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CIRCULAR

To the Members

Guidance on carriage of Direct Reduced Iron－DRI (D)

Various forms of Direct Reduced Iron (DRI) are described in the International Maritime Solid Bulk Cargoes (IMSBC) Code. With the 2025 amendment to the IMSBC Code, DRI (D) has been newly introduced. The International Group of P&I Clubs, in conjunction with Dr J H Burgoyne & Partners LLP (Burgoynes) with input from INTERCARGO, has prepared the attached circular on the handling and transport of this cargo.

The principal forms of DRI are Type A (hot-molded briquettes) and Type B (pellets). Fines generated during manufacture and handling processes were conventionally shipped under DRI (C). However, the IMSBC Code defines the moisture content of this cargo as not exceeding 0.3%. Due to handling practices, such as outdoor storage and handling in rain, the moisture content sometimes exceeds 0.3%. To transport such cargo, DRI (D) (By-product fines with a moisture content of at least 2%) was introduced as the fourth DRI schedule.

In the IMSBC Code, DRI (D) is classified both as Group A, which is liable to liquefy, and Group B as Materials Hazardous only in Bulk (MHB). In particular, the main hazard related to DRI (D) transport is the generation of flammable hydrogen gas in the upper space of the cargo hold, and the code focus on the measurement and control of hydrogen gas concentration through surface ventilation.

Please refer to the attached circular for further details. It should be noted that this circular is for guidance only and the relevant entries from the IMSBC Code, which are appended to this Circular, remain the primary source of carriage requirements which should be relied upon. For your reference, please find the attached relevant entry of IMSBC Code for DRI(D) on the website of the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

All Clubs in the International Group have issued a similarly worded circular.

Yours faithfully,

The Japan Ship Owners' Mutual Protection & Indemnity Association

Attachment: The International Group of P&I Clubs Circular_Guidance on carriage of Direct Reduced Iron－DRI (D)
Entry of IMSBC Code for Direct Reduced Iron－DRI (D) from the Japanese Ministry of Land, Infrastructure, Transport and Tourism website

Introduction

Direct reduced iron (DRI) in various forms is described in the International Maritime Sold Bulk Cargo (IMSBC) Code, (hereinafter, ***the Code***). The latest addition, which becomes a mandatory part of the Code from January 2025, is the entry for the Type D, by-product fines with a moisture content of at least 2%. This entry runs over multiple pages and contains large amount of important information and guidance. In this Circular, the main points of the Type D entry are summarised, and, where appropriate, additional guidance and observational notes have been added.

This Circular has been prepared for the International Group of P&I Clubs (IG) in conjunction with Dr J H Burgoyne & Partners LLP (Burgoynes') with input from INTERCARGO. Explanatory notes provided by Burgoynes are included in blue text within the body of this Circular.

It should be noted that this Circular is for guidance only and the relevant entries from the IMSBC Code, which are appended to this Circular, remain the primary source of carriage requirements which should be relied upon.

Background

Direct reduced iron (DRI) is formed by passing hot reducing gases, such as hydrogen, methane and carbon monoxide, over iron ore, which is usually in the form of lumps or pellets. This produces a highly porous iron material which has a very large internal surface area available for re-oxidation. The principal hazards associated with DRI are its ability to undergo self-heating through oxidation and its ability to generate hydrogen from reaction with water/moisture. When stowed within the confines of a cargo hold, hydrogen produced by reaction with water can form an explosive atmosphere inside the hold, presenting a risk of explosion.

The principal forms of DRI are Type A (hot-moulded briquettes) and Type B (pellets), but fines are also generated during manufacture and handling (via abrasion) and from

filtering particles out of off-gases. Fines are not generally suitable for inclusion with Types A and B, so these are screened out and handled separately.

Formerly, fines would be shipped under DRI Type C, but the IMSBC Code entry for this type defines the moisture level of the cargo as not exceeding 0.3%. That low moisture level is often not feasible due to handling practices for fines, such as outdoor storage and handling being subject to rain.

In addition, the Code calls for DRI (C) cargoes to be shipped under inert gas, as for DRI (B). Inert gas is intended to exclude air (oxygen), thus limiting self-heating due to reaction with oxygen. However, as set out below, self-heating is typically not the main issue with fines. Instead, the prevalent risk is the generation of flammable hydrogen gas due to reaction with water, leading to a scenario where the holds need to be ventilated in order to maintain low hydrogen concentrations, below the lower explosive limit plus a margin of safety.

With the production of DRI(C) fines having a moisture content not exceeding 0.3% being difficult to achieve, in the IG Clubs' experience shippers often sought to ship such cargoes under exemptions in accordance with section 1.5 of the IMSBC Code. Those exemptions often sought to avoid shipment under inert gas, instead using mechanical ventilation as an alternative arrangement, but this proved difficult due to the need for tripartite agreement. Therefore there was a need for the industry to work collectively to seek a more permanent, but safe, long-term solution.

Accordingly, Amendment 07-23 to the Code introduces a fourth DRI schedule: DIRECT REDUCED IRON (D) (By-product fines with a moisture content of at least 2%).

Like DRI (C), DRI (D) is described as a by-product of the manufacturing and handling process of DRI (A) and DRI (B), but has a higher moisture content (≥2% as compared to ≤0.3% for DRI (C)).

There is also reference in the new DRI (D) schedule to the risk of liquefaction if shipped with a moisture content exceeding its transportable moisture limit (TML). DRI (D) is therefore classified as both a Group A and Group B cargo.

The principal hazard associated with DRI (D) fines is the generation of hydrogen, due to the relatively high moisture content and reaction with water. By contrast, the dense packing of the fines often reduces oxygen/air ingress into the bulk, with the result that the propensity for self-heating through atmospheric oxidation reactions is reduced, often to non-problematic levels. As such, there is no requirement in the DRI (D) schedule for purging the cargo hold with inert gas to prevent an explosive atmosphere from forming, nor in keeping the cargo hold tightly sealed to exclude oxygen ingress, whereas there are such requirements for DRI (B) and DRI (C). Instead, a regime of controlled mechanical surface ventilation and regular gas concentration measurements should be introduced in order to keep the hydrogen concentration within the holds below a designated limit.

The IG has previously issued Circulars on DRI cargoes due to a number of incidents some of which have resulted in fatalities. Whilst these advisories were issued nearly two decades ago, given the seriousness of those casualties and a cargo that potentially emits hydrogen, the IG has supported independent expert input to the International Maritime Organisation on the drafting of revised DRI schedules, including this latest one for DRI (D).

Hazards of DRI (D)

The entry for DRI (D) leads with a reference to a potential temperature increase when the material is handled in bulk; and the risk of overheating, fire and explosion due to the reactivity of the cargo with air and water to produce hydrogen gas and heat.

Whilst DRI (D) will react with oxygen and generate heat, its dense packing and the very small spaces between particles are often such that oxygen/fresh air is not able to diffuse into and through the stow to the same extent as with other types of DRI types, particularly the larger briquette/pellet forms. This low permeability means that self-heating is considered a secondary hazard. The primary hazard observed is hydrogen generation, due to the reaction between the DRI and water / moisture. The focus of the new DRI (D) schedule is on the measurement and control of the hydrogen gas concentrations in the ullage spaces.

Although self-heating is considered a secondary hazard, the reaction with air can lead to oxygen depletion in the cargo spaces, and possibly also adjacent spaces, where

flammable gases (i.e. hydrogen) might also accumulate. The Code therefore stipulates that no person shall enter a loaded cargo space (or enclosed adjacent space) unless such space has been ventilated and found to be gas-free.

The Code refers here to the *Revised recommendations for entering enclosed spaces about ships* (Resolution A.1050(27)).

DRI (D) cargoes are liable to liquefaction if shipped at a moisture content in excess of its Transportable Moisture Limit, and is therefore classified as a Group A cargo in the Code in addition to the Group B designation due to its reactivity hazard.

The dust produced during handling of DRI (D) can be hazardous to health (irritation to the respiratory system and/or damage to the eyes).

Preparation of cargo and loading

Holds

As for other DRI cargoes, cargo spaces being prepared for carriage of DRI (D) should be clean, dry and free of salt and residues of previous cargoes. Wooden battens, loose dunnage, debris and other combustible materials shall be removed.

The specific reference to salt is because the reaction between DRI and water is more vigorous in the presence of salt than without (in other words, DRI is much more reactive with sea water than with fresh water).

