Code of Practice:

Coating of internal tanks using

Tankguard CPC

Jotun Coatings

Foreword

The intention of this Code of Practice for application of Tankguard CPC is to stress the importance of good planning and work performance related to the use of protective coatings in aggressive chemical environments.

In order to obtain maximum coating performance, factors like surface cleanliness and profile, a continuous paint film of appropriate thickness and proper curing of the coating system are all of great consequence. We would add the importance of maintaining a safe working environment. This will provide good working conditions and thereby the best (and necessary) possibility to achieve the required quality of work.

Jotun must underline that a coating system's performance is decided by the skill and knowledge of personnel involved in the work procedure. One cannot take for granted that a painting contractor, although well reputed, possesses the special competence required for the surface preparation, coating application or other operations involved in cargo tank coating.

Furthermore, most coating failures are the result of simple omissions and application errors. Coating successes, on the other hand, are the result of thorough planning and skilled craftsmanship.

This Code of Practice is particularly addresses critical factors of special importance to obtain maximum protective lifetime of Jotun's coatings, when doing tank-coating jobs with painting on block stage. It does not comprehend detailed descriptions of various procedures involved in the coating process. Its intention is rather to pinpoint the single elements that may have great impact on coating performance.

Following these guidelines will help the smooth running of any coating procedure. However, because local conditions differ around the world, discussion with Jotun's local Technical Support Department is advised on any contentious subjects.

This Code of Practice deals with various aspects related to protection of steel (and other hard materials), exposed to chemicals, by use of specialist coatings.

It lays down a set of recommended practices required to obtain optimal service life of coatings in corrosive environments.

It describes various criteria for evaluation of surface conditions and coating systems as international standards or, if not existing, as recommended practices.

Jotun has of today supplied coatings for the cargo tanks of more than 500 vessels. We can always be contacted via Internet on www.jotun.com.

Contents

1. Coating System and specification

1.1 General

Note that the specification and surface preparation for Tankguard CPC will differ from different stages of the project, meaning block or hull stage. The application procedure is considered mainly for tanks designated for petroleum cargo. Separate resistance list can be required from Jotun.

1.2 Surface Preparation

1.2.1 Surface preparation on block stage:

The entire area of the block should be grit blasted to minimum Sa 2 ½ according to ISO 8501-1:1988 with a roughness between 50-100 microns.

1.2.2 Surface preparation on hull stage:

The joint welding seams as well as any mechanical damages are to be disc grinded to St 3 according to ISO 8501-1:1988. The surface should be appearing with a distinct rough surface with a roughness of 25 microns.

Overlapping zones to intact coating systems should be roughened in order to create a rough pattern, the overlapping zone should clearly show all three layers in the existing overlapping zone.

1.2.3 The standard of dust cleanliness on all surfaces must be maintained at Rating 1 or less as per ISO 8502-3:1992 (Appendix I).

1.2.4 Water-soluble chlorides (NaCl) remaining on a blast-cleaned surface, prior to coatings application should not exceed 50 mg/m^2 (5,0 µg/cm$^{2)}$. All surfaces must be free from oil and grease.

1.3 Specification

1.3.1 On block stage the coating should be applied as follows:

1st coat:	100 microns	Tankguard CPC	light grey
1st stripe coat		Tankguard CPC	pink
2nd coat	100 microns	Tankguard CPC	pink
2nd stripe coat		Tankguard CPC	light grey
3rd coat	100 microns	Tankguard CPC	light grey

Note: Colours maybe changed depending on owner preference, availability, etc.

1.3.2 On Hull stage, the should be applied as follows:

1st stripe coat:		Tankguard CPC	light grey
1st full coat	100 microns	Tankguard CPC	light grey
2nd stripe coat		Tankguard CPC	pink
2nd full coat	100 microns	Tankguard CPC	pink

3rd stripe coat		Tankguard CPC	light grey
3rd full coat	100 microns	Tankguard CPC	light grey

Note: Colours maybe changed depending on owner preference, availability, etc.

Note: The third stripe coat is depending on existing dry film thickness. This is only added to the specification as an option.

1.3.3 Transportation Pipes inside

1st coat:	100 microns	Tankguard CPC	light grey
2nd coat	100 microns	Tankguard CPC	pink
3rd coat	100 microns	Tankguard CPC	light grey

Note: Paint scheme for Outside of transportation is as same as surrounding area.

1.3.4. Stainless steel in tanks:
All stainless steel in cargo tanks, e.g. stiffeners and ladders should be abrasive swept and painted with above-mentioned coating system. Note, the stainless steel is not to be full coated; only an area of 50 mm from the mild steel should be coated.

1.3.5 Heating coils should be minimum 150 mm above the bottom plate as well as bulkhead.

1.3.4 The minimum dry film thickness per coat is 90 microns dry film thickness.

The minimum dry film thickness for the above system should be a total of 270 microns.

1.3.5 The maximum dry film thickness for a single coat should be 200 microns dry film thickness.

The maximum dry film thickness with this coating system is 600 microns.

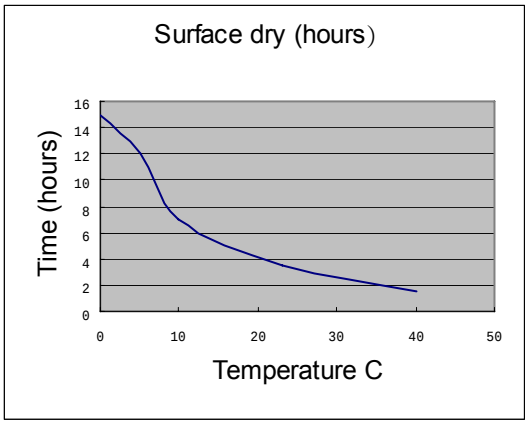
Note: Specially for tanks heavily supported with stiffeners:
In way of areas in tanks, that are difficult to paint due to the configuration, for instance in tanks with many stiffeners and where a certain degree of over thickness is practically impossible to avoid, then spot readings of up to 750 microns can be accepted.

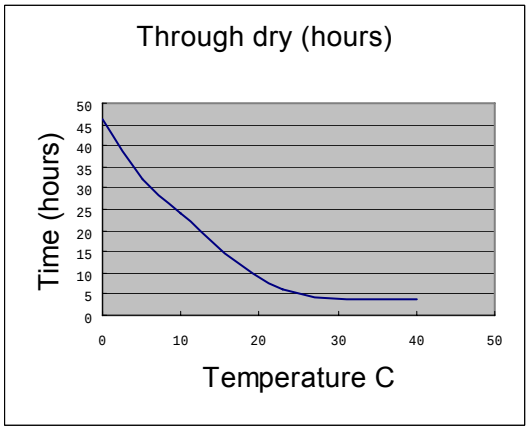
1.4 Curing Curves

With regards to curing and drying of Tankguard CPC, then please consult the below curves for further information, note these curves are just for reference and cannot overrule technical datasheet or drying and curing times noted in point 1.5:

