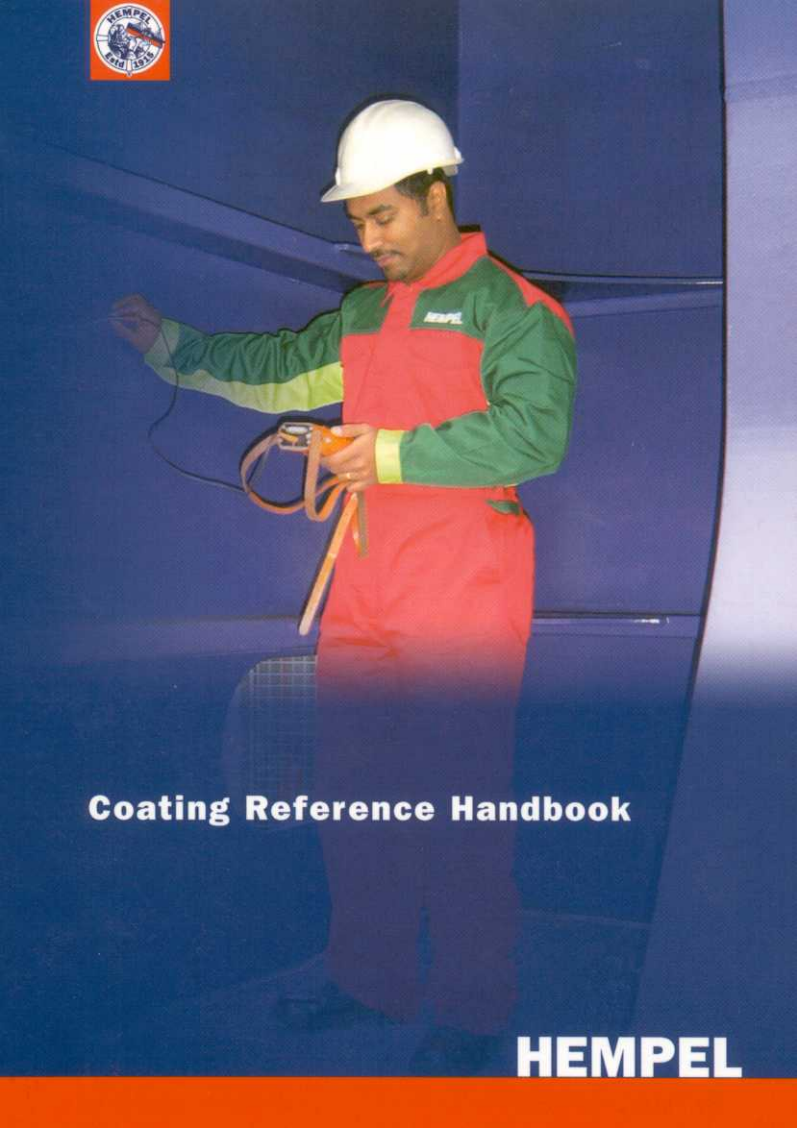

Coating Reference Handbook

HEMPEL

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Dear paint user,

This updated edition of Hempel's Coating Reference Handbook has been put together to help you get the best possible performance from Hempel's paints.

Originally developed as a tool for our own Coating Advisers by Hempel's Centre for Applied Coatings Technology, we hope a wider audience can benefit from the practical advice, data, references, procedures, equipment and standards used within the coatings industry.

Our own Coating Advisers use Hempel's Coating Reference Handbook every day and we hope that you will also be able to put it to frequent good use in getting the best out of your daily work with paint and coatings.

Pierre-Yves Jullien CEO,

Hempel

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Please Note:

Our ISO 9001-Certificated QA-system requires us to inform you that your possession of this Handbook is not registered at HEMPEL.
HEMPEL therefore cannot take responsibility for the accuracy and update of any information given in the Handbook at any time of its use and You are requested to seek such confirmation yourself.

The Coating Reference Handbook
is issued by
HEMPEL A/S
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SUBSTRATES S1

During your job you may run into a number of different substrates that has to be coated.
Below is given a list of the most common ones, and where you may meet them.

ORDINARY STEEL TYPES	
Constructional steel	Consider all these types equal. Same surface preparation acc to ISO 8501-1:1988. Cast Iron may have porous surface Therefore zinc silicates are not recommended on cast iron
Cast Iron	
Cor-Ten Steel	
STAINLESS STEEL TYPES	
Muffler Grade Steel	Muffler Grade is low quality Stainless Steel which should allways be painted: The others are the same paintingwise. **For instruction see S2**
Stainless Steel	
Seawater Resistant Stainless Steel	
ALUMINUM	
Extruded sheets and profiles.	All types to be treated equal. Cast aluminium should always be abrasive blasted **For instruction see S3**
Cast	
METAL COATED STEEL	
Hot dipped Galvanised Steel, fresh.	All unexposed surface should be treated equal. Weathered surfaces are usually easier to paint. **For instruction see S4**
Hot dipped Galvanised Steel, weathered	
Electrolytic Galvanized Steel Sheet	
Zinc - Aluminium Galvanized Steel	
METALLIZING	
Zinc Sprayed Metallising	All surfaces to be treated equal **For instruction see S5**
Aluminium Sprayed Metallising	
Zinc - Aluminium Metallizing	
CONCRETE	
All types	Surfaces preparation and sealing depend on later exposure. **For instruction see S6**

When meeting other substrates or in doubt always consult your TSD-Manager

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STAINLESS STEEL TYPES | S2

Most commonly used Stainless Steel types are:

TYPE:	ALLOYING	COMMON USE:
Muffler Grade Steel	8 -12 % Chromium	Side ond roof panels on Containers.
Stainless Steel:	18-21% Chromium + 8-11% Nickel	Chemical tanks and equipment. Side ond roof panels on Reefer Containers. Panels on transportation equipment
Seawater Resistant Stainless Steel:	As Stainless Steel + 2-3% Molybdenium	Various minor equipment in contact with sea-water (Filters etc).

SURFACE PREPARATION:

Surface preparation allways depends on later performance exposure. The more severe - the more thorough surface preparation is required.

For these substrates you cannot talk about ISO 8501-1:1988 and similar, since no millscale or rust is present on the surface.

What matters is to obtain the necessary adhesion of the coating.

Later Performance Exposure:	Min surface prep	Primer type	Total DFT
MILD	Degreasing	1, 2, 3 or 4.	80-110 micron
MEDIUM	Degreasing (+ Phosphating or Abrasive Sweeping)	1, 2, 3 or 4.	110-150 micron
SEVERE	Abrasive Sweeping to a dense profile	Standard Epoxy Barrier Coating	150-300 micron
IMMERSION	Abrasive Sweeping to a dense profile	Standard Epoxy Barrier Coating	250-300 micron

Primer Type (2006-status):	
1: For Alkyds	HEMPEL'S UNI PRIMER 13140
2: For Physically Drying	HEMPADUR 15552
3: For Epoxies and PU.s	HEMPADUR 15552
4: For WB Acrylics	HEMUCRYL 18200 or HEMUCRYL 18032

Indicated HEMPEL primers may not necessarily be found in the HEMPEL Book.

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ALUMINIUM S3

Most commonly used Aluminium types are:

TYPE:	COMMON USE:
Extruded sheets and Profiles:	Structural Elements, Facade Panels Side ond roof panels on Reefer Aluminium Hulls, Superstructures. Containers and on transportation equipment
Anodized Aluminium:	Sheets and profiles treated chemically to increase oxide laver.
Cast Aluminium:	Various minor equipment

SURFACE PREPARATION:

Surface preparation allways depends on later performance exposure. The more severe - the more thorough surface preparation is required.

What matters is to obtain the necessary adhesion of the coating.

Anodized aluminium cannot be painted directly. The anodizing must be removed beforehand by mechanical methods (abrasive blasting).

Later Performance Exposure:	Min surface prep	Primer type	Total DFT
MILD	Degreasing	1, 2, 3 or 4.	80-110 micron
MEDIUM	Degreasing (+ Phosphating. or Abrasive Sweeping)	1, 2, 3 or 4.	110-150 micron
SEVERE	Abrasive Sweeping to a dense profile	Standard Epoxy-barrier system	150-300 micron
IMMERSION	Abrasive Sweeping to a dense profile	Standard Epoxy-barrier system	250-300 micron

Primer Type (2006-status):	
1: For Alkyds	HEMPEL'S UNI PRIMER 13140
2: For Physically Drying	HEMPADUR 15552
3: For Epoxies and PU.s	HEMPADUR 15552
4: For WB Acrylics	HEMUCRYL 18200 or HEMUCRYL 18032

Indicated HEMPEL primers may not necessarily be found in the HEMPEL Book.

Avoid copper containing anti-foulings on immersed areas of aluminium hulls.

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GALVANIZING S4

Most commonly painted Galvanizing (Metal Coating) types are:

TYPE:	COMMON USE:
Hot dipped Galvanizing: (Fresh)	Structural Elements, Lightpoles, Handrails, Roadguards. Side and roof panels on Reefer Containers.
Hot dipped Galvanizing: (Weathered)	As fresh hot-dipped galvanizing.
Electrolytic galvanizing:	Sheets, bolts and minor equipment.
Zinc-Aluminium Galvanizing (Sendzimir)	Sheets, Facade Panels

SURFACE PREPARATION:

Surface preparation allways depends on later performance exposure. The more severe - the more thorough surface preparation is required.

What matters is to obtain the necessary adhesion of the coating.

Any white rust protection treatment of electrolytic or Sendzimir galvanizing must be removed.

Later Performance Exposure:	Min surface prep	Primer type	Total DFT
MILD	Degreasing */	1, 2, 3 or 4.	80-110 micron
MEDIUM	Degreasing + (+ Phosphating. **/ or Abrasive Sweeping)	2, 3 or 4.	110-150 micron
SEVERE	Abrasive Sweeping to a dense profile	Standard Epoxy barrier system	150-300 micron
IMMERSION	NOT RECOMMENDED		

*/ On weathered galvanizing white rust formation must be removed mechanically.

**/ Some tradenames for phosphatising solutions are LITHOFORM and "T"-WASH.

Primer Type (2006-status):	
1: For Alkyds	HEMPEL'S UNI PRIMER 13140
NB: Only for MILD exposure	
2: For Physically Drying	HEMPADUR PRIMER 15552
3: For Epoxies and PU.s	HEMPADUR PRIMER 15552
4: For WB Acrylics	HEMUCRYL 18200 or HEMUCRYL 18032

Indicated HEMPEL primers may not necessarily be found in the HEMPEL Book.

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METALLIZING S5

Most commonly used Metallizing types are:

TYPE:	
Zinc Metallizing:	Structural Steel in heavy duty environment.
Aluminium Metallizing:	Structural Steel in heavy duty environment and exposed to high temperatures.
Zinc-Aluminium Metallizing (85/15):	Structural Steel in heavy duty environment.

SURFACE PREPARATION:

Metallizings should be overcoated as soon as possible to avoid zinc- and aluminium salts to form from the very active surfaces. If done so no further surface preparation is required.

If already exposed, high pressure hosing and removal of zinc/aluminium salts by stiff brushes or in severe cases by abrasive sweeping is required.

Metallizings "pop" like zinksilicates and should be painted the same way ie. using a special sealer coat or flash-coat technic.

Sealer Type (2006-status):	
For Alkyds	NOT RECOMMENDED
For Physically Drying	HEMPADUR 45080 or preferably Flash-Coat Technic.
For Epoxies and PU.s	HEMPADUR 45080 or preferably Flash-Coat Technic.
For WB Acrylics	HEMUCRYL 18200 or HEMPADUR 45080

Total DFT depends on later performance exposure:	
MILD	80-110 micron
MEDIUM	110-150 micron
SEVERE	150-300 micron
IMMERSION	NOT RECOMMENDED

Indicated HEMPEL primers may not necessarily be found in the HEMPEL Book.

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CONCRETE S6

Most commonly used Concrete types are:

TYPE:	COMMON USE:
Straigth unreinforced low strength concrete:	Buildings
Straigth reinforced low strength concrete:	Buildings, Concrete elements, Swimming Pools General Purpose
Reinforced high strength concrete:	Bridges, Structural elements in Buildings, Silos, Water Treatment Plants.

SURFACE PREPARATION:

Concretes should be fully cured, (min 28 days for Portland Cement based Concretes) before coating. Uncured concrete is called "green" concrete and is alkaline.

Surface preparation always depend on later performance exposure. The more severe - the more thorough surface preparation is required.

Later Performance Exposure:	Min Surface Prep	Sealer Type	Total DFT.
MILD	1	1, 2, 3 or 4	60-120
MEDIUM	2	2, 3 or 4	80-150
SEVERE	3	3	100-200
IMMERSION	3	3	250-500

Minimum Surface Preparation:

1: Degreasing + Dedusting

2: Degreasing + High Pressure Water jetting or High Pressure Water Hosing with abrasive addition or Abrasive Sweeping.

3: Degreasing + Dry or Wet Abrasive Blasting.

Sealer Type (2006-status):	
1: For Alkyds NB: Only for MILD exposure	HEMPEL'S UNI PRIMER 13140 (thinned 25-30%)
2: For Physically Drying	HEMPEL'S UNI PRIMER 13140 (thinned 25-30%)
3: For Epoxies and PU.s	HEMPADUR SEALER 05970
4: For WB Acrylics	HEMUCRYL 28820

Indicated HEMPEL primers/sealers may not necessarily be found in the HEMPEL Book.

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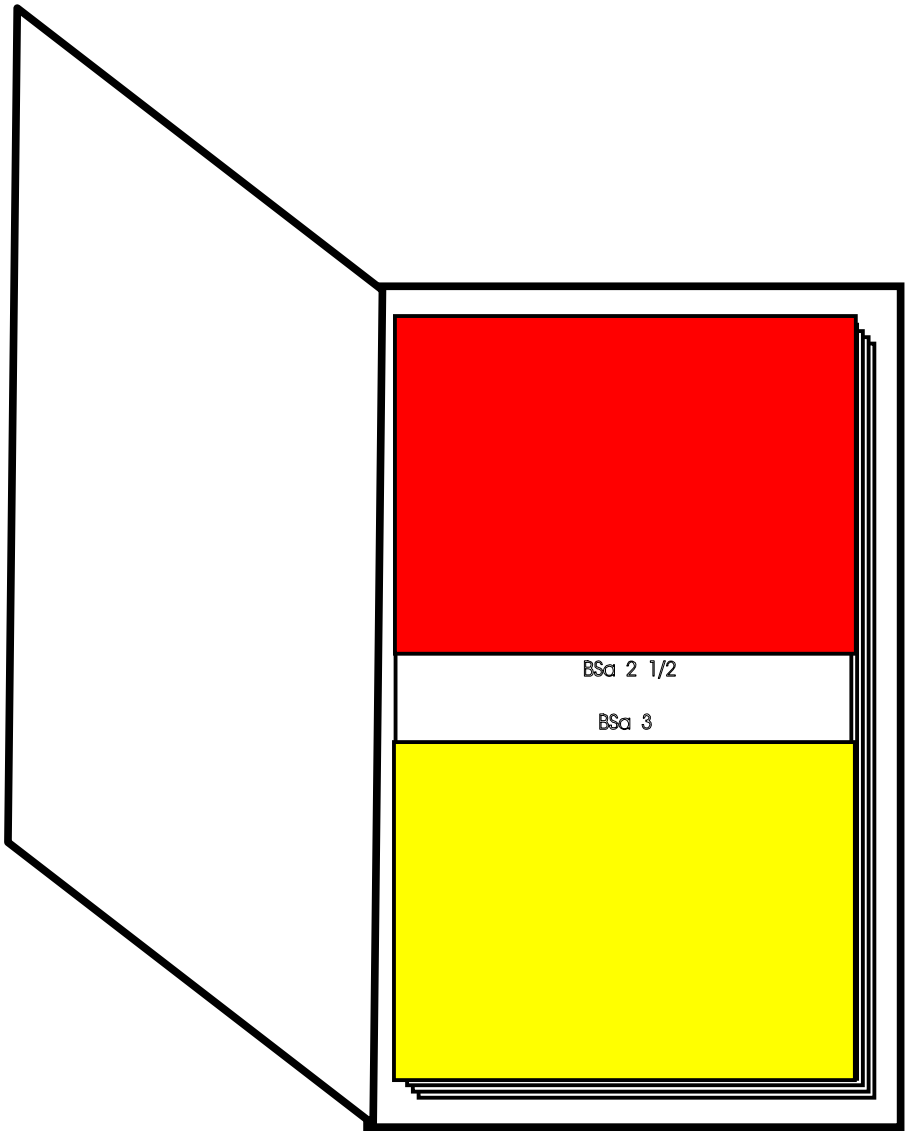
STANDARDS



STANDARDS ST1

Standards are established to assist in defining procedures and results concerning:

- Conditions of surfaces.
- Selection of methods.
- How to carry out methods selected.
- The quality of the final result.

