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**HEMPEL'S TECHNICAL STANDARD  
FOR TANK COATING WORK**

Doc. No.: **TCTF-100-TCW**  
Rev. No.: **3**  
Sign: **nlj**  
Date: **November 2002**

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**NEWBUILDING AND REPAIR**

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### **1.0 Purpose**

The purpose of HEMPEL's Technical Standard for Tank Coating Work is to ensure that a coating applied to the internal surfaces of ship cargo tanks provides adequate protection against corrosion, resistance to cargoes and a surface easily cleaned. This to ensure that the cargo tanks are suitable for carrying products in accordance with the latest version of HEMPEL's Cargo Protection guide for the applied coating system.

All work must be carried out in strict accordance with this standard. Any amendments must be agreed upon by all parties involved.

### **2.0 General conditions**

At newbuildings it is expected that the yard will design and construct the cargo tanks in a manner that enables satisfactory preparation of the surface and application of the coating.

Steel defects in the cargo tanks shall be minimised to ensure the highest possible quality result. This includes, but is not limited to, the rounding of sharp edges, removal or filling of pittings and the smoothing of weld seams. Special attention shall be paid to areas of difficult access.

Unless otherwise agreed in advance, the Yard will supply the skilled labour, all tools and equipment required to carry out the surface preparation and the application of the coating system as specified according to local/national safety regulations.

Subcontractor(s) may be employed to carry out surface preparation and application work. The subcontractor(s) chosen must be well reputed and experienced, with proven satisfactory ability and capacity to comply with the requirements for surface preparation and for the application of the paint system specified.

Any deviations from the specification - whether it be the design of the steel construction, the condition of the steel surface (eg pit corrosion, residual contamination or the like or some other factor) - must be considered from case to case and may influence the chemical resistance and the durability of the cargo tank coating system. The guarantee given will thus be influenced by such circumstances.

The existing paint system will also influence the choice of a new Cargo Barrier System. For example refurbishment of tanks which have previously been coated with zinc silicate usually have to be coated with zinc silicate again.



## **2.1 Communication and meetings**

Close cooperation using the mutual know-how of Yard, possible Subcontractor(s), Owner and HEMPEL is an absolute prerequisite for ensuring an optimum result.

Lines of communication and levels of authority must be laid down before work starts and agreed upon by Yard, possible Subcontractor(s), Owner and HEMPEL.

Depending on the actual agreement, HEMPEL will/may have its own Coating Adviser(s) stationed/available at the yard during the entire period of work, from the start of steel preparation until the coating system is finally accepted by the Owner.

A pre-job conference and ordinary job conferences must be held between Yard, Owner, possible Subcontractor(s) and HEMPEL.

The pre-job conference should at least cover:

- a) Specifications and related standards and documents
- b) Procedures concerning reporting, minutes of meetings, approvals, rejections, recommendations and/or reservations
- c) Review of detailed planing of the work
- d) Outline of the responsibility of the individual parties, owner, yard, possible subcontractor(s) and HEMPEL
- e) Rules of authority/decision makers
- f) Supply of equipment
- g) HEMPEL'S inspection service and inspection routines for all parties
- h) Progress meetings shall be conducted on a daily basis or any time requested by any of the parties involved.

At the progress meetings the agenda shall at least contain the following points:

- a) Work progress in relation to the agreed programme
- b) HEMPEL'S progress reports
- c) Deviations



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- d) Actions caused by possible rejections, recommendations or reservations
- e) Any other business

Minutes are to be taken at every meeting (typically by the yard).

If considered necessary, the yard is to appoint a liaison officer through whom all communications and translations - if required - can take place. At least the yard (and subcontractor(s)) shall appoint a responsible contact person for the HEMPEL coating adviser who is available at all times for the duration of the work.

Procedures concerning reporting, minutes of meetings, approvals, rejections, recommendations, and/or reservations must be described in detail and laid down in writing as agreed upon by all parties, during the pre-job conference.

## **2.2 Inspection**

Recommended inspection routines are an integrated part of the standard. Similarly, quality assurance and quality control should be an integrated part of all phases at all levels of the tank coating job.

The objective of the outlined common inspection procedures are as a guidance to outline the information required for the supervision of a cargo tank coating job. The procedures may be supplemented by experience just as slight deviations will be necessary depending on the actual specification. However it should be understood that deviations should benefit the actual coating job and that any such deviations shall be included in the individual working specification.

Joint inspections including owner, yard, possible subcontractor(s) and HEMPEL shall be carried out before and after each seven main phases of the work:

- Rigging of work site
- Steel work
- Surface preparation
- Paint application
- Destaging and repair
- Seawater test/pinhole test
- Final acceptance

The work at each of these principal phases shall be approved by all parties before moving to the next phase.



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For HEMPEL'S Coating Adviser(s) on site the procedures described in this standard will furthermore be supplemented by HEMPEL'S "Coating Advisers Handbook" containing more detailed information on the performance of the procedures to be carried out.

It should be noted that unless otherwise agreed, all areas shall be inspected and approved in accordance with the specification by the subcontractors and/or the yard's own quality assurance and quality control before calling the HEMPEL Coating Adviser for inspection.

The Yard (or Subcontractor's) must provide HEMPEL's Coating Adviser(s) with adequately furnished office space including telephone, changing lockers, toilets, and washing facilities.

The use of the above-mentioned facilities must be possible at all times, and the Coating Adviser(s) must be admitted to the premises 24 hours a day, seven days a week during the entire tank preparation and application period.

The cooperation, reporting and communication between the parties inspections services shall be agreed upon no later than at the pre-job conference.

It should be noted that by the very nature of inspection work the Hempel Coating Adviser can only be expected to conduct QA as random checks.

The health and safety of the HEMPEL Coating Adviser must at no point be at risk. Care shall be taken that all on site work whether inspection or other business can be conducted according to prevailing regulations. If in doubt the Coating Adviser shall refrain from entering the work site (or part of the work site) which then is not part of the QA scheme.

The HEMPEL Coating Adviser will issue progress reports at agreed intervals and in the case of irregularities, the Coating Adviser will issue a non-conformance report to be circulated to all parties.

Permission to take photographs as necessary should be granted.

### **2.3 Planning**

The planning phase should be comprehensive and must be started in good time.

The master schedule programme chart must be submitted to the Owners and to Hempel for approval before the start of work, just prior to the pre-job conference or earlier.



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The Yard, or on its behalf a Subcontractor, must make all necessary planning including a master schedule containing all steps in the working process as described in this specification.

