



Carriage of Ammonium Nitrate of Class 5.1 (UN1942 & UN2067) and Class 9 (UN2071) to and from Australia

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. IMDG Code references are to the 2014 edition of the Code that includes the 37-14 amendments. All persons involved in the transport of packaged dangerous goods intended to be transported by sea require mandatory training in accordance with 1.3 of the IMDG Code and Marine Order 41 (MO41). This information sheet is therefore not intended to be a guide in how to ship ammonium nitrate.

INTRODUCTION

The purpose of this Information Sheet is to remind all ship owners, ship operators and masters 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 Code¹ 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 2012*. This delegated legislation is known as *Marine Order 41 (Carriage of dangerous goods) 2009* (MO41) and by virtue of the scope of the application of the *Navigation Act 2012* this Marine Order applies to the loading of Regulated Australian Vessels (RAV) and foreign flagged vessels at an Australian port on all voyages. MO41 can be accessed from the AMSA website at: 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.

STOWAGE, HANDLING AND SEGREGATION

The primary source of information on the required stowage, handling and segregation for packaged dangerous goods can be found in the individual entries in the Dangerous Goods List (DGL) in Chapter 3.2 (in Volume 2) of the IMDG Code. Other additional requirements can then be applied as applicable to the material being shipped/loaded. These additional requirements can be found in other applicable Parts and Chapters of the Code – for stowage, handling and segregation requirements, Part 7 “*Provisions Concerning Transport Operations*” is of particular note.

Ammonium nitrate has three entries in the DGL:

UN1942 AMMONIUM NITRATE with not more than 0.2% total combustible material, including any organic substance, calculated as carbon to the exclusion of any other added substance, Class 5.1, PG III

UN2067 AMMONIUM NITRATE BASED FERTILIZER, Class 5.1, PG III

UN2071 AMMONIUM NITRATE BASED FERTILIZER, Class 9, PG III

UN1942 and UN2067 are Class 5.1 and have almost identical stowage, handling and segregation requirements. UN2071 is Class 9 and has slightly modified requirements that recognise the different risks of this material.

In the DGL column 16a uses alpha-numerical codes to provide the stowage and handling instructions, whilst column 16b also uses alpha-numerical codes but to provide the segregation requirements.

In column 16a - UN1942 and UN2067 are both Category C which, it should be noted, is stowage ON DECK ONLY on both cargo ships and passenger ships. This means that these two materials are prohibited from being stowed in a ship's hold.

¹The IMDG Code as adopted by the Maritime Safety Committee of the Organization by resolution MSC.122(75), as amended. The 2014 edition will come into mandatory effect from the 1st of January 2016 but may be used in lieu of the 2012 edition from 1 January 2015 until that time.

The codes in the column then provide additional information. For both materials the codes are SW1 - protected from sources of heat, SW14 - Category A only if the special stowage provisions of 7.4.1.4 and 7.6.2.8.4 are complied with and SW23 – which requires compliance with 7.6.2.12 and 7.7.3.9 for carriage in BK3 flexible bulk containers (FBC) – not to be confused with flexible intermediate bulk containers (FIBC).

Category A is stowage ON or UNDER DECK on both cargo ships and passenger ships, so compliance with SW14 is the mechanism that permits UN1942 and UN2067 to be stowed in a ship's hold. SW14 is therefore critical to compliant and safe carriage of UN1942 and UN2067 in a ship's hold.

In column 16a – UN2071 is Category A which is stowage ON or UNDER DECK on both cargo ships and passenger ships. There is a single code in the column which is SW26 – for special stowage provisions see 7.4.1.4 and 7.6.2.11.1.1.

7.4.1.4 relates to stowage and segregation on container ships. It applies the relevant provisions of 7.6.2.8.4 and 7.6.2.11.1 for carriage of these materials in containers below deck on this type of vessel.

7.6.2.8.4 relates to stowage and segregation on general cargo ships. It relates to the carriage of UN1942 and UN2067 below deck on this type of vessel.

7.6.2.11.1 also relates to stowage and segregation on general cargo ships. It relates to the carriage of UN2071 below deck on this type of vessel.

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, carriers and masters should be particularly aware of.

1. The need to be able to open hatches

Section 7.6.2.8.4 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.**”

It must be remembered that “may be stowed” here is in the context that in accordance with the entries in the DGL, stowage under deck of UN1942 and UN2067 is not permitted unless this provision is complied with.