Standards thus establish the basis on which the control work can be carried out, ensuring that all parties involved understand the requirements in the same way. In the coatng advisers field a number of standards are used. These can be divided into the following groups:

- Internationally recognized standards; should be known to every Paint Coating Inspector.
- National and Association Standards; Should be known to Paint Coating Inspector operating in that specific country.
- Yard Standards; should be known to Paint Coating Inspectors working at the particular yard.

Standards, both international and national, can usually be obtained through the National Bureau of Standards, whereas Association Standards and Yard Standards normally are obtainable at the source only.

The following tables give a survey of internationally recognized standards and some national standards of interest together with comments.

Remember to be specific when making reference to a standard in specificatons. General references to standard works such as Steel Structures Painting Council, ASTM or similar are not unambiguous and will, probably, cause discussion once the paint work has been started.

During the surveying make use only of the standards specified in the specification. If another standard at a later stage is becoming relevant everybody has to agree.

NOTE

Standards are updated at intervals.
You should be aware of the version(s) referred to in the painting specification.

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STANDARDS ST2

Check Point	Standard	Comments
Rust Grade of New Steel	ISO 8501-1: 1988	Photographic standard plus text. Only raw steel with millscale/rust. Rustgrades A, B, C and D.
	SSPC. Standard for the Preparation of Steel Surfaces prior to Painting.	National american standard.
Previously coated surfaces.	The European Scale of Degree of Rusting for Anti-corrosive Paints.	Photografic, Rating from Re 0 (No breakdown) to Re 9 (Complete breakdown). Old, but still very much used in containers (2003).
	ISO 4628/3-1982	Photografic, Rating from Ri 0 (No break-down) to Ri 5 (40/50 % breakdown).
	ASTM D 610	Photografic, Rating from 10 (No breakdown) to 1 (40/50 % breakdown).

Approximate equivalents are:

ISO rust scale	European rust scale	ASTM D 610
Ri 0	Re 0	10
Ri 1	Re 1	9
Ri 2	Re 2	7
Ri 3	Re 3	6
Ri 4	Re 5	4
Ri 5	Re 7	1 to 2

Oil / grease — No recommended standard is available.
See further Pages R3a-b.

Peeling / Cracking / Blistering — ISO 4628 Series. ASTM D 714 and family. These standards are mainly used in the lab. They can be of value at evaluation of existing coating condition.

Soluble salts on the substrate. — NACE/SSPC SP12 defines 3 levels for High Pressure Water Jetting. See further page R16a-b.
See also Page R6a - R6c especially for tank coating jobs.

ISO 8502-6	Bresle Sampling Method
ISO 8502-9	Conductivity Measurements

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STANDARDS ST3

Check Point	Standard	Comments
Preparation Grade See also Page R4	ISO 8501-1: 1988	Photographic standard plus text. Preparation grades St 2, St 3, Sa 1, Sa 2½ and Sa 3. Only visible contamination (i.e. no soluble salts) are considered. Interpretation may be necessary on surfaces blasted with other abrasives than quarts sand and steel grit/shot. Also on shopprimed steel and previously coated surfaces interpretation is necessary.
	ISO 8501-2:1994	Text plus photografic examples of preparation of shopprimed and previously coated surfaces.
	ISO 8501-4 DRAFT	Water-jetting Standard presently being drafted.
	SSPC-SP	American Standard, text. (See page R4a) Preparation grades: SP-5, SP-10, SP-6, SP-7 SP-3, SP-2, SP-11. Corresponds approximately to ISO 8501-1, but differences excist.
	SPSS, Japan 1975 DIN 55928 Teil 4	Other standards comparable to ISO 8501-2:1994 (See page R4b).
	NACE/SSPC SP 12	Standard for preparation by High Pressure Water Jetting. Deals with physical as well as water soluble salt cleanliness.
Roughness See also Page R 5	RUGOTEST No 3	Comparator type for judgement by eyeball, and finger touch.
	ISO 8503	Includes Comparator types for eyeball and touch judgement, microscopic evaluation and pin gauge.
	ASTM D 4417	Includes Keane-Tator Comparator, Testex tape and pin gauge.
Soluble Salts	Consult NACE/SSPS SP 12, ISO 8502-6 and 8502-9 and HEMPEL'S Photo Reference: HMP-STD*WJPHOTO*01-97 also see Pages R6a - R6d.	
Dust	ISO 8502-3	Tape method, classifying dust contamination in 5 ratings. Apply only, if specified and limits of acceptance have been agreed on beforehand. For containers also consult HEMPEL's Code of Practice No 9501-1.

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STANDARDS | ST4

Check Point	Standard	Comments
Dry Film Thickness See Calibration Guide CAL1	ISO 2808	This standard only sets demands to instruments to be used and how to calibrate them. Please DO NOT calibrate on steel surface with roughness. Use HEMPEL method in Calibration Guide CAL1 instead.
	HEMPEL'S CoP 0209-1	
	ISO 19840 SSPC-PA 2	New standards describing calibration, methods of measurements, sampling plans and decision rules. Use of these standards have to be specified and agreed upon before the survey is started. Please observe the special requirements in ISO 19840 regarding steel surface roughness compensation.
Adhesion NOTE: For all methods, coatings MUST be fully dry and cured before testing usually 1 - 2 months old.	ISO 2409	Cross-Cut and X-Cut test, not relevant for film thickness above 200 micron. Acceptable result MUST be agreed beforehand. MUST NOT BE USED FOR ZINCSILICATES.
	ASTM D 3359	X-cut and Cross-Cut. X-cut ususally easier to perform than Cross-Cut. MUST NOT BE USED FOR ZINCSILICATES.
	SIS 184171 ISO 4624	Pull-Off test method. Complicated for field application, but reliable on plane steel of min 6 mm thickness. Min pulling strength and type of acceptable failures to be agreed beforehand.
	HEMPEL'S CoP 0006-1	
	CoP 9803-1	1 MPa = 1 N/mm² = 10 Kgf/cm²
Pores		Low voltage wet sponge poretesters can be used to detect full penetrating porosity. 9V DC should be used, as higher voltage 67 and 90V may give wrong indications. High voltage dry testers are only to be used on critical jobs where a completely porefree surface is a must. Extent is then 100% and all pores repaired.
	HEMPEL'S CoP 0005-1	Too high voltage may destruct intact, safe and sound coating. Allways agree on voltage, extent and pore level on beforehand.
	DIN 55670	Deals with high voltage pore testing.
Appearence	ISO 2813	Gloss requirements in practice are delicate because spray-dust, condensation, surface wavyness etc. might easily reduce gloss locally below any accepted limit.

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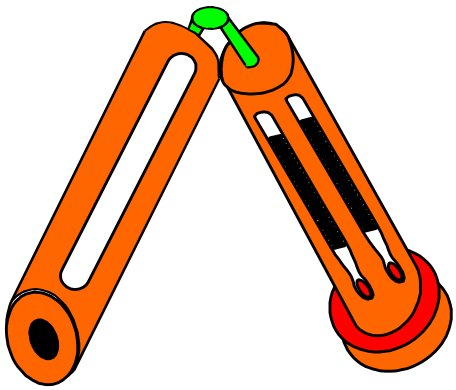
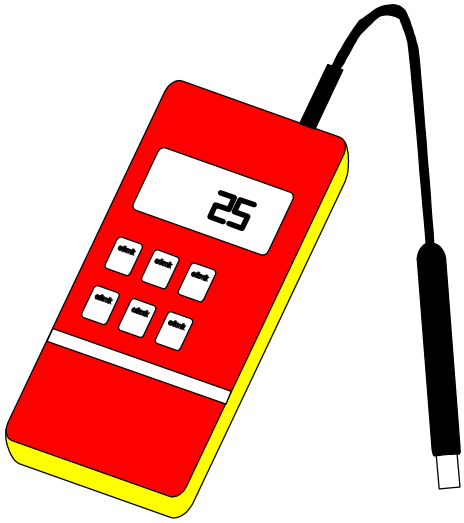
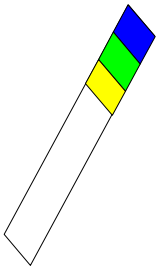
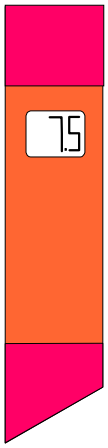
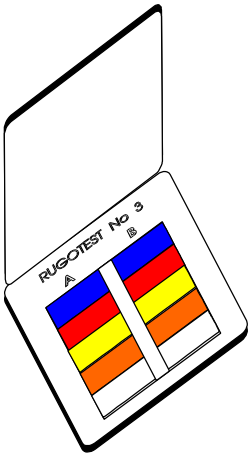
EQUIPMENT

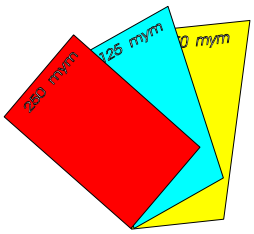


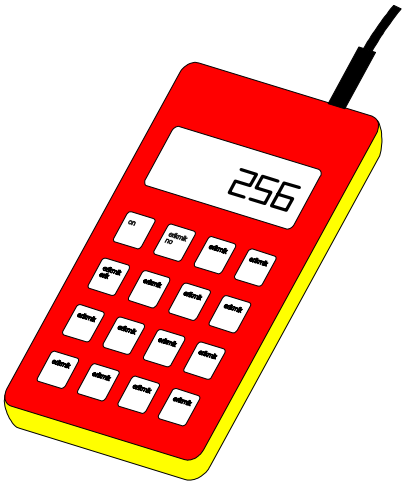












INSPECTION EQUIPMENT E1

The primary tools for the Coating Adviser are the eyes, the fingers and the mind.

Although electronic instruments and computers are in rapid development it should never be forgotten that such instruments can only supplement and assist - not replace - careful observations and logic thinking, planning and recording.

All instruments have their limitations. They are accurate only within limits of geometry and temperature and readings often have to be interpreted.
Correctly adjusted and used they are valuable tools for documentation.
Incorrectly adjusted or used they lead to misconclusions with - in worst cases - early failure of the coating as a result.

The equipment used for the job of coating application surveyance must be carried in a way that provides a safe moving around during the survey - and protects the often fragile instruments

A hard bag approx 35 x 30 x 15 cm with min 3 compartments (one for papers, one for fragile instruments and one for hard items) preferably with straps for shoulder carrying is to allow free hands operation is recommendable.
Such a bag also qualify as hand baggage on airlines and you should of course always carry your valuable equipment as hand bagage when travelling by air.

The equipment available for the job of coating application surveyance can convieniently be divided into 3 groups:

Modern electronic equipment need frequent adjustments. Follow the guidelines given on the pages:

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YOUR EQUIPMENT E2

Equipment	Type	Comments
DFT-Gauge	Small electronic	Accuracy of these instruments is usually 3-5%. Keep probe clean and free of wet paint and iron fillings. Measurements should not be made too close to edges and corners to avoid misreadings from magnetic field distortions.
WFT-Gauge	Metallic	Do not use plastic types, and discourage use of plastic types in general. Do not clean gauge with grinding paper or similar mechanical action. Always clean immediately after each measurement eg with thinner. Measurements should be made immediately (within seconds) after application. Not applicable to shopprimers and be careful with physically drying paints.
Sling Psychrometer	With two fixed thermometers	Make sure that the wet thermometer is moist with preferably distilled water. Sling for two (2) minutes, read, sling for another ½ minute, read, continue untill two consequtive readings give the same results. Those are the readings.
Dew Point Calculator	The disc-type is recommended	Consists of two overlapping discs with the same rotation centre.
Surface Thermometer	Mechanical or Electronic	Both types to be checked with a glas-type standard thermometer regularly, at least once a month.
Flash Magnifier		5-10 x magnification
pH-paper	Universal pH 0-14	Both paper and strips are usable
Knife		High quality steel, sharp.
Marking Chalk		Yellow or white, non-grease.
Filling Knife (Spatula)		Keep clean and sharp
Camera	Digital	Min 1.4 mill pixels. For tank jobs min 3 mill pixels. Do not forget when close-up's are taken also to include overall pictures of the same area. Never distribute pictures/films without the attachment of a descriptive photo legend.
Flashlight		Powerfull. Preferably halogen.
Angle Mirror		
Note Book and Ball Pen	Hempel Note Book	Use water-proof pens for writing
Marking Pens	Permanent Ink ,thick felt, ethanol based types.	Black, red and green.

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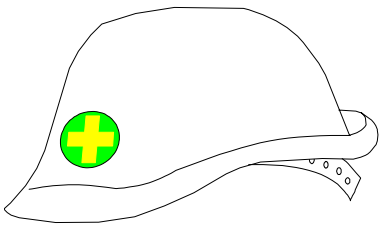
YOUR SAFETY EQUIPMENT E3

You are an important person, because you are doing an important job. Do what you can to take care of your health.

SAFETY FIRST

Equipment	Type	Comments
Safety Helmet	Any, approved by local authority.	
Pair of Safety Goggles	Any, approved by local authority.	
Pair of Safety Boots, Shoes	Any, approved by local authority.	
Pair of Gloves.		Avoid touching blast cleaned steel with your bare hands. Keep gloves clean of dirt, oil and grease, or renew.
Boiler suit, Coverall		
Respiratory Protective Mask		The mask should protect against dust as well as organic solvent fumes. Always bring a spare filter cartridge.
Tube of skin Protective Cream		
Medicine Box		A proposal for contents is given on page E4

YOUR SAFETY



Many work-sites have their particular rules of safety eg in refineries and on drilling and oil platforms. Before you enter work, always make sure that you know of these and is able to comply with these rules.

NOTE:
For special jobs eg tank surveys and tank coating jobs, particular precautions must be taken and particular equipment must be available and used.

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A Proposal for a MEDICINE BOX

E4
2006

For HEMPEL'S Danish Coating Advisers, our company doctor has composed the following medicine chest, which should carry only legal types of medicine, i.e. no drugs or other illegal substances.

Some of the names may be Trade Names, but usually chemists are able to identify such, and offer you identical types.

	Medicine	Against
1:	**Antistina Privin**	Irritation or allergy in the eyes.
2:	**Brentan Creme**	Skin Irritation
3:	**Ciloprin**	Earache
4:	**Diproderm**	Sunrash and allergy.
5:	**Fenoxcillin**	Infection in throat and lungs.
6:	**Fusidin**	Wound infection
7:	**Imodium**	Diarrhoea.
8:	**Chloramphenicol**	Infection in the eyes.
9:	**Codimagnyl**	Pain
10:	**Lucosil**	Infection of the urine tract
11:	**Pronoctan:**	Sleeping pills.
***:**		2 pcs injection syringes
***:**	Water repellant plasters	

Administration of the medicine is not indicated as it may vary from Brand to Brand, but read and follow the instructions along with the medicine very carefully.

HEMPEL undertakes no responsibility for any possible incompliance of the medicine indicated above with any local regulations prevailing.

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PROVIDABLE EQUIPMENT E5

Equipment	Type	Comments
DFT-Gauge	Magnetic and computer electronic	A straigthforward none-electronic should be available for jobs requiring non-spark equipment. A memory- and statistical dft-gauge should be available for heavy documentation jobs like tank coatings and containers, which would otherwice be too time consuming.
ISO 8501-1:1988		Surface preparation grades. Being a pictorial standard, a copy MUST be available to you in case of disputes of your judgement.
ISO 8501-2:1995		Preparation grades for other steel surface conditions than ISO 8501-1:1988, ie shopprimed surfaces and old painted surfaces. Note text is important. Photoes mostly examples.
HEMPEL'S Photo Reference: HMP-STD*WJPHOTO*01-97		Water Jetting
RUGOTEST or ISO 8503 or Keane Tator Comparator.		Surface roughness comparators. Being a comparator standard, a copy MUST be available to you in case of disputes of your judgement. Usually only the one most relevant in your area is necessary. (Consult also pages R5)
Pocket Microscope with ligth.		Magnification approx 10 x
Thermohydrograph (°C + %RH) with one weeks run.		To be used for monitoring application and curing conditions eg at tank coating jobs. When in use protect against contamination from blasting and painting.
X-cut template		In accordance with ISO2409 / ASTM D 3359.
Measuring Tape 25 mtrs		
Conductivity Meter		For evaluation of abrasives and possible surface contamination in connection with eg tank coating jobs.
Bresle Samplers		For evaluation of possible surface contamination in connection with eg tank coating jobs. For use consult page R6c and standard ISO 8502-6/ISO 8502-9.
Spare Parts for personal kits		Batteries, bulbs, thermometers, pH-strips, marking chalk, note books, small plastic bags for samples, films, filters for respiratory masks, skin protective cream, working gloves. Replenishments for medicine chests.