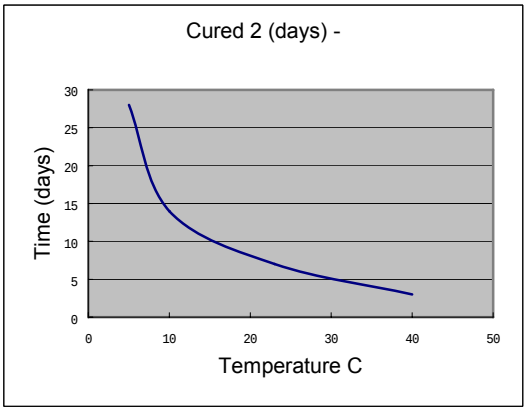
1.4.1 Surface dry

1.4.2 Dry to touch

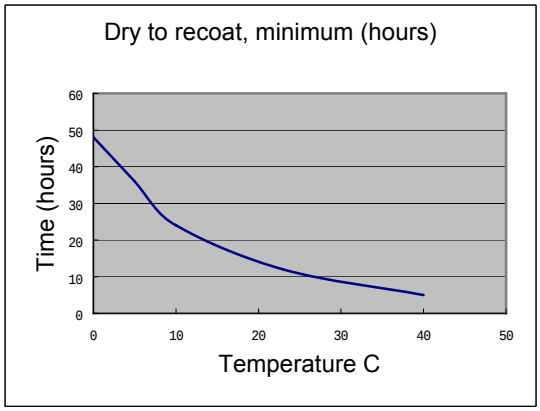




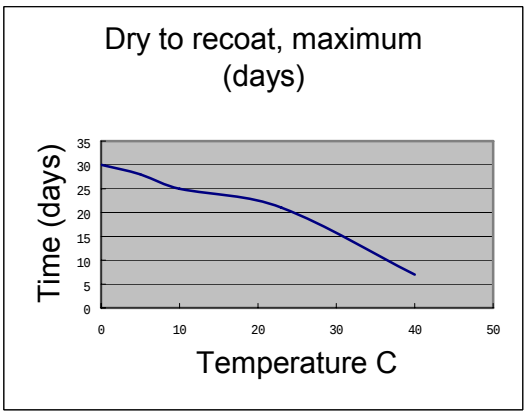
1.4.3 Fully cured:



1.4.4 Dry to recoat, minimum:



1.4.5 Dry to recoat, maximum:



1.5. Drying times, minimum and maximum temperatures.
Drying times are generally related to air circulation, temperature, film thickness and number of coats, and will be affected correspondingly. The figures given in the table are typical with:

* Good ventilation (Outdoor exposure or free circulation of air)
* Typical film thickness
* One coat on top of inert substrate

Substrate temperature	**0°C**	**5°C**	**10°C**	**23°C**	**40°C**
Surface dry	15 h	12 h	7 h	3,5 h	1,5 h
Through dry	46 h	32 h	24 h	6 h	4 h
Cured [2]	-	28 d	14 d	7 d	3 d
Dry to recoat, minimum	48 h	36 h	24 h	12 h	5 h
Dry to recoat, maximum [1]	30 d	28 d	25 d	21 d	7 d

The surface should be dry and free from any contamination prior to application. If the maximum dry to recoat time is exceeded, please contact your local Jotun office for more information.
See the application procedure.

The maximum steel temperature during application should be 40 Degrees Celsius. Minimum steel temperature during application and initial curing should be above 0 Degrees Celsius Naturally higher and lower temperatures can be accepted after the block coating is considered though dried.

With regards to fully cure, then that is only obtained when the coating is exposed to temperatures above 5 Degrees Celsius. The application and overcoating of Tankguard CPC can be done at temperatures down to 0 Degrees Celsius, but fully cured is only achieved when the coating system is exposed to temperatures above +5 Degrees Celsius.

2. Definitions

2.1 Property
Enclosed mild steel tanks (and other mild steel constructions) that are exposed mainly but not limited to petroleum products, and which require protection by chemically resistant coatings.

2.2 Chemical environment
Referring to the environment in which the coatings shall serve. Chemicals involved may be solids, gases, vapours or fluids that are corrosive to steel and other materials.

2.3 Physical environment
The pressure and temperature conditions in which the coatings shall serve.

2.4 Coating

A barrier applied to a substrate as a liquid and cured to protect the steel surface from the corrosive action of liquids, vapour etc.

2.5 Contractor or Shipyard

The Contractor or Shipyard is to be understood as the main contractor for a project.

2.6 Painting Contractor

The Painting Contractor is the party employed to carry out the part of the project that includes surface preparation and application of the coating system.

2.7 Coating Advisor

The Coating Advisor is Jotun's representative with the responsibility on behalf of Jotun to secure and record that all work is carried out in accordance with the agreed specification, working in conjunction with the Contractor's and Owner's coating representatives.

2.8 Owner's Representative

The Owner's Representative is authorised to represent the Owner in matters related to the coating operation.

3 General guidelines

3.1 Approval of Painting Contractor

The Painting Contractor selected for surface preparation and application of the coating system should be an organisation approved by Owner, Contractor and Jotun Paints (if requested to comment).

4.2. Planning

Proper planning of the entire operation is absolutely critical for successful work performance, which in turn is a prerequisite of obtaining optimal protection by applied coating system.

Planning must cover all phases of the coating operation and its intention shall be to secure the correct quality of work and a safe working environment.

A detailed work plan should include the scheduling of all operations to be carried out before, during and after application of the coating system.

The work plan should be available to the Coating Advisor prior to the start of any work related to the coating operation.

4.3 Rules

All work should be performed in accordance with this Code of Practice, Jotun's product technical data sheets and the coating specification.

Deviations from specifications should be authorised by Jotun's Coating Advisor.

All aspects of importance to the operation must be agreed upon and approved by all parties and thereafter strictly adhered to. Deviations thereafter are considered unacceptable if not authorised or approved by the Coating Advisor.

4.4 Documentation of alterations to the specification / procedure

Proposed alterations to the agreed specification / procedure must be approved by all parties before any written alterations to the relevant documentation. Documentation with modifications shall be distributed and available to all parties.

4.5 Responsibilities

4.5.1 The Painting Contractor

The Painting Contractor has the responsibility to carry out the work in accordance with the given specifications. The Painting Contractor is responsible for taking corrective action in the case of non-compliance with specifications.

4.5.2 The Contractor or Shipyard

The Contractor or Shipyard is responsible for all repairs of damages to the completed coating system caused by welding, burning, mechanical impact etc.

4.5.3 The Coating Advisor

The Coating Advisor has the responsibility for Jotun's approval or rejection of any and all aspects of the coating operation. This does not exclude the necessity to carry out inspection work in co-operation with the Owner's Representative and Contractor / Paint Contractor Representatives.

4.5.4 The Owner

The owner has the responsibility to provide written confirmation to the Contractor / Shipyard and Jotun of all intended storage / cargo chemicals, their concentrations and their storage temperatures.

4.5.5 Jotun Technical Support Department (TSS)

In addition to providing a coating specification, Jotun has the responsibility, if appropriate, to provide the Owner with instructions for any special chemical storage preparations and/or cleaning operations (between changing chemical type for storage). Such instruction shall be deemed necessary according to the chemical storage list provided by the Owner.

