

# Liquefying Bulk Cargoes

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## Lessons learned about nickel ore



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# Overview

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- Demand for nickel ore
- Nickel ore incidents
- International regulations: IMSBC
- Problems with the trade
- Liquefaction & moisture migration
- What can be done
- Insurance considerations



# Nickel ore demand

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- Significant demand for nickel ore in China as it is the principal alloy component for stainless steel
- Exports of nickel ore from Indonesia currently suspended
- Exports from Philippines continue

# Nickel ore incidents

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- 27 October 2010: JIAN FU STAR sank while carrying nickel ore from Indonesia to China. (13 fatalities)
- 10 November 2010: NASCO DIAMOND sank while carrying nickel ore from Indonesia to China. (21 fatalities)
- 03 December 2010: HONG WEI sank while carrying nickel ore from Indonesia to China. (10 fatalities)
- 25 December 2011: VINALINES QUEEN went missing en route to China. One sole survivor. (22 fatalities)
- 16 February 2012: HARITA BAUXITE sank while carrying nickel ore from Indonesia to China. (15 fatalities)

# The latest nickel ore incident...

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**TRANS SUMMER** ... luckily, no fatalities.



# Some sobering statistics

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- The nickel ore trade makes up around **0.06%** of bulk shipping world trade... but **80%** of the fatalities in bulk carrier trade.
- The Chinese nickel ore trade accounts for approximately **4 times** the rate of all seafarers killed by pirates around the world annually.

# IMO regulation

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## International Maritime Solid Bulk Cargoes (IMSBC) Code

- Adopted on 4 December 2008 by IMO Resolution MSC 268(85)
- Majority of IMSBC Code is mandatory through additional provisions made to Chapters II, VI, VII to the International Convention for the Safety of Life at Sea, 1974 (SOLAS Convention) as of 1 January 2011

# IMO regulation

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## IMSBC Code: Hazards of concern and objectives

- Code addresses hazards of carriage of bulk cargoes associated with:
  - ü structural damage due to improper cargo distribution;
  - ü loss or reduction of stability during a voyage; and
  - ü chemical reactions of cargo.
- Code objectives are to:
  - ü facilitate safe stowage and shipment of certain bulk cargoes;
  - ü provide information on dangers associated with shipment of certain cargoes; and
  - ü provide instructions on procedures to be adopted for those cargoes.



# IMO regulation

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## IMSBC Code Overview: Code sections

- ü General provisions
- ü General loading, carriage and unloading precautions
- ü Safety of personnel and ship
- ü Assessment of acceptability of consignments for safe shipment
- ü Trimming procedures
- ü Methods for determining angle of repose
- ü Cargoes that may liquefy
- ü Test procedures for cargoes that may liquefy
- ü Material possessing chemical hazards
- ü Carriage of solid waste in bulk
- ü Security provisions
- ü Stowage factor conversion tables
- ü References to related information and recommendations

# IMSBC Code Terminologies

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- ü Flow moisture point (FMP): percentage moisture content (wet mass basis) at which a flow state develops “ *under prescribed methods of testing*”
- ü Transportable moisture limit (TML): maximum moisture content of the cargo which is considered safe for carriage

# IMSBC Code

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## *Cargo declarations*

### Cargo information: SOLAS Chapter VI, Part A, Regulation 2(1)

“The shipper shall provide the master or his representative with appropriate information on the cargo sufficiently in advance of loading...”

“Such information shall be in writing...”

# IMSBC Code

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## *Identification and classification of cargo*

Cargo testing: IMSBC Code, Section 4, Regulation 4.1.4:

“Bulk cargoes shall be classified... in accordance with the *UN Manual of Tests and Criteria*, part III.”

“The various properties of a solid bulk cargo... shall be determined... in accordance with the test procedures approved by a competent authority in the country of origin...”

# IMSBC Code

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## *Cargo information to be provided*

IMSBC Code: Section 4.2: Provision of information to be provided on the appropriate shipping documents include...

