Australian Government
Australian Maritime Safety Authority

Information Sheet

(relevant until the 1st of January 2012 only)

Carriage of Ammonium Nitrate of Class 5.1 (UN1942 & UN2067) to and from Australia

INTRODUCTION

The purpose of this Information Sheet is to advise all ship owners and operators of the requirements for the safe carriage of Ammonium Nitrate on board ships with a particular emphasis on the carriage in Flexible Intermediate Bulk Containers (FIBC), whether these are loaded directly into the ship or are carried in containers, or where the Ammonium Nitrate is loaded loose in a bulk container.

The requirements for the carriage in packaged form of Ammonium Nitrate of all types are detailed in the IMDG Code[1] which in turn is mandated for the carriage of dangerous goods by sea by Regulation 3 of Chapter VII of SOLAS.

The mandatory application of the IMDG Code within Australia is implemented through delegated legislation adopted by the Australian Maritime Safety Authority (AMSA) under the *Navigation Act 1912*.

This delegated legislation is known as *Marine Orders Part 41 – Carriage of Dangerous Goods* (MO41) and by virtue of the scope of the application of the *Navigation Act 1912* this Marine Order applies to voyages of both an interstate and international nature. MO41 can be accessed from the AMSA website at:


Australian Government
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MARINE ORDERS

Part 41

Carriage of dangerous goods

Issue 9

Order No. 12 of 2008

In accordance with subsection 425 (1AA) of the Navigation Act 1912, I repeal Marine Orders Part 41, Issue 8 and make this Order, Marine Orders Part 41, Issue 9 to come into operation on 1 January 2009.

Graham Peachey
Chief Executive Officer
16 December 2008

http://www.amsa.gov.au/shipping_safety/marine_orders/Marine_Orders_currently_in_force.asp

On the basis of both the adoption of the IMDG Code within SOLAS and within Australian legislation the carriage of Ammonium Nitrate (and in fact all dangerous goods) in packaged form must be in compliance with the relevant provisions of the IMDG Code.

> *Note: This information sheet is for advice only and shippers and masters must consult the IMDG Code whenever shipping or carrying Ammonium Nitrate or any other class of dangerous good.*

WHAT ARE THE SPECIFIC REQUIREMENTS?

Where Ammonium Nitrate in packaged form is carried it must comply with all the specific and general requirements contained in the IMDG Code that relate to the material itself, the package in which it is shipped and the relevant stowage, segregation and consignment procedures. However there are a range of issues that shippers and carriers/ships should be particularly aware of.

1. The need to be able to open Hatches

Section 7.1.11.5.1 of the IMDG Code states that AMMONIUM NITRATE, UN1942 and AMMONIUM NITRATE BASED FERTILIZERS, UN2067

> *"may be stowed under deck in a clean cargo space* ***capable of being opened up in an emergency."***

The section goes on to state that the possible need to open hatches in case of fire to provide maximum ventilation and to apply water in an emergency, and the consequent risk to the stability of the ship through flooding of cargo space, shall be considered before loading. This is simply a reminder and does not detract from the need to be able to open hatches. This requirement does not simply apply while the ship is alongside and the ship should be capable of opening up hatches at sea in normal conditions.

Can main hatches be opened?

If a ship is fitted with pontoon type hatches or pontoon tween deck hatches, it is highly unlikely to be able to open up these hatches if relying on a slewing crane. This is due to operating restrictions on the crane and some very