SPECIAL EQUIPMENT E6

Equipment	Type	Comments
Adhesion Tester	Saeberg Adhesion Tester, HATE	Only to be used if specification calls for it. Coating to be fully dried/cured usually 1 - 2 months before testing. Acceptable pull-off strength and type of failures to be agreed on beforehand.
High Voltage Poretester	0-15 kV adjustable DC.	Only to be recommended if coating is to be absolutely porefree. Inspection thus 100% and all pores to be marked and repaired. Testing voltage to be agreed beforehand.
Low voltage Wet Sponge Poretester	9V	67-90V types are not recommended due to unexplainable, faulty indications even on sound coatings Acceptable number of pores to be agreed on beforehand Only if requested according to customers spec.
BSRA-AHR Roughness Gauge	Instrument for assessing hull roughness of ships bottom.	Requires special training. Very seldom used today.
Surftester	ISO 8503	In the few cases where a surface roughness comparator may not be sufficiently precise for estimation of abrasive blasting roughness this delicate laboratory instrument type may assist.
A Set of sieves		For establishing grain size distribution of abrasives.
Standard Colour Cards	BS, RAL NCS	

GUIDELINES for TESTING VOLTAGE:

dft (micron)	Testing Voltage kV:
<200	DO NOT TEST
200-300	1
300-400	2
400-500	3
500-600	4
600-700	5
700-800	6
800-900	7
900-1000	8
>1000	(dft-200)/100

Too high voltage may destruct sound coating.

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HOW TO ADJUST YOUR: CAL 1

Electronic DFT gauge

WHY?

It is important for interpretation of measurement results, that the same procedures and methods are used. Dry film thickness is the item causing the most disputes about results.

HEMPEL always recommend the adjustment procedure described below.

HEMPEL working specifications are based on this procediure (HEMPEL CoP 0902-1).

HOW:

1 You must have in your possesion a smooth steel plate (1), free from oil, grease and milscale, and of a thickness not less than 3 mm for general steel and of 1.5-2 mm for containers.
If the plate gets rusty, clean it with fine 200 paper.

2 Your adjustment shims (2) must be clean and undamaged. Do not believe in the suppliers dft-indications. Have the shims measured with a suitable mikrometer.

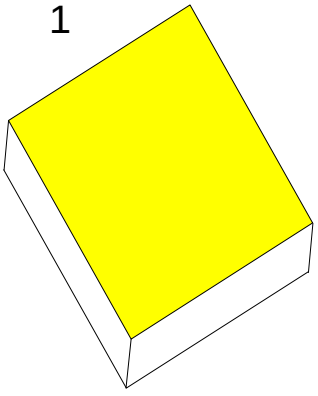
3 Put the DFT-Gauge probe directly on the smooth steel plate and adjust to zero.

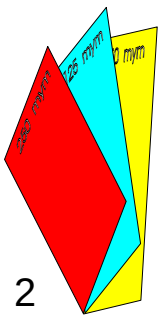
4 Select the shim, which is closest, but above the specified dft.
Put this on the steel plate and adjust the DFT-Gauge to the shim's value.

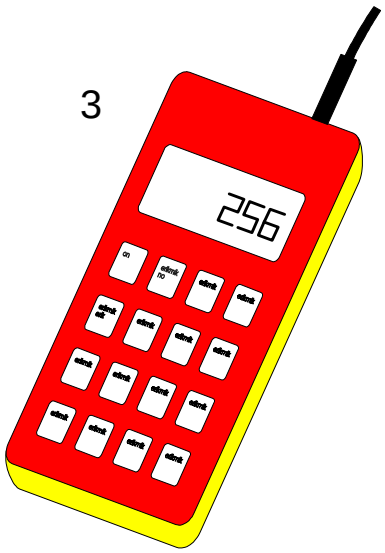
5 Repeat step 3 and 4 untill both adjustment points fit.

Now the DFT-Gauge is adjusted.

Note:
- Check adjustment of electronic gauges every day.
- Always adjust at the temperature, where you are going to measure.
- Keep the steel plate clean and free from rust. If you attach shims to the plate with adhesive tape, check the plate below the shims minimum every 14 days.







HEMPEL

HOW TO ADJUST YOUR: CAL 2

Electronic TEMPERATURE GAUGE

WHY?

Misreading of more than 0.5°C can severely affect your judgement of the possibility of condensation on the surface to be painted. Therefore your gauge must show right within this limit.

Electronic gauges tends to drift. Glass thermometers are usually stable.

HOW:

1 Find a correctly showing glass thermometer. The one in your sling thermometer will usually do.

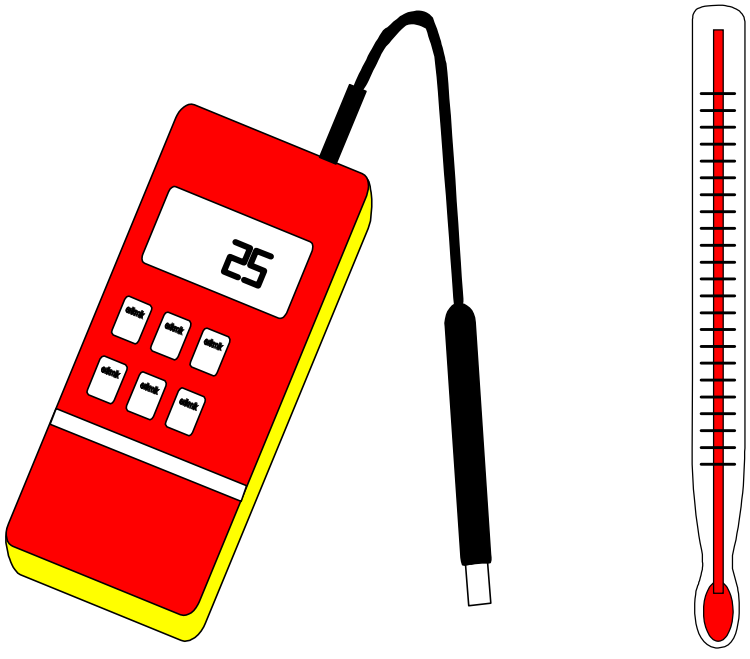
2 In your office (no drag), put your electronic gauge right next to the dry bulb thermoter, and leave them next to each other for at least 5 minutes Compare readings and note down the difference.

3 Find a cool or hot place (depending on where you are in the world, but always in the shade, and repeat 2/.

4 If the difference is the same in steps of 0.5°C and not more than 1°C you can use your temperature gauge. Just note down and remember to add or subtract the difference to your readings.

5 If the difference exceeds 0.5°C or is more than 1°C send your gauge to the supplier for adjustment - and check again on return. You should not try to adjust the instrument yourself, unless a clear instruction is given with the suppliers "How To Use" Manual.

Note: Repeat your check every 6 month!



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CHECK POINTS

HEMPEL

SUBSTRATE: **STEEL** **ISS1**

INSPECTION PHASE:

PREPARATION FOR SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
STEEL SURFACE	P1 a - c
WELDS	P2 a - b
OIL & GREASE	P5
BLASTING EQUIPMENT	P12
MECHANICAL CLEANING EQUIPMENT	P13
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
ACCESS	P7
LIGHTING	P6
QUANTITY OF PAINTS	P16
PAINT QUALITIES	P17
THINNER	P20
SHELF LIFE	P18

HEMPEL

SUBSTRATE: **STEEL** **ISS2**

INSPECTION PHASE:

DURING SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P8
BLASTING PROFILE	P10
STEEL SURFACE	P1b
OIL & GREASE	P5
WATER-SOLUBLE SALTS	P11b
BLASTING EQUIPMENT	P12
MECHANICAL CLEANING EQUIPMENT	P13
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
ACCESS	P7
LIGHTING	P6

HEMPEL

SUBSTRATE: **STEEL** **ISS3**

INSPECTION PHASE:

FINALIZING SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P8
BLASTING PROFILE	P10
STEEL SURFACE	P1b
OIL & GREASE	P5
DUST	P11a
WATER-SOLUBLE SALTS	P11b

HEMPEL

SUBSTRATE: **STEEL** **ISS4**

INSPECTION PHASE:

PREPARATION FOR PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P8
DUST	P11a
WATER-SOLUBLE SALTS	P11b
OIL & GREASE	P5
PAINTED SURFACE	P24 a-c
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
PAINT TEMPERATURE	P28
APPLICATION EQUIPMENT	P15
VENTILATION	P29
ACCESS	P7
LIGHTING	P6
PAINT QUALITIES	P17
QUANTITY OF PAINTS	P16
CURING AGENT	P19
THINNER	P20
THINNING	P21
MIXING/STIRRING	P22

HEMPEL

SUBSTRATE: **STEEL** **ISS5**

INSPECTION PHASE:

DURING PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
PAINT TEMPERATURE	P28
APPLICATION EQUIPMENT	P15
VENTILATION	P29
ACCESS	P7
LIGHTING	P6
PAINT QUALITIES	P17
QUANTITY OF PAINTS	P16
CURING AGENT	P19
THINNER	P20
THINNING	P21
MIXING/STIRRING	P22
WET FILM THICKNESS	P23

HEMPEL

SUBSTRATE:	STEEL	ISS6

INSPECTION PHASE:

FINALIZING PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
APPLICATION EQUIPMENT	P15

HEMPEL

SUBSTRATE:	STEEL	ISS7

INSPECTION PHASE:

FINAL SURVEY

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
PAINTED SURFACE	P30 a-c

HEMPEL

SUBSTRATE: **CONCRETE** **ISC1**

INSPECTION PHASE:

PREPARATION FOR SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
CONCRETE	P3
CONCRETE SURFACE	P4
OIL & GREASE	P5
WATER JETTING EQUIPMENT	P14
BLASTING EQUIPMENT	P12
MECHANICAL CLEANING EQUIPMENT	P13
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
ACCESS	P7
LIGHTING	P6
QUANTITY OF PAINTS	P16
PAINT QUALITIES	P17
THINNER	P20
SHELF LIFE	P18

HEMPEL

SUBSTRATE: **CONCRETE** **ISC2**

INSPECTION PHASE:

DURING SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P9
BLASTING PROFILE	P10
CONCRETE SURFACE	P4
OIL & GREASE	P8
WATER JETTING EQUIPMENT	P14
BLASTING EQUIPMENT	P12
MECHANICAL CLEANING EQUIPMENT	P13
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
ACCESS	P7
LIGHTING	P6

HEMPEL

SUBSTRATE: **CONCRETE** **ISC3**

INSPECTION PHASE:

FINALIZING SURFACE PREPARATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P9
BLASTING PROFILE	P10
CONCRETE SURFACE	P4
OIL & GREASE	P5
DUST	P11

HEMPEL

SUBSTRATE: **CONCRETE** **ISC4**

INSPECTION PHASE:

PREPARATION FOR PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
PREPARATION GRADE	P9
DUST	P11
OIL & GREASE	P5
PAINTED SURFACE	P24 a-c
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
PAINT TEMPERATURE	P28
APPLICATION EQUIPMENT	P15
VENTILATION	P29
ACCESS	P7
LIGHTING	P6
PAINT QUALITIES	P17
QUANTITY OF PAINTS	P16
CURING AGENT	P19
THINNER	P20
THINNING	P21
MIXING/STIRRING	P22

HEMPEL

SUBSTRATE: **CONCRETE** **ISC5**

INSPECTION PHASE:

DURING PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
DEW POINT	P27
PAINT TEMPERATURE	P28
APPLICATION EQUIPMENT	P15
VENTILATION	P29
ACCESS	P7
LIGHTING	P6
PAINT QUALITIES	P17
QUANTITY OF PAINTS	P16
CURING AGENT	P19
THINNER	P20
THINNING	P21
MIXING/STIRRING	P22
WET FILM THICKNESS	P23

HEMPEL

SUBSTRATE: **CONCRETE** **ISC6**

INSPECTION PHASE:

FINALIZING PAINT APPLICATION

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
APPLICATION EQUIPMENT	P15

HEMPEL

SUBSTRATE: **CONCRETE** **ISC7**

INSPECTION PHASE:

FINAL SURVEY

CHECKPOINTS	CHECKPOINT No
AIR TEMPERATURE	P25
SURFACE TEMPERATURE	P26
PAINTED SURFACE	P30 a-c

HEMPEL

CHECKPOINT **STEEL SURFACE** **P 1a**

WHY?

Certain "contaminants" may not be sufficiently removed or cleaned out by the surface preparation specified:

* **SALTS**
* **PITTINGS**
* **ANTISPATTER AGENT**

Salts are not removed by mechanical methods. It will cause osmotic blistering of the coating, reduced adhesion and underrusting.

Pittings invariably contain salts, see above. Also pitted areas receive less dft, when sprayed, causing premature rusting through.

Antispatter agents may be incompatible with the coating, resulting in adhesion failure and osmotic blistering later on with peeling and premature rusting/fouling as a result.

CORRECTIVE ACTIONS:

Salts must be removed by water. Recommend high pressure fresh water hosing or water hosing at the same time using stiff brushes.

For excessive pittings the water hosing must be done during or after the pits have been cleaned up. Recommend wet abrasive blasting or dry blasting followed by high pressure hosing followed by dry blasting again.

Watersoluble Antispatters must be removed by water. Other types must be removed by solvent cleaning.

PREVENTIVE ACTIONS:

Against salts advice to store under shelter or to establish a procedure of fresh water cleaning before material is taken into manufacture.

For pittings advice manufacturers to avoid using pitted, old steel in high performance areas. For refurbishment / dry dockings recommend to include a freshwater hosing /wet blasting in the working procedure as described above under CORRECTIVE ACTIONS.

Discourage the used of antispatter agents or recommend a cleaning procedure as described above under CORRECTIVE ACTIONS.

HOW TO DETECT:

Visually
ISO 8501-1:1988

Salts are difficult to detect. Usually extended exposure to marine or industrial outdoors environment will mean salt contamination.

For CARGO TANK COATINGS and other critical jobs consult the specification and page R 6 a-c.

HEMPEL

CHECKPOINT **STEEL SURFACE** **P 1b**

WHY?

Three additional potential defects of a steel surface are important:

* **LAMINATIONS**
* **SHARP EDGES**
* **DENTS / BURRS**

None of these are removed or smoothened sufficiently by abrasive blasting.

Laminations are overrolled steel from the milling process. A crevice with millscale and contaminants are formed below the surface. Paint cannot penetrate, but water later have plenty of time to do so, causing premature corrosion.

Sharp edges and the contour of dents and burrs produce too low paint film thickness and thus cause premature corrosion as well.

CORRECTIVE ACTIONS:

Laminations must be ground off, in severe cases followed by rewelding.
NOTE: Some laminations are difficult to see on raw plates, therefore check also after abrasive blasting has been carried out.

Sharp edges must be rounded off by grinding.
Dents and burrs must be smoothened by grinding

Areas may require stripe-coat.

PREVENTIVE ACTIONS:

Laminations do occur, even on well rolled plates, but are more frequent from poor steel rolling mills. You cannot do much about it, except correct as given above

Some sharp edges may arise from poorly maintained cutting tools. Talk to QC about such.

Dents and burr may be caused by careless handling of plates or malpractice. Again talk to QC about it. For tankcoatings do not accept markings.

HOW TO DETECT:

Visually, with your knife or spatula and by finger touch.
Unless otherwise specified, edges should not feel sharp by the touch of your finger and be without irregularities
As-rolled edges are normally OK.

ISO has developed a standard for steel surface condition in connection with coatings.
This standard is ISO 8501-3.

HEMPEL

CHECKPOINT **STEEL SURFACE** **P 1c**

The general condition of the steel surface may be different from that being the background for the specification, thus influencing the specified surface preparations possibility of achieving the expected result.:

* **MILLSCALE**
* **RUSTGRADE**
* **TYPE AND CONDITION OF SHOPPRIMER.**

WHY?

Millscale is more noble than steel. If insufficiently removed it will create galvanic corrosion between steel and millscale causing the millscale to peel off together with any coating on top of it.

Knowledge of the rustgrade is necessary to select correct picture for later assessment of the preparation grade.

If shopprimer is not correctly selected and applied (See page R7a-c) saponification, flaking or excessive salting below the paint film may occur causing blistering, peeling and premature corrosion/fouling of the coating on top.

CORRECTIVE ACTIONS:

Millscale must be removed by a suitable method, generally abrasive blasting, to a preparation grade necessary for the coating system and later exposure environment.

PREVENTIVE ACTIONS:

Report about the conditions observed so that these conditions can be taken into considerations in the future.