# Information to be provided by Shipper

## FORM FOR CARGO INFORMATION for Solid Bulk Cargoes

BCSN	
Shipper	Transport document Number
Consignee	Carrier
Name/means of transport	Instructions or other matters
Port/place of departure	
Port/place of destination	Gross mass (kg/tonnes)
General description of the cargo (Type of material/particle size)*	
Specifications of bulk cargo, if applicable: Stowage factor: Angle of repose, if applicable: Trimming procedures: Chemical properties if potential hazard*: * e.g., Class & UN No. or "MHB"	
Group of the cargo <input type="checkbox"/> Group A & B* <input type="checkbox"/> Group A* <input type="checkbox"/> Group B <input type="checkbox"/> Group C	* For cargoes which may liquefy (Group A and Group A & B cargoes) Transportable Moisture Limit  Moisture content at shipment
Relevant special properties of the cargo (e.g., highly soluble in water)	Additional certificate(s)* <input type="checkbox"/> Certificate of moisture content and transportable moisture limit <input type="checkbox"/> Weathering certificate <input type="checkbox"/> Exemption certificate <input type="checkbox"/> Other (specify) * If required
<b>DECLARATION</b> I hereby declare that the consignment is fully and accurately described and that the given test results and other specifications are correct to the best of my knowledge and belief and can be considered as representative for the cargo to be loaded.	Name/state, company/organization of signatory  Place and date  Signature on behalf of shipper

# IMSBC Code

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## *Certificates to tests*

- Cargo testing: IMSBC Code, Section 4.3, Regulation 4.3.1:  
“...the shipper shall arrange for the cargo to be properly sampled and tested.”
- Cargo testing: IMSBC Code, Section 4.3, Regulation 4.3.2 states the shipper shall provide:
  - ü a signed certificate of TML
  - ü TML certificate shall contain or be accompanied by results of TML tests
  - ü a signed certificate or declaration of the moisture content

# IMSBC Code

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## *Sampling procedures*

Cargo testing: IMSBC Code, Section 4, Regulation 4.4 are to take into account important factors such as:

- ü Type of material
- ü Particle size distribution
- ü Manner in which material was stored
- ü Variations in moisture distribution through consignments
- ü Characteristics to be determined: TML, angle of repose, bulk density/stowage factor



# Problems with the trade

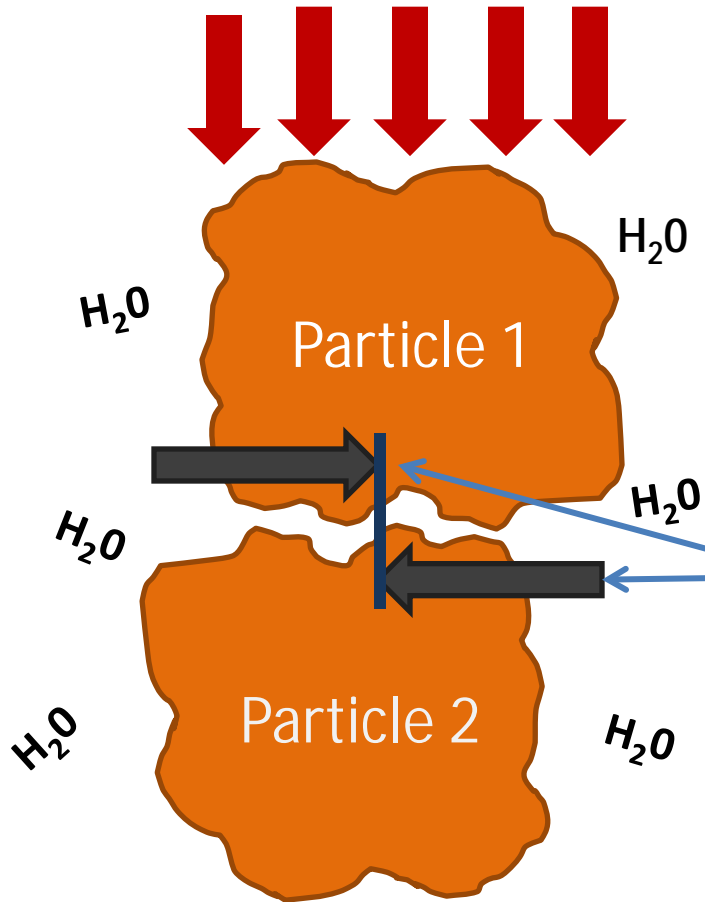
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## *Having IMSBC Code is not stopping casualties*

- ü Shippers unaware of or ignore the problems posed by nickel ore and liquefaction during sea carriage.
- ü Mines remote, Shipper's own labs are not well equipped.
- ü Limitations of present testing methods for nickel ore. Flow table method not most reliable. Penetration test better.
- ü Information provided by Shippers may not be reliable.
- ü Ship's personnel can have inadequate knowledge of the problems and therefore are unaware of potential dangers.