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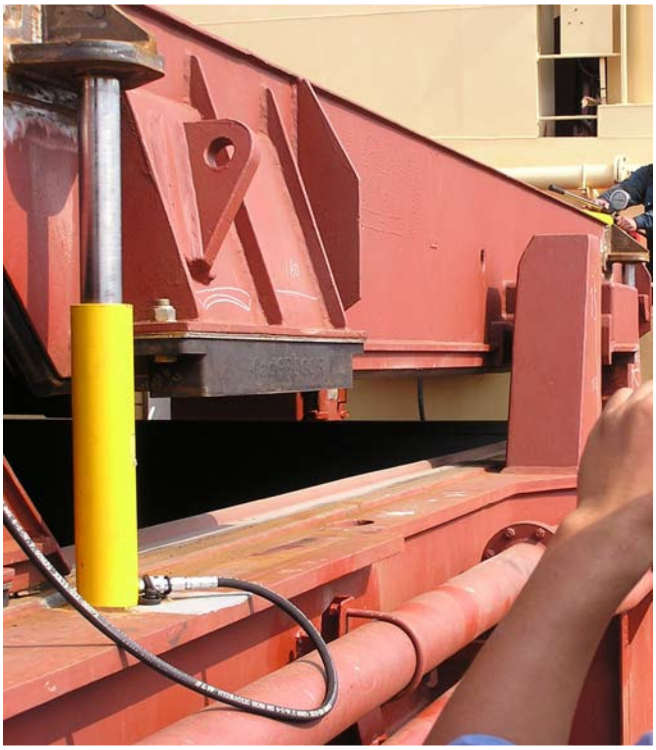
[1]The IMDG Code as adopted by the Maritime Safety Committee of the Organization by resolution MSC.122(75) , as amended. The 2008 edition will come into mandatory effect from the 1st of January 2010 but may be used in lieu of the 2006 edition until that time.

significant safety issues associated with handling hatches at sea. Some ships are fitted with hatch gantry cranes which may mitigate some of the safety issues but many of these have significant operating restrictions that limit their use to smooth water. An option provided by hatch manufactures, that AMSA been made is aware of, that may be satisfactory for pontoon hatches, is a jacking systems that lifts the pontoon hatch within the pontoon guides. This gives an opening of about 400mm or more without the need to use cranes (see image below).

Where options such as hatch gantries are to be relied upon the ship must have **evidence that the flag state or its recognized organization have accepted that the means of opening can be operated at sea,** in conditions where the ship is rolling and pitching. If this evidence cannot be provided then this option cannot be relied upon.



Hatch cover jacking arrangement

Mechanically operated hatches (ram type or similar arrangements) are acceptable but the master should still take care to ensure the hatch will not dismount[2].

The ability of each ship to comply with this requirement will vary depending on the arrangement on each individual vessel, however, **it is not necessary that all hatch covers are able to be opened up**. The general expectation is that hatches accounting for no less than 30 per cent hatch opening area of a single cargo hold will need to be opened up in an emergency.

Where the space is adjacent to a machinery space or other high risk space it would normally be expected that the hatch in the way of the adjoining bulkhead be capable of being opened up for the purpose of boundary cooling[3].

Can tween deck hatches be opened?

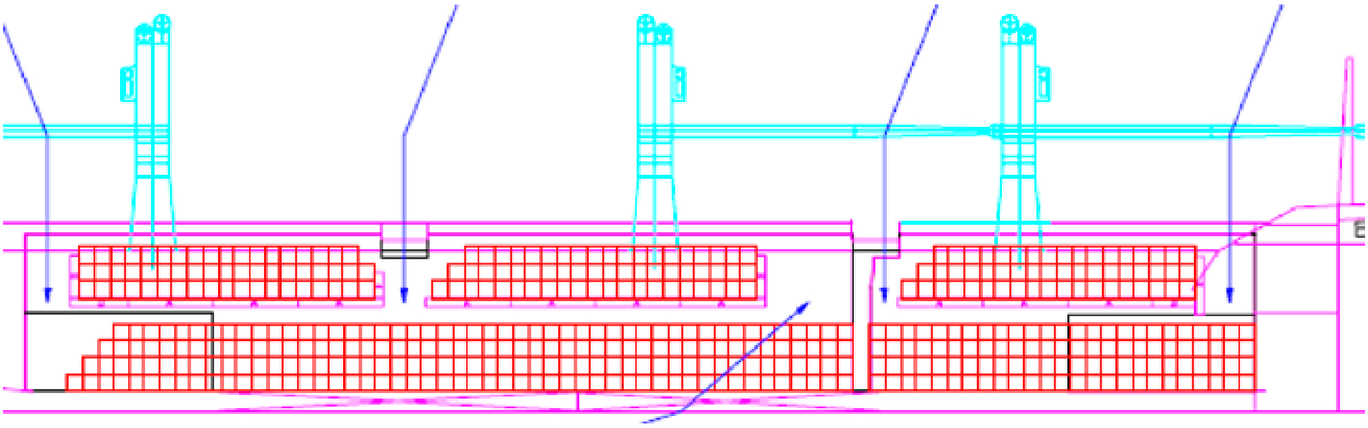
Some vessels have mechanically operated tween deck hatches but many are fitted with pontoon type hatches. In these circumstances the hatches either need to be left opened (and not used to carry cargo) or partially opened up to the extent that section 7.1.11.5.1 can be complied with.