Such a schedule must include an itemised time schedule and a man-hour plan, and must be distributed in due time to all parties involved.

The schedule and the programme plans must comply with the approved contractual specification and must be according to HEMPEL's specification, which shall be jointly reviewed before the start of work.



## **2.4 Responsibilities**

Responsibilities of Yard, possible Subcontractor(s), and HEMPEL must be agreed upon by all parties involved and included as a part of the contract. The responsibility for executing the work rests solely with the Yard/ Subcontractor(s) and the presence of HEMPEL's Coating Adviser(s) shall not relieve the Yard/ Subcontractor(s) of the responsibility for correct execution of the work in hand and Quality Assurance of same.

In all instances responsibility for health and safety during the work rest solely with the Yard and possible Subcontractor(s).

HEMPEL's Coating Adviser(s) will follow local and national safety rules as well as behave in an appropriate manner, subjecting neither themselves nor other persons to any unacceptable risks.

## **2.5 Authority**

Rules of authority of Owner, Yard, possible Subcontractor(s), and HEMPEL must be agreed upon by all parties involved and included as a part of the contract.

## **2.6 Tank coating procedures**

Tank coating jobs are, at different yards, carried out according to different procedures, of which the three main one are:

- a. All surfaces treated in full before destaging
  - all surfaces blasted
  - full system applied to all surfaces
  - destaging
  - tanktop repaired
  
- b. All surfaces treated before destaging, deckhead and bulkheads in full, tanktop in part
  - all surfaces blasted
  - first coat applied to all surfaces
  - deckhead and bulkheads applied full system
  - destaging
  - tanktop sanded, cleaned and applied full system



- c. Deckhead and bulkhead treated in full before destaging, tanktop treated after destaging
- deckhead and bulkheads blasted
  - deckhead and bulkheads applied full system
  - destaging
  - tanktop blasted
  - tanktop applied full system

It is HEMPEL's recommendation that procedure "a" is followed for one-coat systems and procedure "b" for multiple-coat systems

Procedure "c" may be acceptable, but will generally entail a reservation concerning the overlap area on the lower bulkheads due to the high risk of over-blasting damage to full coated areas and dry film thickness in excess of the recommended maximum.

## **2.7 Supply of equipment**

The Yard or possible Subcontractor(s) will supply all necessary equipment for grinding, abrasive blasting, painting, scaffolding, ventilation, dehumidification, heating and insulation (if necessary), vacuum cleaning, lighting, wrapping of heating coils and piping, dismantling, compressed air and power supply, for personal protection (safety) of the labour force, as well as consumable, spares, maintenance, and all other necessary auxiliary equipment.

## **2.8 Sundries**

The Yard or Subcontractor must provide convenient and sufficient space for storage of equipment, tools and all material and consumables including abrasives and paint. Paint must be stored according to recommendations in the technical data sheet for the product in question.

Containerisation of spray equipment and storage of paint for ready use is recommended.

The Yard or possible Subcontractor(s) must ensure that accessibility, material flow, crange and sufficient work space is maintained at all times.

Removal of wasted consumables such as spent abrasives, dirt, empty paint cans, used tool cleaner, etc. are the responsibility of the Yard or possible Subcontractor(s).



### **3.0 Rigging of work site**

In order to execute the various coating operations in a satisfactory manner, it is necessary that adequate working conditions and equipment are provided and further provided in compliance with health and safety regulations.

The fulfilment of this is solely the responsibility of the Yard/ possible Subcontractor(s).

#### **3.1 Work site**

For the duration of the coating job the tank should be regarded as an "off-limit-area" for all people not involved in the coating job.

Plastic sheets beneath permanent ladders, ladder platforms and lower staging level (tank coating procedures 2.6 a & b) will assist in protection against contamination of the tanktop.

All utility supplies (electricity, compressed air, fresh air etc.) must be arranged in an orderly and proper manner.

Suitable storage facilities must be arranged for equipment, spare parts, abrasives and coating materials in order to have it "ready-to-use" available when needed.

All hot work including that pertaining to installations such as, but not limited to, heating coils, pumps and sounding pipes should be completed as far as possible before the blasting process starts.

Both during and after coating work, a high standard of cleanliness is necessary. A shelter should be erected over the tank entrance to stop contamination from the surrounding area entering the tank. Anyone entering the tank shall wear clothes that are free from oil, grease, etc. and either change shoes or use clean shoe covers.

After the final inspection/approval, the tank is to be closed and the entrance locked. Any further access to be logged.

#### **3.2 Staging**

Suitable staging must be provided to allow good access to all surfaces without rearranging the scaffold during the work progress.

Staging should obey ruling safety regulations, the following is recommendations/ guidelines in order to secure the best possible result within the safety regulations.



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Staging should have as few contact points to the tank surface as possible. When free standing staging is used, all contact between scaffolding poles and steel surfaces must be point contact only.

Staging poles and working platforms shall be placed in a distance from the surface to provide suitable work space for all subsequent operations, special care shall be taken secure access to corrugated bulkheads.

In many countries local safety regulations state a maximum distance of 30 cm between platform and bulkheads.

Areas where the staging is so close to the surface that it adversely effect the treatment, shall be regarded as similar to stripe coat areas or in severe cases as repair areas to be treated during destaging.

It is recommended that the platforms consist of gratings to ease cleaning and ventilation. Open ends of piping (staging poles) are to be plugged or capped.

If wooden boards are used, the distance between boards shall be approximately 3 cm to ensure sufficient ventilation. Furthermore, it is recommended that the wood is planed and that the wooden boards are easy to turn over, as this greatly facilitates the removal of abrasives and dust (choice of this procedure must, however, conform to safety rules on site).

Staging should be mounted to fixed stainless steel fittings and should be easy to dismantle without damaging intact painted surfaces.

The staging shall not be removed before final inspection of bulkheads and deckhead has been made.

Damage of intact paint film must be avoided whenever possible. However, any damaged spots must be repaired simultaneously with dismantling of the staging according to the procedure for repair of small areas, as described in section 8.0 Repairs

### **3.3 Items not to be coated**

Items not to be blasted and coated, for instance heating coils and equipment of noble metals, should be protected against over-blast and over-spray by covering/wrapping. During the blasting process the best protection is offered by a wrapping in heavy duty rubber or plastic with all overlaps and joints on the underside of the coils to prevent dust and blast media collecting in the wrapping. During application the covering shall be made of a material such as paper where there will be no flaking of the drying coating to contaminate the fresh paint on the tank top.



