

Jotun marine tank coating guideline

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Jotun does not advise on the efficiency of cleaning additives. The information is given in good faith, and Jotun will not be held responsible for the consequences of changes in composition or mode of use of additives supplied by other companies. Jotun will not be held responsible for coating breakdown caused by the use of tank cleaning additives.

Introduction

The Jotun marine tank coating guideline apply only to the following cargo tank coating materials and systems supplied by Jotun. The data provided gives guidance on the compatibility of the Jotun cargo tank coatings with cargoes carried in the marine bulk liquid trade.

Jotun cargo tank coating systems:

Tankguard Zinc	1 x 100 µm Dry Film Thickness (DFT)
Tankguard CPC	2 x 125 µm DFT
Tankguard HB	3 x 100 µm DFT
Tankguard HB Classic	3 x 100 µm DFT or 2 x 150 µm DFT
Tankguard Special	3 x 100 µm DFT
Tankguard Special Ultra	3 x 100 µm DFT
Tankguard Flexline	3 x 100 µm DFT

The coating system(s) must be applied and cured in accordance with the relevant technical data sheet, application guide (if available) and project specification issued by Jotun.

Product resistant list – www.jotunprl.com

The information in this document must be used in combination with the product resistance list, published on www.jotunprl.com.

The product resistance list is regularly updated to include many proper shipping names, trade names and synonyms for cargoes and noxious liquid substances, which have been transported by sea in bulk liquid form. Many of these names have in recent years been established through Tripartite Agreements and registered with the secretariat of the International Maritime Organisation (IMO) in accordance with Annex II to MARPOL 73/78.

Ship owner must keep detailed logs and cargo samples

Ship owner must keep detailed logs for each tank, of cargo sequences, ventilation procedures and cleaning procedures as carried out, including cleaning additives and cleaning temperatures. In case of coating failure these logs must be freely delivered to Jotun. Cargo samples shall be available on request.

General notes

I. Shop primers

This list applies to Jotun cargo tank coating systems which have been applied directly to abrasively blasted carbon steel. The list does not apply if the coating systems are applied over existing shop primers; hence all shop primer must be removed. The list does not apply to any other substrates unless there is a written agreement with Jotun.

II. Application and curing

This list is not valid unless the Jotun cargo tank coating systems are applied and cured in strict accordance with the correct prevailing Jotun specification and procedure. It is particularly important to apply each coat of the system, and the complete system, within the dry film thickness range specified. Excessive dry film thickness will be detrimental to the coating integrity, will increase ventilation time after unloading and will increase the risk of cross contamination between cargoes. Low dry film thickness will leave the system at risk of failure due to potential breakdown.

III. Hot cure

Hot cure is optional for Tankguard Special and Tankguard Special Ultra but is needed to carry certain aggressive cargoes. Hot cure is mandatory for Tankguard Flexline and must be done prior to carriage of first cargo.

Hot cure may be carried out by exposure of the coating to:

- Hot seawater / freshwater by immersion
- Hot seawater / freshwater using the tank cleaning system
- A suitable hot cargo such as caustic soda, vegetable -, animal - or lubricating oil *

Depending upon the temperatures, the following durations apply:

Coated substrate temperature, °C	Minimum curing time, hours
50 *	24 *
60	16
65	10
70	6
75	4
80	3

* Not applicable for Tankguard Flexline

It is vitally important that the entire coated surface attains the minimum specified temperature for the specified time. This can be ensured by the following:

- The adjacent space must be free of ballast or cargo to reduce the heat loss and prevent a possible cold wall effect coating detachment. If the ambient temperature is low, thermal insulation and / or hot air flushing of the tank outside may be necessary to reduce the heat loss.
- Continuously monitor the steel temperature during the curing period.
- Temperature gauges should be installed at the “worst” locations on the reverse side of the tank interior steel plates.
- By ensuring that the discharged hot water has a temperature above the cure temperature one may have additional control of the operation.

Under no circumstances shall the temperature of the curing medium exceed 80°C. A record of the curing operation data, with measured temperatures shall be retained for future reference. A hot cure guideline and log are available for Tankguard Flexline on jotunprl.com.

IV. Stowage time

This list applies to continuous stowage up to a maximum time of 6 months, unless shorter times are indicated in the specific notes.

V. Cargo temperature

Guidance given in this list is based on stowage temperatures not exceeding 35°C for those cargoes not requiring heating. This limit is general and higher temperatures can be acceptable for certain cargoes; please contact Jotun if higher temperatures are required. Cargoes, which are solid or viscous at normal ambient temperature, will need to be heated for loading, stowage, and unloading. The temperature noted in the list is the maximum temperature allowed for stowage. This temperature may be increased by a maximum of 10°C, for loading and unloading, provided the time at the higher temperature does not exceed 48 hours.