For tween decks arrangements where hatches cannot be opened up, an alternative is to have around 30 per cent of the tween deck pontoons removed to provide the necessary opening to fight fire (boundary cool) and to provide maximum ventilation in an emergency. These should not be removed from a single location but must be spaced along the length of the hold. For short holds it may only be possible to remove the fore and aft tween-decks pontoons. An example is provided on the following page.

Where pontoons are removed measures need to put in place to ensure the cargo is properly secured and protection is provided in respect of the risk of falls in the vicinity of the opening.

[2] Partial opening and then resting on blocks being an option considered by some.

[3] Boundary cooling must be able to be applied from the main deck as AN produces toxic gases when heated. Entry into the cargo space is not practical nor safe given appropriate equipment, suitable for use in such an atmosphere, is not carried on most ships



Where tween deck pontoons are removed, what space is required between cargo and hatches (tween deck and main)?

It is necessary that sufficient space is provided between the top of the stow and the underside of hatches that cannot be opened (tween deck pontoons or over stowed main deck hatches) to allow gases of decomposition to be ventilated.

Where AN is stowed below these hatches and the cargo is not containerised (i.e FIBC cargo), a minimum of 0.5m is to be provided between the top of the stow and underside (lowest protrusion that interferes with air flow) of the hatches.

For containerised cargo the design of the vessel should be such that sufficient space is provided around the containers, however where the cargo is a mixed stow of containerised cargo and break bulk and some of the cargo may obstruct ventilation flows, at least 0.5m of clear space between the top of the cargo and the underside (lowest protrusion that interferes with air flow) of the hatches should be provided.

Where tween deck hatch pontoons are removed cargo cannot be stowed in the resultant opening in a way that it may obstruct ventilation flow from the lower hold. A minimum of 0.5m (more is advisable) along the space between the edge of the hatch and the side of the stow must be provided and consideration be given with respect to the movement of cargo and the impact of lashing arrangements.

2. The need to stow "away from" sources of heat

The individual entries in Chapter 3.2 of the IMDG Code for UN1942[4] and UN2067[5] require that it be stowed "away from sources of heat". Sources of heat are defined in section 7.1.1.15 of the IMDG Code and the relevant part of the section states:

> *"Where, for certain dangerous goods, protection from sources of heat is required, this shall be taken to include sparks, flames, steam pipes, heating coils, **top or side walls of heated fuel and cargo tanks, and bulkheads of machinery spaces** (see regulation II-1/2.8 of SOLAS, 1974 (as amended));"*

What segregation distance is required?

Section 7.2.2.2 of the IMDG Code defines "Away from" segregation as three metres extended vertically. As such where there are heated fuel tanks or an uninsulated machinery space bulkhead, a segregation of 'at least' three metres is to be maintained.

Note: A-60 insulation does not guarantee that heat will not be passed into the hold (hence the need to be able to open up and apply boundary cooling as noted in section 1 above) as this structure is only insulated with the intention that any point on the unexposed side of the bulkhead will not rise 180 above the original temperature[6] for more than 60 minutes. After that it should not be expected the insulation will be effective.

[4]For UN1942 column 16 states: Category C. Category A only if the special stowage provisions of 7.1.11.5 are complied with. 'Away from' sources of heat. 'Separated from' class 4.1, combustible material (particularly liquids), bromates, chlorates, chlorites, hypochlorites, nitrites, perchlorates, permanganates and powdered metals.