### **3.4 Lighting**

Lighting in the tank is vital for safety reasons and furthermore to ensure that a good standard of the coating work is obtained.

General lighting should be considered sufficient if it allows the reading of at normal text page, like the present, at a distance of 30 cm.

At the individual work site the general lighting shall be supported by powerful handheld flood lights.

All lightning and power supply shall be of explosion proof design and in accordance with local regulations.

### **3.5 Ventilation, dehumidification and heating**

Sufficient equipment for ventilation, dehumidification, heating and insulation must be available to achieve the specified results.

Good ventilation is generally obtained by blowing clean dry air into the upper and middle regions and arrange the suction at the bottom of the tank. Note that spot ventilation, multiple suction points and circulation of the air can be necessary in areas with poor "natural" air flow to avoid pockets of stagnant air.

The equipment for ventilation, dehumidifying and heating must have sufficient capacity to maintain the conditions specified for the coating system irrespective of variations in outer climatic conditions. The "Application Instructions" for the products in question contain information about recommended number of air shifts/hour and air supply/litre product to keep safely below LEL (lower explosion limit) and retain correct drying and curing conditions.

To prevent introduction and reintroduction of dust, solvent vapour etc. a light overpressure shall be maintained in the tank and care shall be taken to separation of the in- and outlet ducts in the ventilation system.

Depending on the construction of the ship any necessary heating of tank bottoms may take place by outside heating in a dry-dock or by heating via the double bottom ballast tanks.

Insulation of exterior hull-sides and weather deck may be required during wintertime in cold and temperate climates, but may also be an advantage during warm summer days and in tropical climates to prevent excessive heating of the steel on single skin vessels.



Relative humidity of the air (RH) during and after blasting is of importance for preventing re-rusting. A chemically clean steel surface, not to be confused with the preparation grades in ISO 8501-1, will stay free of corrosion in RH below 50 %. In case of exposure to normally occurring salts, fine dust, soot particles, etc. a max. limit of 40 % RH will still keep the surface from corroding. Some special salts, e.g. magnesium chloride from sea water has some strong absorbing ability that corrosion will take place at practically any level of RH.

Practical experience indicates that a mean value of approx. 40 % RH (never exceeding 50 %) during and after blasting process will keep the surface without any significant re-rusting. Should re-rusting occur, under these conditions it is a strong indication of the presence of water soluble substances, which should be removed due their very harmful impact on the service life of the coating.

#### ***Ventilation during blasting***

Ventilation during abrasive blasting should be balanced between the needs for visibility and low RH. It is important to fully utilise the ventilation capacity by arranging the flow in such a way that it flushes the work surface even if it means moving the in and outlet points according to the blasting progress

#### ***Ventilation, RH and temperature during the coating process***

Ventilation, RH and temperature during application, drying and curing shall be in accordance with the recommendations in the Technical Data Sheet and Application Instructions.

For HEMPADUR 15500 the steel temperature shall in general be minimum 10°C. During drying and curing of an individual coat, an exceptional temperature drop to minimum 5°C is, however, acceptable provided that:

- a. The coat has dried and cured at min. 10°C for a more than 6 hours before the temperature drop.
- b. The temperature drop down to, but not lower than 5°C has a duration of less than 8 hours

A temperature drop as defined here will have no practical influence on the minimum recoating intervals given in the Application Instructions for HEMPADUR 15500 at 10°C.

After application of the final coat, a longer time lowering to minimum 5°C is acceptable during curing, provided that:

- a. The last coat has been kept at above 10°C for minimum 5 days.



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- b. The temperature is raised to minimum 10°C for the remaining part of the curing time, as periods with temperatures below 10°C do not count as curing time

Application, drying and curing at temperatures near the lower limit must be closely monitored using well calibrated electronic temperature gauges.

Again it is of the utmost importance that the air flow is forced to flush all of the coated surface. It can be recommended to check the air flow at areas with a "difficult" design before the application in order to prepare the necessary ventilation arrangements.

### **3.6 Checkpoints**

<b>Check points</b>	<b>Method</b>	<b>Phase/Frequency</b>	<b>Criteria</b>	<b>Action</b>
Scaffolding: dust traps, cleaning, contact points and work space	Visual	During rigging	common sense	Re-rigging or special designation of areas
Wrappings	Visual	During rigging	Common sense	Re-rigging or special cleaning procedures
Ventilators Ducts	Evaluation of capacity versus specifications and application schedule	During rigging	Correct capacity and good working order	Replacement/repair/extra installations
Dehumidifiers	Evaluation of capacity versus specifications and application schedule	During rigging	Correct capacity and good working order RH below 40-50%	Replacement/repair/extra installations
Air flow	Smoke deployment	During rigging	Good ventilation of all surfaces	Rearrangement of ventilation system
Heating	Steel temperature	After rigging	Achieve minimum temperature	Installation of extra capacity or insulation
Lighting	Visual	Daily and by rigging	Minimum sufficient to read paper (see section 3.4)	Installation of extra light

The rigging of the work site shall be concluded with a joint inspection declaring the surface fit for surface preparation. This statement should further rest on the parties written approvals based on documented inspections of each check point. Alternatively non conformance reports shall be circulated.



#### **4.0 Steel and steel work**

This section deals with guidelines for preparing the steel surface for blasting and subsequent application of coating

Before a survey the surfaces must be cleaned and dried to allow adequate inspection.

It will often be beneficial to make a "mock-up" with all relevant welds, edges, openings, construction details etc. included. This should be used for establishing a reference for the different steel surface finish grades and surface preparation work.

#### **4.1 Design**

The construction must be designed in such a way that it will not interfere with the abrasive blasting or paint application according to this specification. No openings, holes, etc. in structural members of tanks shall be less than 50 mm in diameter and distances between structural members shall be above 50 cm as dictated by the possibilities for proper application of the paint.

In the case of one-coat tank coating systems, the in-service performance is extremely dependent on the optimum application of the paint film. A tank design which is as application friendly as possible - i.e. with fewest possible structural members within the tank - will play a very important role in achieving the full benefit of such systems.

Fittings and bolted items, see Section 6.7 Permanent installations

#### **4.2 Condition of steel and steel work**

Acceptable max. rust grade of raw steel is B according to ISO 8501-1: 1988. Areas of the raw steel with more rust than corresponding to grade B should be kept as a minimum and will call for extra attention both during surface preparation as well as during paint application. Note that non-corroded steel may show impressions from the hot-rolling very similar to the appearance of corroded pits in grade D steel.