HOW TO DETECT:

Visually
ISO 8501-1:1988
Yard/Contractors shoppriming specification.
Dry film thickness gauge

NOTE: You cannot measure dry film thickness of a shopprimer directly on abrasive blasted steel, See page R 7 a-c for guidance.

HEMPEL

CHECKPOINT	WELDS	P 2a

WHY?

Welds can be contaminated from the welding process itself. Important checks for this are:

* **SPATTERS**
* **SLAG**
* **SMOKE**
* **BURN-BACK**

* Spatters are not removed totally by abrasive blasting.The contour of a spatter will produce both a too low dft and a shading effect upon paint spraying.
* Slag is formed because of the high temperature during welding. Certain mechanical cleaning methods e.g. wirebrushing do not remove slag.
* Smoke, especially from alkaline electrodes may deposit an alkaline watersoluble substance, that can cause osmosis.
* Burn-back means the an applied shopprimer or other coat deteriorates along or on the rear side of welded areas. The primer looses its adhesion, is partly destroyed, charred and oxidized, which may require more extensive surface preparation than specified.

CORRECTIVE ACTIONS:

* Spatter must be removed by chipping or grinding.
* Slag must be removed by the use of a chipping hammer.
* If alkaline smoke has been exposed to open weather more than one month, no correction is required. Otherwise high pressure hose the welds carefully with fresh water.
* Burn-back should be cleaned carefully to min St 3, ISO 8501-1,1988, if no better surface preparation is specified.

PREVENTIVE ACTIONS:

Excessive spatter is often caused by the weld operators working too fast and with wrong weld parameters. You cannot instruct them, but talk to paint foreman or QC-Department about consequences for surface prep workers.

Welding in shopprimer may be the cause of porosity, when doing MIG/MAG welding. Grinding to reduce dft or remove shopprimer at weld lines may be a solution. Some manual weld positions (vertical) will cause irregular welds.

Slag should be removed by the welder. It is an agreed part of his job.

Burn-back and smoke is not possible to prevent.

HOW TO DETECT:

Visual and by touch.

ISO has developed a standard for steel surface condition in connection with coatings.
This standard is ISO 8501-3.

HEMPEL

CHECKPOINT	WELDS	P 2b

WHY?

Welds are irregular areas along more even areas. Important checks for suitability to be protected are:

* **IRREGULARITIES**
* **UNDERCUTTING**
* **POROSITY**

* Irregularities, i.e. wire residues, protrusions etc. are not removed totally by abrasive blasting. The contours may produce a local low dry film thickness upon paint application resulting in premature local rusting and blistering on submerged areas.
* Undercutting produce a deep sharp edged valley in the steel next to the weld. Similar to irregularities this cannot easily be covered with sufficient paint.
* Porosities may contain millscale and weld flux residues, that are not cleaned by mechanical methods incl. blasting. Paint cannot penetrate and cover such porosity.

CORRECTIVE ACTIONS:

* Irregularities must be ground smooth, so that they do not feel sharp or protruding, by feeling with your finger, or as specified in the working specification.
* Undercutting must be ground smooth or rewelded if too deep.
* Porosity must be removed by grinding, or rewelding. If later exposure is of low corrosivity, a suitable filler is acceptable.

PREVENTIVE ACTIONS:

Excessive undercutting, porosity and irregularities are often caused by the weld operators working too fast and with wrong weld parameters. You cannot instruct them, but talk to paint foreman or QC-Department about consequences for surface prep workers.

Welding in shopprimer may be the cause of porosity, when MIG/MAG welding. Grinding to reduce dft or remove shopprimer at weld lines may be a solution. Some manual weld positions (vertical) will cause irregular welds.

HOW TO DETECT:

Visual and by touch.

At tankcoating jobs it may be advantageous to have the welds blasted before the inspection of the steel surface. Some porosity and undercutting do not show up until after blasting.

ISO has developed a standard for steel surface condition in connection with coatings.
This standard is ISO 8501-3.

HEMPEL

CHECKPOINT	CONCRETE	P 3

WHY?

Contrary to steel the "inside" condition of concrete may influence coating performance.
Before coating - especially with high performance coatings - the concrete should be:

- **FULLY CURED**
- **FREE FROM WATER & CAPILLARY ACTION**
- **SUFFICIENTLY STRONG**

Uncured concrete is strongly alkaline, which may saponify especially alkyd coatings leading to poor adhesion and peeling.

Too much water - more then 4%w/w - lead to loss of adhesion and consequently to peeling. Subsoil capillary action may continuously attract water above this level.

A week concrete may have too low internal strength to carry a heavy duty coating leading to flaking in the concrete and peeling during service.

CORRECTIVE ACTIONS:

If uncured you will have to wait until the concrete is cured. Any paint applied should be removed by blasting.

Normal Portland cement cures in 28 days at 20°C/68°F.

If water content is in excess of 4%w/w or capillary action is discovered contact HEMPEL for advice in each separate situation.

If the strength of the concrete is not up to specification contact HEMPEL for advice in each separate situation.

PREVENTIVE ACTIONS:

Advice contractor to plan paintapplication according to the time specified for full cure of the cement used for the concrete.

Inform the contractor about findings of too high water content, any discovered capillary action or too low strength and ask him to take action.

HOW TO DETECT:

Record date of casting and compare to date of painting. Casting date can be obtained from contractor.

Special equipment is necessary for measurement of water content. Serious contractors should have such equipment available, otherwise contact HEMPEL. Capillary action can be revealed by placing a rubber matt on the surface for 1 day. After removal there should not be humid concrete underneath.

Concrete strength may be determined using the Pull-Off test method. Acceptable strength must be specified beforehand.

HEMPEL

CHECKPOINT **CONCRETE SURFACE** **P 4**

WHY?

Certain "contaminants" may not be sufficiently removed or cleaned out by the surface preparation specified:

- **LAITANCE**
- **FORM OIL**
- **EFFLORESCENCE (White Exudations)**

Laitance is a cementitious sludge layer often formed on concrete surfaces during casting. It has low internal strength and easily peels together with any paint on it.

Form Oil (Slip Agent) is used in casting forms to allow easy removal after the casting of the concrete. It has properties similar to Oil and Grease, see Checkpoint 5.

Efflorescence means water soluble salts brought to the surface by water moving from the interior of the concrete. It has the effect of salts, see Checkpoint 1a.

CORRECTIVE ACTIONS:

Laitance should be removed by high pressure water hosing with abrasive addition or high pressure water jetting. Small areas may be mechanically cleaned.

Form oil is removed by emulsifier cleaning. The concrete surface should be saturated with fresh water before applying the emulsifier. The latter to be removed again with fresh water hosing.

Efflorescence should be removed by high pressure hosing (min 150 Bar). Small areas may be mechanically cleaned or hydrochloric acid treated (Careful with this!).

PREVENTIVE ACTIONS:

All three occurrences above are usually related to the manufacturing and casting procedures, decided upon by the contractor.

Make sure you notify him of the observations including the consequences for extra surface preparation needed.

HOW TO DETECT:

Visually
For laitance also scraping with a good knife

For form oils also "Water-on-Goose" Test.

HEMPEL

CHECKPOINT

OIL & GREASE

P 5

WHY?

Oil and grease is not removed by mechanical surface preparation methods. Contrary it picks up on recycled abrasives and tools, which may then contaminate further areas, when used.

Oil and grease prevents adhesion of subsequent coat to be applied, later resulting in poor mechanical resistance and peeling of the paint film, even on its own.

CORRECTIVE ACTIONS:

Areas affected must be degreased before continuing.
Large areas should be cleaned with emulsifier followed by high pressure fresh water hosing, alternatively stiff brushes and flushing with fresh water.
Spots may be cleaned with solvent and clean rags.

PREVENTIVE ACTIONS:

Locate sources of oil spillage. Influence repair of leakage and manners of the working force, i.e. no spillage and oily boots.

HOW TO DETECT:

Visually, often appears as dark spots.
"Water-on-Goose"-test.

Chaulk-Test:

Chaulk will often slide on oil, leaving much less of a chaulk line here than on surrounding oil-free surface. (See page R3)

HEMPEL

CHECKPOINT

LIGHTING

P 6

WHY?

Improper lighting makes it impossible for the executor to see the area and the surface to be treated properly and therefore to achieve a proper result of the job. Also the inspector will not be able to check the outcome satisfactorily.

The result will be insufficient surface preparation and/or insufficient filmformation and extremely variable dry film thickness of the coating system leading to millscale and rust residues, locally insufficient roughness of the substrate, pinholes in the paint film in some places and solvent retention and sagging in others.

The final consequence will be early rusting and fouling, low chemical resistance and poor aestetical appearance.

Proper lighting means being able to read normal newspaper print at any area of the construction to be treated. Local shadows should be avoided.

CORRECTIVE ACTIONS:

Rearrange lighting to areas affected to fulfill above requirement. Inspect treated substrate and retreat areas not acceptable.

In case of excessive film thickness, saggings or severe pinholing remove affected paint by grinding before repainting.

PREVENTIVE ACTIONS:

Rearrange lighting to fulfill above requirement.

Optimum lighting is often achieved by a combination of stationary general lighting for safety and orientation, combined with moveable lighting for precise adjustment to the area being treated at any time.

Lighting sources should be protected with replaceable protectives e.g. clear plastfoil for protection against spray dust.
Low voltage lamps are to be used in confined spaces.

HOW TO DETECT:

Visually.

It is strongly advised to form an impression of safety of lighting at the same time also for your own safety.

HEMPEL

CHECKPOINT	ACCESS	P 7

WHY?

Improper access to a surface to be painted makes it impossible for the executor to achieve a proper result of the job and for the inspector to evaluate the outcome.

The result will be insufficient surface preparation and/or insufficient filmformation and extremely variable dry film thickness of the coating system leading to millscale and rust residues, insufficient roughness of the substrate, pinholes in the paint film in some places and solvent retention and sagging in others.

The final consequence will be early rusting and fouling, low chemical resistance and poor aestetical appearance.

Proper access means a distance of approx. 30 cm (1 foot) from the working tool the substrate at any location of the construction.

CORRECTIVE ACTIONS:

Rearrange access to area affected to fulfill above requirement. Inspect treated substrate and retreat areas not acceptable.

In case of excessive film thickness, saggings or severe pinholing remove affected paint by grinding before repainting.

PREVENTIVE ACTIONS:

Rearrange access to fulfill above requirement to distance to substrate surface.

Extension poles for spraying may be used, but remember that the painter should have full visual contact to all surfaces to be painted, i e only to be used on smooth surfaces like ships hulls and oil tanks exterior.

HOW TO DETECT:

Visually.

It is strongly advised to form an impression of safety of scaffolding and other types of access at the same time for your own safety.

HEMPEL

CHECKPOINT

PREPARATION GRADE STEEL

P 8

WHY?

Insufficient cleanness (Preparation Grade) will result in millscale and/or rust residues.
Millscale residues are more noble than steel and will therefore create a galvanic cell causing corrosion between the millscale and the steel. Thereby, the millscale residues will peel off together with any coating applied on top of it.

Rust is mechanically weak and porous and may flake thus peeling off with any coating applied on top of it and being sensitive to mechanical impact.

Old rust may contain water soluble salts, leading to osmosis and blistering of the coating.

CORRECTIVE ACTIONS:

Areas insufficiently cleaned must be reblasted or mechanically cleaned to the standard specified in the working specification.

Pitted areas which may contain salts may need a fresh water wash before blasting
See also page P1a.

PREVENTIVE ACTIONS:

Instruct operators of proper preparation grade, i.e. set standard.
Evaluate if working conditions (light, access) are suitable for the work.

HOW TO DETECT:

Visual

ISO 8501-1: 1988	The pictures in the older standard SIS 055900-1967 can still be used for evaluation. Other standards are used. Most common other standards are: USA SSPC JAPAN: SPSS
ISO 8501-4	For waterjetting, being drafted.

Further see Page R4: PREPARATION GRADE RELATIONS

For repair of zinc-rich paints and heavy duty systems by mechanical cleaning SSPC-SP 11 is recommended.

HEMPEL

CHECKPOINT

PREPARATION GRADE CONCRETE

P 9

WHY?

Insufficient cleanness (Preparation Grade) will result in laitance, efflorescence, form oil or contaminants being left on the surface.

Laitance is a weak cement sludge layer formed on the surface during casting. Due to its low strength it will peel off together with any coating applied on top of it.

Efflorescence are salts coming from the inside of the concrete. They will cause osmosis and blistering of the coating.

Form oil or other slip agents are used to ease the removal of casting forms after the casting. They act like oil and grease impairing adhesion of the coating.

CORRECTIVE ACTIONS:

Areas insufficiently cleaned for laitance must be recleaned using a method which can remove laitance, e.g.. abrasive blasting, mechanical cleaning, water jetting or acid treatment.

Efflorescence must be removed by mechanical cleaning (small areas only) or by high pressure hosing.

Form oil must be removed by degreasing.

PREVENTIVE ACTIONS:

Instruct operators of proper preparation grade, i.e. set standard.

Evaluate if working conditions (light, access) are suitable for the work.

HOW TO DETECT:

Visual

Acid treatment involves the use of strong acids which are severe etching solutions giving off fumes as well.
On disposal take care where the acids are going.

It is recommended to avoid acid treatment whenever possible.

HEMPEL

CHECKPOINT **BLASTING PROFILE** **P 10**

WHY?

Three factors of blasting profile are important:

- **HEIGHT**
- **SHAPE**
- **DENSITY**

Too low height, too round shape and to poor density prevents proper adhesion of the coating to be applied. Consequence will be poor adhesion resulting in sensitivity to mechanical impact and peeling to steel, even on its own and thus early corrosion.

Too high profile may lead to profile peaks protruding the coating resulting in esrly pin-point rusting.
Profile cannot be too sharp or too dense.

CORRECTIVE ACTIONS:

Areas showing too low height, too round profile or too poor density must be reblasted with coarser abrasive (too low profile), grit type abrasive (too round) or just reblasted (too low density).

Areas with too high profile should be given one extra coat of thickness corresponding to difference in roughness Rz-value between specified and observed roughness.

PREVENTIVE ACTIONS:

For spendable abrasives, replace abrasive with coarser abrasive (too low profile), finer abrasive (too coarse profile), grit abrasive (too round abrasive) and instruct blasting foreman of required density (too low density).

For recycling abrasives, check that working mix is topped up frequently.
If this does not help, follow guidelines above regarding spendable abrasives.

HOW TO DETECT:

Comparator according to painting specification e.g.:

- RUGOTEST No 3
- ISO 8503
- KEANE-TATOR SURFACE COMPARATOR

Further see Page R5: SURFACE ROUGHNESS

HEMPEL

CHECKPOINT	DUST	P 11a

WHY?

Although paint adheres well to dust, the dust does not adhere to the steel surface.

This results in poor adhesion of the coating and thus sensitivity to mechanical impact and peeling of the coating causing early corrosion.

CORRECTIVE ACTIONS:

Areas insufficiently cleaned must be recleaned with clean compressed air.
In confined spaces use vacuum cleaning

PREVENTIVE ACTIONS:

Instruct operators of proper dedusting requirement, i.e. set standard.
Evaluate if working conditions (light, access) are still suitable for the work.

HOW TO DETECT:

Visual and by touch.
A piece of white cloth.

Tape Test.	This test normally will show some residues. The amount acceptable must be agreed upon on beforehand. Please also consult ISO 8502-3.

HEMPEL

CHECKPOINT **WATER SOLUBLE SALTS** **P 11b**

WHY?

Water-soluble salts are not removed by mechanical surface preparation methods. Contrary they may be imbedded into the surface.

Water-soluble salts under the paint film will be able to absorb water through the paint film, osmosis, and this will lead to premature blistering and penetration of corroson products.

CORRECTIVE ACTIONS:

Salts must be removed by water. Recommend high pressure fresh water hosing or water hosing at the same time using stiff brushes. Always from up towards down.

PREVENTIVE ACTIONS:

Against salts advice to store under shelter or to establish a procedure of fresh water cleaning before material is taken into manufacture.

HOW TO DETECT:

Salts are difficult to detect. Usually extended exposure to marine or industrial outdoors environment will mean salt contamination.

Bresle sampling + Conductivity measurement according to either The HEMPEL Method or alternatively ISO 8502-6:

Soluble salts on the surface are dissolved in distilled water, using a Bresle Sampler.
The amount of dissolved salts are measured by a Conductivity Gauge.
For use consult page R6c (HEMPEL Method) or ISO 8502-6.

For CARGO TANK COATINGS and other critical jobs always consult the specification and page R 6 a-c.

HEMPEL

CHECKPOINT

BLASTING EQUIPMENT

P 12

WHY?