# How does liquefaction occur?

Compression force from other cargo particles



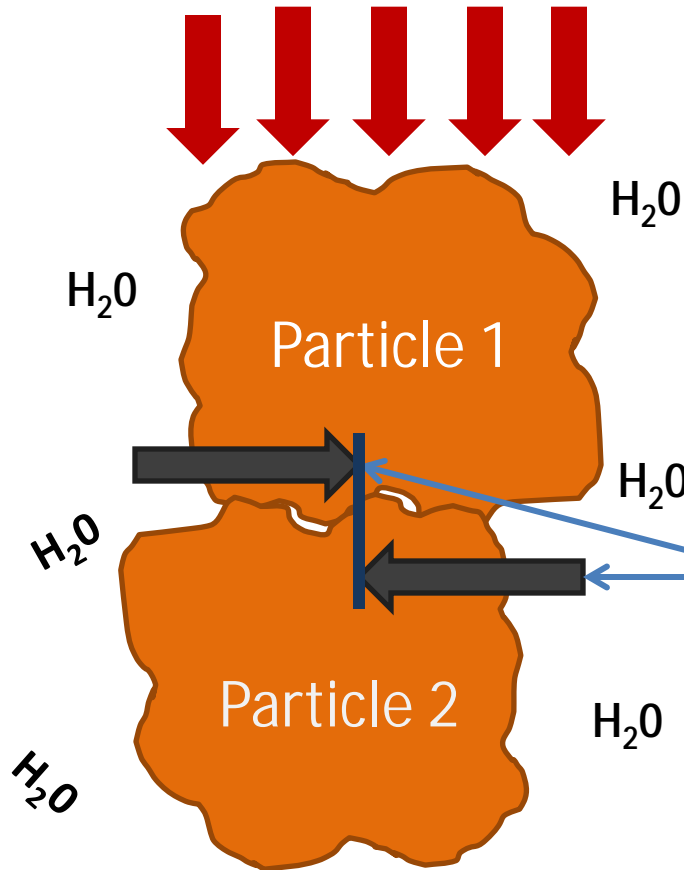
Particle 1 compressing down on Particle 2

Step 1: Volume of space between particles reduce as cargo is compacted owing to ship motion

Sufficient equal and opposite shear forces between Particle 1 and Particle 2

# How does liquefaction occur?

Compression force from other cargo particles



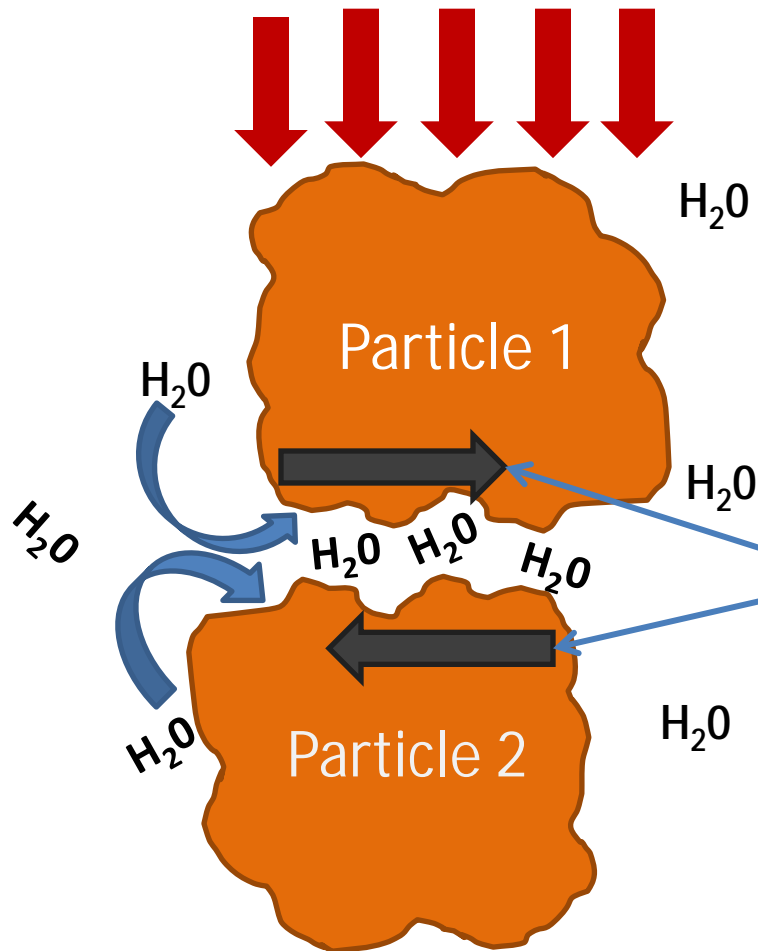
Space between Particle 1 and Particle 2 is further reduced

**Step 2:** Reduction in space between cargo particles causes an increase in water pressure in the space between particles