Cargo ageing

For material being prepared for loading, outdoor stockpiles are permitted, provided that the stockpiles are arranged to promote exposure to the atmosphere and thus facilitate natural ageing.

This “ageing” is the process by which the most active sites on the external and internal surface of the particles react with atmospheric oxygen and thus become "passivated" against further reaction during carriage.

The cargo should be aged in this way for at least 30 days prior to loading, and the shipper is expected to provide the Master with a certificate issued by a competent person (who is recognised by the competent authority of the port of loading) stating that the cargo has been prepared and aged appropriately (i.e. naturally aged for at least 30 days).

The shipper shall also provide the Master with a certificate issued by a competent person (again recognised by the competent authority of the port of loading) stating that the cargo does not meet the criteria for class 4.2 materials (i.e. it is not liable to self-heat).

This is effectively declaring that the cargo does not behave like, say, DRI (B), which can self-heat problematically.

Moisture

Whilst outdoor storage is permitted, the risk of liquefaction means that the moisture content should be kept below its TML during loading operations. This means that the cargo should not be handled in the rain and that non-working hatches are kept closed. Discharge in the rain is permitted as long as the total cargo package in a given hold is to be discharged at that port.

The TML for DRI fines is typically between 9-12% [see the IIMA publication, 'Direct Reduced Iron By-Product Fines (DRI D): A Guide to Handling, Storage & Shipping' found on the IIMA website- www.metallics.org].

Once discharged ashore into the open air, the potentially hazardous consequences of hydrogen production and liquefaction no longer apply.

Temperature

DRI at elevated temperatures should not be loaded, the threshold temperature being 65 °C with measurements being taken at the stock pile over three consecutive days prior to loading. Measurements are to be taken 20-30 cm beneath the surface at 3m intervals throughout the stockpile. Temperatures shall also be measured during loading, with a log detailing the temperature of each lot being recorded, and with a

copy being provided to the Master. Once loaded, thermocouples are placed into the stow for the cargo temperature to be monitored remotely, without entering the holds.

The measurement of temperatures in this way might be limited due to the high degree of thermal insulation offered by the cargo, which can mean that measurements in isolated points throughout the hold might not be representative of the bulk conditions of the stow. Also, localised heating 'hot spots' in areas of the stow away from the thermocouple positions might be missed. That said, a network of thermocouples placed within the stow is preferable to single measurements from bilge sounding pipes or "temperature" sounding pipes, which are usually at only one or two places per hold and are therefore not representative.

Hatch cover closing

Weather permitting, hatch covers shall be left open after completion of loading to allow cooling of the cargo, stabilisation of cargo temperature and natural ventilation of the hold.

This seems to be contrary to the current advice to keep non-working hatches closed, see above. The intention appears to be that the closure of non-working hatches is to protect the cargo against being wetted by rain (if applicable), but once loading is complete, and if there is an opportunity to do so (i.e. a period of dry weather), then the hatch covers should be kept open to assist with heat dissipation and natural ventilation.

Once loading has been completed and the hatch covers are closed, the Code calls for the ship to wait for at least 24 hours before sailing to ensure that the cargo temperatures are stable and do not exceed 65 °C, and that the concentration of hydrogen in the ullages has stabilised and does not exceed 1% by volume for at least 12 consecutive hours.

Hydrogen is a flammable gas; the minimum concentration of hydrogen that is needed to form a flammable mixture with air is 4% by volume. This is the "lower explosivity limit" or LEL. Therefore, the 1% by volume mentioned here represents a quarter of the LEL (25% LEL). Not exceeding 1% by volume gives a safety margin between this 'action level' and 4% by volume, which is the lowest hydrogen concentration in air at which an explosion could occur.

Certification

Prior to sailing, a further certificate shall be issued by a competent person (once again recognised by the competent authority of the port of loading), stating that the proportion of material larger than 12mm in diameter is no more than 3% by weight, that the moisture content is at least 2% and below the TML, and that the temperature of the cargo loaded does not exceed 65 °C.

This section of the Code therefore calls for **three certificates** to be provided by the shipper stating that the cargo:

(i) Does not meet the criteria as a class 4.2 material;
(ii) Has been appropriately aged; and
(iii) Has proportions of large particles, moisture content and temperature below the specified limits.

In addition, the Master is to be provided by the shipper with the temperature log of the cargo during loading.

Carriage & cargo management

General precautions

As noted above the primary hazard associated with the carriage of DRI (D) is the generation of hydrogen, a flammable gas, within the ullage spaces of the hold. Unlike other DRI cargo types, the entry for Type D makes reference to a **risk assessment** to be undertaken in advance of the voyage and which is based on the "comprehensive information on the risk of hydrogen generation and the factors which might affect the rate thereof", to be provided by the Shipper.

This risk assessment might include other factors such as the weather conditions expected en route, the speed of the ship and distance to the discharge port, the availability of ports of refuge along the way, and any information on hydrogen evolution that might be available. The Master, with the aid of the shipper, should also ensure that the crew are properly briefed on the risks involved prior to loading commencement.

The ship should be equipped with the means to take measurements of the concentrations of hydrogen and oxygen. This is achieved using a suitably configured gas detector fitted with a pump and length of hose which can be inserted into the gas sampling points of each cargo hold.

In practice, and as recommended by the Code, the measurement of hold gases and cargo temperatures might typically be undertaken by an experienced cargo technician appointed by the Shipper. The Code recommends that the technician is present during loading and throughout the voyage.

The Code calls for such measurement devices to be suitable for use in an oxygen-depleted atmosphere. This is because some types of combustible gas analysers ("catalytic bead sensors"), which are sensitive to hydrogen, require a minimum level of oxygen in order to operate correctly. In oxygen-depleted atmospheres, as is often found with DRI cargoes, catalytic bead sensors might not provide reliable results. Similarly, some other types of combustible gas sensor that can operate in low oxygen environments are blind to hydrogen. The selection of appropriate sensor equipment is therefore extremely important for all DRI cargoes.

Ventilation

The Code sets out that mechanical surface ventilation shall be provided in each hold to maintain the hydrogen concentration less than 1% by volume (25% LEL).

Given the risk of flammable atmospheres being present, only fans which are suitable for use in explosive environments should be used for mechanical ventilation. It is also important that the ventilation applied is *surface* ventilation, and that fresh air is not introduced into the stow itself (through fan ducts lower down in the hold, for example) as this could encourage oxidation reactions in the bulk, leading to an increase in the heat being generated due to and an increase in the rate of reaction.

Ventilation should be limited to the time required to remove any hydrogen gas accumulations to below 1% by volume, in order to minimise the risk of fresh air/oxygen being introduced into the cargo. The length of time and frequency that ventilation is

applied will be derived to some extent by prior experience, and in this respect the Code introduces the concept of a **time-based gas prediction curve**, the results of which should be used to update the voyage risk assessment.

The time-based gas prediction curve is a tool for understanding the likely rate of hydrogen evolution. It is a graphical representation of how the hydrogen evolution occurs over time, and it is constructed by measuring the hydrogen concentration in the ullage of each hold after ventilation has reduced the concentration to <0.2% by volume (i.e. to below 5% LEL), and plotting this data against time. With mechanical ventilation stopped and natural vents closed, measurements are taken every 2 hours over the course of the next 24 hours, or until the hydrogen concentration exceeds 1% by volume, whichever occurs first. The data are then used to estimate the time required to reach a hydrogen concentration of 1% by volume in the absence of ventilation, and this time period can then be used to optimise the ventilation schedule. It is also useful to understand how quickly hydrogen gas might accumulate within a hold during periods of heavy weather, when it might not be possible to apply ventilation. All of this information is then fed into the risk assessment process.

Expert assistance might be required to analyse the gas concentration data and to derive an appropriate ventilation regime.

Mechanical ventilation shall be by extraction, rather than blowing in air from the outside, with exhaust ducts removing the expelled gases to a safe location (e.g. away from the accommodation). Two spare sets of ventilation equipment shall be available on board, and the crew or other authorised persons shall be familiar with its installation, operation and maintenance. The Code sets out minimum airflows of 1.2 m3 per hour per tonne of cargo.

Emergency procedures

If the hydrogen concentration is approaching or exceeds 1% by volume, then the hold(s) in question shall be ventilated (via mechanical and/or natural surface ventilation) until the concentration falls to or below 0.2% by volume. The hydrogen concentration should be measured more frequently if it exceeds 1% by volume (preferably hourly) provided that prevailing conditions permit. If an elevated hydrogen concentration persists, expert assistance may be required.

