellets. They are then baked until they are strong enough to be fed to a furnace.

TRANSPORT AND STORAGE

Most mines are well inland and material is usually transported to loading ports on road or rail wagons open to the elements.

TRANSPORT AND STORAGE

Some producers do not consider the need for covered storage. This is particularly marked in India, despite the fact that they will be exposed to the effects of monsoon rainfalls.

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TRANSPORT AND STORAGE

Storage with free ground water.

LOADING

An example is shown of primitive loading techniques in India.

Fines are loaded using a payloader to fill rope netting lined with a loose canvas sheet. Ground water is apparent on the quayside.

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LOADING

It is evident from the photograph that ground water would be loaded with the wet fines.

When full the crane's basket would be drawn tight and the wet cargo would be charged to the ship's hold.

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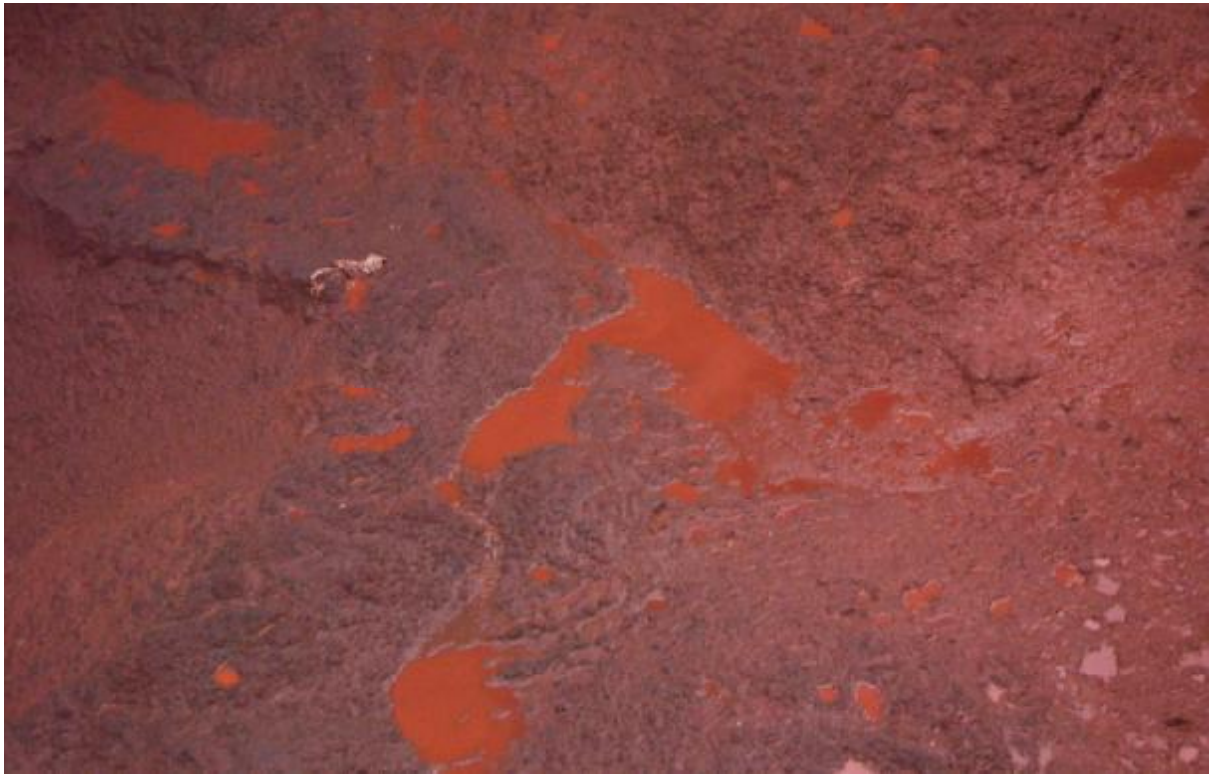
LOADING

Example of wet iron ore fines in a ship’s hold.