Insufficient capacity or dimensions of abrasive blasting equipment will result in either insufficient production speed i.e. delays, or insufficient preparation grade and/or surface profile at the required production speed.

Lack of oil and water separators between compressor and blasting pot may result in oil drops hitting the blasted surface and water impairing the flow of abrasive through the blasting hose.

All equipment should be fully functional and appear well maintained, to avoid stoppage once the job has been started and thus delays due to break down.

CORRECTIVE ACTIONS:

Recommend increased compressor capacity with extra compressors if necessary.
Blasting hoses should be as short as possible and min 5/4" int. dia.
Oil and water separators should be fitted. If not recommend to fit them.

If capacity cannot be increased, check and recommend correct dimensions of existing equipment and have new works-schedule calculated for approval by owners representative

PREVENTIVE ACTIONS:

If contractor/yard is inexperienced with the kind of job at hand, discuss with him the requirements, particularly the ones related to the quality of the surface.

HOW TO DETECT:

Visually

For guidelines on capacity and consumption, nozzle sizes and air requirements, see Page R1: ABRASIVE BLASTING

HEMPEL

CHECKPOINT

MECHANICAL CLEANING EQUIPMENT

P 13

WHY?

Insufficient capacity or condition of mechanical cleaning equipment will result in either insufficient production speed i.e. delays, or insufficient preparation grade and/or surface profile at the required production speed.

Lack of oil and water separators between compressor and equipment may result in oil drops being deposited on the surface.

Bristles of wirebrushes should be sharp and unbend to avoid polishing of the surface.

Grinding discs and sanding paper should be of suitable grain size for the job at hand and not clogged with paint residues and debris.

All equipment should be fully functionable and appear well maintained, to avoid stoppage once the job has been started and thus delays due to break down.

CORRECTIVE ACTIONS:

Oil and water separators should be fitted. If not recommend to fit them. Replace unsuitable or worn out equipment: wirebrushes, grinding discs and sanding paper.

PREVENTIVE ACTIONS:

If contractor/yard in inexperienced with the kind of job at hand, discuss with him the requirements, particularly the ones related to the quality of the surface.

HOW TO DETECT:

Visually

The use of chipping hammers should always be followed by grinding to remove burrs.

HEMPEL

CHECKPOINT

WATER JETTING EQUIPMENT

P 14

WHY?

Insufficient capacity or condition of water jetting equipment will result in either insufficient production speed i.e. delays, or insufficient preparation grade at the required production speed.

Leakage, too low pressure or wrong execution technic will result in insufficient removal of rust, contaminants or old paint from the surfaces.

All equipment should be fully functionable and appear well maintained, to avoid stoppage once the job has been started and thus delays due to break down.

CORRECTIVE ACTIONS:

Leakage should be repaired.
Equipment too small for keeping specified pressure during operation should be replaced.
Nozzles for the hosing should correspond to equipment and be replaced if worn.

PREVENTIVE ACTIONS:

If contractor/yard is inexperienced with the kind of job at hand, discuss with him the requirements, particularly the ones related to the quality of the surface.

Also point out the importance of correct distance during execution.

HOW TO DETECT:

Visually

Water pressure drops very quickly, when the water has left the water jetting nozzle.
Correct distance to obtain full effect is therefore 5-10 cms only.

Further see page R16a-b: WATER CLEANING

HEMPEL

CHECKPOINT

PAINT APPLICATION EQUIPMENT

P 15

WHY?

Insufficient capacity and/or wrong type of application equipment will result in uneven and/or insufficient film formation of the paint film.

A too low capacity may not be able to atomize the paint properly, resulting in fingering, slow drying, sagging and the painters overthinning the paint.

Wrong application equipment may result in too low film thickness of e.g. high-build and solvent-free paints and also in poor wetting of the substrate and and pinholes.

All equipment should be fully functionable and appear well maintained, including clean filters and unworn nozzles to avoid stoppage once the job has started and thus delays due to break down.

CORRECTIVE ACTIONS:

Recommend suitable size of equipment, pressure and capacity. Reduce spray hoses to minimum length and recommended 3/8" int. dia. hoses. Position conventional spray pots for zinksilicate at same level as sprayer. Check special requirements that may be stated in APPLICATION INSTRUCTIONS.

PREVENTIVE ACTIONS:

If contractor/yard in inexperienced with the kind of job at hand, discuss with his relevant responsible person(s) the requirements, particularly the ones related to achieveing correct film thickness and correct film formation.

HOW TO DETECT:

Visually

HEMPEL

CHECKPOINT

QUANTITY OF PAINTS

P 16

WHY?

The available quantity of paints are important to know for two reasons:

- If quantity of any paint in the specification is insufficient, the specified film thickness of that coat cannot be achieved and therefore the specification i.e. the agreement cannot be kept.
- In order to establish paint consumption for the job, and thus to be able to have the required consumption agreed, it is necessary to know the amount of paint available at the start.

In certain situations e.g. some dry dockings, final area estimates cannot be made until after the ship has entered dry dock. Final requirement for paint quantities cannot be calculated before areas have been estimated.

CORRECTIVE ACTIONS:

Extra paint if necessary should be ordered immediately, HEMPEL'S representative on site will be able to assist upon written request.
Remember that a delivery period can exist.

If paint cannot be supplied in time, find out which paints are available on site in necessary quantities and HEMPEL sales person for possible change in specification.

PREVENTIVE ACTIONS:

Lack of sufficient paint quantity may be due to wrong estimate of deterioration and breakdown.

To possibly improve estimates, your reporting of the condition will be a valuable part.

HOW TO DETECT:

Visually, counting cans and drums of each paint, curing agent and thinner.

HEMPEL

CHECKPOINT

PAINT - QUALITIES

P 17

WHY?

The painting specification specifies certain qualities of paint in a certain sequence.

To obtain the intentions of the painting specification, and these intentions may not be completely known to you, the qualities and the sequence must be kept.

Applying incorrect qualities is a violation of the agreement between the parties involved and may result in a performance different from that designed.

CORRECTIVE ACTIONS:

If already applied paint is incompatible with the coating system or the performance requirements, it must be removed completely, even if this cause damage to underlying correct coatings. Blasting should be recommended on larger areas, grinding may suffice on small (a few sqm) areas. Avoid using paint removers.

If applied and compatible contact HEMPEL's representative for possible consequences of this change of specification.
If not applied yet, return to stock and replace by correct quality.

PREVENTIVE ACTIONS:

Storekeeper should know the specification in order to hand out correct paint.
If necessary give him a copy of the specification.

Check that correct qualities are issued, especially before any essential coating application takes place.

HOW TO DETECT:

Visually
Compare labels on cans with specification.

HEMPEL

CHECKPOINT	SHELF LIFE	P 18

WHY?

Paints are "living" materials just like ourselves. When they get old in the can several things can happen. Some are physical e.g.:

* **Settling**

others are chemical, causing chemical reactions to take place in the can rendering the properties different from those intended, e.g.:

* **Gelling**

Physical changes can usually be remedied by intensive stirring of the paint whereas chemical changes cannot be remedied.

Shelf life of HEMPEL paints is indicated only if 1 year or less at 25°C, when stored under cover in original unopened cans. If no specific limits are given one-component paints should not be stored more than 5 years (25°C). Correspondingly two-component paints should not be stored more than 3 years from date of production.
If paints are very old, their condition may need to be verified by HEMPEL before use.

CORRECTIVE ACTIONS:

If DATASHEET specifically states a shorter shelf life, the paint may need to be discarded. If so have it removed from the work site, so that other painters may not accidentally use it.

If the paint is gelled or discoloured discard it and do the same.

Otherwise, try to stir up the paint. If this succeeds and the paint thereafter is sprayable without extra thinning, forms a proper film at specified dft and dries/cures proerly it may be used.

Remember to replenish discarded paint.

PREVENTIVE ACTIONS:

Emphasize the principle of "First in - First out".
Also store paint under cool conditions , 15 - 20 °C.

HOW TO DETECT:

Visually, reading the batchnumbers and consulting DATASHEET.

HEMPEL do not generally accept to take back paints with exceeded shelf life.
HEMPEL's General Conditions of Sales refers.

HEMPEL

CHECKPOINT	CURING AGENT	P 19

WHY?

The curing agent is the one that together with the BASE in two-component paints react chemically to form the paint film and to give it its predesigned properties.

The CURING AGENT must therefore be the right one - and - added in the right proportion, not to forget mixed uniformly in the paint.

If incorrectly selected, added or mixed, the paint will either not cure or only cure partly.

Thereby its resistance to mechanical impact/abrasion ,its waterresistance and its resistance to chemicals will be reduced or even lost, resulting in peeling of subsequent coats, softening and severe wear, dissolution in chemicals supposed to be resisted, and prematurely breakdown with corrosion and/or fouling as consequence.

CORRECTIVE ACTIONS:

Paint that has been wrongly mixed, must NOT be used.

Do not try to adjust wrong mixing ratio. The chance of reaching the correct ratio is too little. To much CURING AGENT is as bad as too little.

Mark wrongly mixed paint clearly, and have it removed from site immediately, so that others are not using it by mistake.

If already applied, the areas must be reblasted and repainted.

PREVENTIVE ACTIONS:

Go through the DATASHEET with the foreman to make sure he is aware of the correct CURING AGENT for each two-component paint and the correct mixing ratio.

Try only to issue sets of the two component paints and try to mix only whole sets.

HOW TO DETECT:

Visually
TECHNICAL DATASHEET.

HEMPEL

CHECKPOINT	THINNER	P 20

WHY?

When supplied, the paint is containing the types and amount of solvents, that secures proper evaporation and film formation, when applied at 20°C and according to Technical Datasheet. If further thinning is required, wrong thinner may - if paint is applied - lead to slow drying, solvent retention, phase separation or crystallizing of the applied coat during drying/curing. It may also result in gelatinization or lumping of the paint to be applied.

In the latter case the paint will loose its application properties or block filters and nozzles when spraying.

In the former case, the defect will not be immediately observable, but the paint may dry slowly and/or remain soft. Phase separation and crystallizing will impair film formation and reduce adhesion of further coats to be applied. The result will be peeling of the upper coats and/or premature rusting/fouling.

CORRECTIVE ACTIONS:

Paint that has been thinned with the wrong thinner and shows gelatinization or lumping must NOT be used. Do not try to rethin with right thinner. Mark such wrongly thinned paint clearly, and have it removed from site immediately, so that others are not using it by mistake.

Paint that has been thinned with the wrong thinner, but looks all right must NOT be used until you have received approval from your HEMPEL-representative on-site.

If already applied your HEMPEL-representative must approve the coat before further coats are applied. If approval is not given, the areas must be reblasted and repainted.

PREVENTIVE ACTIONS:

Go through the DATASHEET with the foreman to make sure he is aware of the correct THINNER for each paint. Avoid wrong (unknown) thinner in the vicinity of the working site.

HOW TO DETECT: Visually
Technical DATASHEET

HEMPEL

CHECKPOINT	THINNING	P 21

WHY?

When supplied, the paint is containing the types and amount of solvents, that secures proper evaporation and film formation, when applied at 20°C and according to Technical Datasheet. Further thinning may be required under certain conditions.

Too little thinning will result in fingering during spray application and poor flow of the paint film due to high viscosity resulting in overthickness (high consumption) and/or poor film formation, solvent retention and long drying times. The film will appear uneven and have reduced chemical and corrosion resistance.

Too much thinning will give the paint a low viscosity, resulting in sagging and running and too low film thickness, the consequence being a uneven surface and premature corrosion or fouling due to the film thickness being too low in relation to specification.

CORRECTIVE ACTIONS

Adjust the thinning ratio to that required for proper application: Do not exceed ratio indicated in the Technical Datasheet or in the Painting Specification.
In case extra thinning beyond this is required, obtain approval from your HEMPEL-representative.

Too heavily thinned paint can be "diluted" with unthinned paint.

PREVENTIVE ACTIONS:

When correct thinning ratio has been established, make sure the paint foreman is informed about it.

HOW TO DETECT: Visually
TECHNICAL DATASHEET

HEMPEL

CHECKPOINT	STIRRING	P 22

WHY?

Before application the paint must be completely uniform throughout the can. Otherwise the paint film will not have the correct composition on the surface, and problems may also arise with blockage of nozzles.

Incorrect paint film composition will lead to insufficient curing, poor visual appearence, premature corrosion and fouling.

Particularly paints with heavy particles, like zinc-rich paints and anti-foulings and solvent free or solvent less paints need a very good initial stirring to make sure that the paints are fully uniformly mixed.

CORRECTIVE ACTIONS:

If not yet applied, continue stirring until completely uniform.
If already being applied, stop application.
For two-component paints, including zinc-rich paints, reblasting should be recommended.

For one-component paints, including antifoulings, the coat should be disregarded as counting in the specification, but removal is normally not necessary.
Thus an extra coat will have to be considered.

PREVENTIVE ACTIONS:

Specify mechanical stirrers and survey the stirring.

HOW TO DETECT:

Visually, and use a of a paint stick or stirrer.

HEMPEL

CHECKPOINT

WET FILM THICKNESS

P 23

WHY?

Wet film thickness (WFT) is directly related to resulting dry film thickness, when thinning ratio is known.

Thus too low wet film thickness spells corresponding too low resulting dry film thickness, and too high wet film thickness will result in too high dry film thickness Too low WFT result in poor flowing together and thus poor film formation.

Too high WFT result in solvent retention, prolonged drying time and minimum overcoating interval, overconsumption of and related risk of shortage of paint.

Please also consult Checkpoint: DRY FILM THICKNESS P 30c for further consequences on long term performance.

CORRECTIVE ACTIONS:

If too low, build up filmthickness to that specified by applying an extra coat. Make sure that a uniform pinhole-free film is achieved.

If too high evaluate if a longer drying time/overcoating interval is needed and specify and follow up that this is then being kept.

For shopprimers a too high filmthickness is detrimental to cohesion.
For zincsilicates it may be so too. In these cases abrasive sweeping/blasting is necessary when later exposure is severe atmospheric or immersion.

If possible adjust total film thickness of anticorrosive system and possible antifouling system by lower film thickness of the following coats.

PREVENTIVE ACTIONS:

Make sure that equipment is in working order, and that thinning is as specified. Painters must have their WFT-Gauges and be instructed to use them - and be informed about the correct WFT.

Subdivide areas to be painted an distribute paint as relevant for each subdivided area.

Frequent check of WFT, and control of consumption.

HOW TO DETECT: Wet Film Thickness Gauge.
Area/Consumption calculation and control.

HEMPEL

CHECKPOINT

COATED SURFACE BEFORE OVERCOATING

P 24a

WHY?

Contamination of the coated surface may hinder adhesion of the coat to be applied:

* **SALTS**
* **OIL SPILLAGE.**
* **FOREIGN MATTER and/or DUST**

Salts may occur during foggy periods near seaside or heavy industry. It will cause osmotic blistering of the coating, loosing adhesion, causing peeling and premature corrosion/fouling.

Oil/grease spillage as well as other foreign matter/dust prevents adhesion, causing peeling and consequently also premature corrosion/fouling.

CORRECTIVE ACTIONS:

Salts must be removed by water. Recommend high pressure fresh water hosing or water hosing at the same time using stiff brushes.

Oil/grease must be removed on larger areas by emulsion cleaning. Small spots may be removed by clean rags and thinner.
Never use alkaline cleaners or other chemicals at this stage of curing/drying.

Other loose foreign matter and dust must be wiped off. Scrape and clean if the dust has settled firmly.

PREVENTIVE ACTIONS:

For salts advice to store under shelter or to establish a procedure of fresh water cleaning before overcoating.

Repair any oil leakage and influence instruction of other trades not to walk on areas being painted.

Try to avoid blasting and other dust creating works in the vicinity of painting.

HOW TO DETECT:

Visually

For critical areas see further Page R6a-d.

Salts are difficult to detect. Usually extended exposure to marine or industrial outdoors environment will mean salt contamination. Also fog tends to deposit salts.

HEMPEL

CHECKPOINT

COATED SURFACE BEFORE OVERCOATING

P 24b

WHY?

Abnormalities in film formation of the coat to be overcoated may hinder adhesion and correct properties of the coat to be applied:

* **Spray Dust**
* **Exudation/Sweathing**
* **Holidays and pinholes**

Spray dust acts similar to other dust, preventing or reducing adhesion causing peeling and premature corrosion/fouling

Sweating/Exudation is the separation of binders or other material to the surface of the applied coating. Consequence is loss of adhesion of the coat to be applied and subsequent peeling and premature corrosion/fouling.

Holidays and pinholes cause lack of dry film thickness build-up. Also certain coats are applied to obtain certain properties. Lack of these coats may influence the final coatings behavior. Pinholes may blow their way through subsequent coats.