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 only apply while the ship is alongside and the ship should be capable of opening up hatches at sea in normal conditions.

Section 7.6.2.11.1.1 of the IMDG Code states that AMMONIUM NITRATE BASED FERTILIZER, UN2071 “shall be stowed under deck in a clean cargo space **capable of being opened up in an emergency.** In the case of bagged fertilizer or fertilizer in containers or in bulk containers, it is sufficient if, in the case of an emergency, the cargo is accessible through free approaches (hatch entries), and mechanical ventilation enables the master to exhaust any gases or fumes resulting from decomposition.”

Where the specified cargo cannot be accessed through free approaches (such as stowage below hatch covers and/or tween decks where the cargo space has no access points) or where there is insufficient ventilation, hatches must be capable of being opened in an emergency. Where this is the case the section continues with the same requirements as for UN1942 and UN2071.

Can main hatches be opened?

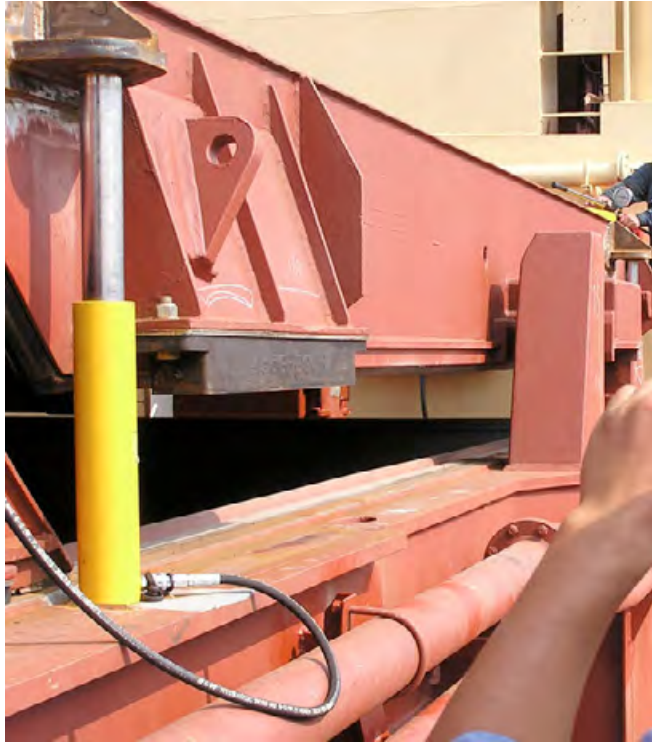
Mechanically operated hatches (ram type or similar arrangements) are acceptable but the master should take care to ensure that the hatch will not dismount² and take into account the manufacturer's instructions for the covers.

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 significant safety issues associated with handling unrestrained 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.



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

An option provided to ship owners by hatch manufactures, that AMSA been made is aware of, for pontoon hatches is a jacking system 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).



Hatch cover jacking arrangement

Where options such as hatch gantries or jacking systems 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 these options cannot be relied upon.

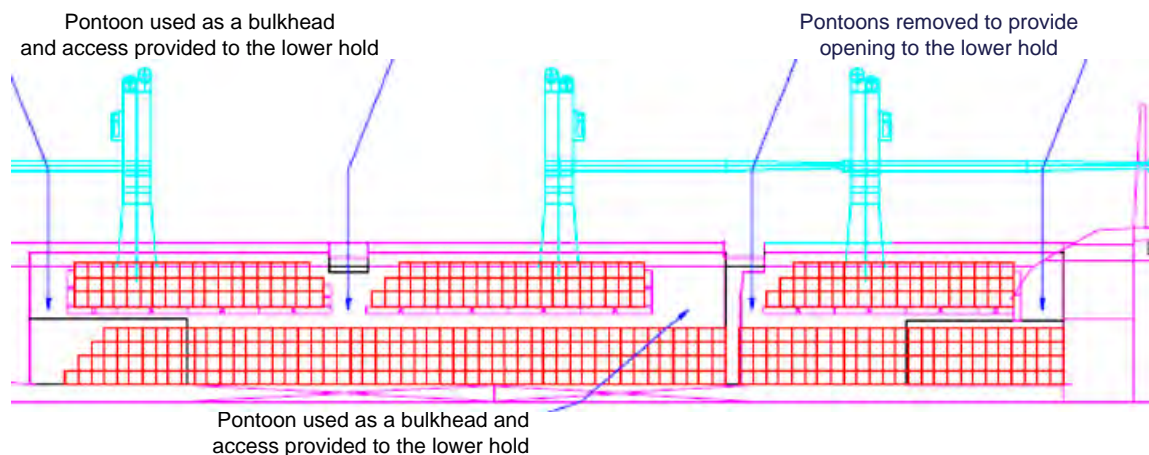
The ability of each ship to comply with this requirement will vary depending on the arrangement on each individual vessel, however, **it is not necessary that all hatch covers are able to be opened up**. The general expectation is that hatches accounting for no less than 30 per cent hatch opening area of a single cargo hold will need to be opened up in an emergency. The openings should be spaced so cargo below deck is accessible from the main deck by water jet for cargo cooling purposes. 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 cooling³.

