



BUREAU VERITAS METALS & MINERALS TRADE  
**THE IMPORTANCE OF  
TRANSPORTABLE MOISTURE LIMIT**



*Move Forward with Confidence*

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# INTRODUCTION

TML – Transportable Moisture Limit – has long been one of the hottest shipping safety topics and the subject of many publications by the IMO (International Maritime Organization) and alerts by Marine Insurers. Why? Because whenever ‘TML’ is mentioned it leads inevitably to the issue of liquefaction of a solid bulk cargo

Liquefaction of a solid bulk cargo - such as bauxite, iron and nickel ore – has been identified as a cause of the capsizing of cargo vessels. Lives have been lost.

Shippers, of solid bulk cargoes that may have the potential to liquefy have a legal obligation and responsibility to make sure their cargo is considered safe for transport by sea.

This paper explains Bureau Veritas’ views on TML testing, the role of competent authorities and its position as a leading safety testing and inspection service provider.

## WHAT IS TRANSPORTABLE MOISTURE LIMIT?

The International Maritime Solid Bulk Cargoes Code (IMSBC) makes recommendations about cargoes that may liquefy. The IMSBC Code specifies the sampling, testing and control procedures of such potentially life-threatening cargoes.

The provisions of the IMSBC Code are mandatory for the 159 contracting States and Governments of the SOLAS treaty – Safety of Life At Sea. These 159 contracting States represent approximately 99% of the world’s merchant fleet.

The IMSBC Code sets out three different categories of cargo:

**Group A** – for cargoes that may liquefy if shipped with moisture content in excess of their TML.

**Group B** – for cargoes that possess a chemical hazard that are potentially dangerous.

**Group C** – for cargoes that are neither liable to liquefy nor chemically hazardous.

Appendix 1 of the Code can help shippers to determine in which group their cargo falls. Shippers are expected to know the code and the mandatory provisions; it is their duty and responsibility. Highly qualified inspectors, such as those employed by Bureau Veritas, can offer advice.

# LIQUEFACTION AT SEA

A solid bulk cargo consists of three main components: a solid component; a moisture component; and an amount of air (void space) in between.

Vibration and the motion of a vessel may compact a solid bulk cargo. In certain conditions a cargo can compact to such an extent that there is no more void space (air) between solid and water particles. If vibration and motion continue to put pressure on the cargo, the water may become separated and will start to prise the solid particles apart. The cargo is then transformed from a solid state to a viscous fluid.

A liquefied cargo that has changed from a solid state to a viscous fluid state might unexpectedly flow from one side in the hold to the other. This has a dramatic effect on ship's stability: in heavy seas the cargo can flow to one side, not return with a roll the other way... and even capsize.

- **The space** between particles reduces
- **Air** is expelled
- **Water** pushes particles apart
- There is a loss of **shear strength**
- Solid cargo becomes **liquid**
- Ships **capsize**



p.3

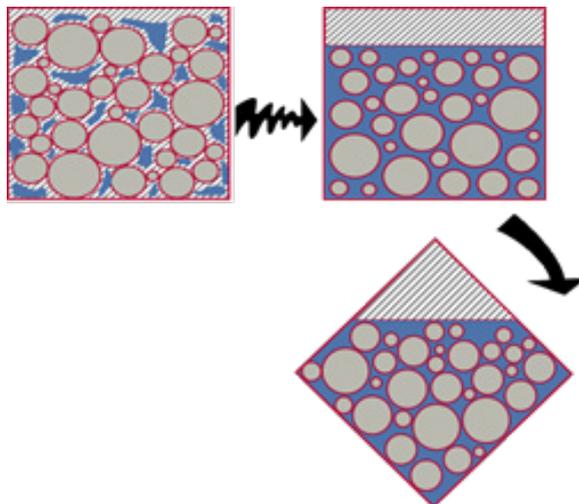
Bureau Veritas Metals & Minerals Trade  
Transportable Moisture Limit

## TML - A LABORATORY TEST

TML test procedures are designed to be standardised and based on same principle: applied energy, rearrangement of particles, compaction of voids, build-up of water saturation and a point where a sample starts to flow.

The test procedures were developed around the maximum expected vibration and motion of ship at sea. The energy simulation during test procedures is typically much more than as experienced by a ship in a normal sea-passage.

As with all standardised tests they must be repeatable, easily reproducible between laboratories and meaningful. This requires tight control of the amount of energy that is applied on a test sample. When the test procedures of the IMSBC Code are correctly applied, the results provide information on the liquefaction characteristics of the sample to help the shipper and Master make the decision to accept or reject the cargo.



There are three general types of TML testing:

1. **Flow Table Testing** where the point is determined at which the sample starts to flow. This point is called FMP – Flow Moisture Point. TML is calculated by taking 90% of the moisture content at FMP.
2. **Penetration Testing** also determines FMP and calculates TML using the moisture content after drying of the sample at that point.
3. **Proctor/Fagerberg Testing** determines compaction and degrees of saturation of successive sample portions for its TML calculation model.

Variations of these tests may be used, but only at the discretion of the competent authorities and only when alternative procedures are at least as effective and safe as those provided by the IMSBC Code. Competent authorities are required to publish an exemption when they deviate at any stage from the provisions of the Code.

Variations of the Proctor/Fagerberg test specifically for Iron Ore Fines and for Coal are expected to be included into next edition of the IMSBC Code. For Iron Ore Fines SOLAS member governments are asked to voluntarily implement (by exemption) as soon as possible.



## SHIPPERS' RESPONSIBILITY

TML determination for cargo safety acceptability is a fundamental responsibility of the shipper, who must also establish procedures for sampling, moisture-testing and controlling the moisture content. All these procedures must be approved by the competent authority of the port of loading.