Sufficient equal and opposite shear forces between particles maintained

# How does liquefaction occur?

Compression force from other cargo particles

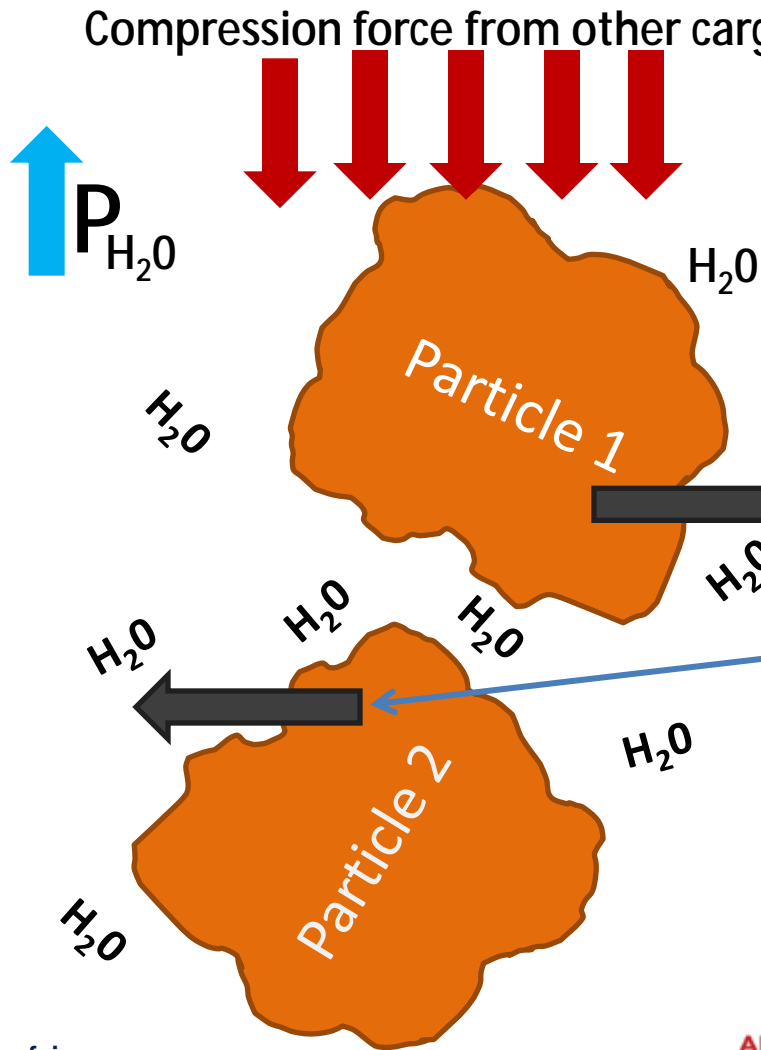


Water pressure forces water between Particle 1 and Particle 2

**Step 3:** Increase in water pressure reduces the friction between cargo particles

As water pressure increases and forces itself between particles, shear pressure decreases as space widens between particles

# How does liquefaction occur?



Water pressure forcing water into space between Particle 1 from Particle 2 leads to further separation

**Step 4:** Reduction in sheer strength in the cargo and the cargo liquefies!

Sheer forces between Particle 1 and Particle 2 no longer exists. Liquefaction occurs.

# How does liquefaction occur?

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## Liquefaction does not occur when...

- Cargo carries many small particles. Particle cohesion and restrictions on water pressure.
- Very large particles or lumps. Water is able to pass easily between particles without an increase in water pressure.
- Cargo contains a high percentage of air and low moisture content. Increase in water pressure is inhibited and dry cargoes are unable to liquefy.

## Liquefaction may occur when...

- Moisture content exceeds the TML.