When stowing cargoes, the temperature of the cargo must not exceed the maximum stowage temperature for cargoes in adjacent tanks.

VI. First cargoes

It is recommended that the first cargo loaded into tanks coated with Jotun cargo tank coating systems should be a non-sensitive cargo. Jotun does not recommend the loading of sensitive cargoes which may be affected by transmission of small traces of solvent retained in the newly applied tank coating.

VII. New cargoes

This list is regularly updated to include proper shipping names, trade names, and synonyms for cargoes that have been registered through IMO Tripartite procedures. Jotun will be pleased to carry out assessment of cargo/coating compatibility based on proper shipping name and/or trade name/synonym, complete technical data and a sample for testing, where considered necessary by Jotun. Data and enquiries should be sent to Jotun Technical Sales Support (tss@jotun.com).

VIII. Coating discolouration

Coatings can be discoloured by the carriage of some cargoes. The discolouration may be due to naturally occurring coloured components of the cargo, which are adsorbed to the surface of the coating. Alternatively, synthetic dyes may have been added to the cargo for special reasons. Whatever the cause of discolouration by adsorption, the chemical resistance of the coating is usually not affected. However, adsorbed discolouration may cause cleaning problems and may present a contamination threat depending on subsequent cargoes.

IX. Inert gas systems

Carbon deposits from flue gas inert gas systems are readily adsorbed to the surface of all tank coatings. They may contribute to a reduction in the coating life. Carbon emissions may be adsorbed to the surface of the coating causing and aggravating discolouration and increasing the potential for contamination of subsequent cargoes. High SO_x and NO_x emissions from poorly maintained inert gas systems can create harmful acidic conditions leading to coating damage, particularly in zinc coated tanks.

X. Cargo contamination

Freshly applied cargo tank coatings may present a small contamination potential. Similarly, tank coatings are known to absorb cargoes. The absorbed cargo will start to evaporate from the coating immediately after unloading of the cargo, provided the tank is effectively ventilated. There are several factors which influence the rate of evaporation, but temperature and efficiency of ventilation have the greatest effect. To minimize the potential for cross contamination between cargoes, the cargo must be completely removed from the tank, followed by effective ventilation for up to 5 days or longer to reach a steady state, gas free condition. The tank may then be washed with warm seawater for maximum 6 hours, during which time effective ventilation must continue. The water used for warm tank washing must not be fresh or brackish water, it must be saline seawater.

The temperature of the seawater used for washing must not exceed the temperatures in the below table depending upon the kind of Tankguard product:

Product	Temperature °C
Tankguard CPC and Tankguard HB	50
Tankguard HB Classic and Tankguard Zinc	60
Tankguard Special	70
Tankguard Special Ultra and Tankguard Flexline	80

The tank should then be flushed with clean cold fresh water and, immediately after, drained, mopped dry, and then ventilated to a dry condition, for a minimum of 24 hours. Jotun recommends that edible end-use or sensitive cargoes are not loaded into tanks which previously carried absorbing cargoes (R1A, R1B, R2, R16, R18 or R19 designated cargoes), until the absorbed cargo has been removed.

XI. Acidic and alkaline cargoes

Tankguard Zinc, in common with all zinc silicate coatings, has poor resistance to acidic and alkaline environments. They are however compatible with some mildly acidic or mildly alkaline cargoes within the pH range 5.5 – 10.0.

For all tank coatings, diluted solutions of some cargoes can become aggressive if left in the tanks. Jotun recommends that after all tank washing activities, the tank must be flushed with fresh water so that the final pH of any residues is neutral. All residues after washing must be completely removed by draining, mopping, and finally by ventilation for a minimum period of 24 hours.

XII. Beverages and potable liquids

Jotun cargo tank coatings are resistant to several of these cargoes. These cargoes should not be carried until the tank has been in service for some time (three cargo voyages after launch). Similarly, these cargoes should not be carried immediately after a R1A, R1B, R2, R16, R18 or R19 cargo.

XIII. Tank cleaning and cleaning additives

Jotun recognizes the need for tank cleaning with or without the addition of tank cleaning additives. Tank cleaning also helps to minimize potential contamination between cargoes. However, tank cleaning cannot be done entirely without risk to the coating. It must be recognized that some additives, whilst being efficient cleaning agents, may not be compatible with the coatings, and the activity of tank cleaning exposes the coating to a corrosive environment. This can shorten the life of the coating.