Any parts of cast iron must have a non porous surface.

As the performance of the coating furthermore depends on the finish and the surface configuration of the steel work, the following rules are a condition for achieving a optimum performance:

Welding seams shall be smooth without holes, undercuts, cracks etc. Minimum corresponding to Grade D in "Weld Replica NACE RP 0178" Seams falling behind these requirements shall be remedied by grinding



and/or welding. Note, however, that some of the faults might first show up after blasting. They will then require repair.

Sharp edges shall be ground to a radius of minimum 2 mm or as a minimum be chamfered by three succeeding passes leaving no knife edges or whiskers. (Rolled profiles etc. from steel mills are normally acceptably rounded).

Undercuts and dents with sharp edges from mechanical impact shall be ground back to a smooth surface.

Weld splatter, lugs, brackets etc. shall be removed by chipping or grinding.

Laminations shall be removed by grinding and in severe cases levelled by welding (according to the classification societies' requirements). Note however that the hammering effect of the blasting might turn up laminations that have previously not been seen.

Gas cutting of edges in thick steel might have increased the hardness of the steel surface to an extent that prohibits the blast profile. The upper approx. 0.3 mm of the cutting edges shall be removed by grinding

All hot work like welding and flame cutting on the outer side of a tank must be finished before the tank is released for abrasive blasting and painting, or must be executed in such a way that the temperature of the coated side of the steel plates will not exceed 120°C at any time.

Most of the above work is carried out by disk grinder. This however, cannot get into corners and small openings where the grinding shall be done by the use of a high-speed drill. The conical stone is also recommended for cleaning pits and porosity's deeper than 3 mm. Such irregularities cannot be ground down to a smooth surface, but must be filled up by welding.

To facilitate the observation of porosity's and pinholes in welding seams it is recommended to pre-blast all seams prior to inspection of the steel work

If certain small defective areas cannot be remedied immediately, these areas shall be taped off for later repair and their positions noted. However, sufficient time shall be allowed at the steel survey so that any repair work may be carried out immediately. The same procedure can be used for areas discovered during the blasting process

#### **4.3 Chemical contamination**

A number of types of harmful chemical contamination can be present on the steel surface, most commonly:



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Welding smoke along manual welding seams containing alkaline salts. A zone of 2-8 cm on both sides of the seam can be checked with pH-paper. If the reading is above 9 the area shall be high pressure washed.

Water soluble salts in general for example originating from seawater shall be removed by high pressure fresh water hosing if the concentration is above 7  $\mu\text{g Cl/cm}^2$  (check by conductivity of water sample according to ISO 8502-6) or HEMPEL's "Coating Advisers' Handbook").

Oil and grease shall be removed irrespective of the concentration by washing with emulsifier followed by high pressure fresh water hosing (check by visual means combined with "chalk mark test" or checking the surface tension by applying water and seeing if it "beads").

Anti-spatter agents are in general NOT recommended. Observe the supplier's recommendations for cleaning and checkpoints.

Before blasting any deposits of grease or oil shall be removed from the steel surface with a suitable emulsifier followed by high pressure fresh water hosing. Minor spots of oil/grease may be cleaned with thinner and clean rags - avoid smearing out the contamination.

Alkaline weld deposits, possible chemicals used for testing of welds, or soap residues from the pressure testing shall be removed by high pressure fresh water hosing.

If welding seams have been exposed to the weather including rain for more than a month, they can be considered free from alkaline welding deposits. If in doubt then a check, as described above, shall be conducted.

steel plates may occasionally be contaminated with salts due to unfavourable conditions of transportation or storage. One or more high pressure fresh water hosing will then be necessary before the abrasive blasting is carried out (in severe cases even after blasting).

Before blasting, existing, old steel surfaces must be checked for any contamination. Existing blisters must be broken before washing.

If thick rust scale has been removed or deep pitting has been encountered after blasting, control procedures for contamination shall be carried out. If still contaminated, the abrasive blast cleaned steel surface will need a repeated cleaning for salts and/or oil/grease followed by a final abrasive blast cleaning.

Refer also to section 4.4



#### **4.4 Pitted steel and heavily contaminated steel**

Special care shall be taken in maintenance situation and when the steel surface is heavily pitted and contaminated.

**The following demands have to be complied with if the same guarantee as for a newbuilding coated with the corresponding Cargo Barrier are to be given. If this is not possible, the limitations within the guarantee must be based upon the actual condition.**

It is recommended to make a rough abrasive blast cleaning to facilitate visual inspection and any necessary repair of the existing steel work. For tank bottoms with pit corrosion this rough blasting will also provide a better basis for a decision about possible welding of corroded pits.

There is a possibility of contamination from both previous cargoes and sea water (water soluble and corrosive salts). This may be avoided by thorough cleaning by the ship's tank cleaning equipment. Various cleaning agents and water at the appropriate temperature shall be used. These will be dictated by the cargoes carried.

In case of only partial refurbishment, cleaning procedures and chemicals shall not harm or damage the existing coating.

In case of total refurbishment there is obvious no need to consider any possible damage to the existing coating by the cleaning procedure.

In case where the surface is contaminated, cleaning procedures must be repeated and/or improved. Pit corroded steel will need special attention and often the only possible way to remove contamination from the pits is abrasive blast cleaning followed by a very thorough cleaning with fresh water and detergents/ emulsifiers if necessary. Depending on the water quality and layout of the horizontal areas it may be necessary to manually remove the final rinse water. This can be done with scraper or even by mopping or vacuum cleaning especially where the water is pooled in depressions. This will avoid new deposits of salt contamination where the water is left to evaporate from the surface.

After repeated control and drying, the entire surface will need abrasive blast cleaning to obtain the specified degree of cleaning.



#### **4.5 Checkpoints**

<b>Check point</b>	<b>Method</b>	<b>Phase / Frequency</b>	<b>Criteria</b>	<b>Action</b>
Splatter	Visual	Before blasting	Not accepted	Removal by grinding
Laminations	Visual	Before blasting	Not accepted	Removal, grind/weld
Sharp undercuts	Visual	Before blasting	Not accepted	Repair, grind/weld
Rough welds	Weld Replica NACE	Before blasting	Min. Grade D	Grind/weld
Sharp edges	Visual	Before blasting	$R \leq 2 \text{ mm}$	Grind/chamfer
Lug, brackets etc.	Visual	Before blasting	Not accepted	Removal, grind
Porosity's in welds	Visual	Before blasting	Not accepted	Remedy, punch/weld
Welding smoke	pH-paper	Before blasting	$\text{pH} \leq 9$	Wash weld. zones
Oil and grease	Visual (rust pattern), "water beading" or "Chalk mark test"	Before blasting or on suspicion	No detectable amount are accepted	Wash with solvent or emulsifier and high pressure hosing
Soluble salts	ISO 8502-6 (conductivity)		Max. $7 \mu\text{g Cl} / \text{cm}^2$	High pressure hosing

The steel work phase should be concluded with a joint inspection declaring the surface fit for surface preparation. This statement should further rest on the parties written approvals based on documented inspections of each check point. Alternatively non-conformance reports shall be circulated.