CORRECTIVE ACTIONS:

Spray dust must be scraped away and dedusted.

Sweating/Exudation may need a thinner- or a water-wash. However always contact your HEMPEL-representative.

Holidays must in case of primers, sealers and topcoats be touched up before overcoating.

For intermediates extra thick application of next coat may suffice to compensate for lack of dry film thickness. Pinholes if very few are generally not considered except in tanks. If many, ask your HEMPEL-representative for solution to the specific case.

PREVENTIVE ACTIONS:

Influence application technic and shelter against heavy winds/ high temperatures to reduce/ avoid dust spray.

Exudation occur normally only at too low temperatures, too high film thickness too poor ventilation and/or upon exposure to rain/condensation too early. Influence correct application conditions within the specified limits.

Influence application technic and stripe coating to avoid holidays and avoid too low film thickness causing possible pinholing in next coat.

HOW TO DETECT:

Visually

Exudation often shows as a discoloration of the painted surface or a oily/ greasy layer on top of the coating.

HEMPEL

CHECKPOINT

COATED SURFACE BEFORE OVERCOATING

P 24c

WHY?

Variations in filmthickness influence drying and the protective properties of the coating:

* **Too low film thickness**
* **Too high film thickness**

Too low film thickness may cause poor flow together of the film and result in pinholing through the next coat and so on. Result will be an open film of low dry film thickness resulting in premature blistering/pinpoint rusting.

Too high film thickness prolong drying time, and may cause sagging/ running. If not respected also risk of sagging of the next coat and solvent retention which will reduce the coatings corrosion protective properties and mechanical and chemical resistance.

For antifoulings cold flow may occur.

For zincsilicates mud-cracking/flaking may occur.

CORRECTIVE ACTIONS:

For too low film thickness apply an extra coat of same paint, in case of primers, sealer or topcoats. If intermediate you may be able to catch up in next coat. It is very important that an uniform pinhole-free paint film is achieved.

For too high film thickness allow an increase in the drying time before overcoating or taking into use. Provide good ventilation to all surface affected during this period.
For zinc silicates mudcracked areas must be reblasted or scraped depending on size of the areas and repainted.

PREVENTIVE ACTIONS:

Instruct in the right film thickness and how to measure continuously during application (WFT-Gauge). Recommend areas to be subdivided and assist in calculating the amount of paint going on each area.

Influence stripe-coating of areas difficult to spray.

HOW TO DETECT:

Dry film thickness gauge.

Observe that the gauge may penetrate into soft and uncured coatings leading to too low readings. Therefore only use the measurements as guideline.

HEMPEL

CHECKPOINT

AIR TEMPERATURE

P 25

WHY?

A too high air temperature during application may lead to dry spraying and thus poor film formation of the coating, with premature rusting as a consequence.

A too low temperature will usually also affect the substrate temperature negatively leading to slow drying, risk of solvent retention, sagging and for two-component paints insufficient cure and correspondingly risk of side reactions and sweating/exudation of one or more components of the paint material, e.g. curing agent, plasticizer, etc.

The result may be insufficient corrosion resistance, poor chemical resistance, poor adhesion of subsequent coats, and for antifoulings "Cold Flow".

CORRECTIVE ACTIONS:

Areas with dry spray and poor film formation due to high temperature must be scraped or sanded to remove dust spray,and applied an extra coat. It is very important that the extra application secures a uniform paint film free of porosities. In severe cases remove damaged coating by blasting.

Areas affected by too low temperatures must for physically drying paints be allowed longer drying time before overcoating or taken into use.

For chemically curing paints provisions must be arranged for increasing temperature to acceptable range (See Datasheet), and protection against rain, and condensation arranged. Before overcoating check for possible sweating/exudation.

PREVENTIVE ACTIONS:

For too high temperature look for possibility for sheltering, cooling or painting in nighttime. Find if possible suitable amount of thinning, even if this exceeds datasheet recommendations slightly. However always use recommended thinner.

For too low temperature, replan schedule according to prevailing temperature. For two-component paints provisions must be made for increasing temperature, i.e. in tanks and confined spaces, heaters to be installed and insulation to be provided.

DO NOT change spec unless agreed with HEMPEL-representative

HOW TO DETECT:

Thermometer (e.g. slingpsykrometer dry bulb) and visually.

HEMPEL

CHECKPOINT **SURFACE TEMPERATURE** **P 26**

WHY?

A too high substrate temperature during application will lead to too quick drying of the coating film resulting in poor film formation, with poor adhesion and premature rusting as a consequence.

A too low substrate temperature may cause condensation on the substrate preventing adhesion of the coat to be applied, with later peeling as a consequence

Also slow drying, risk of solvent retention, sagging and for two-component paints insufficient cure and correspondingly risk of side reactions and sweating/exudation of components of the paint material can occur. The result may be insufficient corrosion resistance, poor chemical resistance, poor adhesion of subsequent coats, and for antifoulings "Cold Flow".

CORRECTIVE ACTIONS:

Areas with dry spray and poor film formation due to high temperature must be scraped or sanded to remove dust spray,and applied an extra coat. It is very important that the extra application secures a uniform paint film, free of porosities. In severe cases remove damaged coating by blasting, scraping or sanding as relevant.

Areas where a coat has been applied on areas having had condensation must be reblasted to a sound adhering surface and repainted from there on.

Areas affected by too low temperatures must for physically drying paints be allowed longer drying time before overcoating or taken into use.
For chemically curing paints provisions must be arranged for increasing temperature to acceptable range (See Datasheet), and protection against rain, and condensation arranged. Before overcoating check for possible sweating.

PREVENTIVE ACTIONS:

For too high temperature look for possibility for sheltering , cooling or painting at nighttime. Find if possible suitable amount of thinning, even if this exceeds datasheet recommendations slightly. However always use recommended thinner.

For too low temperature, replan schedule according to prevailing temperature.
For two-component paints provisions must be made for increasing temperature, i.e. in tanks and confined spaces, heaters to be installed and insulation to be provided.

NOTE **DO NOT change spec unless agreed with HEMPEL-representative.**

HOW TO DETECT:

Surface Thermometer.
Additionally for establishing dewpoint: Slingpsykrometer
Dewpoint calculator

See Page T5 for Dewpoint Calculation

HEMPEL

CHECKPOINT	DEW POINT	P 27

WHY?

The dew point of the air tells about the humidity and the risk of condensation. If the dewpoint of the air is higher than the substrate temperature, condensation will take place on the substrate.

Paint applied to substrates with condensation will unless a specially formulated paint is utilized (Reference is made to the datasheet or the specification) not achieve adhesion.

The consequence of applying paint to a substrate with condensation will thus be poor adhesion and later peeling, leading to premature corrosion and/or fouling.

CORRECTIVE ACTIONS:

Areas where a coat has been applied on a surface with condensation must be reblasted, scraped or ground, whichever is relevant, to a sound adhering surface and repainted from there on.

PREVENTIVE ACTIONS:

Establish dew point and steel temperature at location of application before the application start. Steel temperature must be over dew point temperature of the air or according to the specification.

Dew point temperature do not change by heating the air, only by dehumidifying.

Alternatively increase substrate temperature e.g. by planning application to proceed during daytime. Condensation happens most frequently during evening and night time.
Beware of local variations in steel temperature e.g. caused by not emptied ballast tanks and local differences in dew point/humidity e.g. under flat bottoms in a dry dock.

NOTE

DO NOT change spec unless agreed with your HEMPEL-representative.

HOW TO DETECT:

Slingpsykrometer
Dewpoint calculator
Additionally for establishing substrate temperature Surface Thermometer

See Page T5 for dewpoint calculation.

HEMPEL

CHECKPOINT

PAINT TEMPERATURE

P 28

WHY?

A too high paint temperature during application may lead to dry spraying and thus poor film formation of the coating, with premature rusting as a consequence. Also a too high temperature will result in a dramatic reduction in two-component paints pot-life.

A too low temperature will lead to high viscosity making the paint difficult to stir up properly and impossible to atomize correctly. Overthinning may be the painters solution, resulting in slow drying and poor sagging resistance - and - consequently too low dry film thickness being applied, with premature rusting and fouling as a result.

CORRECTIVE ACTIONS:

Areas with dry spray and poor film formation due to high temperature must be scraped or sanded to remove dust spray,and applied an extra coat. It is very important that the extra application secures a uniform film, free of pinholes. In severe cases remove damaged coating by blasting.

Areas with sagging may be ground and together with areas with too low dry film thickness must receive extra coats of paint to bring the dft up to the specified.

PREVENTIVE ACTIONS:

For too high temperature look for possibility for sheltering or cooling. Find if possible suitable amount of thinning, even if this exceeds datasheet recommendations slightly. However always use recommended thinner.

For too low temperature, take paint into heated room in sufficient time before application to get it heated (24 hours suggested). Do not bring it out to the application site until last minute before it is to be used.

Optimum paint temperature for most paints is 15-25°C.

HOW TO DETECT:

Thermometer.

Solvent-free paints already has a very short pot-life. At high temperatures >25°C, it may be necessary to cool down the paint in a reefer container before the application process.

HEMPEL

CHECKPOINT

VENTILATION

P 29

WHY?

Solvents need to evaporate from the paint after application. This is valid for solvent-borne paints as well as for water-borne. For evaporation ventilation is needed. Only exeption to this is solventfree paints.

Incorrect ventilation (including wind) can be either:

* **Too poor (insufficient), or**
* **Too Heavy (excessive)**

Too poor ventilation leads to too slow drying and risk of solvent retention Thus overcoating intervals may have to be extended and solvent retention may cause reduced mechanical and chemical resistance including water resistance and cold flow of antifoulings.

Too heavy ventilation may result in dry spraying, increased consumption and skin drying. The latter will also cause solvent retention, giving similar negative performance effects as described above

Beware that locally you may find areas e.g. in a tank, exposed to either insufficient or excessive ventilation.

CORRECTIVE ACTIONS:

Allow applied coating to dry for an extended period before overcoating.

Scrape spray dust which has occurred and allow the coating longer time to dry through before overcoating.

PREVENTIVE ACTIONS:

Insufficient ventilation is seldomly occurring during painting out of doors. In confined spaces and during workshop painting, painting must be stopped until mechanical ventilation has been established.
For local areas ventilators may suffice.

Excessive wind should cause the application to stop to avoid over consumption. In installations with mechanical ventilation reduce ventilation or shield off the application area from the direct ventilation.

Solvent vapours are heavier than air. Ventilation exhaust must therefore always take place from the lowest parts of the construction, e.g. tank.

HOW TO DETECT:

Visually and by judgement and observing application behaviour.

HEMPEL

CHECKPOINT

COATED SURFACE FINAL ACCEPTANCE

P 30a

WHY?

Integrity of the coating in the service environment is necessary to secure that the coating remains on the substrate. Important factors are:

* **Adhesion**
* **Cohesion (Internal Strength)**

Both poor adhesion to the substrate or between coats and poor cohesion may lead to blistering and peeling of the coating thus reducing film thickness and giving poor cosmetic appearance and poor mechanical and chemical resistance. Consequence will be premature corrosion/fouling and unsatisfactory appearance of the coating.

CORRECTIVE ACTIONS:

Insufficient adhesion and cohesion cannot be remedied by further coating application. Thus insufficiently adhering or cohering coatings have to be removed by abrasive blasting or other mechanical methods and coatings reapplied from damage and upwards to full film thickness.

Never use alkaline cleaners or other chemicals at this stage of curing/drying.

During drying/curing adhesion/cohesion may not be complete to full strength.
Therefore ALWAYS consider results obtained as guidance.
Contact your HEMPEL-representative in case of doubt.

PREVENTIVE ACTIONS:

Analyze possible causes for insufficient adhesion/cohesion using checkpoints to find out why cause has not been discovered before. Influence these checkpoints to be used in the future.

A properly applied coating according to approved HEMPEL-specification will always have adhesion/cohesion properties, which are characteristic for the particular coating system.

HOW TO DETECT:

Visually and by the use of a knife.

More advanced adhesion methods exist. However a value can never be employed or accepted until a HEMPEL-approved minimum value for the result of the test has been obtained.

Requirement to adhesion and cohesion depend on later exposure and is therefore considered in a HEMPEL-specification. Therefore use adhesion/cohesion tests only if in doubt of some excecutional defects or if specified by customer.

HEMPEL

CHECKPOINT

COATED SURFACE FINAL ACCEPTANCE

P 30b

WHY?

Abnormalities in film formation influence the appearance and protective properties of the coating:

* **Spray Dust**
* **Orange Peel**
* **Holidays and pinholes**

Spray dust and orange peel provide a poor cosmetic appearance, and an increased roughness, which especially on antifoulings will cause drag and premature fouling.
For other surfaces difficulties in cleaning may be the consequence.

Holidays and pinholes cause local insufficient dry film thickness resulting in premature blistering/pinpoint rusting, salting of zinc rich primers and premature fouling.

CORRECTIVE ACTIONS:

If cosmetic appearance is very important or extend of spray dust or orange peel is judged to be excessive, the areas involved must be scraped, sanded and - after dedusting - be touched up with a coat of final coat.
Holidays must be touched up to full dry film thickness.

Pinholes if very few are generally not considered except in tanks, where they have to be touched up, if necessary after a sanding.
If many, ask your HEMPEL-representative for solution to the specific case.

PREVENTIVE ACTIONS:

Analyze why potential defect are observed now instead of earlier. Consult checkpoints in the respective phases.

Find those check point(s) which have failed during the work and influence these to be considered in the future.

HOW TO DETECT:

Visually

5 - 10 X Magnifier.

HEMPEL

CHECKPOINT

COATED SURFACE FINAL ACCEPTANCE

P 30c

WHY?

Variations in filmthickness influence the protective properties of the coating:

* **Too low total dry film thickness**
* **Too high total dry film thickness**

Too low film thickness means that the specification, as the customer has bought it is not met. Technically the coating may not be able to perform as long as expexted/promised or guaranteed, i.e. early corrosion or fouling may occur and for chemically resistant coatings, they may fail in their protection.

Too high filmthickness will cause reduced mechanical resistance, and reduced chemical resistance because of solvent retention.
For antifoulings cold flow may occur if the vessel is sailing early after application.
For zincsilicates mud-cracking may occur eliminating protection in cracked areas.

CORRECTIVE ACTIONS:

For too low film thickness apply extra coat(s) of final coat, where necessary, locally or full depending on extend of insufficient dft. It is important, that a uniform pinhole-free paint film is achieved.

For too high film thickness allow an increase in the drying time before overcoating or taking into use. Provide good ventilation to all surface affected during this period.

For zinc silicates mudcracked areas must be reblasted or scraped depending on size of the areas and repainted.

PREVENTIVE ACTIONS:

Instruct in the right film thickness and how to measure continuously during application (WFT-Gauge). Recommend areas to be subdivided and assist in calculating the amount of paint going on each area.

Influence stripe-coating of areas difficult to spray.

HOW TO DETECT:

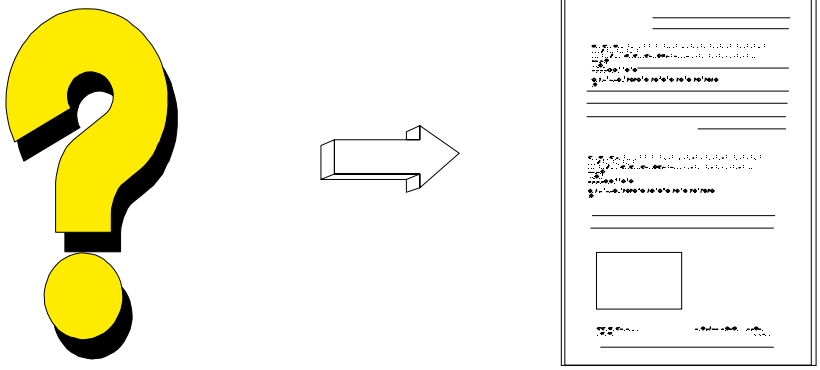
Dry film thickness gauge.

Observe that the gauge may penetrate into soft and uncured coatings leading to too low readings. Therefore allow as long time as necessary before making the dft measurements, usually 1-2 days.

Note special procedures for containers and shopprimers.