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 7.6.2.8.4 (and 7.6.2.11.1.1 if applicable) 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 openings 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 below.

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.



³Boundary 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 UN1942 and UN2067 “protected from sources of heat”

In column 16a the individual entries in Chapter 3.2 of the IMDG Code for UN1942 and UN2067 include code SW1 – protected from sources of heat. This term is defined in section 7.1.2 of the IMDG Code:

Protected from sources of heat *means that packages and cargo transport units shall be stowed at least 2.4 m from heated ship structures, where the surface temperature is liable to exceed 55°C. Examples of heated structures are steam pipes, heating coils, top or side walls of heated fuel and cargo tanks, and bulkheads of machinery spaces. In addition, packages not loaded inside a cargo transport unit and stowed on deck shall be shaded from direct sunlight. The surface of a cargo transport unit can heat rapidly when in direct sunlight in nearly windless conditions and the cargo may also become heated. Depending on the nature of the goods in the cargo transport unit and the planned voyage precautions shall be taken to ensure that exposure to direct sunlight is reduced.*

Use of A60 insulation in lieu of the specified distance on surfaces that are likely to exceed 55°C should be at the discretion of the vessel's Flag Administration or RO. For example for machinery room bulkheads, when considering the temperature rise of the cargo hold side of the bulkhead in case of a fire in the machinery space.

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, the master may consider such a tank not to be a heated fuel tank for the purposes of the definition of “protected from sources of heat” during that voyage.

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

Where the master can demonstrate there are procedures in place to ensure heated fuel tanks adjacent to UN1942 or UN2067 in packaged form cannot (or are managed in a way that they will not) attain a temperature of more than 50°C, this is would be acceptable to AMSA.

3. UN2071 and the engine room bulkhead

Whilst the entry for UN2071 in the DGL does not have a requirement to protect from sources of heat, there is a special provision in 7.6.2.11.1.3 requiring the cargo is stowed out of direct contact from metal engine room bulkheads – for example by the use of wooden boards between the cargo and the bulkhead. It should be noted that “out of direct contact” includes the package which is not considered by itself to prevent direct contact.

4. Carriage of AN in FIBC

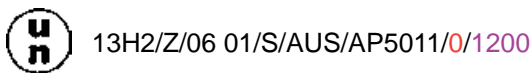
Ammonium Nitrate is commonly carried in Flexible Intermediate Bulk Containers (FIBC) either directly into the hold or within containers. Under these circumstance the FIBC are invariably stacked. For FIBC to be used for UN1942, UN2067 or UN2071 (or any other dangerous goods where FIBC are permitted) the requirements of Chapter 6.5 of the IMDG Code will apply.

In respect of stacking; sections 6.5.2.1 (marking) and 6.5.6.6 (stacking test) apply to FIBC and the maximum allowable stacking load of an FIBC must not to be exceeded.

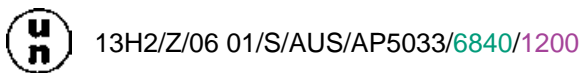
What is the maximum allowable stacking load?

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 – it is not the maximum stack load that can be applied in normal use.

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



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



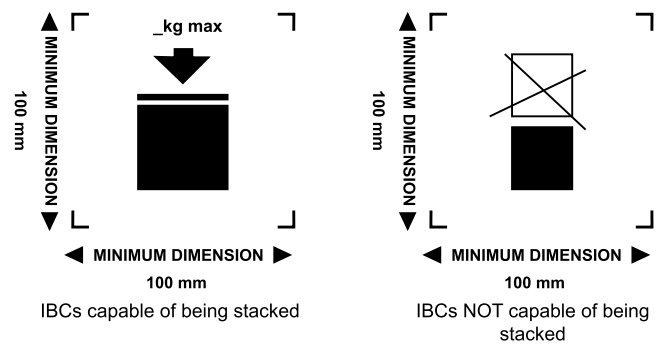
In this case the number 6840 indicates the applied stacking test load (meaning the FIBC can be stacked) and again the number 1200 indicates the maximum permissible mass.