Some general rules apply:

- Increase in cleaning temperature increases risk of coating failure
- Increase in cleaning time increases risk of coating failure
- Increase in frequency of cleaning increases risk of coating failure
- Increase in concentration of additives increases risk of coating failure

Tank cleaning should therefore be done at the lowest effective temperature, for the shortest time, using the lowest effective concentration of additives and as seldom as possible.

The Tankguard products demonstrate good compatibility with tank cleaning additives provided they are used at the concentration recommended by the supplier. Solutions of chemicals in water shall not exceed the temperatures found in the below table, the maximum period for washing is 6 hours and the chemical shall be included as acceptable in the cleaning additive resistance list found on jotunprl.com.

Product	Temperature °C
Tankguard CPC and Tankguard HB	50
Tankguard HB Classic	60
Tankguard Special, Tankguard Special Ultra and Tankguard Flexline	70

Some tank cleaning additives are acidic or alkaline in solution. Tankguard Zinc is more sensitive to these tank cleaning additives due to possible reaction with zinc in the coating. Care must be taken in the selection and use of cleaning additives for zinc silicate coatings.

Additives may be used at the concentration recommended by the manufacturer provided the solution is within the pH range of 5.0 – pH 12.0, the contact time is limited to a maximum of 3 hours, the temperature is limited to a maximum of 50°C and the chemical is included as acceptable in the cleaning additive resistance list. Highly acidic (pH < 5) or alkaline (pH > 12) cleaning additives will react with the coating and will cause damage.

Given the relatively high porosity of zinc silicate coatings, Tankguard Zinc might be difficult to clean after exposure to fuel oils, vegetable oils and other high molecular cargoes.

Cleaning additives which contain phosphoric acid (eg. Metal Brite) will severely damage all coatings and shall generally not be used on Jotun coated tanks. Also note that excessive use of bleach will damage all coatings beyond repair.

Cleaning water and cleaning additives can cause damage to the coating if not fully removed before loading of the next cargo. Cleaning water, with or without cleaning additives, must never be left on the tank top after the cleaning procedure is completed, but must be removed in its entirety within 30 minutes. One must carry out minimum 24 hours active ventilation after cleaning, prior to loading of the next cargo.

The cleaning additive resistance list gives an overview of relevant cleaning chemicals from various suppliers.

XIV. Fuel additives and fuel dyes

Jotun recognizes the need of adding dyes and additives to fuel oil, diesel oil, gasoline and other refined petroleum products. A range of additives and dyes evaluated by Jotun can be found in the fuel additives and dyes resistance list on jotunprl.com.

XV. Ventilation

Requirements regarding ventilation might serve 3 different purposes:

- Ensure proper curing
- Ensure safe entry to the tank
- Promote desorption of absorbed cargo or cleaning water from the coating

Ventilation using the displacement method is the most efficient way of removing desorbed cargo from the tank. Most cargo vapours are heavier than air and will accumulate in the bottom part of the tank; hence flexible hoses should be positioned so that cargo vapours are extracted from the bottom of the tank while fresh air can enter from the top of the tank. Increased temperature and low relative humidity of the fresh air will promote efficient desorption of cargo from the coating.

The following principles apply with regards to ventilation:

- Minimum 2 openings; one with air into the tank and one with contaminated air out of the tank
- The openings must be some distance apart
- Use flexible hoses to make sure difficult to reach areas are also ventilated efficiently

XVI. Abbreviations used in this list

ASTM	American Society for Testing of Materials
EC	European Community
FOSFA	Federation of Oils, Seeds and Fats Associations Ltd.
Marpol 73/78	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978.
NIOP	National Institute of Oilseed Products

Explanation of resistance data

R	=	Resistant without any specific notes
NR	=	Not Resistant
R1-20	=	Resistant with limitation - See specific notes
NT	=	Not Tested
FS	=	Further Specification/Information needed

Specific notes

1A - Aggressive cargoes

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading.

The stowage time for these cargoes must not exceed 60 days. After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater and cleaning water) or any cargo before the coating is restored to its original condition.

This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition. Exposing to the above cannot take place within:

- 30 days for Tankguard HB
- 20 days for Tankguard HB Classic
- 10 days for Tankguard Special and Tankguard Special Ultra
- 5 days for hot cured Tankguard Special Ultra
- 3 days for Tankguard Flexline

R1A cargoes must not be carried until the coating has been in service for three (3) months (3 months after the carriage of first cargo) carrying unrestricted (R) cargoes only, or after a hot cure is done.

1B - Aggressive cargoes

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading.