Experience has shown that measurement of gas concentrations during period of active ventilation may lead to unreliable results, particularly if the remote sensing hose of the gas detector is inserted into the hold within a stream of intake air or expelled gases. Care therefore needs to be taken when measuring gases during ventilation, which might be indicative only. Accurate gas readings might only be possible once ventilation has stopped, even if only for a short period of say a few tens of minutes.

In the event of a breakdown in mechanical ventilation, continuous natural ventilation can be applied until the mechanical fans can be restored. Weather conditions will need to be considered of course, and the frequency of monitoring hydrogen concentration and cargo temperatures should be increased.

If cargo temperatures increase above 65 °C, the Code calls for increased mechanical and natural ventilation to dissipate heat and any hydrogen, and to increase the frequency of gas and temperature measurements. It precludes the use of CO_2, water or steam on the cargo, but does suggest bulkhead cooling if possible (e.g. spraying water from empty adjacent holds).

The Code does not set out the possible circumstances under which the cargo might exhibit elevated temperature, and clearly there might be issues with ventilating a cargo that is exhibiting heating due to reaction with air / oxygen. It might be appropriate in some circumstances to seek expert advice; any expert involvement would certainly have to include consideration of the full history of the cargo, including the logs of temperature and gas concentrations since loading.

Discharge

Hatch covers should only be opened if the hydrogen concentration in the ullage space of a hold has been determined to be below 1% by volume. Additional ventilation may therefore be required to achieve this threshold before discharge can commence.

A hydrogen concentration of 1% by volume is substantially below the lower flammability limit, giving a built-in safety margin. Moreover, the hydrogen content in the hold atmosphere will become increasingly diluted once the covers have been cracked open, adding a further safety margin.

As noted above, the Code allows for DRI (D) cargoes to be discharged during rain, but only if the entire complement of cargo within a hold is discharged at the same port, and not transshipped on to another vessel or leaving part of the (wet) cargo on board. If holds do need to be closed during periods of rain at the discharge port, the hydrogen concentration monitoring process will need to be restarted for those holds.

Summary

The IMSBC Code entry for DRI Type D differs substantially from the existing Type C entry: Both are for by-product fines, but the Type D entry recognizes the primary hazard of fines, which is hydrogen evolution due to reaction with water, rather than from self-heating via reaction with oxygen in air. The focus of the Code is therefore on the measurement and control of the hydrogen gas concentration by surface ventilation. This is unlike the other Code entries for DRI, where the basis for safety is the exclusion of both moisture and air.

Accordingly, Masters and crews will need to be appropriately trained in order to be prepared to contribute effectively to the assessment of the hydrogen evolution risk for a given voyage, with consideration of distances, speeds, the location of potential ports of refuge and weather conditions being factored in. In addition, a time-based gas prediction curve is plotted in order to estimate the length of time before the hydrogen concentration in each hold will reach the safety limit, this being 1% by volume, i.e. 25% LEL, and this data is then used to optimise a ventilation strategy. Typically, shippers would be expected to provide an expert cargo technician to assist with this process.

The cargo technician's role is defined in more detail the Appendix to the schedule, and includes the following responsibilities:

- monitoring during loading operations and providing advice as appropriate;
- advising on and supervising the installation of the thermocouples for temperature measurement;
- monitoring and reporting on the cargo parameters (temperature and gas concentrations);

- assisting and advising the Master and crew in the development of the time-based gas prediction curve; and
- advising and coordinating with the Master and crew in connection with the operation of the ventilation system during the voyage.

Additional information can be found in the IIMA publication, 'Direct Reduced Iron By-Product Fines (DRI D): A Guide to Handling, Storage & Shipping' found on the IIMA website- www.metallics.org

DIRECT REDUCED IRON (D)
(By-product fines with moisture content of at least 2%)

還元鉄(D)(含水率 2%以上の微粒副生物)

DESCRIPTION

Direct reduced iron (DRI) (D) is a porous, black/grey odourless metallic material generated as a by-product of the manufacturing and handling processes of DRI (A) hot-moulded briquettes and/or DRI (B) lumps, pellets and cold-moulded briquettes, which has been aged for at least 30 days prior to loading.

貨物の説明

還元鉄(D)は還元鉄(A)熱間成型ブリケット及び/又は還元鉄(B)塊、ペレット、冷間成型ブリケットの製造・取扱工程で副産物として発生する多孔質の黒色/灰色、無臭の金属材料で、積荷前に少なくとも 30 日間熟成させたものである。

CHARACTERISTICS

Physical properties			
Size	Angle of repose	Bulk density (kg/m^3)	Stowage factor (m^3/t)
Fines and small particles with an average size less than 6.35 mm, particles larger than 12 mm not to exceed 3% by weight	Not applicable	1,850 to 3,300	0.30 to 0.54
Hazard classification			
Class	**Subsidiary hazard(s)**	**MHB**	**Group**
Not applicable	Not applicable	SH and/or WF	A and B

貨物の性状

物理的特性			
粒径	静止角	見かけ密度(kg/m^3)	載貨係数 (m^3/t)
平均粒径が 6.35mm 未満の粉末又は微粒子で、12mm 以上の粒子は重量比が 3%以下	適用対象外	1,850 ～ 3,300	0.30 ～ 0.54
危険性分類			
等級	**副次危険性**	**MHB**	**種別**
適用対象外	適用対象外	SH and/or WF	A and B

HAZARD

Temporary increase in temperature of about 30°C over ambient, due to oxidation and consequent self-heating, may be expected after material handling in bulk.
There is a risk of overheating, fire and explosion during transport due to the fact that this cargo reacts with air, fresh water and seawater to produce hydrogen and heat. Hydrogen is a lighter than air, flammable gas, that can form an explosive

危険性

酸化とそれに伴う自己発熱により、ばら積み時の物質の取扱後、一時的に周辺に 30 度以上の温度上昇を起こす恐れがある。
この貨物は空気、真水、海水と反応して水素と熱を発生するため、輸送中に過度の発熱、火災、爆発の危険性がある。水素は空気より軽い可燃性ガスで、体積比 4%以上の濃度で空気と混合すると爆発性雰囲気を形成する可能性がある。

atmosphere when mixed with air in concentrations above 4% by volume. Oxygen in cargo holds and in enclosed adjacent spaces may be depleted. Flammable gas may also build up in these spaces. This cargo may liquefy if shipped at a moisture content in excess of its transportable moisture limit (TML). See sections 7 and 8 of this Code.	船倉や隣接する閉鎖された区画の酸素が欠乏する可能性がある。また、これらの区画に可燃性ガスが蓄積する可能性がある。 この貨物は運送許容水分値を超える水分値で輸送した場合、液状化するおそれがある。コードの第 7 節及び第 8 節参照。
STOWAGE & SEGREGATION "Separated from" goods of classes 1 (division 1.4S), 2, 3, 4 and 5, and class 8 acids in packaged form (see the IMDG Code). "Separated from" solid bulk materials of classes 4 and 5. Goods of class 1, other than division 1.4S, shall not be carried in the same ship. Boundaries of compartments where this cargo is carried shall be resistant to fire and passage of liquid.	**積付及び隔離要件** 等級 1.4S、等級 2、等級 3、等級 4、等級 5 の個品危険物及び等級 8 個品の酸類と別の船倉又は区画に積載すること(国際海上危険物規程参照)。 等級 4 及び 5 の固体ばら積み物質と別の船倉又は区画に積載すること。 等級 1.4S 以外の等級 1 の危険物は、同じ船舶で運搬してはならない。この貨物が積載される区画の境界は、耐火性及び耐水性でなければならない。
HOLD CLEANLINESS The cargo spaces shall be clean, dry and free of salt and residues of previous cargoes. Prior to loading, wooden fixtures such as battens, loose dunnage, debris and combustible materials shall be removed.	**船倉の清浄さに係る要件** 船倉は清浄な乾操状態とし、塩分及び前の貨物の残滓がない状態とすること。積荷前にバッテン、ばらのダンネージ、破片、可燃性物質等の木製の備品が除去されていること。
WEATHER PRECAUTIONS Storage in the open air shall be permitted prior to loading, subject to any requirements of the competent authority of the port of loading. During storage, the material shall be piled such as to allow the greatest possible exposure to the atmosphere and thus facilitate its natural ageing. When a cargo is carried in a ship other than a ship complying with the requirements in 7.3.2 of this Code, the following provisions shall be complied with: .1 the moisture content of the cargo shall be kept less than its TML during loading operations and the voyage; .2 unless expressly provided otherwise in this individual schedule, the cargo shall not be handled during precipitation; .3 unless expressly provided otherwise in this individual schedule, during handling of the cargo, all non-working hatches of the cargo spaces into	**天候に係る要件** 屋外での保管は、積荷港の所轄当局の要件に従い、積荷前に許可されるものとする。保管中は、可能な限り大気に触れさせ、自然に養生させるよう堆積すること。 このコードの第 7.3.2 節の要件を満たす船舶以外の船舶で運送される場合は、以下の規定を満たすこと: .1 積載中及び航海中は貨物の水分値を運送許容水分値より低く保つこと。 .2 この貨物に関する付則の中で別途明確に規定されない限り、この貨物は雨中で荷役してはならない。 .3 この貨物に関する付則の中で別途明確に規定されない限り、この貨物の荷役中は、この貨物を積載しているまたは積載する予定であって荷