5 Pre-project

5.1 Preliminary meeting

A pre-project preliminary meeting shall be arranged before any coating-related work starts. Representation from all involved parties; Owner, Contractor / Shipyard, Painting Contractor and Jotun is compulsory.

The pre-project meeting must settle all matters of importance to the scope of work, and make available all documentation necessary to carry out the work in accordance with the requirements and specifications.

The Coating Advisor and/or other Jotun Representatives shall use this meeting to ensure that the other parties are familiar with the products to be used, the coating specification, product and safety data sheets, and other documentation. Furthermore, responsibilities are to be stressed, as are consequences of any non-conformances,

and the necessity for the Painting Contractor to quality control their own work during the whole operation, and likewise comply with specifications.

5.2 Follow-up meetings

Decision about regular follow-up meetings is also to be made in the pre-project preliminary meeting. Meeting frequency and participation shall be agreed upon.
The follow-up meetings should be set to discuss or review the following points: -

- Unpredictable difficulties hindering the ordinary work progress
- Deviations from specifications
- Elements to add to, or delete from, the work schedule
- Conditions effecting compliance with specification

6. General tank condition prior to work commencement

Prior to the commencement of steel repairs, cleaning and grit blasting, it is essential that the tanks are in a condition suitable for the work ahead.

For new constructions, the steel should not have deteriorated below steel grade B according to ISO 8501:1 1988 (see Appendix 1).

All vulnerable fittings should be masked off with a suitable protective material to avoid the possibility of damage.

All hot work in way of the tank must be completed.

It shall be understood by all parties that lighting will be critical to achieve the correct coating quality, safely and in good time. Adequate electrically safe lighting by means of both spotlighting and background lighting must be approved by Jotun.

7. Staging / scaffolding

7.1 General

A suitable and safe system of staging is to be provided. The construction design shall allow easy cleaning of scaffolding. It should be possible to easily ‘turn’ all boards (so that grit and dust can be released easily). Scaffolding tubes are to be capped at open ends using wooden or hard rubber stoppers. Taping the ends is not recommended.

7.2 Access

The staging must provide free access to all surfaces to be treated without shifting of planks or erection of temporary ladders. It must also provide adequate working space and support for the maximum numbers of workers. The staging design must not hinder ventilation in any way.

The scaffolding shall have a minimum distance of 30 cm to surfaces to be treated, and about 2 m between each level. Enough space should be available, allowing the operator to execute his work properly, and to move from level to level fast and efficiently.

7.3 Dismantling / removal of staging

The scaffolding shall not be dismantled before the upper areas of the tank have been fully coated and accepted.

Utmost care not to destroy the coating must be taken when dismantling and removing the scaffolding. Any damages should be repaired in accordance with the original specification

8. Basic work sequence for tank coating, when doing the main part of the application on block stage.

The procedure of applying the main part of the coating system on block stage, is not new and there is therefore several ways to carry out this work. In general Jotun recommends the following procedures:

Block stage:

(1) Pre-blast welds
(2) Grit / dust removal
(3) Steel repairs
(4) Degrease and cleaning
(5) Full blast all areas
(6) Grit / dust removal
(7) Application of the full system, including stripe coating, keeps a distance from the edge of the block at about 100 mm for the first coat. There should be an overlapping zone of 100 mm for each coat from the block edge. Total distance from block edge to final coat should then be 300 mm.

Hull stage:

(1) Grinding of all welds
(2) Dust removal
(3) Steel repairs
(4) Degrease and cleaning
(5) Grinding of all welding joints and mechanical damages to St 3, with a profile of minimum 25 microns roughness. Overlapping zone to intact coating should be feathered clearly showing all existing coats.
(6) Dust removal
(7) Apply full coating system to all grinded areas, including the overlapping zone.
(8) Touch-up repairs
(9) Remove all staging
(10) Grind or vacuum blast any mechanical damages
(11) Dust removal
(12) Touch up and repair all spots on the floor.
(13) Continue ventilation of tank until fully cured.
(14) Close tank
(15) Water immersion test
(16) Touch-up repairs
(17) Close tank

Note: If the shipyard or contractor prefer, then naturally Tankguard CPC can be applied on hull stage alone.

9. Surface Preparation

9.1 Pre-blasting of welds Prior to steel repair work on block stage: all welds, plus 20 cm out from either side of the welds, should be blasted to visual cleanliness standard Sa 2½ ISO 8501:1 1988 (see Appendix 1). This is in order to open any hidden weld blowholes, and to facilitate fast and efficient detection of steel surface defects thereafter. Remove grit and dust after pre-blasting.

9.2 Steelwork repairs
Steel repairs shall be carried out in order to produce a smooth surface contour, which is a prerequisite of obtaining a continuous coating of appropriate thickness.

Sharp edges should be rounded by using grinder or disc sander to approximately 2 mm radius as minimum (r ≥2 mm). Practically this should be done by using three passes with a grinding disc. One on each side and one on the top.

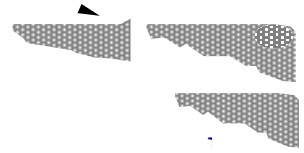
Undercuts and surface indentations with a depth exceeding 0.8 mm and a width less than the depth should be repaired by welding and grinding.

Weld blowholes shall be repaired by welding and grinding. All weld spatter to be removed.

Rough weld seams to be smoothed by grinding. The surface irregularity should not exceed 2 mm.

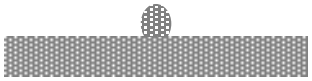
Overlap welding beads with sharp notches to be repaired by welding and grinding.

Gas cut surfaces to be smoothed by grinding



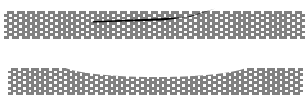
A. Remove by grinder or disc sander.

B. Rolled steel sections normally have round edges. Therefore can be left untreated.



A. Remove visible spatter before grit blasting with grinder or chipping hammer.

B. For spatter not redily removed, remove using grinder/disc



Lamination
Remove using grinder.

Undercut
Undercuts exceeding classification ruling should be repaired by welding and grinding.

Manual weld bead
Sharp profile peaks to be smoothened using grinder

9.3 Degreasing and cleaning

9.3.1 General

This shall be carried out prior to grit blasting in order to prevent contamination of the steel during blasting. Both organic (grease and oil) and inorganic (chlorides and ions) should be removed before blast cleaning.

9.3.2 Standards

There are no standardised methods for the quantitative determination of grease/oil on cleaned surfaces. This should give rise to caution (rather than negligence) during the cleaning operation.

There are several methods for the quantitative determination of chlorides. A practical field method is to use ISO 8502-6 conductive testing (see Appendix I) using Bresle testing equipment.

Water-soluble chlorides (NaCl) remaining on a blast-cleaned surface, prior to coatings application should not exceed of 50 mg/m^2 (5,0 µg/cm$^{2)}$.

9.3.3 Procedure for removal of oil and grease

Clean oil and grease deposits using scrubbing brushes and an approved water-based industrial degreasing detergent. Repeat this process until water no longer ‘snakes’ or ‘beads’ when poured down the substrate.