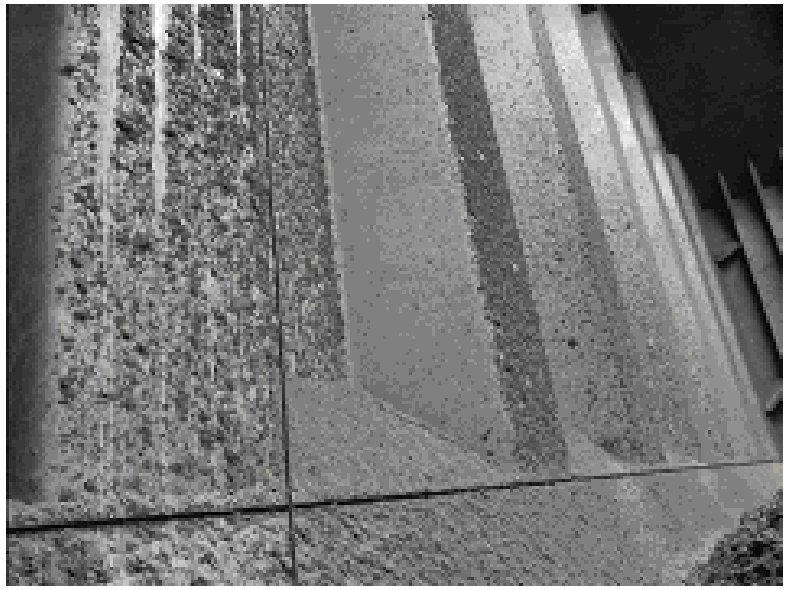
LOADING

A wet fines cargo with the “appearance” of quicksand.



LOADING

Note the “splattering” of the bulkheads caused by loading a wet cargo to a hold.



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LIQUEFACTION

The IMSBC Code relates to those cargoes, which contain a proportion of small particles and moisture,which if shipped with a moisture content in excess of the transportable moisture content may liquefy during the voyage.

The finely divided state and high moisture content of iron ore fines would indicate that the fines may liquefy under certain conditions.

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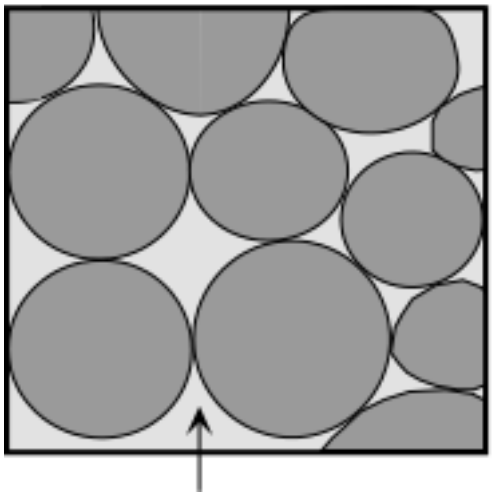
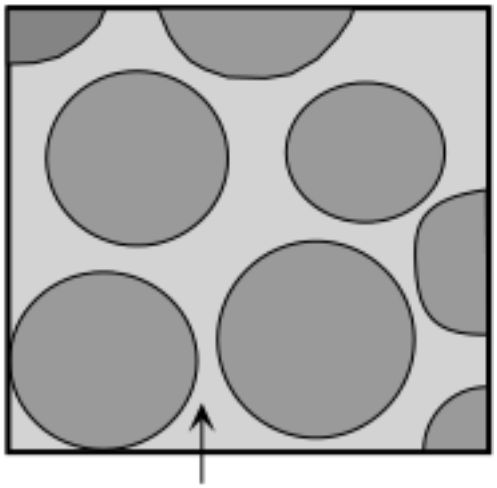
LIQUEFACTION



Below a critical moisture level friction between particles in contact holds the particles together.



Above a critical moisture level motion from the ship compresses the particles. The pore water pressure increases to a point where friction is reduced and the particles pass into a flow state.

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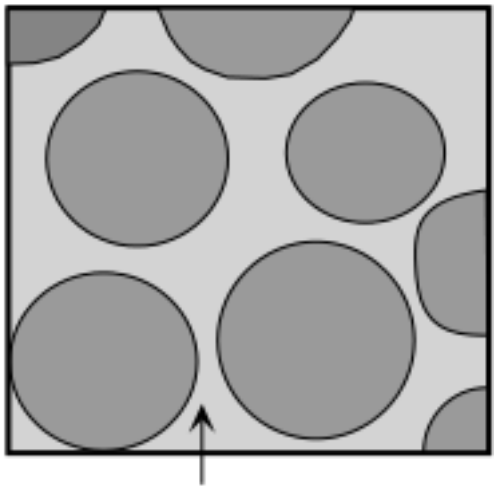
LIQUEFACTION

If the cargo shifts while it is in this condition it may flow to one side of the ship which can cause the ship to list or possibly even capsize.

The critical point is known as the Flow Moisture Point (FMP).