which the cargo is loaded, or to be loaded, shall be closed; and	役を行っていない全ての船倉のハッチカバーを閉鎖すること。
.4 the cargo in a cargo space may be discharged during precipitation provided that the total amount of the cargo in the cargo space is to be discharged in the port.	.4 船倉内の貨物の全量をその港で荷揚げする場合は、その船倉の貨物は雨中で揚げ荷することが出来る。
LOADING	**積荷役時の要件**
Prior to loading this cargo, the shipper shall provide the master with a certificate issued by a competent person recognized by the competent authority of the port of loading stating that the cargo does not meet the criteria for class 4.2 materials.	この貨物の積荷前、荷送人は積荷港の所管当局が認めた者が発行する、貨物が等級 4.2 の自己発熱性物質の基準を満たしていないことを記載した証明書を船長に提出すること。
As the density of the cargo is extremely high, the tank top may be overstressed unless the cargo is evenly spread across the tank top to equalize the weight distribution. Due consideration shall be given to ensure that the tank top is not overstressed during the voyage and during loading by a pile of the cargo.	貨物の密度が非常に大きいため、重量分布を均等にすべく貨物をタンクトップ全体に均一に広げないと、タンクトップに過大な応力が作用するおそれがある。貨物の堆積によりタンクトップに過大な応力が作用しないことを確実にするよう検討すること。
Prior to loading, the cargo shall be prepared and aged naturally for a minimum of 30 days. Prior to loading this cargo, the shipper shall provide the master of the ship with a certificate issued by a competent person recognized by the competent authority of the port of loading stating that the cargo has been prepared and aged naturally for a minimum of 30 days.	積荷前に貨物を用意し、少なくとも 30 日間自然熟成させること。この貨物の積荷前、荷送人は積荷港の所管当局が認めた者が発行する、貨物が用意され少なくとも 30 日間自然熟成されたことを記載した証明書を船長に提出すること。
Prior to loading, the temperature of the cargo in the stockpile to be loaded shall be measured by the shipper for three consecutive days and recorded in a log. Measurements shall be taken 20 to 30 cm below the surface and at 3-metre intervals over the length and width of the stockpile. The cargo shall not be loaded if its temperature is in excess of 65°C.	積荷前、荷送人は積荷となる備蓄の貨物の温度を 3 日間連続で測定し、記録すること。測定は、貨物の表面下 20～30cm の位置で、積荷の長さと幅にわたって 3m 間隔で行う。貨物の温度が 65°Cを超える場合は、貨物を積み込んではならない。
Care shall be taken by all parties concerned to ensure that particles coarser than 6.35 mm are, as far as is practicable, evenly distributed throughout the entire cargo, in order to avoid build-up of concentrations of coarse material.	すべての関係者は、可能な限り大きさが 6.35mm を超える粗い粒子が貨物全体に均等に分散されるように注意すること。
Trim in accordance with the relevant provisions required under sections 4 and 5 of this Code.	この規則の第 4 節及び第 5 節の関連する規定に従って荷繰りすること。
The cargo temperature shall be monitored during loading and recorded in a log detailing the temperature of each lot of cargo loaded, a copy of which shall be provided to the master.	積み荷役中は貨物の温度を計測し、積載する各貨物のロットの温度をログに記録すること。ログの複写を船長に提出すること。
Hatch covers shall, weather permitting and subject to the absence of precipitation,	ハッチカバーは、好天時、降水がないことを条件として、貨物の冷却、貨物温度の

remain open after completion of loading of the respective holds and placement of thermocouples, in order to allow cooling of the cargo, stabilization of cargo temperature and natural ventilation of the hold. Otherwise, hatches shall be closed and sealed immediately upon completion of loading and placement of thermocouples. Monitoring of temperature and hydrogen concentration shall then be commenced.

安定化、船倉の自然換気を可能にするため、各船倉への積荷が完了し、熱電対が設置された後も開いたままとすること。そうでない場合、ハッチは積荷と熱電対の設置が完了したら直ちに閉じ、密閉する。その後、温度と水素濃度の監視を開始する。

On completion of loading, the ship shall wait for 24 hours (or longer as may be required) before sailing, in order to ensure that:

積荷の完了後、出航前に 24 時間(または必要に応じてそれ以上)待機し、以下を確認すること:

.1 all loaded cargo holds are correctly closed and sealed;

.1 貨物が積載されたすべての船倉が正しく閉じられ、密閉されていること。

.2 the temperature of the cargo at all measuring points is stable and does not exceed 65℃ for at least 12 consecutive hours; and

.2 全ての計測点において貨物の温度が安定しており、少なくとも 12 時間連続で 65℃を超えていないこと。

.3 that the concentration of hydrogen in the head space of the holds has stabilized and does not exceed 1% by volume (25% of the lower explosive limit (LEL)) for at least 12 consecutive hours.

.3 船倉上部の空間における水素濃度が安定しており、少なくとも 12 時間連続で 1Vol%(爆発下限界値の 4 分の 1)を超えないこと。

If after loading and before sailing any cargo temperatures are found to be in excess of 65℃, the material so affected shall be allowed to cool naturally to 65℃ or less, or be cooled by mechanical intervention prior to sailing, for example with a front end loader, subject always to proper monitoring and safety precautions being in place. Other measures may be specified by the competent authorities concerned.

積荷後、出航前に貨物の温度が 65℃を超えていた場合、適切な監視と安全予防措置が常に講じられることを条件に、その影響を受けた物質を 65℃以下まで自然冷却させるか、出航前にフロントエンドローダーなどで機械的に冷却すること。その他の措置は、関係当局によって指定される場合がある。

On completion of loading and before sailing, a certificate shall be issued by a competent person recognized by the competent authority of the port of loading, stating that:

積荷が完了し出航する前に、積荷港の所管当局が認めた者が、次の事項を記載した証明書を発行しなければならない:

.1 the proportion of material larger than 12 mm is no more than 3% by weight;

.1 12mm 以上の物質の割合が重量比で 3%以下であること。

.2 the moisture content of the cargo loaded is at least 2% and below the TML; and

.2 積載された貨物の水分値は少なくとも 2%以上且つ運送許容水分値以下であること。

.3 the temperature of the cargo loaded does not exceed 65℃.

.3 積載された貨物の温度が 65℃を超えないこと。

PRECAUTIONS

各種の要件

It is recommended that an experienced cargo technician appointed by the shipper be on board the ship during loading and throughout the voyage.