[5]For UN2067 column 16 states: Category C. Category A only if the special stowage provisions of 7.1.11.5 are complied with. 'Separated from' class 4.1, combustible material (particularly liquids), bromates, chlorates, chlorites, hypochlorites, nitrites, perchlorates, permanganates and powdered metals. 'Away from' sources of heat.

[6]The average temperature on the unexposed side should not rise more than 140ºC above the original temperature.

What if fuel tanks are not heated?

All Heavy Oil fuel tanks have heating fitted; however, it will not always be necessary to heat these tanks during the course of a voyage. Where a vessel has planned its voyage in such a way that heat will not be applied to a particular tank, AMSA will not consider this tank as a heated fuel tank for the purpose of the voyage.

What if fuel tanks are only heated to a certain temperature?

The Bulk Cargos (BC) Code[7] permits bulk AN to be stowed immediately adjacent to fuel tanks that cannot (or are managed in a way that they will not) attain a temperature of more than 50ºC. This interpretation will be accepted by AMSA for the segregation of packaged AN, however, how such temperatures will be maintained (particularly for side tanks) may be examined by an AMSA surveyor.

3. Carriage of AN in FIBC

Ammonium Nitrate is commonly carried in Flexible Intermediate Bulk Containers (FIBC) either directly into the hold or within containers. Under these circumstance the FIBC are invariably stacked. For FIBC to be used for UN2067 or UN1942 (or any other dangerous goods where FIBC are permitted) the requirements of Chapter 6.5 of the IMDG Code will apply.

In respect of stacking; sections 6.5.2.1.1 (marking) and 6.5.6.6 (stack test) apply to FIBC and the maximum allowable stacking load of an FIBC must not to be exceeded.

What is the maximum allowable stacking load?

The maximum allowable stacking load is shown on the specifications markings applied to the FIBC in accordance with section 6.5.2.1 of the IMDG Code. As noted in section 6.5.2.1.1.7. **Where the figure zero (0) is included in the specification the FIBC cannot be stacked**. Where a figure is provided in the specification marking then this is the stacking test load applied to the FIBC.

As an example of IMDG Code markings with respect to stacking look at the following:

13H2/Z/06 01/S/AUS/AP5011/0/1200

In this case the number 0 indicates the FIBC cannot be stacked while the number 1200 indicates the maximum permissible mass.

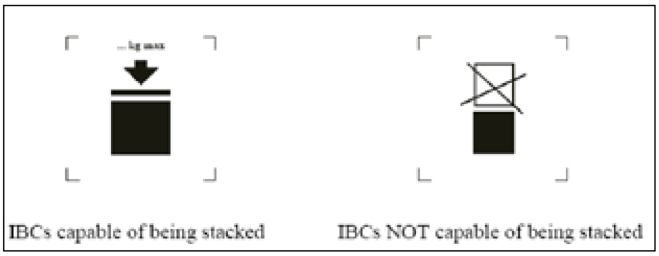
13H2/Z/06 01/S/AUS/AP5033/6840/1200

In this case the number 6840 indicates the applied stacking test load (meaning the FIBC can be stacked) and again the number 1200 indicates the maximum permissible mass.

Where an FIBC can be stacked the maximum allowable stack load can be arrived at by dividing the applied stacking test load by 1.8[8]. For the example above:

Applied test load	=	6480 kg
÷ 1.8	=	3600 kg maximum allowable stack load

Therefore only three similar FIBC with a maximum permissible mass of 1200kg can be carried on top of this FIBC.



Stacking pictogram to be applied to IBC under section 6.5.2.2.2 of the 2008 edition of the IMDG Code

It should be noted that as of 1 January 2011, IBC manufacturers will be required to put the new pictogram shown above on their IBC's. This will clearly indicate the allowable stack limits and it is recommended this practice be adopted as soon as practical to limit confusion in this regard.

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[7] The Code of Safe Practice for Solid Bulk cargoes (2004 Edition) - Being replaced by the International Maritime Solid Bulk cargoes (IMSBC) Code.