Prior to loading, the shipper must provide the captain of a bulk carrier with all relevant cargo information, including which group it belongs, the TML of that cargo and the moisture content of the material which is to be loaded. This is stipulated in IMSBC Code section 4.2. A copy of the approval document from the competent authorities of the load port should be provided to the master as well.

More than 18 months after mandatory enforcement by SOLAS governments, many shippers are not fully aware yet, or do not know where to start, to fulfil their 'legal' IMSBC obligations.

Often they believe that sending a sample for TML and another sample for Moisture is sufficient (if it shows that the moisture content is less than the TML). Or they believe

## Appendix

(Identification of the competent authority)

(State)

Approval Number

Approval issued under the provisions of paragraph 4.3.3 of the  
*International Maritime Solid Bulk Cargoes (IMSBC) Code*

Name and address of the shipper .....

Port of loading .....

Bulk cargo shipping name .....

Reference of the procedure for sampling .....

Reference of the procedure for testing .....

Reference of the procedure for controlling moisture content .....

Date of initial/renewal verification on which this approval is based .....

This is to approve the procedures mentioned above and that they have been verified in accordance with MSC.1/Circ.1454 on Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy.

Specific remarks .....

This approval is valid until ..... subject to verifications in accordance with MSC.1/Circ.1454 on Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy.

Issued at .....

Date of issue .....

(Signature of the competent authority issuing the approval)

that contracting a third party inspection company will satisfy the requirements of the competent authorities. Unfortunately this is not correct as shippers are required to demonstrate that the sampling shall follow international standards and must represent the entire shipment quantity. Taking of a surface sample of an unprocessed mineral stockpile is not permitted since January 2015.

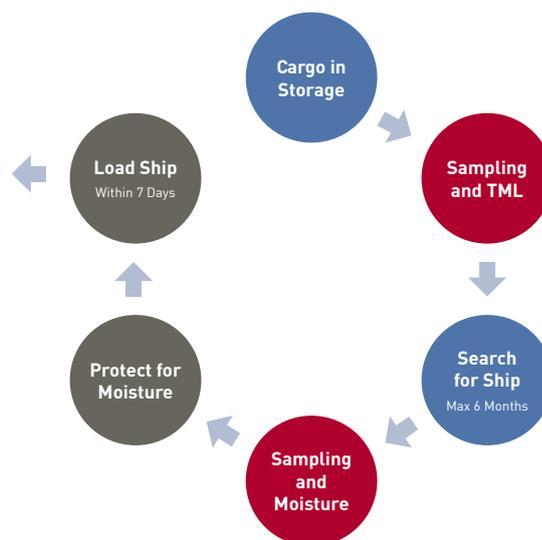
Shippers must provide full sampling access throughout building up of the stockpile that is to be shipped and the competent authorities are required to validate and verify such access and sampling.

The same applies for selecting the appropriate method for TML testing. For example, on a concentrate mineral product where particles are smaller than 3 to 4mm the Flow Table Test may apply. But with a high clay bauxite with particles up to 20mm, the Penetration Test method is the method identified in IMSBC Code – Appendix 2. As that method can accommodate larger particles. For all tests the shipper has to demonstrate appropriateness for the cargo to the competent authorities.

When it comes to moisture testing most procedures are based on the same principle, that is, drying to a constant weight at 105°C. Here the period between sampling and loading becomes more critical. Whereas shippers are allowed 6 months between sampling for TML and loading, the time between sampling for moisture and loading cannot be more than 7 days. In this short period the shippers must also fulfil their last obligation of protecting the stockpile from becoming wet. Shippers have to demonstrate that adequate procedures for controlling the moisture content have been taken.

Third party inspection companies may consult with shippers and offer advice about sampling access and designing a sampling plan. Terminal representatives and stevedores may assist shippers with procedures to protect the cargo from moisture ingress.

Extra care and awareness of possible changes in moisture content is required when a cargo is shipped in certain climatic circumstances. For example, from a tropical climate with a wet season, when shipping under arctic conditions and snow/ice in the cargo may thaw during transport, or when open-top barges are used to supply the seagoing vessel at anchorage.



## THIRD PARTY INSPECTION COMPANIES

Inspection companies may be entities that are recognized by competent authorities (IMSBC Code 4.3.2). In contrast to the shipper's approval, recognition is not mandatory. In fact, some competent authorities decided not to recognize entities for testing alone, but will only consider IMSBC Code 4.3.3 and will approve the shippers' procedures for sampling, testing and controlling of moisture content for cargoes which may liquefy. Third party laboratories' own testing procedures should then be included as part of the shipper's procedures.

Other competent authorities decided that recognition will assist them being more efficient and effective as they only need to audit a testing entity once every period and do not have to repeat the process for every individual shipper.

Third party inspection companies such as Bureau Veritas are specialized in designing sampling plans according to international sampling standards as issued by organizations such as ISO (International Organization for Standardization), ASTM (American Society for Testing and Materials) and JIS (Japanese Industrial Standards). When an inspection company is provided proper access to the cargo, shippers will benefit from representative samples for TML and moisture testing. They can also be assured that the sampling procedures shall be properly documented to facilitate getting the approval from the competent authorities for sampling procedures.

Similarly testing for TML and moisture determination by third party laboratories must follow the appropriate standard using suitably calibrated equipment by proficiently trained laboratory technicians and chemists.

Bureau Veritas makes sure that sampling as per IMSBC Code under 4.4 is expertly done and that testing for TML follows the most stringent conformity with the TML test procedures as listed in Appendix 2 of the Code and/or procedures as exempted by competent authorities. All locations that provide TML services on traded solid bulk cargoes are centrally audited and monitored by Bureau Veritas' Global Technical Governance team. Ask your nearest Bureau Veritas office for a copy of their Certificate!

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