#### **5.0 Surface preparation**

As for all paint systems tank coatings are also highly dependant on the standard of the surface preparation, if the preparation is below specification a reduction in performance can be expected, in other words the chemical resistance according to the latest edition of HEMPEL's Cargo Protection Guide as well as the anticorrosive performance cannot be met without the specified preparation and condition of the surface.

Chemical and physical cleanliness are considered of equal importance. The purpose of preparation is therefore to create a clean surface with a sharp dense roughness profile fit for the specified coating.

#### **5.1 Abrasive blast cleaning**

Before the blasting is started, the capacity of the ventilation system should be proven able of providing the desired ambient conditions: Clearing the dust from the work area, keeping the RH below 40 - 50 % and the steel temperature min. 3 degree C above dew point (see section 3.0).

Before starting the main blasting process a reference area should be blasted and jointly inspected by all parties for acceptance of degree of cleaning and roughness profile.

The "mock-up" described in 4.0 will be suited for such a reference of surface preparation.



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The steel surface must be abrasive blast cleaned according to ISO 8501-1:1988, Sa 2½-3. This demand is to be understood as Sa 3 at the moment of abrasive blasting, but giving allowance for a slight reduction to minimum Sa 2½ at the moment of paint application.

Irrespective of condition any shopprimer shall be removed. To facilitate the blasting process shopprimers shall have a colour contrasting to blasted steel.

All marking (paint) must be removed.

The surface profile must be equivalent to:

Rugotest No. 3, BN10a ( $R_a$  min. 12.5 microns/0.5 mil), or Keane-Tator Comparator, 3.0 G/S, or ISO 8503-1 Grit, Medium Grade (MG, where profile has to be above segment 2 and up to but excluding segment 3).

When blasting, the importance of working systematically must be stressed. Poorly blasted areas covered with dust are very difficult to locate during the blast inspection made after the rough cleaning.

At completion of blasting or a blasting shift, the area should be cleaned and checked by the yard's or the subcontractor's quality control (see check points in section 5.4).

It is recommended to use blasting abrasives which are supplied with a certificate, for example according to ISO 11124, parts 1-5; ISO 11125, parts 1-8; ISO 11126, parts 1-10 and ISO 11127, parts 1-8. Each delivery of blast media should then carry a certificate stating conformity against the ISO norms.

Blast media supplied on site without certificates shall be tested by the yard or the subcontractor in accordance with HEMPEL's instructions stated in Hempel's "Coating Advisor's Handbook" concerning:

- Level of water soluble salts (according to ISO 11127-6), max. 25 mS/m
- Contamination with oil / grease, no contamination accepted
- Hardness and grain size, practical test to produce the specified degree of cleanliness and roughness profile.

Properties of the blast media are to provide the specified blasting results, without leaving "smeared out" particles on the surface.

Tank, staging, etc. must be cleaned after blasting to remove all dust and abrasives of all surfaces, staging, etc. The final cleaning must be vacuum cleaning, which is the only acceptable method of dust removal.



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In cases where the entire tank is not abrasive blasted in one go, overlap zones must be treated with great care. Damage caused by over-blasting must be avoided, paint edges must be feathered and consecutive layers of paint coatings given greater and greater overlaps - previously applied coats being roughened corresponding to these overlaps (when sandpapering, use free-cut paper, grain size 80).

Protection against over-blasting damage of already painted surfaces (eg upper part of tank) may be done by masking off the coated areas within approx. half a metre from the un-coated zone.

Areas where blasting reveals pitting shall be recorded for a extra application with a thinned first coat brushed carefully into the pitting.

Areas where heavy pitting is revealed will be recorded and reservation will be taken.

Depending on the actual conditions, corroded pits may influence the durability of the cargo tank coating.

## **5.2 Maintenance of old coatings**

Overlapping of old cargo tank coating required extra care to be taken.

This is particularly important when dealing with organic tank coating systems and much attention has to be placed on proper feather-edging of overlap zones.

Furthermore, the old paint system must be examined very carefully for any possible defects such as, but not limited to, micro-blistering, weak intercoat adhesion, weak adhesion to the substrate and/or under film corrosion.

If such defects are not remedied, they will lead to reduced performance of the repair executed.

When overlapping old inorganic zinc silicate cargo tank coating with a new one, the overlap zone shall be kept as narrow and as straight as possible to facilitate a good overlap - avoid damage by over-blasting.

## **5.3 Checkpoints**

During inspection of abrasive blast cleaning, special care shall be taken to cover areas with difficult access. This shall be done using good lighting and mirrors. The same is valid for the final check of the cleaning for dust and debris, these contaminants can hide in all sorts of cavities, recesses and joints in the tank and the staging. For this reason the staging shall be carefully cleaned and the ventilation run at full capacity before the final cleaning is inspected.



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When checking ambient conditions special care shall be taken to record the full variation (hot and cold areas) of the steel temperature caused by - for example day/night rhythm, orientation to the sun, water level, inlet of heating etc.

Check point	Method	Phase / Frequency	Criteria	Action
Wrappings	Visual	Before start of blasting	Correctly mounted	Re-rigging or special cleaning procedures
Remove "blast wrapping"	Visual	After approval of blasting	Removed	Remove
Degree of cleaning	ISO 8501-1, 1988	By completion of rough cleaning	Sa 2½-3 No pitting	Reblasting Reservations
Roughness profile	Rugotest No. 3 Keane-Tator Comparator ISO 8503-1	20-30 spots picked at random represent. the tank	BN 10 a 3.0 G/S Medium Grade (MG)	Reblasting using more aggressive method or media
Rough cleaning	Visual	Full area by completion	Shall allow full inspection of blasting	Re cleaning
final cleaning	Visual	Full area by completion	No dust	Re cleaning by vacuum cleaner
Soluble salts	ISO 8502-6 (conductivity)	If pitting or rapid re-rusting	Max. 7 µg Cl / cm <sup>2</sup>	High pressure hosing
Oil and grease	"Chalk mark test"	On suspicion	No detectable amount is accepted	Wash with solvent or emulsifier and high pressure hosing
Laminations	Visual	By completion of rough cleaning	Not acceptable	Grinding and reblast/ rough grinding
Ambient conditions <sup>1)</sup>	Dry bulb temperature Wet bulb temperature Relative humidity Steel temperature Dew point	2-3 times/shift By changes in out door conditions Steel temp. at areas with extreme temp.	RH 40-50 % Steel temp. depending on product and 3°C > dew point	Improve conditions or stop blasting work

**Note:**

- (1) A calibrated capacitive RH - meter can be used. Measurement close to the specified criteria shall be double checked using a sling psychrometer.