# Nickel ore in a cargo hold – slumping?

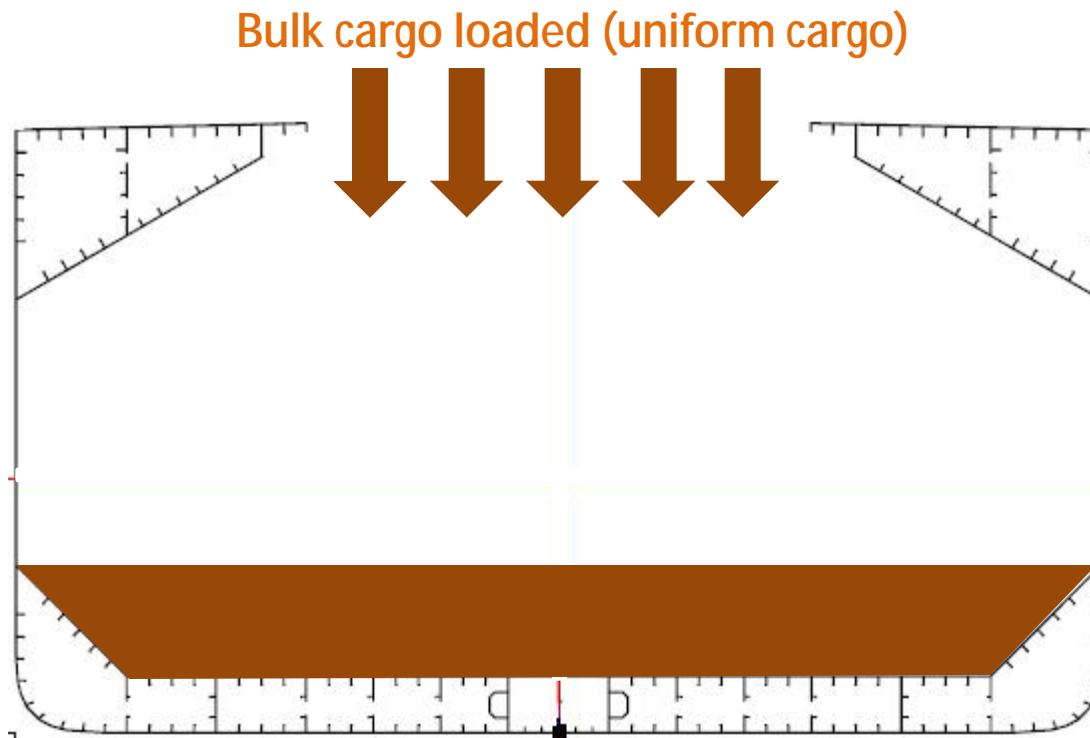
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# Moisture migration

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Uniform loaded bulk cargo with moisture content < TML