For large affected areas, apply the detergent through airless spray equipment. Start at the bottom of the tank and work upwards. After the detergent has been on the surface for 20-30 minutes, it should be rinsed off by steam-cleaning (preferably) or by high-pressure water washing (at least 200-bar pressure). The water used for steam cleaning or water washing must be of a suitable quality and approved by Jotun in advance. Rinsing should start at the bottom of the tank and work upwards, following the course taken when applying the detergent. All detergent should be thoroughly removed so that no foaming occurs when water washing.

This cleaning procedure should be repeated until appropriate cleanliness of treated surfaces is obtained.

9.3.4 Procedure for removal of remaining contaminants from all areas.

In addition to those areas which are detergent cleaned, all areas of the tank must be high-pressure freshwater washed (200-bar minimum) to remove contaminations such as acidic weld smoke residue, and to reduce surface chloride levels prior to full grit blasting.

9.4 Abrasive blast cleaning and mechanical grinding

9.4.1 General working conditions

All work in adjacent areas, which may negatively affect the quality of blast cleaning, and/or impose safety hazards, should be completed or stopped before the blasting or grinding operation starts.

9.4.2 Ambient conditions and ventilation

Condensation must be avoided during blast cleaning and mechanical grinding. The steel temperature must be kept at least 3ºC above the dew point. The relative humidity must be kept below 55% throughout the blasting and grinding operation up until application of the first coat.

During the grit blasting operation, ventilation is necessary to allow adequate visibility. Flexible ventilation trunking should be used to allow the point of extraction to be reasonably close to the worker. The ventilation system and trunking should be so arranged that 'dead spaces' do not exist. Note: It is expected that the blocks will be very open and therefore a sufficient ventilation in the painting room is considered sufficient.

Dehumidification equipment, when required, must be of adequate capacity to maintain the condition of blasted steelwork to the required standard.

9.4.3 Protection from rain and dust

In way of all manholes, ladders and tank entrances: adequate covering must be provided to prevent water, dust or other contaminants from entering working areas during grinding and thereafter.

9.4.4 Hygiene

Good personal hygiene of those entering the tank after completion of grit blasting and throughout all stages of coating application and curing is required. The availability and use of clean clothing is required to avoid surface contamination. All efforts should be made to avoid human sweat falling onto the substrate. All persons entering the tank and the blocks must wear foot covers. This is done in order to keep any dust level to an absolute minimum.

9.4.5 Abrasive

The selected abrasive must be compatible with both the surface to be blast cleaned and the specified coating system. The abrasive shall meet relevant specifications as per ISO 11124-2 & 3, or ISO 11126-2 to 8 (see Appendix I). It should be sampled according to ISO 11125-1 or ISO 11127-1, and tested according to ISO 11125-2 to 7 or ISO 11127-2 to 7 as appropriate.

Dry storage of abrasive and shelter for blasting pots is necessary to prevent equipment becoming clogged with damp abrasive.

Recycling of used abrasive is prohibited unless approved by Jotun.

9.4.6. Grinding discs

The discs used to grind the joints should be a hard and rough type. Wire brushing can be needed when removing rust or welding slag. But after wire brushing, rough disc should be employed to obtain distinct surface profile.

9.4.7 Air supply

A minimum air pressure of 7-bar at nozzle is required to obtain acceptable surface cleanliness and profile within an acceptable time.

The supply of clean air to blasting pots must be secured to avoid contamination of abrasive and thereby of blast cleaned surfaces. Compressors must be fitted with sufficient traps for oil and water. It is also recommended to fit two water separators at the blasting machine to ensure a supply of moisture-free air to the abrasive chamber.

9.4.8 Visual cleanliness and surface roughness standard

The cleanliness of the blast cleaned surfaces shall be of preparation grade Sa 2½ or better according to ISO 8501-1:1988 (see Appendix I).

The roughness (profile) of blast cleaned surfaces to be Medium (G) according to ISO 8503-2:1988 (see Appendix I) unless otherwise specified in Jotun's technical data sheets. "Medium: defines a surface profile with maximum peak-to-valley height of 60-100 microns. "G" tells that the surface profile is obtained by grit blasting.

9.4.9 Removal of dust and abrasive particles

Surface preparation shall not be considered complete until the blast cleaned surface is totally free of dust or abrasive particles as may remain lodged in and on the surface. Vacuum cleaning will be required.

A recommended practice is the use of stiff fibre brushing followed by vacuum cleaning, or to attach stiff brush around the vacuum nozzle orifice in order to agitate dust away from the surface. The operation shall start at the top of the tank and proceed downwards, finishing with the removal of dust from the tank floor.

This procedure is applicable for the scaffolding as well. Staging planks must be vacuum cleaned, turned, and vacuum cleaned again. Any ends of tubular parts of staging that have accidentally opened shall be vacuumed at the tubular entrance and then stopped up with wooden or hard rubber plugs.

Determination of remaining dust on surfaces after vacuum cleaning shall be performed in accordance with ISO 8502-3:1992 (Appendix I). The quantity of dust remaining should be no grater than pictorial reference quantity rating 1: ISO 8502-3 and be of no grater size than class 2: ISO 8502-3

9.4.10 Determination of water-soluble chlorides

Water-soluble chlorides (Water-soluble chlorides (NaCl) remaining on a blast-cleaned surface, prior to coatings application should not exceed 50 mg/m^2 (5,0 µg/cm$^{2)}$. When performing ISO 8502-9 conductive testing (see Appendix I) using Bresle testing equipment. (See appendix IV)

Tests should be carried out randomly, but with an emphasis on places that typically have higher chloride levels: flat horizontal surfaces, corners and the tank floor. The number of tests per tank should be discussed and agreed pre-project.
Depending on the size of the tank, a suitable number of tests could be one test for every 150-300 m²

If the tank is found to have too high a surface chloride level, re-washing must be carried out followed by sweep blasting to remove flash rust. Then steps 7.5 and 7.6 must be repeated.

10. Conditions required for application:

10.1 All work in adjacent areas, which may negatively affect the quality of coating application, and/or impose safety hazards, should be completed or stopped before the application operation starts. It is vitally important that sufficient ventilation, dehumidification, heating equipment and lighting shall be provided to meet conditions as described in Jotun Coatings' technical data sheets, this Code of Practice, and those required by the relevant regulatory bodies.

For additional necessary information on how to provide a safe environment for tank coating application, refer to section 12 of this Code of Practice, entitled: Safety.