[8] See the note to section 6.5.2.1.1.7 and section 6.5.6.6.4.

[9] Refer to the Guidelines on the preparation of the Cargo Securing Manual, approved by the Maritime Safety Committee of the Organization and promulgated by circular MSC/Circ.745

How are FIBC to be secured?

Regulation 5 of Chapter VI requires that all cargoes (other than solid and liquid bulk cargoes), cargo units and cargo transport units shall be loaded, stowed and secured throughout the voyage in accordance with the Cargo Securing Manual (CSM) approved by the Administration. For dangerous goods this is reinforced by Regulation 5 of Chapter VII of SOLAS.

The CSM is to be drawn up to a standard at least equivalent to relevant guidelines developed by the Organization[9] and is to include information on how to secure the cargo being carried. It has been noted that many vessels which carry FIBC directly in the hold of a ship (not in containers) do not comply with this as the CSM contains no instruction for the safe stowage of FIBC[10]. If the CSM does not include such guidance, then FIBCs cannot be carried without the specific approval of the ship's flag state or an organisation recognised by the flag state[12].

Where a vessel carries cargo that is not addressed, or adequately addressed, by the Cargo Securing Manual then port State Control action may be taken[11].

What about FIBC in Containers?

Where FIBC are carried in a container, the stacking limitations still apply. An FIBC which is marked to indicate it cannot be stacked, cannot be stacked in a container. In addition, as indicated in section 1, the need to be able to open hatches in an emergency still needs to be complied with.

4. Carriage of AN in Bulk Containers (BK2 Packages)

The individual entries in Chapter 3.2 of the IMDG Code for UN1942 and UN2067 allow Ammonium Nitrate to be carried in Bulk Containers as a "BK2" package as described in Chapter 6.9 of the IMDG Code. In addition for UN1942, a BK2 may only be employed if use of the package is specifically approved by the competent authority by virtue of Special Provision 952. A copy of this approval is to be available to the master of the vessel by virtue of provision 8 of MO41.

AN cannot be shipped in a BK2 unless the package complies with the relevant provisions of Chapter 4.3 and 6.9. If a package does not fully comply with these chapters of the IMDG Code, the package can only be used if an exemption approval is issue by AMSA (or the country of origin for cargoes not originating from Australia).Regardless, such exemptions need not be accepted by other authorities (or by AMSA if the shipment originates form another country) as noted in Chapter 7.9 of the IMDG Code.

Is a Freight Container suitable for use as a BK2?

A Freight container may be used as a BK2 package provided it complies with section 6.9.3 of the IMDG Code.

Generally speaking, most freight containers are general purpose (GP) containers designed and tested in accordance with ISO 1496-1:1990 "Series 1 Freight containers- Specification and testing - Part 1: General cargo containers for general purposes". These containers will **not** be designed with end wall strength that would pass the tests specified in ISO 1496-4:1991 "Series 1 Freight containers- Specification and testing - Part 4: Non pressurized containers for dry bulk". This requires that the end wall be tested to 0.6P in lieu of 0.4P as applied to GP containers. For the test "P" is the container payload[13].

BK2 packages must be able to pass this test standard, be sift proof (with a liner of sufficient strength where one is used) and be able to withstand the full load (1.0P) on the door end if they are to be discharged by tilting.

This does not mean a GP container cannot be used, however, it does mean that a CA approval will be required and the container will be limited to a payload that is equivalent to a test load of 0.6P for the cargo actually carried in the container. This will be calculated using the following formula:

$$\text{Maximum Allowable Payload} = \frac{((\text{Maximum Gross Weight} - \text{Tare}) \times 0.4)}{0.6}$$

In addition, a GP container will need to be fitted with service equipment to make it sift proof (a liner) and allow for safe discharge (take the load off the doors). Such equipment must also comply with Chapter 4.3 of the IMDG Code and it should be noted that section 4.3.2.3 requires that the arrangement be so constructed that the cargo cannot come into contact with wood or other incompatible cargo. As such timber should not be used for the service equipment such as barriers.