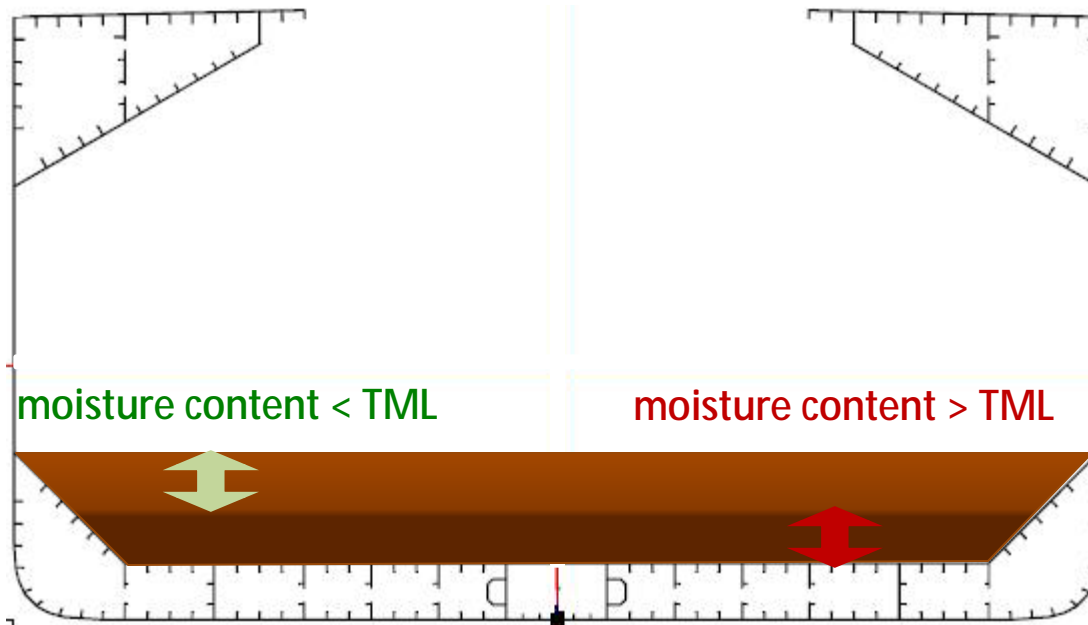




# Moisture migration

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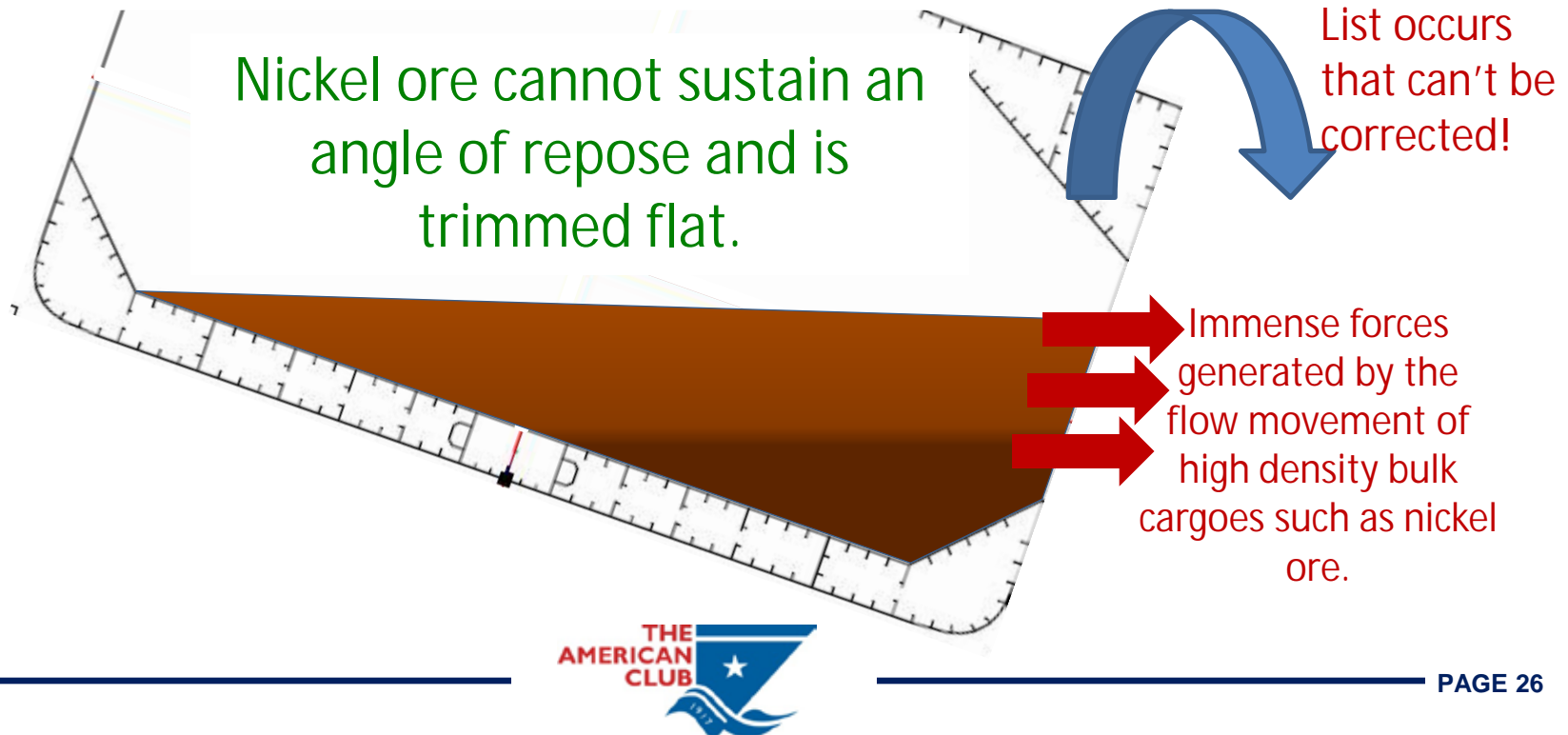
Water migrates via gravity...