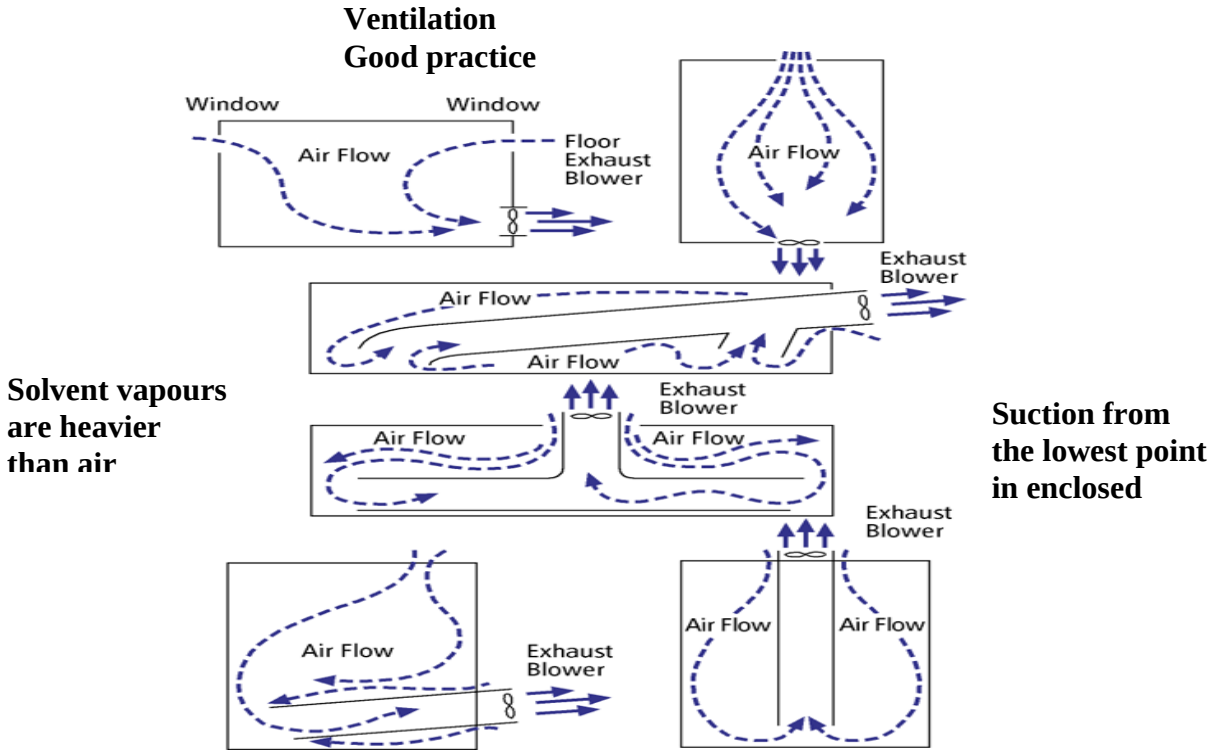
10.1 Substrate conditions See section 1.2.

10.1.1 Ambient conditions; The steel temperature must be kept at least 3ºC above the dew point. The relative humidity to be kept below 80% throughout the painting operation and shall be maintained during throughout the curing period. In addition, both the steel temperature and the air temperature must be within the range of the recommendations in the products TDS.

10.2 Ventilation and dehumidification

10.2.1 General

Good ventilation, meaning sufficient air supply and air exchange in all parts of the coated object is required to remove solvent vapours and thereby promote solvent evaporation and curing of coating. Ventilation must be maintained during application and continue throughout full curing whilst solvent is released from the paint film.



For additional necessary information on how to ventilate tanks safely, refer to section 12.4.2 of this Code of Practice, entitled: Management of solvent vapour concentration.

10.2.2 Air quality, equipment and trunk system design

Air to be supplied must be of acceptable quality with regard to temperature, relative humidity and purity. The injected air should be no higher in temperature than the steel surface (in order to prevent condensation, skin drying etc).

Equipment must not re-introduce deposits, solvent vapour etc. into tanks. For this reason, a positive pressure above normal atmospheric pressure should be maintained inside the space.

For successful removal of solvent fumes, suction from the lower sections of the confined space is required (solvent fumes are heavier than air).

Flexible ventilation trunking should be used to allow the point of extraction to be reasonably close to the worker. The ventilation system and trunking should be so arranged that 'dead spaces' do not exist.

Provision must be made for 24-hour surveillance of ventilation equipment.

10.2.3 Air exchange

The ventilation system must prevent the solvent vapour concentration exceeding 10% of the Lower Explosive Limit (or less than this if required by local regulators).

As a guideline only, Jotun often recommends approximately 9 air changes per hour during early curing phase. However, this air exchange rate is very dependent upon the coating used and structural configuration of the tank. The correct rate should be calculated according to the formula shown under section 12.4.2 of this Code of Practice. The correctly determined rate should be maintained for at least 48 hours after the application of the system. Thereafter, during later curing stages, the air exchange rate may be reduced to approximately 4 air changes per hour.

During application, to minimise possible dry spray, a lower level of ventilation may be temporarily maintained. Under certain circumstances this could be approximately 4 air changes per hour. However, the air exchange rate and the paint application rate must be balanced to ensure that the solvent vapour content is below the 10% Lower Explosion Limit.

10.3 Dehumidification

DH equipment, when required, must be of adequate capacity to maintain the condition of blasted steelwork to the required standard. Additionally, in order to prevent condensation, the steel temperature should always be kept 3 °c higher than the dew point.

10.4 Heating

If heating is necessary to satisfy the painting specification, it should be by means of a heat exchange system, i.e. air admitted to the tank should not pass directly through a combustion chamber.

Temperatures should be maintained from application to full cure, and provision should be made for 24-hour surveillance of equipment.

10.5 Staging / scaffolding

See section 6.

10.6 Lighting

It shall be understood by all parties that lighting will be critical to achieve the correct coating quality, safely and in good time. Adequate electrically safe lighting by means of both spotlighting and background lighting must be approved by Jotun.

10.7 Protection from rain and dust

In way of all manholes, ladders and tank entrances: adequate covering must be provided to prevent water, dust or other contaminants from entering working areas during coating application and curing.

10.8 Hygiene

Good personal hygiene of those entering the tank after completion of grit blasting and throughout all stages of coating application and curing is required. The availability and use of clean clothing is required to avoid surface contamination. All efforts should be made to avoid human sweat falling onto the substrate. Foot covers must be worn by all persons entering the tank after grit blasting.

11. Application of the coating system

11.1 General

The application of coating systems intended for service in aggressive chemical environments is a delicate matter. The slightest deviations from specifications may have considerable consequences for coating performance. Consequently, the coating operation shall be entrusted to skilled and experienced painting contractors only.

Jotun's recommendations, as laid down in the product technical data sheets, Tank Protection Manual, coating specification and this Code of Practice, should be strictly adhered to before, during and after the application of the coating system. Deviations should only be authorised or approved by the Jotun.

11.2 Storage of coatings

The paint should be stored out of direct sunlight so that the temperature of the material will not exceed 30°C for prolonged periods of time.

11.3 Mixing

The mixing of paint components must be carried out thoroughly in order to get a homogenous product. Insufficient mixing will reduce the quality of the applied coating dramatically. Clean, efficient power-mixing equipment must be used. The mixing

device should not agitate the paint excessively otherwise bubbles and/or craters in the applied paint film can result.

The mixed paint must be allowed to stay in the tin for the recommended induction time before application.

The temperature of mixed paint shall not be less than 10ºC and not more than 30 ºC. Lower / higher temperatures will negatively effect application properties and thereby coating performance, unless stated otherwise in the relevant product technical data sheet.