The stowage time for these cargoes must not exceed 90 days. After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater and cleaning water) or any cargo before the coating is restored to its original condition.

This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition.

Exposing to the above cannot take place within:

- 30 days for Tankguard HB
- 20 days for Tankguard HB Classic
- 10 days for Tankguard Special and Tankguard Special Ultra
- 5 days for hot cured Tankguard Special Ultra
- 3 days for Tankguard Flexline.

R1B cargoes must not be carried until the coating has been in service for three (3) months (3 months after the carriage of first cargo) carrying unrestricted (R) cargoes only, or after a hot cure is done.

2 - Very aggressive cargoes

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading.

The stowage time for these cargoes must not exceed 30 days. After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater, cleaning water) or any cargo before the coating is restored to its original condition. This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition. Exposing to the above cannot take place within:

- 30 days for Tankguard HB
- 20 days for Tankguard HB Classic
- 10 days for Tankguard Special and Tankguard Special Ultra
- 5 days for hot cured Tankguard Special Ultra
- 3 days for Tankguard Flexline

R2 cargoes must not be carried until the coating has been in service for three (3) months (3 months after the carriage of first cargo) carrying unrestricted (R) cargoes only, or after a hot cure is done.

3 - Animal oils, vegetable oils and fats

These cargoes contain varying amounts of Free Fatty Acids (FFA) depending on type, origin, age and quality of the oil. Solid or semi-solid types such as Palm Oil, Tallow (Lard), are transported at elevated temperatures to facilitate cargo handling. Excessively high temperatures and/or prolonged heating can cause an increase in FFA content, especially in the region around heating coils and in heat exchangers. The FFA content of oils is usually expressed as % FFA and is measured according to ASTM D - 1980. In accordance with ASTM D - 1980 the amount of FFA in an oil is expressed as its "Acid Value". The Acid Value is approximately 2 x the % FFA. For example, oil with an Acid Value of 5 will have a % FFA of approximately 2.5.

The maximum acceptable levels of FFA's for Jotun cargo tank coatings are as follows:

<u>Cargo Tank Coating</u>	<u>Acid Value (ASTM D-1980)</u>	<u>Approximate %FFA</u>
Tankguard Zinc	4	2%
Tankguard CPC	30	15%
Tankguard HB	30	15%
Tankguard HB Classic	30	15%
Tankguard Special	80	40%
Tankguard Special Ultra	No Limit	up to 100%
Tankguard Flexline	No Limit	up to 100%

The water contained in the oil must not exceed 1%, as water may react with the FFA to create H_3O^+ which will damage the coating if the concentration is too high. No free mineral acid is permitted. Certain vegetable oil derivatives such as Fatty Acid Distillates and Acid Oils have been known to contain traces of mineral acids, as well as water and free fatty acids. They are very aggressive towards coating systems. These products may only be carried provided specific approval has been given by Jotun. Please contact your local Jotun office for further information.

End users are advised to consult FOSFA, NIOP Rules and Qualifications and EC Regulations concerning FFA levels and prior cargoes, when transporting oils in coated tanks.

4 - Hydrolysable cargoes and amines

Esters, chlorinated or brominated compounds, amine cargoes and others will react with any moisture present to form aggressive by-products, which will attack the coating and/or carbon steel. Such cargoes must therefore be free from moisture and be carried in completely dry tanks, which are protected against water ingress.

The water content of these cargoes must not exceed 0.02% (200ppm).

For FAME type of cargoes, a water content of up to 300ppm combined with a maximum acid value of 0,5 is acceptable for voyages up to 5 days.

5 – Crude oil and crude oil derivatives

Crude oil and fuel oil may contain variable amounts of acidic materials, which may be detrimental to Tankguard Zinc. The maximum acceptable Neutralisation Number (ASTM D 664) for these cargoes is 0.4.

7 - Unleaded gasoline

Many unleaded gasoline products may have considerable amounts of oxygenated solvents added to them to improve their combustion characteristics. Methyl tert-butyl ether (MTBE) and ethyl alcohol are common additives to gasoline.

- The coating is fully compatible with unleaded gasoline containing MTBE as the sole oxygenated additive, provided the concentration is less than 20% by volume
- The coating is fully compatible with unleaded gasoline containing ethyl alcohol (ethanol) as the sole oxygenated additive, for concentrations up to 99% by volume when carried in accordance with specific note 1A
- The coating is fully compatible with unleaded gasoline containing methyl alcohol (methanol) as the sole oxygenated additive, for concentrations up to 20% by volume when carried in accordance with specific note 1A
- The coating is fully compatible with unleaded gasoline containing isopropyl alcohol (isopropanol) as the sole oxygenated additive, for concentrations up to 20% by volume when carried in accordance with specific note 1A

For unleaded gasoline containing additives different to the above, different concentrations or mixtures, JOTUN must be consulted for specific advice.