The surface preparation process should be concluded with a joint inspection declaring the surface fit for coating. This statement should further rest on the parties written approvals based on documented inspections of each step in the process. Alternatively deviation reports shall be circulated.

**6.0 Paint application**

The application is more or less an ongoing process. This makes it very important that pumps are well maintained, equipped with clean hoses, spray guns and tips and that spare parts are at hand.

Paint of the specified type, with the correct temperature shall be stored on site in an amount relevant to consumption.



A smooth running process is a prerequisite for obtaining the expected coating properties.

As a general rule, it is recommended that the application be started from the lower part of the tank, working upwards to the deckhead. Any dust/dry-spray falling to the painted surfaces can be removed by very light sandpapering between coats. Covering the entire lower staging floor level with plastic will reduce the amount of dust falling to the tanktop considerably.

### **6.1 Ambient conditions**

The steel temperature must be maintained at least 3°C above the dew point during the whole application process. Curing and ventilation conditions must be as described in section 3.5 and the Application Instructions for the coating product applied.

When relevant, the temperature of the inlet air used to increase the steel temperature can be reduced during and after application of the tank coating. Only sufficient hot air should be supplied to keep the steel temperature of the tank at the temperature needed for drying/curing. Too large a volume of too hot air may lead to surface drying/curing and solvent entrapment.

The volume of air and the circulation over the coated surface must at all times be capable of removing the evaporating solvents at a rate ensuring drying conditions and keeping their concentration below 10% of LEL.

### **6.2 Standard of work**

It is of special importance that a continuous, properly coalesced and pinhole-free paint film is obtained at application of each coat. An application technique which will ensure good film formation on *all* surfaces must be adopted.

It is very important to use tips of the correct size, and that there is a proper, uniform distance from the spray gun to the surface. 30-50 cm shall be aimed at.

Furthermore, great care must be taken to cover edges, openings, rear sides of stiffeners, welding seams etc. Thus, on these areas stripe coating with brush is required.

To obtain good and steady atomising, the viscosity of the paint must be suitable and the spray equipment must be sufficient in output pressure and capacity. At high working temperatures, use of extra thinner may be required to avoid dust-spray.



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The paint coat must be applied evenly and as close to the specification as possible. The consumption of paint must be controlled to avoid excessive film thickness eg by controlling paint consumption and measuring wet film thickness.

Areas in line with the staging boards and around corners of corrugations are especially prone to dry-spray and/or poor film formation. Special care must be taken when spraying these areas.

An application technique which will reduce dry spray tendencies must be adopted. The coating must be wet and smooth just after application. At high working temperatures the use of extra thinner may be necessary.

During application the operators and/or their supervisor shall maintain a close monitoring of the wet film thickness (WFT) making sure that the WFT of each coat is kept on level with the specification.

Dry spray is not acceptable as this will reduce the protective properties of the paint and make later tank cleaning difficult. Dry spray can be avoided/reduced by using adequate staging, spraying equipment, parameters and procedures.

The finished coating shall appear as a homogeneous film with a smooth surface. Irregularities and contamination in the film such as dust, dry spray, abrasives, shall be remedied.

Cracking is normally considered a crucial fault to be remedied. If however, it is a zinc silicate coating exhibiting cracks, a thorough examination must be carried out to decide whether it is fine, hair-like cracking (checking-type) which does not reduce the properties of the cured paint film, or whether the cracking clearly gives a low mechanical strength leading to flaking later on. The first mentioned type does not necessarily need repair as opposed to the last type. In any case position and type of cracks must be reported.

### **6.3 Overlap zones**

The paint application is usually carried out as one operation to all interior areas of the tank, more or less following one of the procedures outlined in section 2.6, irrespective of which there will be overlap zones calling for special attention during both application and inspection:

In case of abrasive blasting executed in more than one go, precautions must be taken against damage by over-blasting.

Overlap zones and adjacent areas shall be easily accessible for inspection and repairs.



With multi-coat systems the various coats in the system must be applied in the overlap zone with greater and greater overlap of the subsequent coat over the preceding one.

Special attention to the overlap zones is required when recoating intervals are exceeded. Previously painted areas must be feathered and dry-spray removed to ensure good adhesion and a smooth surface.

The same precautions must be taken in case of section painting when section joints are treated.

Items treated prior to fitting in the tanks must be fully coated. Alternatively, the painted surfaces must be abrasive sweep- blasted or sanded to produce a uniform dull appearance to aid adhesion before further coating.

#### **6.4 Measurement of dry film thickness**

Dry film thickness control shall not be carried out within the first 24 hours after application of the final coat (20°C, sufficient ventilation). It should, however, be made soon enough to make rectifying of too low film thickness possible, ie within the recoating interval - see "Application Instructions" for the products. The measurements must be carried out using an electromagnetic dry film thickness gauge (ISO 2808 / 6Aa) calibrated with shims placed on a smooth steel substrate

The dry film thickness stated in the standard specifications are nominal dry film thickness (DFT). For measurement of the film thickness the following applies.

The minimum DFT is evaluated according to the "80:20"-rule unless otherwise agreed per specification. The "80:20"-rule means that no more than 20% of the total number of measurements must be below the specified DFT and no measurements must be below 80% of the specified DFT. For a standard specification of 3 x 100 microns (3 x 4 mils) this means no readings below 80 microns and max. 20% of the reading between 80 and 100 microns for the individual coats.

The maximum film thickness is stated in "Application Instructions" and shall be considered an absolute maximum for the film build, both on individual coat and coating systems.

For epoxy coatings the max. DFT per coat is 200 microns (8 mils) at steel temperatures above 15°C and 150 microns (6 mils) at steel temperatures below 15°C.