# Moisture migration

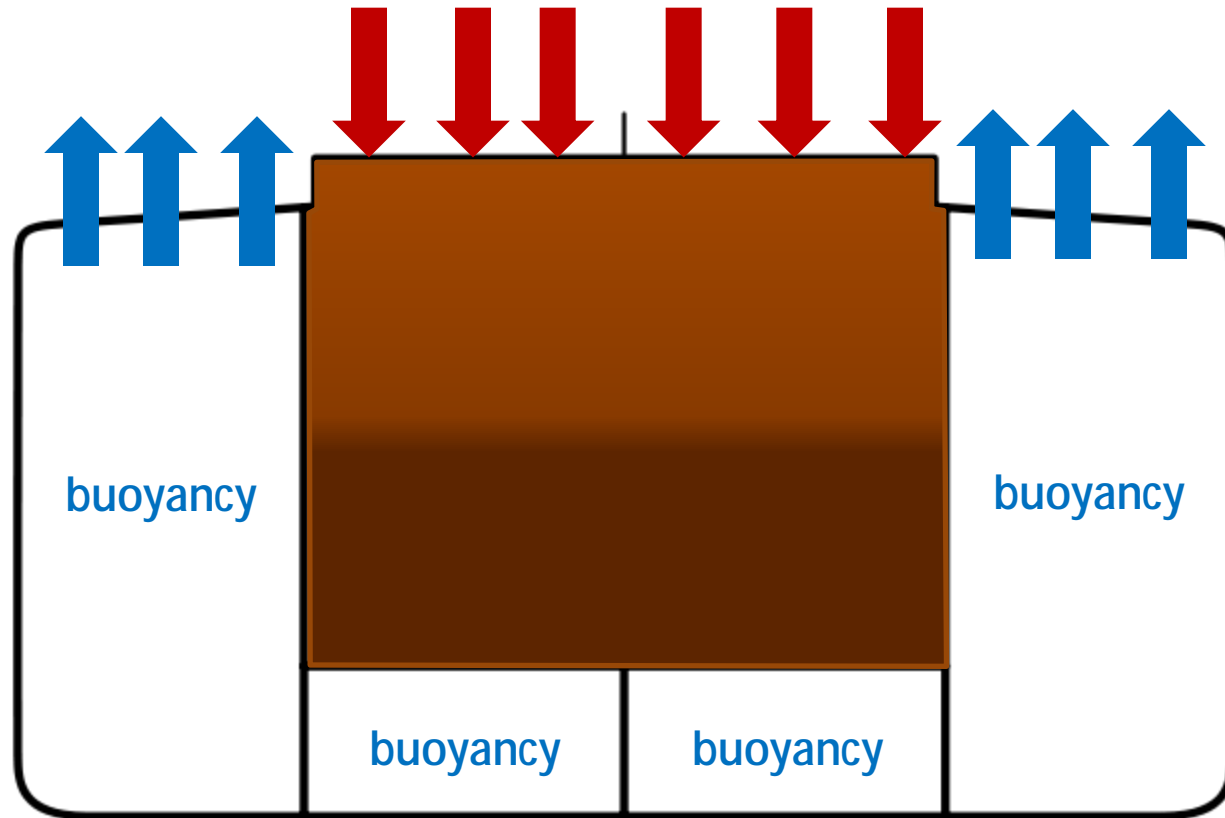
Cargo testing: IMSBC Code, Section 7, Regulation 7.3.2

"...the cargo surface may appear dry, undetected liquefaction may take place resulting in shifting of cargo. Cargoes with high moisture content are prone to sliding, particularly when the cargo is shallow and subject to large heel angles."



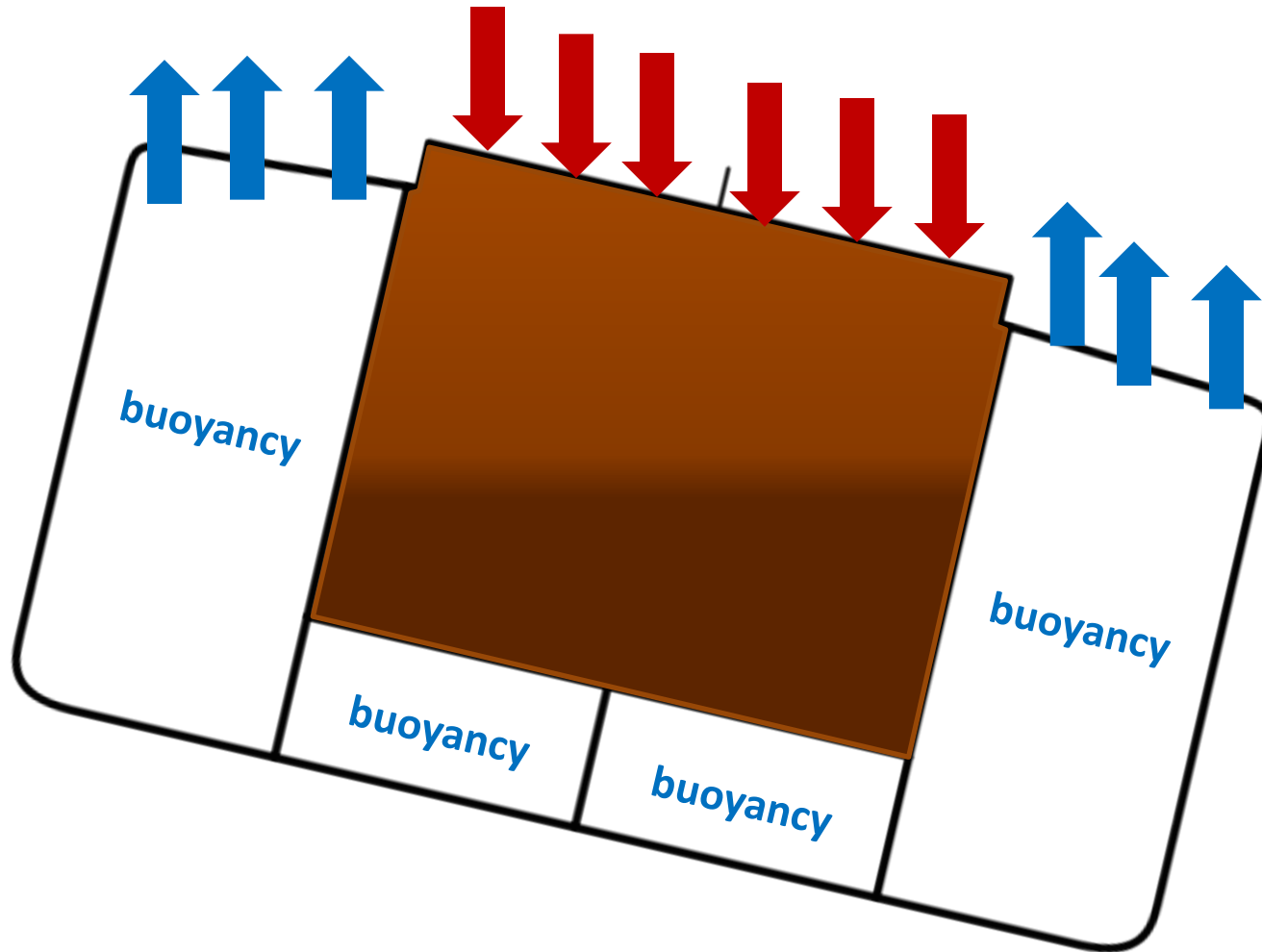
# Designed to carry Group A cargoes?