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[10]Refer to Annex 10 of the Code of Safe Practice for Cargo Stowage and Securing adopted by IMO Res A.714(17) as amended

[11]Normally the ships classification society.

[12]This assumes the vessel is permitted to carry Dangerous Goods by virtue of SOLAS II-2/19.

[13]The payload "P" is the Maximum Gross Mass less the Tare Weight of the container.

An example of the type of arrangement that may be accepted by AMSA is provided in the image below.

Are there serviceability requirements for BK2 packages?

Yes, chapter 5.4 and 7.4 require that all BK2 packages should be inspected before they carry dangerous goods and container based systems must have a valid CSC plate. This is reinforced for BK2 packages by section 4.3.1.15 which requires that a bulk container be visually inspected prior to being filled to ensure it is structurally serviceable[14], its interior walls, ceiling and floors are free from protrusions or damage and that any inner liners or substance retaining equipment are free from rips, tears or any damage that would compromise its cargo retention capabilities.

WHAT IS THE RISK WITH AMMONIUM NITRATE

When heated, all Ammonium Nitrate (AN) will start to decompose into gases including oxygen and nitrogen oxides, but the nature of gases produced by decomposition depends on temperature and conditions under which heating occurs. It can be induced to decompose explosively by detonation when large quantities are heated to the point it decomposes, or the product is involved in a fire, and the gases are contained.

Ammonium Nitrate is a salt of Ammonia and Nitric Acid and when heated at lower temperatures (80°C. to 93°C.) the decomposition, simultaneous vaporization and dissociation of ammonium nitrate into ammonia and nitric acid, is an endothermic vaporization reaction which tends to offset or balance the heat-producing reaction effectively cooling the cargo. Under these conditions when the external heat source is removed from the AN the temperature of the material drops rapidly as a result of endothermic nature of the volatilization into ammonia and nitric acid[15].

$$NH_4NO_3 \longrightarrow NH_3 + HNO_3$$

However, the effectiveness of this self-limiting effect during heat decomposition will be removed where the material is tightly confined such as when carried in the hold of a ship. This is the reason that hatches need to be able to opened up as specified in section 7.1.11.5 and 7.1.16 of the IMDG Code. Under these circumstances the energy from the exothermic decomposition into nitrous oxide and water overpowers the moderating effect of the vaporization reaction, thereby resulting in a rapid escalation of temperature and reaction rate which can accelerate to detonation state conditions.

$$NH_4NO_3 \longrightarrow N_2O + 2H_2O$$

At approximately 166°C to 212°C, ammonium nitrate begins to melt and decomposes exothermically into nitrous oxide and water vapour[15] as described in the formula above. The nitrous oxide is a supporter of combustion, even in confined spaces where there is a lack of oxygen. As the temperature rises the rate of decomposition increases and more toxic oxides are liberated. This increases the risk of detonation. This is compounded by the fact that molten ammonium nitrate is more shock sensitive and requires much less pressure under heat conditions to offset the self-limiting effect and trigger a deflagration or detonation. Under these circumstances an explosion may be caused by compression or some sort of impact on the molten material.

When the temperature of the material exceeds 250°C, or if the material is subject to a strong shock then violent decomposition occurs[16]:

$$NH_4NO_3 \longrightarrow N_2 + 2H_2O + \tfrac{1}{2}O_2$$

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[14]Section 4.3.1.15 indicates some of the issue that would result in a container not being structurally serviceable.

[15]This reaction requires energy to break the bonds (heat in this case) as such the reaction absorbs heat. The enthalpy of the reaction express as ΔH is about 171kJ/mol (+41kcal/mol), where: ΔH = energy used in breaking the bonds – energy released in the bond making process. Where “bond making” is the process of the formulation of the resultant molecules from the reaction.

[16]This reaction releases energy as the energy used to break the bonds if the AN is much less that that released but the formulation of Nitrous Oxide and water vapour. As a result the ΔH is about -23kJ/mol (-5.5kcal/mol).

[17]See http://www.hillakomem.com/ammonium-nitrate.html