For zinc silicate coatings the max. DFT per coat is 150 microns (6 mils) independent of temperature.



Unusually high or low readings that cannot be repeated shall be discarded.

The practical execution of the final measurements, the following guidelines shall be followed:

- The number of measurements shall on average be 1 per 2 sqm. painted surface - a little less on regular surfaces and a little more on complicated and difficult to apply surfaces.
- The areas shall be selected so that all construction details are represented in the sample. The possible subcategorise of the tank surfaces could for example be:
  - plain bulkheads
  - deck with or without stiffeners
  - bottom
  - longitudinal bulkheads
  - transverse bulkheads
  - corrugated bulkheads
  - web frames
  - longitudinals, upper sides
  - longitudinals, under sides
  - bottom frames (if made with facebars, remember undersides of these)
  - brackets, knees and other small stiffeners
  - cargo pipes
- Furthermore, individual measurements shall be taken distributed to yield a representative profile of the coating thickness - for example distinguishing between open surfaces (smallest dimension > 150 mm) and narrow surfaces (smallest dimension < 150 mm).
- The selection of areas and measurement spots shall also reflect observation of application procedure etc.
- The location of over and under thickness shall be recorded. Marking of the individual area shall only be used when there is a clear understanding that the markings solely covers the faults found by the above procedure and not necessarily map the full extent of the non conforming areas.

#### **6.5 Holidays, pinholes and damaged spots**

The normal procedure for checking for bare spots and pinholes is through filling the tank(s) completely with fresh, natural sea water. The sea water shall be left in the tank(s) for minimum 24 hours before the tank(s) is/are drained.



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To a certain degree the extent of bare spots and pinholes can be detected by using the tank cleaning system. The tank is washed and closed, and the water allowed to stay in the bottom of the tank for minimum 3 days at a level that is high enough to cover possible stiffeners on the flat bottom and/or any heating coils. Preferably sea water shall be used to speed up the process of corrosion of the bare spots. If fresh water is used, the exposure period shall be at least doubled.

In case of zinc silicate coatings it should be stressed that small bare spots and small damaged areas usually will not show up by such short-term exposure because of the galvanic protection from the surrounding paint film.

Visual detection of damaged spots of the metallic grey, flat surface of zinc silicates is very difficult. It is therefore essential that the process of surface preparation and paint application is well planned and carried out by trained operator backed by a high level of QA resulting in the fewest possible number of holidays and damage. This is *also* valid for organic multi-layer coatings. A high working standard and discipline will always be the best way to prevent imperfections.

All areas of the tanks shall be hosed down with fresh water and the surface be allowed to dry and then checked for rust indicating bare spots, pinholes, damage, etc.

#### **6.6 Removal of staging or scaffolding**

Normally, staging is removed after the upper areas have been painted according to the specification and accepted by all parties concerned. On no account shall staging be removed until the (upper part of the) tank has passed all the check points. During removal of staging it is inevitable that damage will occur. Destaging damage is always difficult to see from the tank bottom. Consequently, a systematic repair and touch up shall be carried out during dismantling of staging. Start from the upper part and finish repair - note especially the fittings - before the next level of staging is removed.

Mechanical damage/bare spots observed after dismantling of staging should be repaired whenever possible.

#### **6.7 Permanent installations**

The tanks are equipped with a number of installations some coated before mounting, some in noble metals and some to be coated on site.

##### ***Piping system***

The large piping systems in cargo tanks, like cargo pipes, stripping lines, pipes for inert gas, and pipes for permanently fixed tank washing equipment, couplings, valves, pipe supports, etc. must, in case of being coated, be



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abrasive blasted internally (and/or externally), and coated with the full cargo tank system before installation. Also, supports for pipes should be abrasive blasted and coated before installation.

On approval by the Owner, pipes, supports etc. may be hot dip galvanised, or coated by fusion bonded epoxy powder, zinc silicate or epoxy or phenolic epoxy tank coating, as appropriate.

***Uncoated noble metal***

Such items, for instance heating coils, should be protected against over-blast by covering with rubber and over-spray by covering / wrapping with eg paper. Plastic is not recommended for this purpose, as the dry paint easily flakes off from this substrate and thus may contaminate the fresh paint of the bottom.

Whenever possible, items of stainless steel, brass or similar should be insulated from the tank surface to prevent the risk of galvanic corrosion.

***Fittings for scaffolding***

If fittings are made by stainless steel, great care must be taken to obtain a good paint film on the welding zone, in general at least covering the first 100 mm of the stainless steel to the tank surface. If approved by owner, the fittings may be hot dip galvanised.

***Bolted Installations***

Items assembled by bolts and, therefore, not later accessible for painting should before mounting be completely coated according to the specification, at least on the contact faces. It is recommended to make all bolts of a resistant stainless steel quality to avoid heavy corrosion of bolts and nuts. Protect the bolted items with plate washers of tetrafluoro ethylene polymer ("Teflon") covered with plate washers of stainless steel. Allow for sufficient space for mounting and tightening of bolts. Alternatively hot dip galvanised bolts may be used depending on owners' approval.

Damage caused by mounting of bolted items is to be repaired according to the repair procedures for small areas, see Section 7.2

**7.0 Checkpoints, reporting and documentation**

All stages of the tank coating work are to be logged and systematically recorded. It is essential that all information relating to the work is passed on to all relevant parties as soon as possible.

For the purpose of documentation several inspection forms and painting logs must be completed with the required data.



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It is important that the information requested on Daily Report Forms is recorded. Any problem encountered during the day shall also be recorded; for example paint problems, complaints, ventilation or dehumidification problems.

