ZIRCON INDUSTRY ASSOCIATION

# Industry Position Paper on Corrosivity to Metals

## Summary

Zircon sand is **not** corrosive to metals when tested in accordance with IMO's Interim Guidance for Conducting the Refined MHB (Materials Hazardous only in Bulk) Corrosivity Test.

## Corrosivity to metals - concerns about the IMO's UN C.1 test

The International Maritime Organization's (IMO) International Maritime Solid Bulk Cargoes (IMSBC) Code requires cargoes carried in bulk to be tested for corrosivity to metals. However, the required UN C.1 test[i] was developed for liquids (or solids that may become liquid during transportation) and was not validated for solids. Industry experience and tests on mineral sands indicated that this test method resulted in anomalous and highly variable results for zircon sands and other solid cargos.

## Our response

A Global Industry Alliance (GIA) was formed under the auspices of the International Council on Mining and Metals (ICMM) in order to improve the assessment of corrosivity in solid bulk cargoes. Following an international research programme, which considered a range of commodities, the GIA concluded that potential sources of variation can be removed by defining and standardising important parameters. Thereby reducing the degree of variability in test outcomes to acceptable levels.

As a result, refinements to the IMSBC code and guidance that extends and details the corrosivity testing method were developed. The IMO member states of Australia, Brazil, Canada and the USA proposed the refinements along with member industry groups.

## What are the main refinements to the test method?

| UN C.1 test | Refinement |
|---|---|
| Minimum 10% moisture content | Representative sample, as-shipped moisture content and condition |
| Steel and aluminium coupons tested | Only steel coupons tested |
| Limited description of coupon preparation, testing and storage | Detailed description of coupon preparation and storage, coupon introduction in the test material, test vessel atmosphere and post-test guidance. |
| Limited description of interpretation of any observed corrosion | Enhanced detail on qualification and quantification of any localised corrosion |

## Moving forward

The proposed refinements to the test method are passing through an IMO approval process for adoption of the changes in 2020. It is likely that the updated IMSBC code would come into force in January 2023, with voluntary implementation from January 2022.

To provide some clarity in the short term, ZIA appointed an independent global consulting, testing and advisory firm, DEKRA Insight, to carry out a corrosivity test on zircon sand, which previously failed the UN C.1 test. Zircon sand from the same sample was re-tested at the same laboratory, using the refined test methodology. The results of the re-test, which was carried out over a 7-day period in February 2019, showed that the sample of zircon sand was not corrosive. The test concluded that there was 0% mass losses on steel over seven days and no pitting was observed. Therefore, the material is not a candidate for classification as a corrosive MHB. Information outlining the test protocol and results in detail is attached.

A full copy of the test report is available to ZIA members and relevant Authorities on request to **enquiries@zircon-association.org**

[i] an accelerated corrosion test run at 55°C that assesses the rate of corrosion to steel test coupons exposed to a solid bulk cargo material. The test duration should be a minimum of seven days.



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# Test protocol and results

DEKRA Insight (UK) undertook tests in order to determine the corrosive properties of a zircon sand sample: a solid with 0.02% moisture content, when transported in bulk. The test was conducted according to the method described in the UN recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Test C.1 as defined by the IMO Interim Guidance for Conducing the Refined MHB (CR) Corrosivity Test (MSC.1/Circ.1600)

# Summary of the test protocol

Three pairs of steel coupons (type S275JR) with nominal dimensions of 20mm x 50mm x 2mm were used. The coupons were ground on all sides and all edges to a finish of 120 grit. The coupons were then ultrasonically cleaned in deionised water and rinsed with high purity acetone and immediately dried with high purity gas (e.g. Nitrogen).

The representative sample of zircon sand was in its as-shipped cargo carriage conditions including moisture content, bulk density, particle size distribution and atmospheric conditions.

Pairs of steel coupons, in the vertical position were placed as follows:

- Fully buried in the material, placed in the sample during the loading of the vessel.
- Half buried at the top of the sample, placed in the material during the final stages of loading the vessel.
- Suspend in the gas phase. Coupons were placed so as not to be directly below the condenser nor below the plastic support rods, to prevent moisture being channelled directly onto the coupons.

The test vessel with steel coupons and sample was closed with a fitted glass lid equipped with a reflux condenser. The top of the condenser was set to represent the atmospheric carriage conditions of the material being tested. The lid was effectively sealed to ensure no loss of moisture during the test.

The test temperature of the sample in the vessel was maintained at 55°± 1°C. The test vessel was heated and the temperature of the material monitored, checked and recorded throughout the test. Heating was achieved evenly throughout the sample within one hour.

At the completion of the test the vessel was allowed to cool to room temperature. The coupons were removed and any excess material removed by hand, followed by inhibited pickling using a suitable procedure for corroded steel coupons in accordance with ASTM G1-03.

The general corrosion rate is calculated from the mass loss, the coupon dimension and the exposure time. The test is considered positive if the mass loss of the metal coupon is more than 13.5% over the 7-day test period. The minimum intrusion depth for a 7-day test duration is 120µm.

After removal of corrosion products, coupons were analysed on both sides to identify the occurrence of localised corrosion. Localised corrosion and qualification is conducted as NACE/ ASTM G193-12d.

Table 4.3: Test Results for Steel Coupons

| Coupon number | Position of coupon | Final mass (g) | Weight loss (g) | Percentage mass loss (%) | Intrusion depth (µm) |
|---|---|---|---|---|---|
| 1 | Vapour Space | 13.7600 | 0.0002 | 0.0 | * |
| 2 | Vapour Space | 13.8061 | 0.0001 | 0.0 | * |
| 3 | Half Submersed | 13.8204 | 0.0003 | 0.0 | * |
| 4 | Half Submersed | 13.7330 | 0.0002 | 0.0 | * |
| 5 | Fully Submersed | 13.6054 | 0.0004 | 0.0 | * |
| 6 | Fully Submersed | 13.8979 | 0.0000 | 0.0 | * |

* No pitting observed

# Comments on steel coupons after test

The steel coupons remained essentially unchanged in appearance after removal from the test vessel.

# Comments on zircon sand test material after test

The test material remained unchanged. Some condensation was observed at the base of the condenser.

Corrosivity Test Results

| Bulk Material | Results |
|---|---|
| Zircon Sand | Not Corrosive |

The mass losses on steel over 7 days were found to be < 13.5 % and no pitting was observed. Therefore the material, zircon sand, is not a candidate for classification as a corrosive MHB of the IMSBC Code.