HEMPEL

Indicative GUIDE LINES to PROCESSES and PROCEDURES



HEMPEL

OPEN NOZZLE ABRASIVE BLASTING R1a

CAPACITY AND CONSUMPTION: (Indicative values)

AREA TYPE	Sa 2 1/2 NON-METALLIC ABRASIVE KG/SQM	Sa 2 1/2 SQM pr MAN-HOUR	Sa 3 NON-METALLIC ABRASIVE KG/SQM	Sa 3 SQM pr MAN-HOUR
NEW STEEL, RUST GRADE A-B				
Smooth	40	9	60	6
Normal	45	8	65	5.5
Complicated	60	6	80	4.5
SHOPPRIMED STEEL * /				
Smooth	30	12	50	7.5
Normal	35	10	55	6.5
Complicated	50	7.5	70	5
OLD STEEL, RUST GRADE C-D				
Smooth	50	7.5	70	5
Normal	60	6	80	4.5
Complicated	80	4.5	100	3.5

Figures are primarily based on practical experience with tankcoating jobs.
Abrasive blasting using 12 mm nozzles at 7-8 bars.

* / Some types of shopprimers are difficult to remove completely: PVB-types and zinc-shopprimers. The latter will leave some zinc hammered on to the surface.

NOZZLES SIZE AND AIR REQUIREMENT: (Indicative values)

NOZZLE SIZE		PRESSURE AT NOZZLE (Bars)				
mm	inch	4	4,6	5	6	7
8	1/3	3,0	3,2	3,5	4,0	4,6
9.5	5/16	4,0	4,5	-	5,5	6,5
10	3/8	4,6	-	5,7	6,4	7,2
11	7/16	5,5	6,1	6,8	7,5	9,1
12	1/2	6,7	-	8,2	9,3	10,4
		AIR CONSUMPTION in cbm pr min				

NOTE: Wear of nozzles quickly increases air requirement. Also other work, e.g. grinders, airless pumps etc. may require air.

The Compressor should therefore have a 25-50% higher air capacity, than required according to above table.

Venturi shaped nozzles are recommended for maximum efficiency.
They should remain undamaged and be replaced when their internal diameter has worn approx. 1-2 mm.

NOTE

Remember to check and empty oil- and water separators frequently, before they run full.

OPEN NOZZLE ABRASIVE BLASTING R1b

HOSES

Hoses cause pressure loss and thus loss of effect.
Following is good practice:

1. Use min 5/4" hoses with external couplings, and wire for proper grounding of the blasting equipment.
2. The blasting hose gives more pressure loss than the air hose. Therefore if necessary, always long air hose and short blasting hose, i.e. the blasting pot should be as close to the work area as possible.
3. Do not kink the hoses, always lay them out in as straight lines as possible.

Pressure loss in bars pr 10 m smooth air hose at 7 bar. (Indicative)

Nozzle Size: mm	8	9,5	10	11	12
inch	1/3	5/16	3/8	7/16	1/2
Air consumption cbm/min	4.6	6.5	7.2	9.1	10.4
Internal Diameter of air hose					
1/2" / 12 mm	na	na	na	na	na
3/4" / 18 mm	0.6	na	na	na	na
1" / 25 mm	0.12	0.25	0.33	0.55	0.66
5/4" / 32 mm	0.05	0.10	0.13	0.18	0.20
1 1/2" / 38 mm	0.02	0.05	0.06	0.08	0.09

na: means a pressure loss of more than 1 bar pr 10 m length.

Over the blast pot there will usually be a pressure drop of 1/2 - 1 bar.

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ABRASIVES, RECYCLABLE R2a

Recyclable abrasives are typically steel grit, steel shot, cut wire and iron grit.
For blasting of aluminium and stainless steel corundum can be used.

STEEL AND IRON GRIT

SAE J444:1984-Nomination					
	Grain size		Corresponding		
	Average	Distribution	ISO 11124:1993	HARDNESS	
SIZE	mm	mm	designation	Nomination	HRc
G12	1.7	1.4-2.4	G200	S	45-50
G14	1.4	1.2-2.0	G170	M	50-55
G16	1.2	1.0-1.7	G140	L	55-60
G18	1.0	0.7-1.4	G120	H	60-65
G25	0.7	0.4-1.2	G100		
G40	0.4	0.3-1.0	G070		
G50	0.3	0.2-0.7	G050		

Ex: LG18 is 0.7-1.4 mm grit with a nominal size of 1.0 mm and a hardness HRc of 55-60

BS 2451/63-Nomination	
	Distribution
SIZE	mm
G55	1.4-2.0
G47	1.2-1.7
G39	1.0-1.4
G34	0.85-1.2
G24	0.6-1.0
G17	0.43-0.85
G12	0.3-0.7

STEEL SHOT

SAE J444:1984-Nomination					
	Grain size		Corresponding		
	Average	Distribution	ISO 11124:1993	HARDNESS	
SIZE	mm	mm	designation	Nomination	HRc
S550	1.4	1.2-2.0	S170	S	45-50
S460	1.2	1.0-1.8	S140	M	50-55
S390	1.0	0.8-1.4	S120	L	55-60
S330	0.8	0.7-1.2	S100	H	60-65
S280	0.7	0.6-1.0	S080		
S230	0.6	0.5-0.8	S070		
S170	0.4	0.4-0.7	S060		

BS 2451/63-Nomination	
	Distribution
SIZE	mm
S550	1.4-2.0
S470	1.2-1.7
S390	1.0-1.4
S340	0.85-1.2
S240	0.6-1.0
S170	0.43-0.85
S120	0.3-0.7

MINERAL RECYCLABLE

These abrasives usually follow the guidelines for NON-METALLIC SPENDABLE abrasives (See page R2b)

ABRASIVES, SPENDABLE R2b

Spendable abrasives are typically used only once or a few times
The are normally NON-METALLIC and typical examples are:

* Quartz sand
* Aluminium silicate
* Copper Slag
* Oven or Coal Slag

A lot of local products are found.

Spendable abrasives should be sharp edged and hard, they should be high quality, washed with fresh water, dried and classified, and should not leave any foreign matter on the blasted surface.

Suitable abrasives should comply with ISO 11126:1993.

For tank coating jobs, the abrasive should be checked according to the tank coating specification before starting the job.

Sea sand and river sand are often rounded and chloride contaminated, and should therefore be avoided for heavy duty coatings.

SIZE DISTRIBUTION:

The size distribution is often given in manufacturers own grade numbers and. in mm.
Typical distributions are:

0.4-0.8 mm	For general blasting, fine profile
0.4-1.2 mm	For general blasting, somewhat coarse profile
0.2-2.0 mm	For high profile blasting on old pitted steel
1.2-2.0 mm	For high profile blasting on new, unpitted steel

Suitable abrasives grain size distribution should as a minimum comply with ISO 11126:1993.

Mixture of grades for specific purposes can usually be supplied in the distributions or mixtures thereof as requested.

ISO 11126 - Water Solubles Conductivity Measurements:

The ISO 11126 states as a requirement to conductivity of water extracts of abrasives a maximum of 25 mS/m. This method is now described in page R6a, and R6d.

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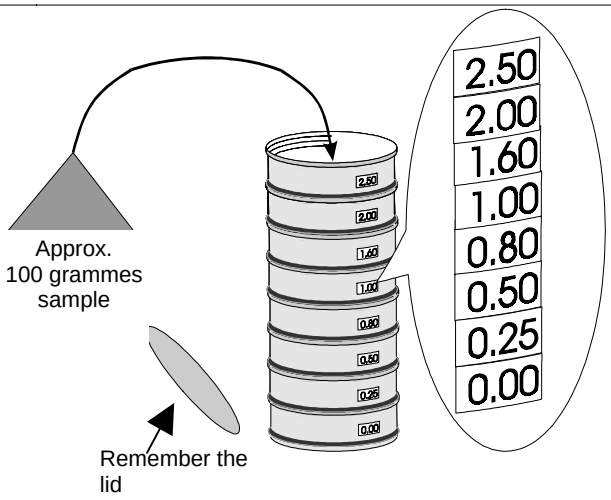
ABRASIVES - GRAIN SIZE DISTRIBUTION

R2c

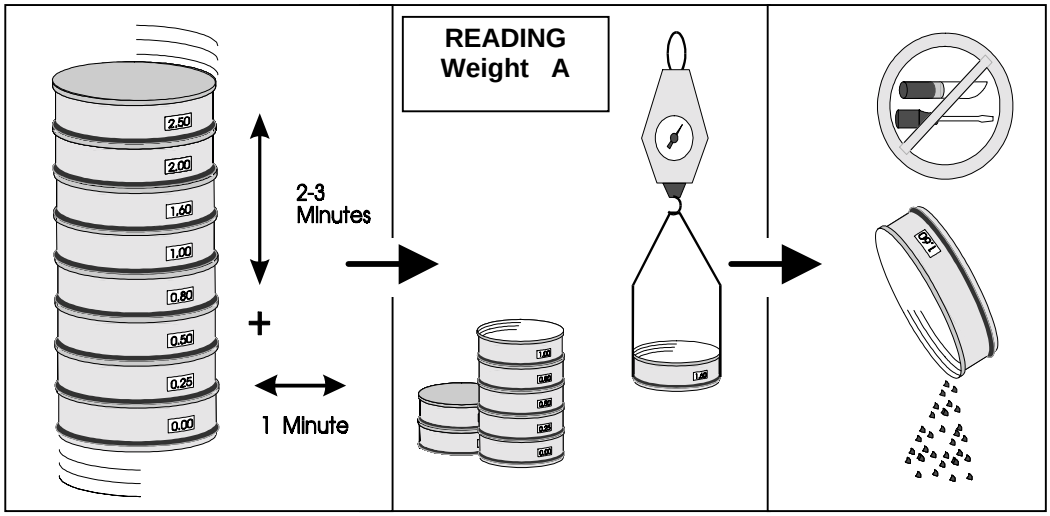


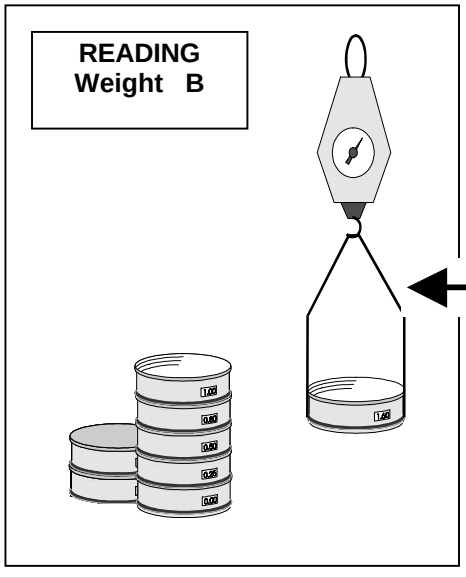
THIS YOU NEED:

- A HEMPEL set of sieves
- A spring weight (OHAUS)
- A calculation form, Page R2d

TAKING THE SAMPLE:

Collect samples at min
5 places in the abrasive
at random.
Mix them well and take the
test sample from the mix.





REPEAT FOR ALL SIEVES

FILL IN ON THE FORM ON PAGE R2d

-

AND CALCULATE RESULTS

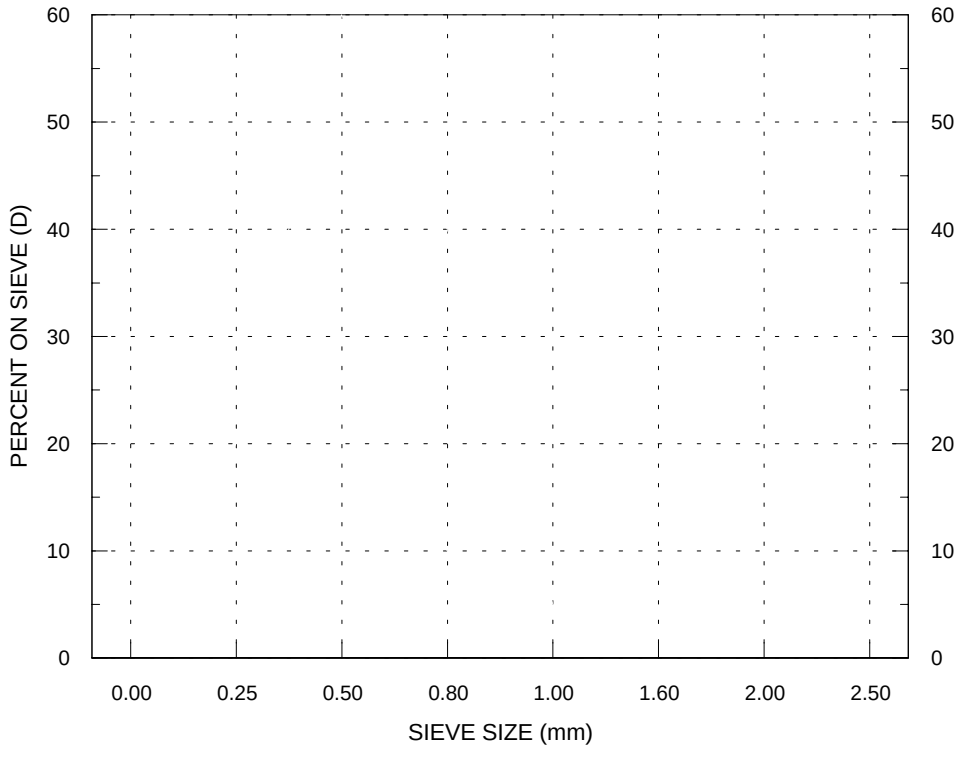
HEMPEL

ABRASIVES - GRAIN SIZE DISTRIBUTION **R2d**

Grain size distribution of the abrasive has significant influence on the surface roughness especially on the roughness height.

Using the charts below you can calculate and plot the distribution obtained.
It is advisable to copy the page and use the charts on the copy.

SIEVE No	GRAIN SIZE (mm)	READING **A** gramme	READING **B** gramme	**(A - B)** gramme	**D = (A-B)*100 / C** Amount in %
2.50	> 2.50				
2.00	2.00-2.50				
1.60	1.60-2.00				
1.00	1.00-1.60				
0.80	0.80-1.00				
0.50	0.50-0.80				
0.25	0.25-0.50				
0.00	0.00-0.25				
TOTAL AMOUNT OF ABRASIVE: **C=Sum(A-B)**					



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DETECTION OF OIL & GREASE R3a

Many methods are described for detection of oil and grease.

Unfortunately most of these are either lab-methods or requiring tools unsuitable for on-site use.

The primary detection method is appearance of the surface. Oil and grease generally cause the surface to have a slightly darker appearance than clean surroundings and grease can usually be felt by the touch of a finger.

Other conditions can cause similar appearance e.g. humidity, so visual appearance is not always definite, especially in the case of spot wise contamination from cutting, drilling and punching in raw steel material.

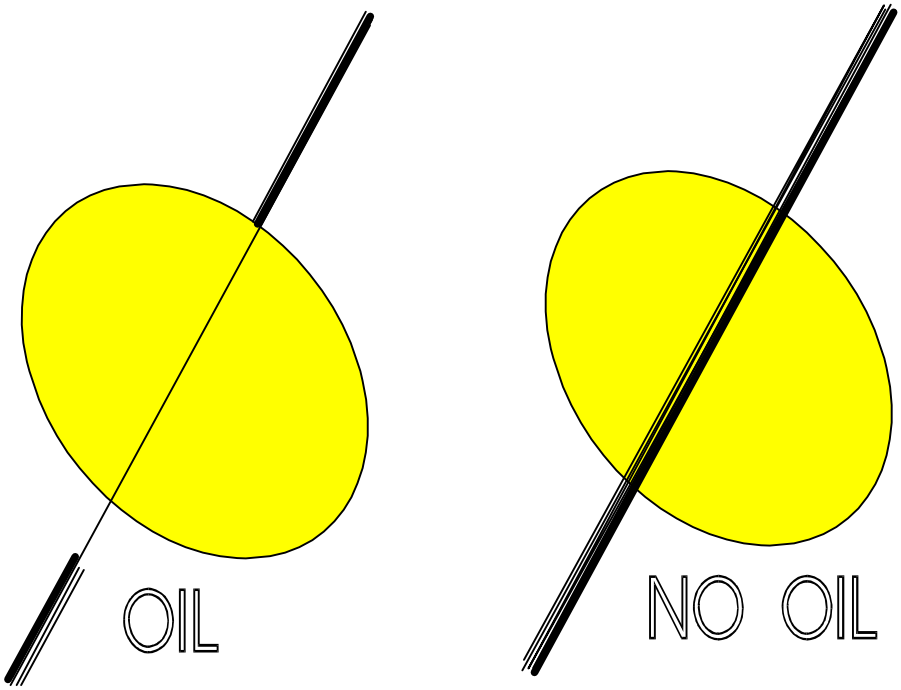
In such cases a simple method using a piece of chalk can often quickly decide if degreasing is necessary.

The method works as follows:

1. Draw a line at medium pressure with the piece of chalk from a clean area through the suspect area on to another clean area.
2. If the line through the suspect area decreases in intensity, but intensity is regained in the second clean area again, the suspected area is contaminated to the extent, that degreasing is required.

You will probably need some exercise on the right pressure on the piece of chalk to get full benefit from the method.