**7.1 Checkpoints during application**

Check point	Method	Phase/Frequency	Criteria	Action
Rigging of site <sup>(1)</sup>	As section 3.6	Before start-up	As of section 3.6	Re-rig, clean up
Application equipment	Inventory	Before start-up	Pumps, hoses, tips, wet film gauge etc. in order	Additional equipment
Arrangement of application equipment	Visual	Before start-up	Good shielded mix. and work procedures <sup>(6)</sup>	Rearrange
Ventilation system	As section 3.6	Before start-up and 2 times daily until full curing	As section 3.6	As of section 3.6
Wrapping	Visual	Before start-up	Correct mounted	Rearrange
Mixing, stirring and paint temperature	Observe procedure & condition record batch & consumption	By start-up and daily	According to data sheet, instructions & specified thickness	change procedures
Paint storage	Ambient conditions	Daily	Data sheet	Change conditions
Application schedule	Record time	At start-up	Max.4h since final inspection	Re-inspection
Stripe coating <sup>(2)</sup>	Visual (mirror)	After 1st. and 2nd. coat	Full coverage	Touch-up and full inspection routine
Individual coats <sup>(3)</sup>	Visual, (wft) and dft <sup>(4)</sup>	Each coat according to section 6.4	Full coverage, correct film formation, min/max dft according to specification	Touch-up, sanding, correct spray procedures or parameters

**Notes:**

- (1) Following the check point of section 3.6 precaution to avoid ingress of contaminants into the tank, precautions shall be taken. Used blast media shall have been cleaned away from the deck, and all openings into the tank shall be protected against ingress of dust and water. Operators entering the tank shall change to clean soft soled shoes or put on clean shoe covers.
- (2) Special care shall be taken on areas with difficult access.
- (3) WFT shall be taken during application by the operator, especially at the beginning of the application. DFT. to be taken as soon as the coating is dried. Visually the coating shall be uniform in colour, gloss and structure without spray dust, contamination of dust, debris or paint flakes and saggings. Again special care shall be taken on areas difficult to reach or cover by spraying, such as reverse sides, cut outs, corners, edges and welds.
- (4) DFT measurements to be taken according to ISO 2808, ISO 2178, SSPC-PA2 with a electromagnetic gauges calibrated in the region of the specified film thickness using shimps placed on smooth steel. The shims shall be with out any signs of wear and be verified according to a documented procedure.



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(5) Markings during inspections to be done with an ethanol based marker and kept as limited as possible.

(6) Preferably container with heating/cooling facilities.

### 7.2 Checkpoints for final inspection

Check point	Method	Phase/Frequency	Criteria	Action
Finish	Visual (mirror)	After completion of area before destaging	Uniform colour, gloss and structure, no sags, sticking spray dust and contaminants	Removal or sanding and touch up
Imperfections	Visual (mirror)	After completion of area before destaging	Full coverage. No pinholes, holidays and cavities	Sanding and touch up
Holidays, pinholes	Sea water test See section 6.5	After completion	No rusty spots or areas accepted	Repair, see section 8.0
Dry film thickness	Electro magnetical gauge (ISO 2808) according to plan <sup>(1)</sup>	After completion of area before destaging	According to min/max DFT in specification	Grinding, touch up or application of extra coat

**Note:**

(1) Develop a plan based on the guidelines in section 6.4.

### 7.3 Exception Reports

An Exception Report Form shall be issued for any deviation from the specification which is not suitably rectified. Subcontractor's, shipyard's and owners' representatives shall be notified of any deviation from the specification. The method of rectification shall be established by all parties concerned and approved or disapproved by HEMPEL. If the rectification is approved by HEMPEL, the Exception Form remains in force, but it shall be stated in the report that the rectification was approved by HEMPEL. If the rectification is not approved by HEMPEL and work is still in progress, an Exemption Form shall be issued, stating the reason why the recommended rectification was not carried out. Exception Forms are to be signed by representatives from all parties and copies to be retained by each party.



## **8.0 Repairs**

It is very important that all damage to the coating is repaired. The repair process should be started as early in the scheme as possible. It is important that the repaired areas, as well as the rest of the coated areas, are fully cured before the tanks are taken into use.

### **8.1 Materials for repair**

Repairs shall be carried out using the same coating materials as specified for the main work.

Please note that repairs by brush application *always* require additional number of coats compared to spray application.

### **8.2 Repair process**

Before mechanical surface preparation is started the areas to be repaired shall be cleaned for any salts and other contamination.

The various size of the repair area calls for different methods. In the following the procedure has be laid out distinguishing between three sizes.

Overlap zones shall be suitably prepared and coated.

#### ***Small areas***

Small areas are areas in this context less than 5 x 5 cm or scratches of up to a few millimetres across.

The surface preparation can be executed by grinding to a clean rough metal surface, feathering edges of intact coating and slightly roughening the adjacent surface and remove all dust.

Touch-up with the coating material specified using stippling for the first brush coat.

This method of repair is only acceptable in view of the risk of excessive damage by vacuum blasting or open nozzle blasting such small areas.

Cracks, in corners or at single runners, may preferably be repaired according to this method, even if they fall outside the area definition.

#### ***Medium sized areas***

Medium sized areas are areas up to 1 m<sup>2</sup>.



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Such areas have to be prepared by vacuum blasting or by open nozzle blasting (pencil blast) - depending on the extent of the repair. Precautions must be taken against damage from over-blasting.

Degree of surface preparation as of the original specification, see also section 5.2

Touch-up as described for small areas, however, spray application with narrow angle nozzles may be used.

**Large areas**

Areas larger than 1 m<sup>2</sup> or areas where several small damaged areas are concentrated.

The procedure is basically a repetition of the original specification. Precautions must be taken against damage from over-blasting.

**9.0 Coating systems**

According to individual painting specification and in accordance with HEMPEL's Cargo Protection Guide.

**10.0 Taking the coating into service**

"Zinc silicate coatings like GALVOSIL 15610 and GALVOSIL 15620 must not be steam cleaned during the first 30 days of service". Full curing according to relevant Cargo Protection Guide.

**THE INFORMATION GIVEN IN THIS STANDARD WILL NOT COVER ALL ASPECTS OF A TANK COATING JOB. WHILST WE ENDEAVOUR TO ENSURE THAT ALL ADVICE WE GIVE RELATING TO THE USE AND/OR APPLICATION OF OUR PRODUCTS (WHETHER IN THIS PAPER OR OTHERWISE) IS BOTH CORRECT AND USEFUL, WE HAVE NO CONTROL OF EITHER THE QUALITY OR CONDITION OF THE SUBSTRATE OR THE MANY FACTORS AFFECTING THE USE AND APPLICATION OF OUR PRODUCTS. THEREFORE ALL PRODUCTS DELIVERED AND ANY TECHNICAL ASSISTANCE GIVEN BY US ARE SUBJECT TO OUR GENERAL CONDITIONS OF SALE, DELIVERY AND SERVICE, AND, UNLESS OTHERWISE EXPRESSLY AGREED IN WRITING, MANUFACTURER AND SELLER ASSUME NO LIABILITY IN EXCESS OF THAT STATED THEREIN FOR RESULTS OBTAINED, INJURY, DIRECT OR CONSEQUENTIAL DAMAGE INCURRED FROM THE USE AS RECOMMENDED ABOVE OR OTHERWISE.**



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