Contamination of paint during mixing by dust and water must be prevented. Filtering may not be an acceptable corrective action if contaminants are soluble or small in particle size.

11.4 Thinning

Thinning of paint is not normally required and any thinning should be agreed with Jotun's representative.

11.5 Spray equipment

All paints should be applied by airless spray except for stripe coats where, in general, non-synthetic brushes should be used.

Available air pressure and capacity for spray equipment is required according to Jotun's product technical datasheet. Air supply from the compressor must be free from oil and moisture by means of the appropriate oil and water traps.

All spray equipment must be in good working order and be capable of performing to the output requirements defined in Jotun's product technical data sheet. Oil and water filters must be in good working order.

Tips should be the size stipulated on the product technical data sheet, or as agreed with the Jotun representative on site. Tips should not be in a worn condition, and should be the reversible type.

The fan angle of the spray gun tip should be appropriate for the configuration / shape of the structure being coated.

Spray hose line should be in good working order, and usually 3/8 " diameter.

11.6 Spray application

All spray application should be done using airless spray; with a spraying technique using horizontal and vertical spray passes. This should be performed in order to achieve an even film thickness.

Difficult areas such as profiles, corners, edges etc. are always sprayed first. The surrounding areas are sprayed immediately afterwards, wet-on-wet.

11.7 Stripe coating

Stripe coating is required to ensure sufficient coating thickness on areas that cannot be adequately coated with airless spray. Such areas are, but not limited to: -

- Behind bars
- Plate edges
- Cut outs, scallops, manholes, etc.
- Welds
- Areas of difficult access for spraying ladders and handrails
- Small fitments of difficult configuration
- Areas of pitting
- Notches

The first stripe coat may be applied after the first full coat if manual welds are smooth enough according to the decision of Jotun's coating advisor. Thereafter, stripe coats should be applied prior to each full coat.

Stripe coats should be applied by brush, not roller, in order to obtain acceptable penetration of the surface, and to avoid air entrapment.
Stripe coating by brush also permits a higher film thickness than does stripe coating by roller.

To further improve penetration of high solid paints, and to help with brushing characteristics, thinning of the first stripe coat may be required.

Note that the stripe coat might be applied in a different sequence from block stage to hull stage. See chapter 1 – coating system and specification.

11.8 Touch-up's

11.8.1 Touch-up application

Touch-up repairs of low DFT and/or damaged areas shall be carried out after each full coat by spray or brush (as appropriate) so that the quality of each full coat coincides with the overall requirements of original specification requirements.

11.8.2 Repair of exposed steel for touch-up

Damages, which reach back to the steel substrate, shall be repaired according to the area size of exposed steel, and according to the condition of the exposed steel.

If the exposed steel has retained the original cleanliness level of Sa 2½, and the profile is as per that achieved during full blasting, then the area needs only to have the damaged paint edges feathered back prior to touch-up application.

Should the exposed steel be rusty, or be visually less than Sa 2½, the steel must be prepared prior to touch-up application. Such areas of exposed steel on the tank floor, if they are no more than in area, can be disc-grinded to standard St 3 as described in ISO 8501-1:1988

12. Inspection

12.1 General

Project control by regular inspections by representatives from Jotun, Contractor/ Shipyard, Painting Contractor and Owner is vital to successful tank coating projects, and in maximizing the potential of a coating system.

Quality control and self-inspection by the relevant Contractor / Shipyard and Painting Contractor personnel is required. It must be emphasised that inspection of work quality and work performance is not solely the responsibility of Jotun's representative. Teamwork through affective inspection by all involved parties is required throughout the project.

12.2 Extent and frequency of inspections

All parties involved in the coating work must agree an inspection procedure prior to work commencing. This should outline how and when both work and inspection will be undertaken. The extent, frequency and purpose of inspections should be agreed upon and implemented accordingly. However, Jotun, and any other authorised personnel, retain the right to inspect any stage of the work process.

In general, Jotun should attend as many inspection as practically possible, considering the following stages of the work:

Block Stage:

1) After completion pre-blasting and grit / dust removal
2) Steel repairs after completion
3) Degreasing and cleaning, during and after completion
4) General block conditions before full grit blasting
5) Ventilation and dehumidification arrangement for blasting
6) Commencement of full grit blasting
7) After full blasting and grit/dust removal
8) Ventilation, dehumidification and heating for coating application
9) Paint mixing for all stripe coats
10) Application of all stripe coats
11) All stripe coats (once dry)
12) Paint mixing for all full coats
13) Commencement of application of all full coats

14) All full coats (once dry)
15) Paint mixing for all touch-up's
16) Application of all touch-up's
17) All touch-up's (once dry)
18) After eventual staging removal

Hull stage:

1) After completion pre-grinding and dust removal
2) Steel repairs, during and after completion
3) Degreasing and cleaning, during and after completion
4) Commencement of grinding of joints and eventual damages.
5) Ventilation, dehumidification and heating arrangement for coating application
6) Paint mixing for all stripe coats
7) Application of all stripe coats
8) All stripe coats (once dry)
9) Paint mixing for all spray applications
10) Commencement of application of all spray applications
11) All sprayed coats (when dry)
12) Paint mixing for all touch-up's
13) Application of all touch-up's
14) All touch-up's (once dry)
15) After staging removal
16) Grinding of damages on tank floor
17) Dust removal on lower tank level
18) Paint mixing for all touch-up's
19) Application of all touch-up's
20) All touch-up's (once dry)
21) Start of water immersion test (if appropriate)
22) After water immersion test (if appropriate)

12.3 Inspection notification

Inspection notification / invitation should be sent by Contractor / Shipyard to Jotun's Coating Advisor for all previously agreed stages of the work. Such notifications must be sent in advance, thus allowing Jotun's Coating Advisor enough time to attend the inspections in good time.

12.4 Project management and meetings

Daily briefings should be arranged to confirm the previous day's work performance, and to confirm the work and inspection schedules for the coming day. In attendance at these meetings must be representatives from Jotun, Contractor / Shipyard, Painting Contractor and Owner. Minutes of these briefings should be taken and circulated to all participants daily.

The Contractor / Shipyard must supply interpreters if necessary.

12.5 Inspection records

Jotun's Coating Advisor has the responsibility to record all relevant data pertaining to each day's work, as detailed in Jotun's Tank Coating Inspection Report forms (see Appendix III).

Jotun's Coating Advisor shall immediately report to the Contractor / Shipyard and Owner's Representative if any coating specification requirements are not complied with. Such reports shall be put in writing for signing by all three parties, with a copy then distributed to each party.

On completion of the contract all relevant documentation will be retained, and safely archived, by Jotun's local Technical Support Manager.