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. For the example above:

Applied stacking 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.

It should be noted that in accordance with section 6.5.2.2.2 of the IMDG Code, from 1 January 2011 all manufactured, repaired or remanufactured IBCs are required to bear the new pictogram shown below in addition to the markings noted above. This pictogram clearly indicates the allowable stack mass limits and it is recommended this practice be adopted as soon as practical to limit confusion in this regard.



Stacking pictogram to be applied to IBC in accordance with section 6.5.2.2.2 of the 2014 edition of the IMDG Code

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 Organization⁴ 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 FIBC⁵. 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^{6,7}.

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.

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 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

⁵ Refer to Annex 10 of the Code of Safe Practice for Cargo Stowage and Securing adopted by IMO Res A.714(17) as amended

⁶ Normally the ships classification society.

⁷ This assumes the vessel is permitted to carry Dangerous Goods by virtue of SOLAS II-2/19.

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

The individual entries in Chapter 3.2 of the IMDG Code for UN1942, UN2067 and UN2071 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 subsections 9.1.3 and 9.1.4 of MO41.

AN cannot be shipped in a BK2 unless the package complies with the relevant provisions of Chapter 4.3 and 6.9 of the IMDG Code. If a package does not fully comply with these chapters, the package can only be used if an exemption/approval is issued 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 from 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 payload⁸.

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 requirement is not mitigated by procedures that are intended to prevent the possibility of the tilting occurring with one or both doors still closed.

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.

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, chapters 5.4 and 6.9 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 serviceable⁹, 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.

⁸The payload “P” is the Maximum Gross Mass less the Tare Weight of the container.

⁹Section 4.3.1.15 indicates some of the issues that would result in a container not being structurally serviceable when inspected.

6. Carriage of AN in Flexible Bulk Containers (FBC or BK3 Packages)

Flexible bulk containers (FBC or BK3 packages) are not to be confused with Flexible Intermediate Bulk Containers (FIBC) nor with Bulk Containers (BK2 packages).

For UN1942 and UN2067 carriage is permitted in BK3 packages as indicated in column 13 of the DGL. For UN2071 carriage in BK3 packages is NOT permitted.

A BK3 package must be designed, constructed, inspected and tested in accordance with section 6.9.5 of the IMDG Code. The section also includes the marking requirements in 6.9.5.5 that practically mean an FBC is marked in terms of the maximum stacking load in the same way as an FIBC - but excluding the new pictogram.

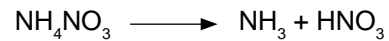
The use of a BK3 has restrictions in the Code that include that they may only be carried in the hold of a ship and can only be stacked three high (maximum permitted and only where the stacking test load marked permits it). Any BK3 specific restrictions are in addition to other applicable provisions such as those required to be complied with by the codes in columns 16a and 16b of the DGL and all other applicable general requirements for the cargo. This means that the need to open hatches and other requirements noted above in points 1 and 2 above still apply when BK3 packages are used.

WHAT IS THE RISK WITH AMMONIUM NITRATE

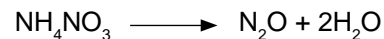
When heated, all Ammonium Nitrate (AN) will start to decompose into gases including oxygen and nitrogen oxides, but the nature of gases produced by decomposition depends on temperature and conditions under which heating occurs. It can be induced to decompose explosively by detonation when large quantities 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 the endothermic nature of the volatilization into ammonia and nitric acid¹⁰.



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 be 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.



At approximately 166°C to 212°C, ammonium nitrate begins to melt and decomposes exothermically into nitrous oxide and water vapour¹¹ 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:



¹⁰ This reaction requires energy to break the bonds (heat in this case) as such the reaction absorbs heat. The enthalpy of the reaction expressed 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.

¹¹ This reaction releases energy as the energy used to break the bonds if the AN is much less than that released but the formulation of Nitrous Oxide and water vapour. As a result the ΔH is about -23kJ/mol (-5.5kcal/mol).