荷主が指名した経験豊富な貨物技術者が、積荷中および航海中、船に同乗することが推奨される。

Prior to loading, the shipper shall provide the master with comprehensive information on the risk of hydrogen evolution and the factors which may affect the

積荷前、荷送人は船長に対し、水素発生の危険性及び水素発生率に影響を及ぼす可能性のある要因に関する包括的な情報を提供すること。

rate thereof. Such risk assessment may include, but not be limited to: .1 expected weather conditions; .2 such information as is then available on the hydrogen evolution rate; .3 planned speed of the ship; .4 availability and accessibility of ports of refuge en route; and .5 distance to the port of discharge. It is strongly recommended that weather routing be utilized in the above-mentioned risk assessment. Prior to shipment, the master, with the aid of the shipper and/or the cargo technician if appointed, shall ensure that all concerned crew members have been informed about and understand the potential risks associated with the carriage of this cargo. Such knowledge exchange shall be recorded in the ship-shore safety checklist. The shipper shall ensure that expert advice is available at all times during the voyage and shall provide relevant contact details to the master prior to sailing. Any material that has become wetted, for example, due to precipitation, shall not be loaded unless such material has been rectified regarding its moisture content. In the event that a hold carrying this cargo has to be closed prior to completion, for example, due to precipitation, such hold shall be monitored for hydrogen concentration as frequently as required and ventilated to keep the hydrogen concentration less than 1% by volume (25% LEL). The ship's cargo holds shall be provided with the means of reliably measuring the temperatures at several points within the stow and the concentrations of hydrogen and oxygen in the cargo hold atmosphere during the voyage without entering the cargo holds. Such measuring devices shall be suitable for use in an oxygen-depleted atmosphere and of a certified safe type for use in an explosive atmosphere. Holds carrying this cargo and adjacent spaces may become oxygen-depleted. No person shall enter a loaded cargo space or enclosed adjacent space unless such space has been ventilated and the atmosphere tested and found to be gas-free and	このようなリスク評価には以下が含まれる。なお、これらに限定されるものではない： .1 予想される気象条件。 .2 その時点で入手可能な水素発生率に関する情報。 .3 船の計画速度。 .4 航路途中の避難港の有無及びアクセス。 .5 排出港までの距離。 上記のリスク評価では、ウェザールーティングを活用することを強く推奨する。 積荷前、船長は荷送人及び／又は貨物技術者（選任されている場合に限る。）の助けを借りて、関係する全ての船員が、この貨物の運送に関連する潜在的なリスクについて知らされ、理解したことを確認すること。このような知識交換は、船陸間安全チェックリストに記録すること。 荷送人は、航海中常に専門家の助言を受けられるようにし、出航前に船長に関係者の連絡先の詳細を提供すること。 降水等によって濡れた物質は、その水分値が改善されない限り、積載しないこと。 降水等のために、この貨物を積載した船倉を積荷の完了前に閉鎖しなければならない場合、随時船倉の水素濃度を監視し、水素濃度を体積比 1%（爆発下限界値の 25%）未満に保つように換気すること。 当該船舶の船倉には船倉に立ち入ることなく、航海中の船倉内の数箇所の温度及び船倉の空気中の水素及び酸素の濃度を確実に測定する手段を備えておくこと。当該測定装置は酸欠空気での使用に適し、爆発性雰囲気で使用するために認証された安全なタイプのものであること。 この貨物を積載した船倉及び隣接する区画において酸欠状態になる可能性がある。この貨物を積載した船倉及び隣接する区画に立ち入らないこと。ただし、当該区画を換気した上で空気試験を行い、ガス・フリーで生命を維持するのに十分な酸素があることが確認された場合はこの限りでない。

to have sufficient oxygen to support life.*	
VENTILATION During the voyage, mechanical surface ventilation shall be provided in each cargo hold carrying this cargo, in order to keep the hydrogen concentration less than 1% by volume (25% LEL). The mechanical surface ventilation system shall be of a certified safe type for use in an explosive atmosphere, capable of ventilating the cargo surface, as stipulated in 3.5 of this Code. Suitable wire mesh guards shall be fitted over inlet and outlet ventilator openings.	**通風要件** 航海中、水素濃度を体積比 1%（爆発下限界値の 25%）未満に保つため、この貨物を積載する船倉において貨物表面を機械通風すること。当該機械表面通風システムは爆発性雰囲気で使用するために認証された安全な型式で、本規則 3.5 に規定される通り、貨物表面の通風ができるものでなければならない。換気口の出入口には適切な防火金網を取り付けること。
Mechanical surface ventilation shall be available at all times, either by compliance with the Load Line Convention, Annex I, regulation 19(3), or by adopting measures to avoid a situation whereby the cargo hold mechanical ventilation system could not be used due to rough seas, such measures to be in keeping with good seamanlike practices as for similar cargoes emitting intermittent combustible gases and advice from weather routing service providers.	ロードライン条約の附属書 I 規則 19(3)に従うか、又は荒海のために船倉の機械表面通風システムが使用できない状況を回避する手段を採用することにより、機械表面通風を常時利用できるようにすること。なお、このような手段は、同じく断続的に可燃性ガスを排出する貨物の場合と同様に、優秀な船員の経験とウェザールーティングサービス提供者の助言に沿ったものでなければならない。
Ventilation shall be such as to provide surface ventilation and to avoid the possibility of the build-up of flammable gas/air mixtures. Ventilation other than surface ventilation shall not be applied and on no account shall air be directed into the body of the cargo.	換気は表面通風を行い、可燃性ガスと空気の混合物が蓄積する可能性を回避すること。表面通風以外の通風を行ってはならず、いかなる場合も貨物内部に空気を入れないこと。
In order to minimize the possibility of the introduction of oxygen and moisture into the cargo holds, periods of surface ventilation shall be limited to the time necessary to remove hydrogen which may have accumulated in the cargo holds and maintain the hydrogen concentration below 1% by volume (25% LEL).	船倉に酸素や水分が混入する可能性を最小限に抑えるため、表面通風の時間は、船倉に蓄積した水素を除去し、水素濃度を体積比 1%（爆発下限界値の 25%）未満に維持するのに必要な時間に制限されるものとする。
Mechanical ventilation shall be such as to enable an airflow of at least 1.2 m^3 per hour per tonne of cargo in each hold carrying this cargo when needed, and in any case shall have an adequate capacity to ventilate down to a concentration of 0.2% hydrogen by volume (5% LEL) or less.	機械通風は、必要に応じて、貨物を搭載する各船艙の貨物トン当たり毎時最低 1.2m^3 の気流を可能にするものでなければならず、いかなる場合にも、体積比 0.2%の水素濃度（爆発下限界値の 5%）以下まで換気できる十分な能力を有するものでなければならない。
Prior to loading, an inspection of the mechanical ventilation system shall be conducted to ensure that it is functioning properly.	積荷前、機械通風システムの検査を実施し、適切に機能していることを確認すること。
Two spare sets of ventilation equipment of a certified safe type for use in an	航海中、爆発性雰囲気で使用するために認証された安全な型式の通風装置の予

* Refer to the Revised recommendations for entering enclosed spaces aboard ships (resolution A.1050(27)).

explosive atmosphere shall be available on board the ship during the voyage. A crew member or other person with the ability to install the spare fans shall be available on board throughout the voyage.	備を 2 セット船内に備えておくこと。航海中、予備の換気扇を取り付ける能力を有する乗組員又はその他の者を、船内に配置しなければならない。
In addition, natural ventilation shall be provided in enclosed cargo holds intended for the carriage of this cargo.	加えて、この貨物の運送を目的とした密閉された船倉内において自然通風装置を備えなければならない。
The operating period and frequency of the ventilation system shall be determined based on the measured hydrogen concentration and the indicated rate of increase/decrease thereof over time. It is therefore very important to establish a time-based gas prediction curve (see the appendix to this schedule). Such curve shall be first determined prior to sailing and, recognizing that conditions can change during the voyage, be updated from time to time during the voyage as may be appropriate, for example in the case of seawater intrusion into a hold carrying this cargo.	通風システムの運転期間および運転頻度は、測定された水素濃度およびその経時的な増減率に基づいて決定されること。したがって、時間ベースのガス濃度予測曲線を確立することが非常に重要である（本附則の付録を参照）。この曲線は、まず出航前に決定し、例えば、この貨物を積んだ船倉に海水が浸入した場合など、航海中に状況が変化する可能性があることを認識した上で、航海中、適切な場合には随時更新すること。
Based on the time-based gas prediction curve(s), the risk assessment shall as soon as possible be updated accordingly, and the voyage plan shall be optimized to avoid a situation where the cargo hold mechanical ventilation system might not be able to be used due to rough seas for periods greater than the estimated time for the concentration of hydrogen to reach 1% by volume (25% LEL).	時間ベースのガス濃度予測曲線に基づき、可能な限り早急にリスク評価を適宜更新し、水素濃度が体積比１%（爆発下限界値の 25%）に達するまでの予測時間を超える期間、荒波のために貨物倉の機械通風システムが使用できない可能性がある状況を回避するよう、航海計画を最適化すること。
The port authorities at planned ports of refuge shall be advised in advance and a confirmation that access would be granted shall be obtained prior to adding such port to the voyage plan.	計画された避難港の所管当局に事前に通知し、当該港を航海計画に追加する前に、寄港が許可されることの確認を得なければならない。
The risk assessment, voyage plan, and weather routing, if adopted, shall be updated as frequently during the voyage as updates on the weather become available, as well as actual hydrogen evolution rates.	リスク評価、航海計画、ウェザールーティング（採用された際）は、航海中、最新の気象情報が入手できるようになった場合、実際の水素発生率に応じて随時更新されるものとする。
Gases in the cargo holds carrying this cargo shall be removed by extraction, rather than by blowing in the air from outside. Mechanical ventilation exhaust shall be directed to a safe location, away from personnel. All inherent risks associated with the location of the ventilation exhaust openings shall be considered and risk mitigation measures shall be taken to address any such identified potential risk, as appropriate. Ventilation shall be such that exhaust gases cannot enter living quarters in hazardous concentrations.	この貨物を搭載する船倉内のガスは、外部からの送風ではなく、抽気により除去すること。機械通風による排気は、船員から離れた安全な場所に向けること。通風口の位置に関連するすべての固有のリスクが考慮されるものとし、そのような特定された潜在的リスクに対処するため、必要に応じてリスク軽減措置が講じられるものとする。通風は排気ガスが危険な濃度で居住区域に流入しないようなものとする。
In the event that mechanical ventilation cannot be operated for whatever reason	何らかの理由で機械通風ができない場合（機械の故障や電気系統の故障など）:

(for example in the event of mechanical breakdown or electrical failure):	
.1 continuous natural ventilation shall be applied until mechanical ventilation is restored; repairs to the non-functioning ventilator shall, if practicable and safe, be carried out away from cargo holds containing this cargo; a ventilator which cannot readily be repaired shall be replaced with a spare one;	.1 機械通風が回復するまで、継続的な自然通風を行うこと。機能しない通風装置の修理は、実行可能で安全な場合、当該貨物を含む貨物倉から離れた場所で実施すること。容易に修理できない通風装置は、予備のものと交換すること。
.2 if necessary and practicable, use other available means of forced ventilation, preferably in extraction mode;	.2 必要かつ実行可能であれば、他の利用可能な強制換気手段を使用すること。
.3 weather routing advice, if available, shall be updated as soon as possible and, where appropriate, consideration shall be given to re-routing and/or adjusting speed to avoid heavy weather;	.3 ウェザールーティングの助言がある場合は、可能な限り速やかに更新し、適切な場合は悪天候を避けるためルート変更および／または速度の調整を検討すること。
.4 the frequency of monitoring of hydrogen concentration and cargo temperature shall be increased;	.4 水素濃度と貨物温度の監視頻度を増やすこと。
.5 subject to the discretion of the master, during heavy seas, consideration shall be given to leaving open one or more of the natural vents on the leeward side that are situated in locations protected from the serious effects of the heavy weather, in order to provide some useful dissipation of hydrogen gas from the holds;	.5 船長の裁量に従い、荒天時には船倉からの水素ガスの放散に役立てるため、荒天の深刻な影響から保護された場所にある風下側の自然通風口を1つ以上開けておくことを考慮しなければならない。
.6 mechanical ventilation shall be restarted as soon as possible and operated continuously until the concentration of hydrogen falls to or below 0.2% by volume (5% LEL), and thereafter operated, as necessary, to sustain the hydrogen concentration below 1% by volume;	.6 機械通風はできるだけ早く再開し、水素濃度が体積比 0.2%（爆発下限界値の 5%）以下になるまで継続的に運転し、その後は必要に応じて水素濃度を体積比1%以下に維持するように運転すること。
.7 due care shall be exercised in restarting the ventilation, both mechanical and natural, so as not to create an ignition source; and	.7 機械通風、自然通風ともに着火源を作らないよう、通風の再開には十分な注意を払わなければならない。
.8 seek advice from the shipper or other suitably qualified expert, as appropriate.	.8 必要に応じて、荷送人または適切な資格を有する専門家に助言を求めること。
In all cases, mechanical ventilation shall be operated for an appropriate period of time prior to discharge.	いずれの場合も、揚荷前に適切な時間、機械通風を行うこと。
CARRIAGE	**運送時の要件**
The concentrations of hydrogen and oxygen and cargo temperature in holds carrying this cargo shall be measured daily during the voyage in the presence of or by the	この貨物を積載する船倉内の水素及び酸素の濃度並びに貨物温度は、航海中毎日、本船指定の乗組員若しくは代理人の立会いの下、又は貨物技術者が任命され

ship's designated crew member or representative, or by or under the supervision of the cargo technician, if appointed, and the results of such measurements shall be recorded in a log, given to the master, and kept on board for a minimum of two years.	ている場合はその者の立会いの下、若しくはその監督下で測定するものとし、その測定結果は日誌に記録し、船長に渡し、最低 2 年間船内に保管すること。
The frequency of monitoring shall be determined on the basis of the information provided by the shipper, the advice of the cargo technician if appointed, and the information obtained through the analysis of the atmosphere in the cargo holds. Consideration shall be given to increasing the frequency of cargo monitoring following periods of bad weather or following mechanical breakdown of the ventilation system.	監視の頻度は、荷送人から提供された情報、貨物技術者が任命されている場合はその助言、船倉内の大気の分析を通じて得られた情報に基づいて決定されるものとする。悪天候又は通風システムの機械的故障の後は、貨物の監視の頻度を増やすことを考慮しなければならない。
As soon as the results of monitoring indicate that the hydrogen concentration is approaching or has reached 1% by volume (25% LEL), the following precautionary measures shall be taken:	監視の結果、水素濃度が体積比１%（爆発下限界値の 25%）に近づいている、または到達していることが判明次第、以下の予防措置を講じること:
.1 verify proper operation of the mechanical and natural ventilation systems;	.1 機械通風および自然通風システムの適切な動作を確認すること。
.2 maintain, and if possible, increase mechanical and natural surface ventilation until the hydrogen concentration falls to or below 0.2% by volume (5% LEL);	.2 水素濃度が体積比 0.2%（爆発下限界値の 5%）以下になるまで、機械および自然表面通風を維持し、可能であれば増加させること。
.3 take care to prevent any spark generation or other potential source of ignition in the vicinity of the cargo holds, adjacent spaces, or open decks; and	.3 船倉、隣接する空間、またはオープンデッキの近辺で、火花の発生やその他の潜在的な発火源を防ぐよう注意すること。
.4 increase the frequency of monitoring of the hydrogen concentration in the cargo holds with the proper equipment, preferably to hourly, provided always and to the extent that prevailing conditions permit.	.4 船倉内の水素濃度の監視の頻度を、常に、そして一般的な状況が許す限りにおいて、適切な装置を用いて、できれば 1 時間ごとに増加させること。
If the hydrogen concentration remains above 1% by volume after such increased monitoring and ventilation, seek expert advice. Other than in the case of last resort, opening the hatches for the purpose of additional ventilation shall be undertaken only following receipt of relevant expert advice. Personnel shall under no circumstances enter the affected cargo spaces.	このような監視と通風の増加後も水素濃度が体積比で1%を超える場合は、専門家の助言を求めること。最終手段以外の場合、追加通風を目的としたハッチの開放は、関連する専門家の助言を受けた後にのみ実施すること。いかなる場合でも、影響を受ける船倉に人が立ち入らないこと。
A cargo temperature of 65℃ in a cargo hold is an indicator of a potential emergency situation and is, therefore, a trigger for increased monitoring and vigilance, as well as preparation for dealing with the emergency. In such cases, the following	船倉内の貨物温度が 65℃を超えた場合は緊急事態の可能性を示しているため、監視と警戒を強化し、緊急事態に対処するための準備をする必要がある。このような場合、以下の予防措置を講じなければならない:

precautionary measures shall be taken:	
.1 if possible, increase the rate of mechanical and natural ventilation to dissipate heat and any hydrogen;	.1 可能であれば、機械及び自然通風の割合を増やし、熱と水素を放散させること。
.2 monitor temperatures every 2 to 3 hours and hydrogen concentration every hour if possible, but in any event not less frequently than every 4 hours, provided always and to the extent that prevailing conditions permit;	.2 可能であれば、温度は 2～3 時間ごと、水素濃度は 1 時間ごとにモニターし、いかなる場合においても、4 時間ごとを下回らない頻度であること。
.3 do not use CO2, water or steam on the cargo;	.3 二酸化炭素、水、蒸気を貨物に使用しないこと。
.4 monitor hydrogen and oxygen levels in adjacent cargo holds and spaces and if possible, ventilate them;	.4 隣接する船倉や区画の水素および酸素レベルを監視し、可能であれば通風を行うこと。
.5 if possible, check for bulkhead heating in adjacent cargo holds; if significant bulkhead heating is detected from within an empty cargo hold, spray with water from the empty cargo hold side, provided the bulkheads are mechanically sound (water shall not be allowed to enter into contact with this cargo);	.5 可能であれば、隣接する船倉の隔壁が加熱されていないかを確認すること。空の船倉側の隔壁の著しい加熱が検出された場合、隔壁が機械的に健全であれば、空の船倉側から水を噴霧すること（この貨物に水が接触してはならない）;
.6 check for signs of abnormal heat in affected sounding pipes and air pipes; and	.6 影響を受けたサウンディング・パイプやエア・パイプに異常な熱の兆候がないか確認すること。
.7 if and when the temperature returns sustainably to 65℃ or less, regular monitoring procedures shall be resumed.	.7 温度が持続的に 65℃以下に戻ったら、定期的なモニタリングを再開すること。
In the event that the cargo temperature reaches or exceeds 100℃, follow the emergency procedures given in the appendix to this schedule.	貨物の温度が 100℃以上になった場合は、本附則の付録に記載されている緊急時の手順に従うこと。
Bilge wells shall be checked regularly for the presence of water. If water is found, it shall be removed by pumping or draining the bilge wells.	定期的にビルジウェルの水の有無を確認すること。水が発見された場合は、ビルジウェルを汲み上げるか排水することにより除去すること。
In the event that during the voyage the ship begins to exhibit motions indicative of cargo shifting, the appearance of the surface of this cargo shall be checked, subject always to the provisions for safe entry given in the section for “Precautions” hereof. If free water above the cargo or fluid state of the cargo is observed, the master shall take appropriate actions to prevent cargo shifting and potential capsize of the ship and give consideration to seeking emergency entry into a place of refuge.	航海中、本船が貨物の移動を示す運動を開始した場合、本附則の「各種の要件」の項に記載された安全進入のための規定に常に従うことを条件として、貨物の表面の状態を確認するものとする。貨物の上部に自由水がある場合、または貨物の流動状態が確認された場合、船長は、貨物の移動および転覆の可能性を防止するために適切な措置を講じ、避難場所への緊急進入を求めることを考慮しなければならない。
DISCHARGE	**揚荷役時の要件**
The hydrogen concentration in the relevant cargo hold atmospheres shall be	ハッチカバーを開ける作業を行う直前に、関連する船倉の大気中の水素濃度を測

measured immediately before any action to open the hatch covers is undertaken. If the hydrogen concentration is greater than 1% by volume (25% LEL), hatch covers shall not be opened. Additional ventilation shall be applied until the hydrogen concentration falls to or below 1% by volume. Special attention shall be given to the opening of hatch covers, in order to avoid sparks being generated. If in doubt, expert advice shall be sought.

定しなければならない。水素濃度が体積比 1%（爆発下限界値の 25%）を超える場合は、ハッチカバーを開けてはならない。水素濃度が体積比 1%以下になるまで、追加の通風を行うこと。火花の発生を避けるため、ハッチカバーの開放には特別な注意を払わなければならない。疑わしい場合は、専門家の助言を求めること。

The cargo in a hold may be discharged during precipitation, provided that the total amount of the cargo in such hold is: (1) to be discharged in the port; and (2) not to be transferred to another ship. Otherwise, during precipitation, all cargo operations shall be suspended and hatches of holds containing this cargo shall be closed. Monitoring of the hydrogen concentration in those holds containing this cargo shall be resumed.

船倉内の貨物は降水中に揚荷することができる、但し、当該船倉の貨物の総量は次のとおりとする：(1)港内で揚荷されること、(2)他の船舶に移送されないこと。但し、降水時には、全ての貨物作業を中断し、この貨物を積載した船倉のハッチを閉鎖すること。この貨物を含む船倉の水素濃度の監視を再開すること。

CLEAN-UP

Accumulations of dust from this cargo on deck or in proximity to cargo holds shall be removed as quickly as possible. Hosing with seawater shall be avoided. Consideration shall be given to carefully cleaning exposed radio communications equipment to which dust from the cargo might adhere, such as radar, radio aerials, VHF installations, AIS and GPS.

清掃に係る要件

甲板上または船倉に近接する場所で、この貨物に由来する塵埃が蓄積した場合は、可能な限り速やかに除去すること。海水による洗浄は避けること。レーダー、無線空中線、VHF 設備、AIS、GPS など、貨物からの粉塵が付着する可能性のある、露出した無線通信機器を注意深く清掃するよう検討すること。

EMERGENCY PROCEDURES

非常時の措置

SPECIAL EMERGENCY EQUIPMENT TO BE CARRIED
Self-contained breathing apparatus.
EMERGENCY PROCEDURES
As provided by the shipper.
EMERGENCY ACTION IN THE EVENT OF FIRE
The specific procedures provided by the shipper should be consulted and followed, as appropriate.
Do not use CO2. Do not use water. Do not use steam.
MEDICAL FIRST AID
Refer to the Medical First Aid Guide (MFAG), as amended.

備えるべき特別非常用装備
自蔵式呼吸具
非常時の措置
荷送人により提供。
火災発生時の行動
荷送人から提供された具体的な手続きを参照し、適宜それに従う。 二酸化炭素を使用しないこと。水を使用しないこと。蒸気を使用しないこと。
応急医療
改正応急医療指針参照

Appendix	付録
DIRECT REDUCED IRON (D) (By-product fines with moisture content of at least 2%)	還元鉄(D) （含水率 2%以上の微粒副生物）
Precautions to be taken by the shipper prior to and during loading	積荷前および積荷中に荷送人が講じるべき措置
1 The cargo temperature shall be monitored by the shipper for the three days prior to loading to verify temperature stability. Measurements shall be recorded in a log detailing the temperature for each lot of cargo loaded, a copy of which shall be provided to the master prior to sailing.	1 貨物の温度は、温度の安定性を確認するため、積荷前の３日間、荷送人により監視されること。測定値は、積荷の各ロットの温度を詳述したログに記録されるものとし、その写しは出航する前に船長に提供されるなければならない。
2 Material exhibiting temperature instability beyond the temporary increase of up to about 30° C or with a temperature above 65° C shall not be loaded.	2 一時的に約 30℃を超える温度上昇をするような温度の不安定性を示す物質または 65℃を超える温度の物質は、積載してはならない。
3 If necessary, once the pre-shipment moisture content has been determined, each pile of cargo to be loaded may be covered with tarpaulins and during loading, the tarpaulins progressively removed as the pile is loaded. In the event of precipitation during loading such that a pile becomes wet, loading from such a pile shall be suspended and, weather permitting, loading shall be resumed from a different pile which has been tested for moisture content. The wet material shall be resampled for moisture content pursuant to 4.5.2 of the IMSBC Code and, such moisture content to be certified as suitable for loading by a competent person recognized by the competent authority of the port of loading.	3 積荷前に水分値が決定された後、積荷中は必要に応じて、船積みされる貨物の各パイルを防水シートで覆い、船積みされたものから防水シートを徐々に取り外しても構わない。積荷中に降雨でパイルが濡れた場合、当該パイルからの積荷を中断し、天候が許せば、水分値の検査を受けた別のパイルから積込みを再開すること。湿った物質は IMSBC コードの第 4.5.2 節に従って水分値を再サンプリングし、その水分値は積荷港の管海官庁によって認められた担当者によって、積込みに適していると証明されなければならない。
4 Prior to loading and after loading has been stopped due to precipitation, the shipper shall ensure that the conveyor belts and all other equipment used for loading this cargo contain no accumulations of water or other substances.	4 積荷前及び降水により積荷が中止された後、荷送人は、本貨物の積荷に使用するコンベヤベルト及びその他すべての設備に水その他の物質が溜まっていないことを確認すること。
5 Each time loading operations are commenced or resumed, all conveyor belts shall be operated unladen, but not over a cargo hold.	5 積荷作業が開始または再開されるたびに、船倉内を除き、すべてのコンベヤベルトは荷を積まない状態で運転すること。
Additional precautions to be taken	追加で講じるべき措置
1 Where practical, ballast tanks adjacent to the cargo holds containing this cargo, other than double-bottom tanks, shall be kept empty.	1 可能な限り、二重底タンク以外のこの貨物を積載する船倉に隣接するバラストタンクは空にしておくこと。
2 Bilge wells shall be clean, dry and protected from ingress of the cargo with	2 ビルジウェルは清浄な乾燥状態とし、貨物の侵入を防止するため不燃性の