8 - Coating discolouration

The coating may be discoloured by this cargo. The discolouration will not affect the resistance of the coating, but may make tank cleaning more difficult, and increase the risk of contaminating subsequent cargoes. See also section VIII.

9 - Zinc pick-up

Certain cargoes are sensitive to the presence of zinc particles, which could possibly be picked up during transportation in zinc coated tanks. Small particles of zinc picked up by the cargo will have no effect on the Tankguard Zinc, but may affect the quality of the cargo.

11 - pH sensitive cargoes

Products in this class can be transported when the pH is within the range 5.5-10.0.

12 - Molasses

Molasses may be carried in tanks coated with Tankguard Zinc if the pH of the cargo is between 5.5 – 10.0. The pH of molasses may decrease during transportation due to fermentation.

14 - Phenol and Cresols

Tankguard Zinc is resistant to Phenol and Cresols provided the coating has been in service for at least 3 months.

16 - Extremely aggressive cargoes

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading. The stowage time for these cargoes must not exceed 30 days (except for 1,2-dichloroethane (EDC) and acrylonitrile, where 60 days can be accepted for Tankguard Special Ultra and 90 days for Tankguard Flexline). After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater and cleaning water) or any cargo before the coating is restored to its original condition. This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition.

Exposing to the above cannot take place within:

- 10 days for Tankguard Special
- 5 days for hot cured Tankguard Special Ultra
- 3 days for Tankguard Flexline

Methyl alcohol (methanol) cargo must be pure (contamination with acetaldehyde, formaldehyde, formic acid, acetone and acetic acid should be below 30 ppm per contaminant). The methyl alcohol should be "water free" (maximum permissible water 0.020 % or 200 ppm). Samples of the methyl alcohol must be taken prior to both loading and discharge. The sample must be sealed, properly marked and dated and retained on board for a minimum of 6 months after discharge of the methyl alcohol cargo.

Prior to carriage of these cargoes, the coating must be hot cured within 3 months in service (3 months after the carriage of first cargo) whilst carrying unrestricted (R) cargoes only. Hot cure must be carried out for these cargoes, and cannot be substituted by post curing, i.e. three (3) months in service.

18 - Tankguard Special Ultra; methyl alcohol, ethyl alcohol and vinyl acetate

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading. After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater, cleaning water) or any cargo before the coating is restored to its original condition. This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition. Exposing to the above cannot take place within:

- 5 days for hot cured Tankguard Special Ultra

Methyl alcohol (methanol) cargo must be pure (contamination with acetaldehyde, formaldehyde, formic acid, acetone and acetic acid should be below 150 ppm per contaminant). The methyl alcohol should be "water free" (maximum permissible water 0.10 % or 1000 ppm). Samples of the methyl alcohol must be taken prior to both loading and discharge. The sample must be sealed, properly marked and dated and retained on board for a minimum of 6 months after discharge of the methyl alcohol cargo.

Prior to carriage of these cargoes, the coating must be hot cured within 3 months in service (3 months after the carriage of first cargo) whilst carrying unrestricted (R) cargoes only. Hot cure must be carried out for these cargoes, and cannot be substituted by post curing, i.e. three (3) months in service. If a hot cure is not carried out, note 2 apply.

19 - Tankguard Flexline; methyl alcohol, ethyl alcohol and vinyl acetate

These cargoes can cause softening and swelling of the coating system. The coating will however recover hardness as the cargo evaporates from the coating after unloading. After unloading of these cargoes, the tanks must not be brought into contact with water (seawater, freshwater, cleaning water) or any cargo before the coating is restored to its original condition. This may be obtained by actively ventilating the tank with dry air until it is in a steady state gas-free condition. Exposing to the above cannot take place within:

- 3 days for Tankguard Flexline

Methyl alcohol (methanol) cargo must be pure (contamination with acetaldehyde, formaldehyde, formic acid, acetone and acetic acid should be below 150 ppm per contaminant). Methyl alcohol should be "water free" (maximum permissible water 0.10 % or 1000 ppm). Samples of the methyl alcohol must be taken prior to both loading and discharge. The sample must be sealed, properly marked and dated and retained on board for a minimum of 6 months after discharge of the methyl alcohol cargo.

20 – Sodium- and potassium hydroxide

Maximum allowable concentration is 50% for storage temperatures up to 60°C.