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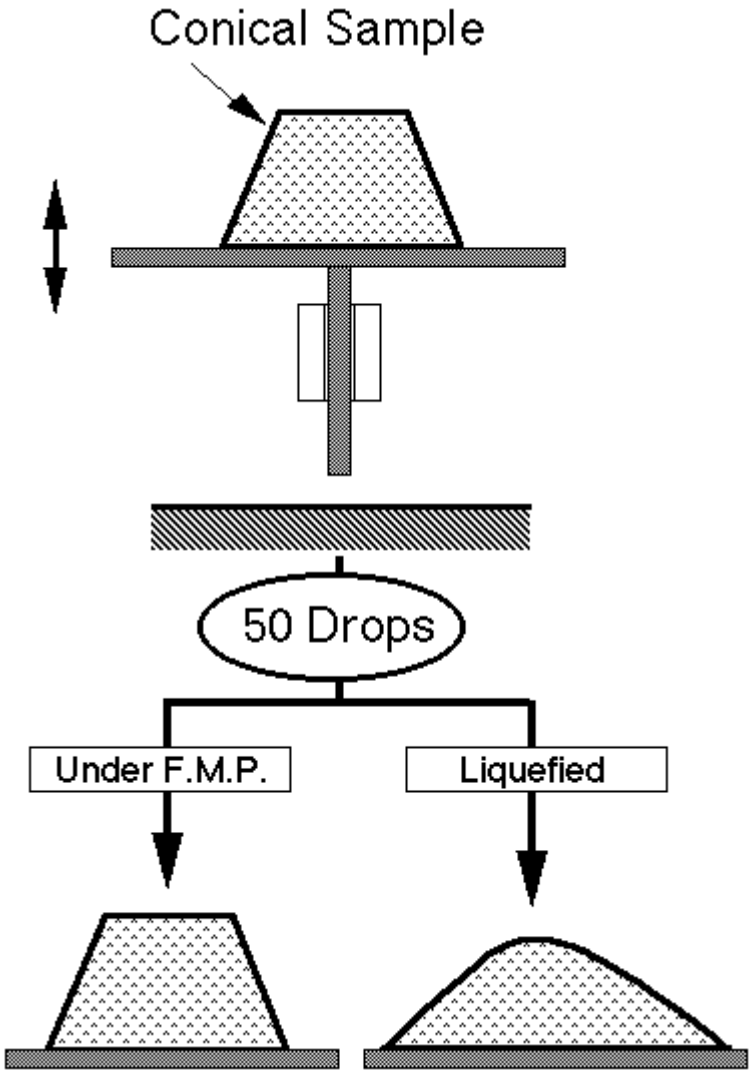
FLOW TABLE TEST

BC Code – Appendix 2
Section 1.1.1 Scope:

"*The flow table is generally suitable for mineral concentrates or other fine material with a maximum grain size of 1 mm. It may also be applicable to materials with a maximum grain size up to 7 mm…..*
…..may not give satisfactory results for some materials with high clay content"



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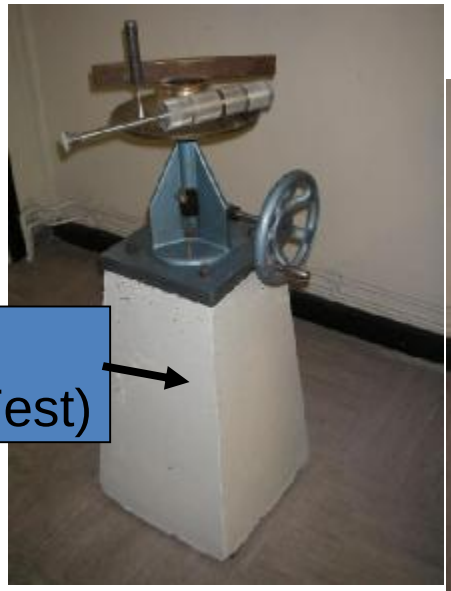
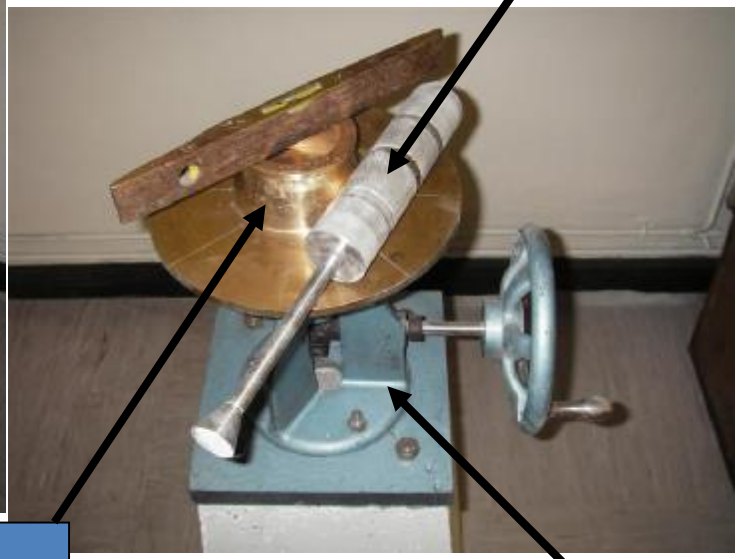
FLOW TABLE TEST

Flow Table Test - Construction

Spring Loaded Tamper
(To Get Accurate Tamping
For Expected Height Of Cargo)





Plinth
(Stability For Test)

Brass Mould
(To Form Up Test "Pudding")

Flow Table
(With Rotating Cam
To Simulate Ship Motion)

FLOW TABLE TEST

Common incorrect setup.