non-combustible material. Bilge wells shall be checked regularly for the presence of water. If water is found, it shall be removed by pumping or draining the bilge wells.	素材で適切に覆われていること。ビルジウェルは、定期的に水の有無を確認すること。水が発見された場合は、ビルジウェルを汲み上げるか排水することにより除去すること。
3 The introduction of moisture and accumulation of condensation in the cargo holds shall be avoided.	3 船倉の湿気及び結露の蓄積を避けること。
4 Appropriate precautions shall be taken to protect machinery and accommodation spaces from the dust of the cargo. Due consideration shall be given to protect sensitive equipment such as radars and exposed telecommunications equipment from the dust of the cargo.	4 貨物の粉塵から機械設備及び居住空間を保護するため、適切な予防措置を講じること。レーダーや露出した電気通信機器のような繊細な機器を貨物の粉塵から保護するために、十分に配慮すること。
5 Persons who may be exposed to the dust of the cargo shall wear protective clothing, goggles or other equivalent dust eye-protection and dust filter masks, as necessary.	5 この貨物の塵埃に晒されるおそれのある者は、必要に応じて保護衣、保護眼鏡若しくは他の同等な塵埃からの眼の保護及び防塵マスクを着用すること。
6 During any handling of this cargo, “NO SMOKING” signs shall be posted on decks and in areas adjacent to cargo holds, and no naked light shall be permitted in these areas. Smoking, burning, cutting, chipping, grinding or other sources of ignition shall not be allowed in the vicinity of cargo holds containing this cargo at any time.	6 この貨物の荷役中は「禁煙」の標識を甲板上及び貨物区画の近傍に掲げること。また、この貨物を積載している船倉の近傍では常に、喫煙、火気使用工事、焼付け、切削、錆打ち、研削または他の着火源を許可しないこと。
7 All electrical equipment within any cargo hold in which this cargo is carried shall be of a certified safe type for use in explosive atmospheres or effectively isolated from the electrical supply.	7 この貨物が積載される船倉のすべての電気器具は、爆発性雰囲気で使用するために認証された安全な型式のものまたは電気供給源から効果的に絶縁されたものでなければならない。
8 Prior to loading, an ultrasonic test or another equivalent method shall be conducted to ensure weathertightness of the hatch covers and closing arrangements, and all readings shall confirm weathertightness.	8 積荷前、ハッチカバー及び閉鎖装置の風雨密を確実にするため、超音波試験または適切な機器による他の同等な方法を実施し、全ての結果で風雨密が確認されること。
Development of time-based gas prediction curve A time-based gas prediction curve is an important tool for understanding the likely rate of evolution of hydrogen from this cargo. In order to develop such a curve, a cargo hold shall be ventilated until the hydrogen concentration falls to or below 0.2% by volume (5% LEL), then ventilation (both natural and mechanical) to such hold shall be stopped, and the hydrogen concentration measured every 2 hours thereafter for at least 24 hours or until it reaches 1% by volume, whichever occurs first. If the concentration reaches or exceeds	**時間軸のガス予測曲線の開発** 時間軸のガス予測曲線は、この貨物から発生する水素の概ねの発生量を理解するための重要なツールである。このような予測曲線を作成するためには、水素濃度が体積比 0.2%（爆発下限界値の 5%）以下になるまで船倉を通風した後、通風（自然換気および機械換気の両方）を停止し、その後少なくとも 24 時間、または水素濃度が体積比1%に達するまでのいずれか早い時点まで、2 時間ごとに水素濃度を測定しなければならない。水素濃度が体積比1%以上になった場合、それぞれの船倉を通風し、水素濃度が体積比

1% by volume, the respective cargo holds shall be ventilated and measurements continued to ensure that the concentration of hydrogen has stabilized and remains sustainably at or below 0.2% by volume (5% LEL). Based on this data, the length of time needed to reach a concentration of 1% by volume in the absence of ventilation shall be calculated and employed for updating the voyage plan and optimizing the weather routing.	0.2%（爆発下限界値の 5%）以下に安定し、持続的に維持されていることを確認するために測定を継続するものとする。このデータに基づき、通風を行わなかった場合に濃度が体積比1%に達するまでに必要な時間を算出し、航海計画の更新や気象ルーティングの最適化に利用するものとする。
Emergency measures in case of high cargo temperature 1 In the event that the cargo temperature in a hold reaches or exceeds 100° C, the first step is to seek expert advice, in order to determine the best course of action, taking into account the prevailing circumstances and history of the cargo in question; for example, the rate of temperature increase, the remaining sailing time to the scheduled discharge port, etc. 2 Depending on the expert advice received, the following two solutions may be considered: .1 deviation to a port of refuge to discharge the affected cargo if the cargo temperature exceeds 120° C, in which case preparations should be made for grab discharge; and .2 as a last resort and only if safe, flooding the affected cargo holds with water, always taking into account the stability and strength of the ship. 3 The temperatures mentioned in this section, i.e., emergency measures in case of high cargo temperature, are indicative only, and the advice of the appointed surveyor or expert shall be followed.	**貨物温度が高い場合の緊急措置** 1 船倉内の貨物温度が 100℃以上になった場合、まず専門家の助言を求め、当該貨物の状態や動き、例えば、温度上昇の速度、排水予定港までの残り航行時間等を考慮し、最適な対応策を決定すること。 2 専門家の助言に応じ、以下の 2 つの解決策をとることを考慮すること: .1 貨物の温度が 120℃を超える場合、その貨物を揚荷するために避難港に移動し、グラブによる揚荷役を準備すること。 .2 最後の手段として、また安全な場合に限り、船舶の安定性と強度を常に勘案して影響を受けた船倉を水浸しにすること。 3 本節に記載されている温度、すなわち貨物温度が高い場合の緊急措置はあくまでも目安であり、選任された測量士または専門家の助言に従うこと。
Duties of the cargo technician 1 The cargo technician, if appointed, shall: .1 Monitor the loading operations and provide advice as appropriate. .2 Advise on and supervise the installation of thermocouples in the cargo holds for temperature monitoring, monitor the performance of the thermocouples, and keep the master informed accordingly; if a cargo technician is not appointed, the shipper shall advise on and supervise the installation of the thermocouples in the cargo holds.	**貨物技術者の要件** 1 貨物技術者が任命されている場合、以下の措置を講じること。 .1 積荷作業を監視し、適切に助言すること。 .2 温度監視のための船倉への熱電対の設置について助言及び監督するとともに熱電対の性能を監視し、船長に適宜報告すること。貨物技術者が任命されていない場合、荷送人は船倉への熱電対の設置について助言及び監督すること。

.3 Monitor and report on the cargo parameters, namely temperature and hydrogen and oxygen concentrations, as well as other data or information relating directly to cargo behaviour, such duty to include taking readings in conjunction with designated crew members and ensuring that readings are communicated on a regular and frequent basis to the master, or their designated representative, who shall forward them to the shipper to seek appropriate advice.	.3 貨物のパラメータ、すなわち温度、水素及び酸素濃度、並びに貨物の挙動に直接関連するその他のデータ又は情報を監視し、報告すること。この職務には、指定された乗組員と共に測定し、測定値が定期的かつ頻繁に船長又は指定代理人に伝達されることを確実にし、船長が適切な助言を得るために荷送人に転送することも含まれる。
.4 Assist and advise the master and crew in the development of the time-based gas prediction curve and the frequency of updating thereof.	.4 時間軸のガス予測曲線の作成とその更新頻度について、船長と乗組員を支援し、助言すること。
.5 Advise and coordinate with the master and crew, as appropriate, in connection with the operation of the ventilation systems.	.5 通風システムの操作に関して、船長および乗組員に適宜助言し、調整すること。
.6 Provide advice and assistance to and cooperate with the master and crew in case of an emergency pertaining to the cargo.	.6 貨物に関する緊急事態が発生した場合、船長及び乗組員に助言及び援助を行い、協力すること。
2 In carrying out such duties the cargo technician shall act in an advisory capacity and be subject to the authority and decision of the master of the ship.	2 この職務を遂行する際、貨物技術者は助言をする立場で行動し、船長の権限と決定に従うこと。
3 In the absence of the appointment of a cargo technician, the master or their designated representative shall seek advice from the shipper or other competent person.	3 貨物技術者が任命されていない場合、船長又は指定代理人は、荷送人その他の適当な人物に助言を求めるものとする。