12.6 Inspection tools

The following tools and equipment may be used for inspection during the work: -

- Surface chloride detection kit (Bresle device)
- Surface profile comparator plate: G – Grit
- Wet Film Thickness gauge
- Dry Film Thickness gauge
- Inspection mirror
- Adhesion tester
- Pinhole / pore / holiday detector
- Steel temperature gauge
- Humidity gauge
- Wet and dry temperature gauge
- Instruments for measurements of surface dust contamination
- Inspection forms and sketches
- Safety equipment
- Photographic equipment
- Torchlight
-
- Miscellaneous additional equipment
- Documentation with relevant standards and recommended practices

12.7 Wet film thickness (WFT)

WFT must be measured immediately after application since evaporation of solvents will effect the reading if not performed at once. WFT measurements shall be performed in accordance with ISO 2801:1997 Method No 1 (see Appendix I).

WFT measurements should be made in partnership with paint consumption calculation / estimation in order to help achieve the correct Dry Film Thickness.

Spray applicators are expected to have WFT gauges, and to use them regularly – especially at the start of each application session.

12.8 Dry film thickness (DFT)

12.8.1 General

DFT measurements shall be carried out after sufficient curing of each coat applied.

Recommended non-destructive methods for the determination of DFT on substrates are described in Method 6 and 7 of ISO 2801:1997 (see Appendix 1).

Calibration of DFT instruments is to be performed according to Method No 10 of ISO 2801:1997. Daily calibration is required. Calibration should be done using a small steel plate with similar thickness to the tank substrate, and using plastic shims with similar thickness to the specified DFT to be measured.

Destructive methods to determine DFT of coating systems are not recommended, but may be used if necessary to verify compliance with specifications.

12.8.2 DFT measurement system

A typical method / system for taking DFT readings is seen below. However, it should be emphasised that common sense is required when considering where to take readings, and when considering whether or not an area has acceptable DFT. The number of spot readings to be performed should be determined case-by-case since the design of the construction for coating must be taken into consideration.

(1) Take three readings in close proximity to one another in a triangular formation, with each measurement about 25 mm from the other. The average of these three readings is recorded on the substrate using an approved marker. This average is called a 'Spot DFT'.

(2) Should a Spot DFT be less than 90% of the specified DFT, more readings should be taken in an ever-growing circle from the point of the first Spot DFT in order to establish where the low DFT area ends?

(3) Such low areas should be marked for touch-up repair using an approved marker.

(4) Up to 10% of all spot DFT's may be as low as 90% of the specified DFT. If more than 10% of the spot DFT's are less than the specified DFT, there should be corrective action by means of either: (a) one extra full coat, or (b) increasing the specified DFT of the subsequent full coat.

12.9 Salt water immersion testing

If salt water immersion testing is carried out, Jotun recommends at least 48 hours immersion. Another option is to spray the entire area with salt water, leave salt water in the tank bottom floor and the close the tank for 48 hours. Freshwater immersion testing will require a longer immersion time.

13. Safety

13.1 General

First of all it is important to note that all safety requirements mentioned below is made as guidelines. Safety requirements should above all always comply with local safety regulations. This is the responsibility of the contractor.

Safety is the overriding consideration for all enclosed space coating work, and the responsible Contractor / Shipyard Safety Officer must be made fully aware of all aspects of the operation, and all potential dangers.

Detailed attention must be given to the following dangers: -

- Danger of explosion or fire
- Danger of asphyxiation / suffocation by solvent fumes
- Danger of falling from staging
- Danger of skin damage from toxic coating materials

13.2 Safety preparations

Safety matters shall be included as a topic in the preliminary pre-project meeting. All safety requirements and rules shall be agreed upon and made available for all parties involved.

The Painting Contractor should be pre-qualified, and his operational staff certified through a plant / shipyard safety programme to ensure that they are familiar with safety and operational procedures. These operational staff must also be trained in plant / shipyard emergency procedures.

Before coating work starts, authorised personnel from the Contractor / Shipyard shall review the work arrangements of the Painting Contractor to ensure that no procedure is will take place which could endanger any person's health or life.

The Coating Advisor shall be provided with safety regulations valid for the plant / shipyard.

The Contractor / Shipyard and Painting Contractor will be provided with Jotun's material safety data sheets.

13.3 Elimination of ignition sources

Welding, cutting or grinding in the tank should be completed before grit blasting. By the time of coatings application, this rule shall apply to all areas within a 20-metre radius of the tank and the trunking outlets.

Areas where work is in progress must be clearly identified and sectioned off. Hazard warnings showing "EXPLOSION RISK" and "NO SMOKING" must be placed clearly visible around all tank entrance holes during coating operations and shall not be removed before the concentration of flammable vapours is too low to cause a fire hazard. Such hazard warnings should extend out from tank entrances in a 10-metre radius.

For ships' cargo tank coating projects, coamings and hatch openings must be covered so as to efficiently prevent spark entry should welding be carried out on the superstructure or deck area.

Lights, including hand torches, must be no more than 24-volts and certified by the manufacturer as flash proof / suitable for use in a solvent-laden atmosphere.

Smoking must be prohibited in or near tanks, or near extraction systems.

All equipment in use must be earthed properly. This includes, but is not limited to, compressors, blasting equipment and spraying equipment.

Explosion and spark-certified equipment should be used during application of coatings. Electric cables, motors and lighting system must be type-approved. Extension cables with connections inside should never be used. No electrical junction boxes should be allowed in tanks.

Personnel working in confined spaces during paint application and curing must use rubber-soled shoes.

If heating is necessary to satisfy the painting specification, it should be by means of a heat exchange system, i.e. air admitted to the tank should not pass directly through a combustion chamber.

Mobile telephones and electrical cameras must not be used in or near tanks or extraction systems until paint fumes are totally dispersed.

13.4 Management of solvent vapour concentration

13.4.1 General advice

Any organic solvent-based coating can give off sufficient solvent vapour to produce an explosive mixture in a tank. When such vapour concentration reaches 1% by volume in air, the mixture is already explosive. However, at 1% the solvent fumes produce an intolerably unpleasant odour, with irritating skin effects and painful to the eyes. These symptoms must be taken as a warning sign that better ventilation is needed. 0.1% solvent vapour in air is normally recommended to give a tenfold safety margin. At 0.1% concentration, no explosion can occur.

13.4.2 Ventilation and air exchange

For successful removal of solvent fumes, suction from the lower sections of the confined space is required (solvent fumes are heavier than air).

Flexible ventilation trunking should be used to allow the point of extraction to be reasonably close to the worker. The ventilation system and trunking should be so arranged that 'dead spaces' do not exist.

Theoretical ventilation requirements

The Required Air Quantity is the amount of air needed for each litre of paint to ventilate to the required level. For RAQ values please contact Jotun. The TLV (Threshold limit value) for the mixture of components and solvents in the paint or for the mixture of solvents used in thinners has been calculated.
The quantity of ventilation required in m³ per minute during application and drying can be calculated from the formula:

$$\frac{(PXM)+(QXN)}{t}$$

P= quantity of paint consumed in litres
Q= quantity of thinner consumed in litres
M= min.ventilation air quantity needed to reach TLV of 1 litre of paint
N= min.ventilation air quantity needed to reach TLV of 1 litre of thinner
t = application time in minutes

As a guideline only, Jotun often recommends approximately 9 air changes per hour during early curing phase. However, this air exchange rate is very dependent upon the coating used and structural configuration of the tank. The correct rate should be calculated according to the formula above, and the determined rate should be maintained for at least 48 hours after the application of the system. Thereafter, during

later curing stages, the air exchange rate may be reduced to approximately 4 air changes per hour.