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# Designed to carry Group A cargoes?

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# What can Owners & crew do?

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## Pre-Loading/Loading

- Instruct experienced surveyor to attend to inspect cargo stockpiles and lab facilities ashore, establish background information about cargo and documentation.
- Surveyor to assist Master.
- Ensure ship's personnel aware of the dangers of liquefaction and requirements of the IMSBC Code.
- Owners to support Master and surveyor and liaise with other parties as required.

# What can surveyor & crew do?

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## Pre-Loading/Loading

- Visual inspections of cargo on barges prior loading.
- Cross check ashore – is cargo being loaded, the cargo sighted at stockpiles?
- Closely monitor and record the weather conditions.
- Surveyor to train crew in 'can' tests. Surveyor & crew to rotate 'can' test duties during loading at regular intervals.
- Take photographs of barges and 'can' test results. Keep accurate written records of barges and loading progress.
- If in doubt, question/verify moisture content figures in the cargo declaration.

# 'Can' test – is this a FAIL?

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# Cargo splattering in hold

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# What can surveyor & crew do?

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## BEWARE!

### Pre-Loading/Loading

- A good 'can' test result does not necessarily mean the cargo is safe for shipment
- Even when the cargo appears to be dry, it may still contain moisture in excess of the TML

# What can surveyor & crew do?

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## Loading objective

- Overly 'wet' cargo must not be loaded. Problematic to discharge – leads to delays, disputes.

# What can the crew do?

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## Voyage

- Regular visual checks of the cargo surface
- Daily cargo hold bilge soundings and pumping
- Avoid vibrations and sharp alterations of course

# What can the crew do?

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## BEWARE!

### Voyage

- Regular visual cargo surface inspections may not reveal cargo condition
- If there is free water, the cargo might be expected to drain... but the cargo can hold the moisture and develop a wet base

# Insurance considerations

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- Pollution (bunker) claims
- Wreck removal
- Crew claims: injury and death
- Bills of Lading: shipper's liability
- Charterparty dispute
- P&I policy
- H&M policy
- Cargo insurance

# Summary

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- 81 seafarers lost their lives since October 2010 on ships carrying nickel ore. Sadly, there may well be more.
- Regulations lagging behind realities of the nickel ore trade.
- Political, economic and commercial interests and pressures make any significant progress difficult at present.
- Changes to IMSBC Code take time.
- Industry stakeholders (e.g. Intercargo, BIMCO, IG P & I Clubs) undaunted but challenged to produce unified solutions.
- If a ship sinks carrying nickel ore... it is most likely the nickel ore that caused the sinking!

# Liquefying Bulk Cargoes

Lessons learned about nickel ore

Thank you