ASTM C230-68 requires the test apparatus to be mounted on a concrete base of specified design.

Sample exposed to reduced impact and a higher FMP is obtained.

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FLOW TABLE TEST

- Tamping pressure simulates the packing of the cargo in the vessels holds:
  - Density of the cargo at the loaded moisture content
  - Maximum depth of the cargo

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FLOW TABLE TEST

BC Code, Appendix 2, Section 1.1.4.2
Identification of a flow state

“the moulded sides of the sample may deform, giving a convex or concave profile”

“cracks may develop on the top surface”

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FLOW TABLE TEST

When FMP is determined the Transportable Moisture Limit (TML) can be calculated.

$$TML\ (\%) = FMP\ (\%) \times 0.9$$

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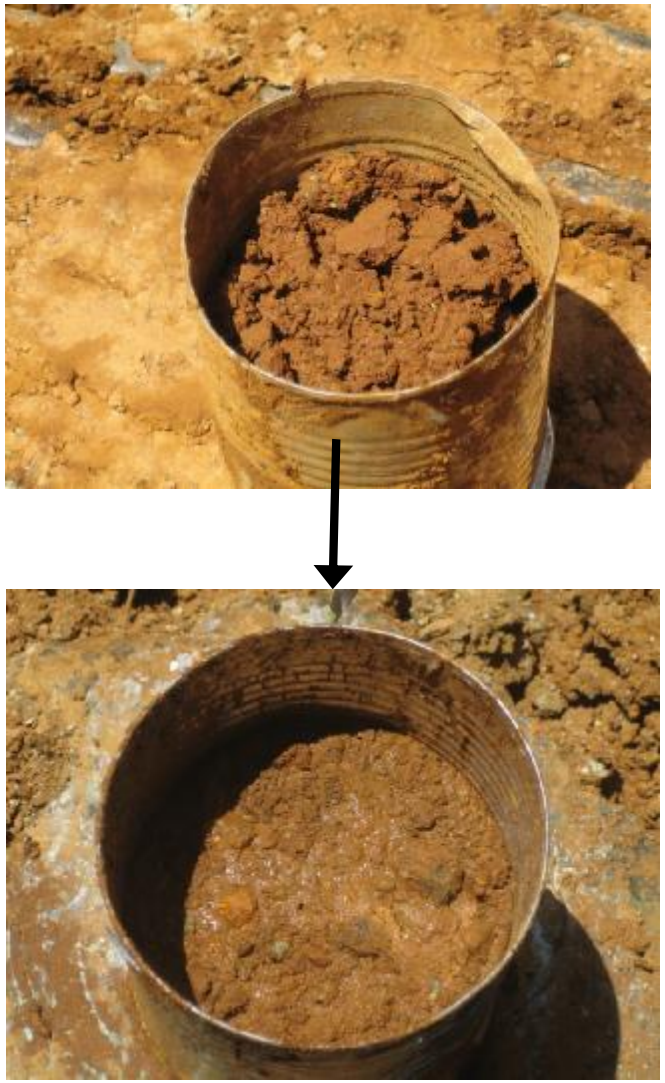
CAN TEST

Rule of thumb -

Fill a can with a sample of cargo. Strike the can firmly on a hard surface 25 times. If free moisture is evident on the surface of the material then it is above its flow point.



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SUMMARY

Issues with iron ore fines is not a new phenomenon.

– some years ago similar cargo from India, ship lost without trace

– 2002, two ships from Australia lost ,one with all lives, only two saved in other.

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SUMMARY

Increased demand for iron ore (and fines) in recent years.

India major exporter to China.

Chinese imports of iron ore

- year 2000 = 75 MT
- year 2008 = 500 MT

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SUMMARY

An old problem that has now escalated to extremes.

It has to be accepted that the cargoes may be liable to liquefy if shipped with a moisture content in excess of TML.

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SUMMARY

The preparation process will add moisture to the fines.

Carriage to the Port and storage on the quayside without covered protection will again increase the moisture content, particularly during the monsoon period.

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SUMMARY

Thus testing in accordance with relevant test procedures and rejection of material above the Transportable Moisture Limit are essential for safe ocean transport.

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