Ventilation to provide a atmosphere below LEL

It is usual to specify that ventilation should be provided to reduce vapour concentration to less than 10 % of LEL. This large safety margine is required to allow for variations in ventilation in all parts of a compartment.

The minimum ventilation air in m³ per minute may be calculated from the formula:

$$\frac{(PXA)+(QXB)}{t}$$

Calculation
P=Volume of paint applied in the compartment in litres during time t minutes
Q=Volume of added solvent used in paint applied in the compartment in litres in time t minutes

A=Ventilation air quantity for 1 litre of paint to reach 10% LEL
B=Ventilation air quantity for 1 litre of solvents to reach 10% LEL
t = time of application in minutes of volume P of paint

13.4.3 Monitoring the ventilation system

An authorised person must check the solvent vapour content before work starts and at regular intervals (i.e. every two or three hours thereafter) until completion of the tank coating work. Particular attention must be paid to 'dead spots' in the tank, where locally high concentrations may occur. The maximum allowed solvent concentration is 10% of the Lower Explosion Limit (LEL). The oxygen level must not fall lower than 21% by volume.

If the concentration rise above 10% LEL, painting must stop until the vapour concentration is reduced to a safe level again.

Provision must be made for 24-hour surveillance of ventilation equipment.

13.5 Protective clothing and equipment for blasters

Sufficient protection during blast cleaning, such as air-fed open-circuit masks, solid rubber gloves, dead man's handle etc should be available and used.

13.6 Protective clothing and equipment for sprayers

Whilst tank coating is in operation, no ventilation system can reduce solvent vapour levels to below the Occupational Exposure Limit. Painters must, therefore, wear air-fed closed circuit masks or pressure-fed masks with additional eye protection. Air-fed masks that provide a curtain of air across the visor are available. (These help to prevent settlement of spray mist onto the visor.)

Normal protective clothing must be worn, e.g. overalls, gloves, and suitable rubber footwear of non-spark type.

13.7 Skin irritation

If proper protective clothing has been worn, e.g. overalls, gloves, air fed hood, etc. no difficulty should be experienced from skin irritation.

Any small areas not protected by clothing, e.g. wrists or neck, can be treated with a non-greasy barrier cream. (Petroleum jelly is not recommended as this can assist the transport of solvents into the skin.)

Any areas of skin accidentally contaminated with paint should be thoroughly washed with soap and water. A skin conditioner that is designed to replace the natural oils in the skin can be used.

13.8 Staging safety

A suitable and safe system of staging is to be provided. The staging must provide free access to all surfaces to be treated without shifting of planks or erection of temporary ladders. It must also provide adequate working space and support for the maximum numbers of workers. The staging design must not hinder ventilation in any way. Enough space should be available, allowing the operator to execute his work properly, and to move from level to level fast and efficiently.

Waist-high safety rails (scaffold tubes) must be erected between all uprights on the inner perimeter of the scaffold construction above the first level of staging. The same applies for any other danger spots. This is required to stop persons falling from the staging.

12.8 Summary of the principal precautions to be taken

- Provide adequate ventilation
- Ensure that the tanks and surrounding areas are flame and spark free
- Provide painters with full respiratory protection
- Ensure that suitable protective clothing is worn
- Enforce a no smoking policy in and around the tank throughout the coating work
- Erect safe, secure and well thought-out staging

Appendix I

Standards below have been referred to in previous sections of the Code of Practice ISO standards are preferred if they cover necessary evaluation requirements. Other recognised standards may be used if appropriate for the purpose and approved.

Standards

ISO 8501-1:1988 Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness -- Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

ISO 8502-3:1992 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

ISO 8502-6:1995 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 6: Extraction of soluble contaminants for analysis -- The Bresle method

ISO/DIS 8502-9:1998 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 9: Field method for the conduct metric determination of water-soluble salts

ISO 8503-2:1988 Preparation of steel substrates before application of paints and related products -- Surface roughness characteristics of blast-cleaned steel substrates -- Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel -- Comparator procedure

ISO 11124-2 to 3:1993 Preparation of steel substrates before application of paints and related products -- Specifications for metallic blast-cleaning abrasives -- Part 2: Chilled-iron grit -- Part 3: High-carbon cast-steel shot and grit

ISO 11125-1 to7:1993 Preparation of steel substrates before application of paints and related products -- Test methods for metallic blast-cleaning abrasives:
-- Part 1: Sampling
-- Part 2: Determination of particle size distribution
-- Part 3: Determination of hardness

-- Part 4: Determination of apparent density
-- Part 5: Determination of percentage defective particles and of microstructure
-- Part 6: Determination of foreign matter
-- Part 7: Determination of moisture

ISO 11126-3 to 8:1993 Preparation of steel substrates before application of paints and related products -- Specifications for non-metallic blast-cleaning abrasives
-- Part 3: Copper refinery slag
-- Part 4: Coal furnace slag
-- Part 5: Nickel refinery slag
-- Part 6: Iron furnace slag
-- Part 7: Fused aluminium oxide
-- Part 8: Olivine sand

ISO 11127-1 to 7:1993 Preparation of steel substrates before application of paints and related products -- Test methods for non-metallic blast-cleaning abrasives
-- Part 1: Sampling

-- Part 2: Determination of particle size distribution
-- Part 3: Determination of apparent density
-- Part 4: Assessment of hardness by a glass slide test
-- Part 5: Determination of moisture
-- Part 6: Determination of water-soluble contaminants by conductivity measurement
-- Part 7: Determination of water-soluble chlorides

ISO 2808: 1997 Paints and varnishes -- Determination of film thickness
Method 1: Assessment of wet film thickness
Method 6: Magnetic method
Method 7: Eddy current method

ISO 4624-1978 Paints and varnishes -- Pull-off test for adhesion

NACE RP0188-99 Standard Recommended Practise. Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

Appendix II

The following pages show one example of a suitable Tank Coating Report forms when applying Tankguard CPC. Others report forms are available at owners or shipyards request.

Note that the report formats consist of one format for block stage and one for hull stage. Please note that both formats are used in excel format for more practical usage:

BLOCK COATING INFORMATION

HULL NO. : BLOCK NO. : YARD :

INSPECTOR : OWNER : SUPERINTENDANT :

LOCATION	COAT	DATE	TIME	PAINTNAME	SPECFIED D. F. T	ACTUAL D. F. T	BATCH NO		WEATHER CONDITION					
							COMP. A)	COMP. B)	D.T	R.H	D.P	W.T	S.T	WEATHER

BLOCK LOCATION						
DATE						
LOCATION						

REMARKS :

HULL STAGE COATING INFORMATION

HULL NO. : POSITION : YARD :

INSPECTOR : OWNER : SUPERINTENDANT :

LOCATION	COAT	DATE	TIME	PAINTNAME	BATCH NO		WEATHER CONDITION					
					COMP. A)	COMP. B)	D.T	W.T	R.H	D.P	S.T	WEATHER
REMARKS : SIGNATURE:												