NB: The method has been experienced not to work well on very smooth surfaces, e.g. on smooth stainless steel and aluminium.



DETECTION OF OIL & GREASE R3b

For tank coating work, newbuilding and repair, the method described in HEMPEL'S TECHNICAL STANDARD FOR TANK COATING WORK TCTF-100-TCW may be employed:

Hydrocarbon Test with isopropanol:

1 sqm of the surface is washed with cotton-wool and hydrocarbon free isopropanol.

After each washing the isopropanol is transferred from the cotton-wool into a beaker by pressing.

Filtrate the contents of the beaker.

Mix in a test tube the filtrate with 2-3 times as much distilled water.

The mixture is shaken and must be allowed to stand for approx. 20 minutes.

If the sample in the test tube is cloudy, the surface is contaminated with grease and/or oil.

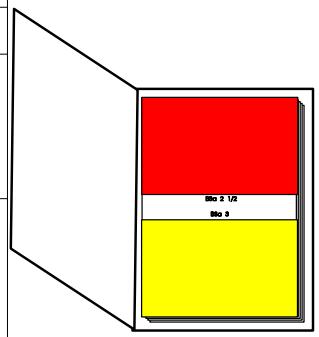
Make a blank mixture of the isopropanol with distilled water as a reference.

Instead of isopropanol a hydrocarbon free acetone may be used.

HEMPEL

PREPARATION GRADE RELATIONS (Nearest equivalents). R4a

ISO 8501-1:1988	SSPC	
Sa 3	SP-5	(White Metal)
Sa 2 1/2	SP-10	(Near white Metal)
Sa 2	SP-6	(Commercial Blast)
	NOTE	Is NOT identical to ISO 8501-1:1988 You must consult the SSPC Standard when you meet it in a specification.
Sa 1	SP-7	(Brush -Off Blast)
None	SP-11	Mechanical cleaning to bright metal
St 3	SP-3	Machine Tool Cleaning
St 2	SP-2	Hand Tool Cleaning



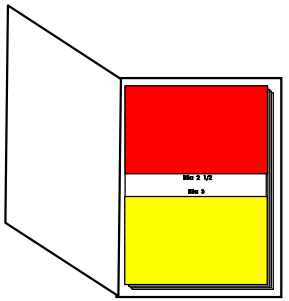
OTHERS Swedish Standard SIS 055900, 1967 contains pictures identical to those in ISO 8501-1:1988.
Japanese Standard JSRA SPSS-1975 is an expansion of SIS 055900 containing also pictures of shopprimer secondary surface preparation and surface preparation of welds and burns. Since this standard is referred to by some Paint Manufacturers page R4b summarise this standard.
ISO 8501-2:1994 is an expansion of ISO 8501-1 covering preparation of shopprimed and previously coated surfaces.
NACE/SSPC SP-12 concerns high pressure water jetting preparation grades, please see page R16a-b.
ISO 8501-4 is at present (May 2005) still being drafted for Water Jetting.

HEMPEL

SECONDARY PREPARATION GRADE RELATIONS (Nearest equivalents). R4b

Some other Paint Manufacturers refer in their specifications to Secondary Surface Preparation Standards.
Below you may find a brief survey of the contents of the most common of these. For details please refer to the specific Standard which is in both cases a pictorial standard similar in layout to the ISO 8501-1:1988.

DESCRIPTION	JSRA SPSS-1975	International Paint
Surface prepared by wire-brushing and by disc sander. Loose rust and foreign matter are fairly removed	Pt1	
Surface prepared by wire-brushing and by disc sander. Almost all rust and foreign matter are fairly removed.	Pt2	
Surface prepared by wire-brushing and by disc sander. Rust and foreign matter are removed to the extent that the surface has a uniform metallic sheen.	Pt3	
Surface prepared by light blast cleaning of slug sands or grit. (Shopprimer with the little trace of rust is noticeable).	Ss	AS. 1
Surface prepared by thorough blast cleaning of slug sands or grit. Almost all mill scale, rust or foreign matter are fairly removed	Sd2	AS. 2
Surface prepared by very thorough blast cleaning of slug sands or grit. Mill scale, rust and foreign matter are removed to the extent that the surface has a uniform metallic sheen.	Sd3	AS. 3

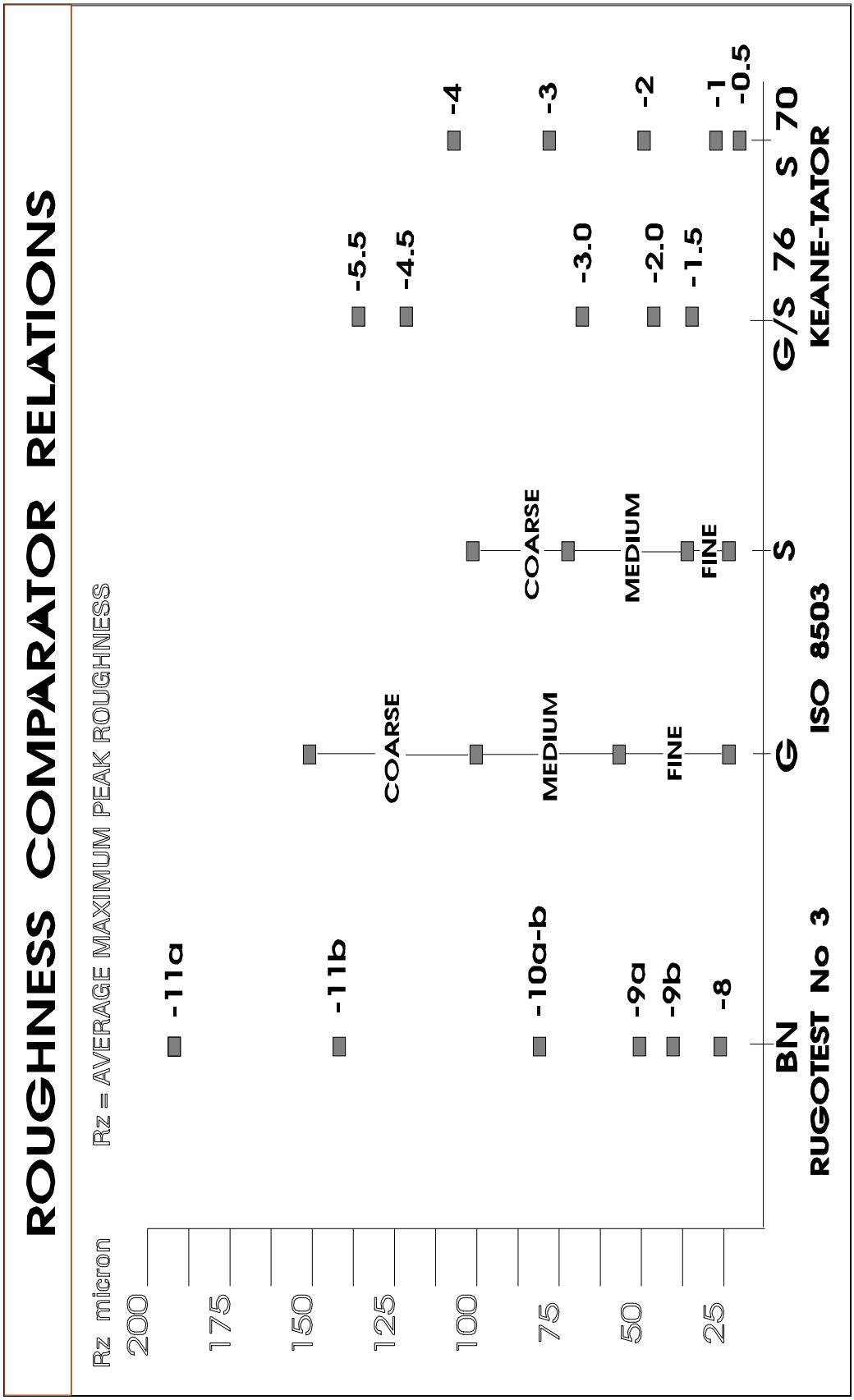


Before these mechanical or abrasive blast cleaning methods, oil and grease as well as water soluble material which has contaminated the surface should be removed.

HEMPEL

SURFACE ROUGHNESS

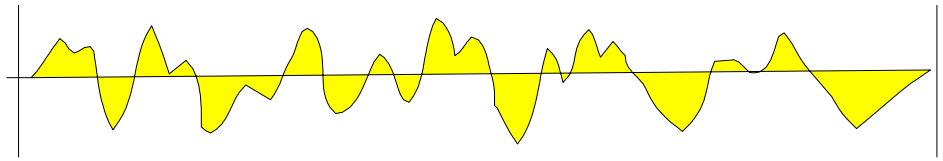
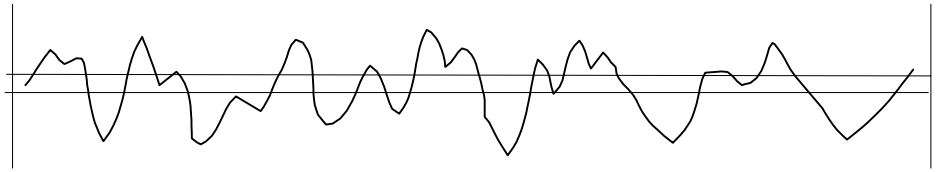
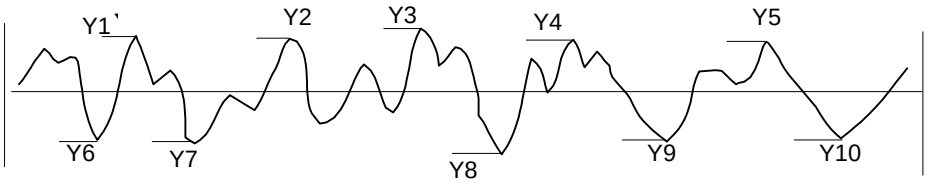
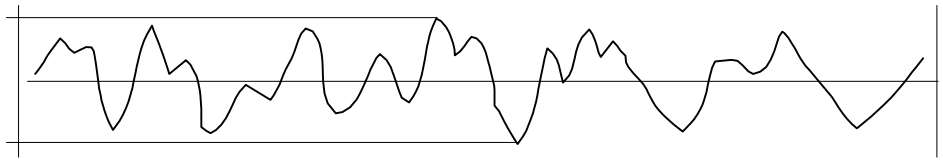
R5a



HEMPEL

SURFACE ROUGHNESS — The Ra, Rz and Rmax - Values — R5b

HEMPEL makes use of the Rz-value, when specifying surface roughness

Centre Arithmetical **Mean Line** (Centre Line)	A line relative to which assessment of the profile is performed. The areas limited by the centre line and the profile are equal on both sides	
Arithmetical Mean deviation of the profile **Ra** (= CLA and AA)	The arithmetical mean of the absolute values of the profile departures within the sampling length. **Used on the RUGOTEST**	**Ra** 
Ten point height of irregularities **Rz**	The average value of the absolute values of heights of five maximum profile peaks and the depths of five maximum profile valleys. Rz = 1/5*(Y1 + Y2 +....+ Y9 + Y10) **Rz is approx. 4-6 times Ra**	**Rz** 
Maximum height of the profile **Rmax** (Ry)	The distance between the highest point and the lowest point on the profile. **Rmax is approx. 6 times Ra**	**Rmax** 

HEMPEL

WATER SOLUBLE SALTS CONDUCTIVITY MEASUREMENTS

R 6a

WHY?
Excessive amounts of water soluble salts cause osmotic blistering of the paint coating.
In many immersion situations this may be detrimental to coating performance, and in such cases checks may be specified or have to be made.
Typical jobs are coating of ballast and cargo tanks and off-shore structures

WATER SOLUBLES ON THE STEEL SURFACE

HEMPEL PROCEDURE - in full compliance with ISO 8502-9.
See Page R 6c

Table 1.

		Conductivity µS/cm	equiv. Cl mg/m²	equiv. NaCl mg/m²
		0	0	0
		2,5	6	10
NORSOK	**Note 6, see page R6b**	5	12,0	20
		7,5	18	30
HEMPEL	**Note 1, see page R6b**	10	24,0	40
IMO	**Note 5, see page R6b**	12,5	30,0	50
		15	36	60
		20	48	80
		25	60	100
HEMPEL	Note 2, see page R6b	27,5	66,0	110
		40	96	160
		60	144	240
HEMPEL	Note 3, see page R6b	80	192	320
		125	300	500
HEMPEL	Note 4, see page R6b	185	444	740

SALTS IN MINERAL ABRASIVES

PROCEDURE ISO 11127-6, See Page R 6d

NOTE

Conductivity acceptance levels are indicated for an abrasive bulk density of 1.7 kg/l.
Limits are given for densities 1.4 to 2.0

Table 2.

HEMPEL'S recommended maximum limit for:	**MEASURED CONDUCTIVITY mS/m** 0 5 10 15 20	
ISO 11126:1993 limit for abrasives	25	Always 25
Tank Coatings with Cargo Protection Guide or other RESISTANCE GUIDEs or for fresh/brackish water	30	35-25
Other tank Coatings & Heavy duty Coatings	50	60-40

HEMPEL

WATER SOLUBLE SALTS CONDUCTIVITY MEASUREMENTS

R 6b

WATER SOLUBLES ON THE STEEL SURFACE RELATIONS OF TERMINOLOGY

Conductivity µS/cm	Conductivity mS/m	equiv Cl µg/cm²	equiv Cl mg/m²	equiv. NaCl µg/cm²	equiv. NaCl mg/m²	Note
0	0,0	0,0	0	0,0	0	
2,5	0,3	0,6	6	1,0	10	
5,0	0,5	1,2	12	2,0	20	6
7,5	0,75	1,8	18	3,0	30	
10,0	1	2,4	24	4,0	40	1
12,5	1,25	3	30	5,0	50	5
15	1,5	3,6	36	6,0	60	
20	2,0	4,8	48	8,0	80	
25	2,5	6,0	60	10	100	
27,5	2,75	6,6	66	11	110	2
40	4	9,6	96	16	160	
60	6	14,4	144	24	240	
80	8	19,2	192	32	320	3
125	12,5	30	300	50	500	
185	18,5	44,4	444	74	740	4

Notes:

Conductivity when measured according to the HEMPEL-method, Page R6c.

1: HEMPEL'S recommended maximum conductivity level for areas permanently immersed in demineralised, potable and hot water.

2: HEMPEL'S recommended maximum conductivity level for immersed areas and for MULTI-STRENGTH products.

3: HEMPEL'S recommended maximum conductivity level for non immersed areas, equivalent to max conductivity accepted by NACE/SSPC SP 12: SC-2.

4: Equivalent to max conductivity accepted by NACE/SSPC SP 12: SC-3.

5: Max conductivity accepted by IMO Performance Standard for Protective Coatings and for tank coatings with Cargo Protection Guide or other RESISTANCE GUIDES.

6: Max conductivity accepted by NORSOK off-shore standard.

HEMPEL

HOW TO DETERMINE:
WATER SOLUBLES ON A STEEL SURFACE

R 6c

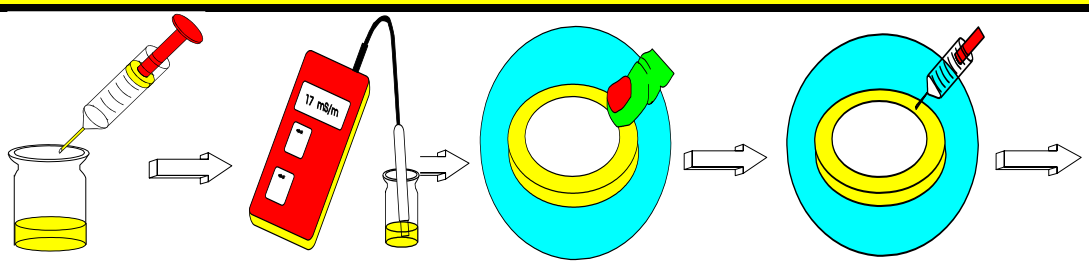
THE HEMPEL METHOD

PREPARATION:

* **DO NOT** dedust or touch test area using bare hands. Use only clean gloves, if needed.
* **DO NOT** touch the test area of the sampler by any means.
* A blind test of the A-1250 samplers own contribution to conductivity should be made every time a new package is opened. Use salt free substrate like eg. smooth plastic or steel washed in distilled water and air-dried.Procedure as below.
  Result = C

THIS YOU NEED:

- Bresle Samplers, A-1250.
- Syringe, 5 ml plus needle.
- Conductivity Gauge with range 0 -2000 µS/cm. Accuracy 2 µS/cm or better - and automatic temperature compensation to 25°C/77°F.
- Glass beaker, Diameter 3.5 cm
- Distilled Water, High purity.

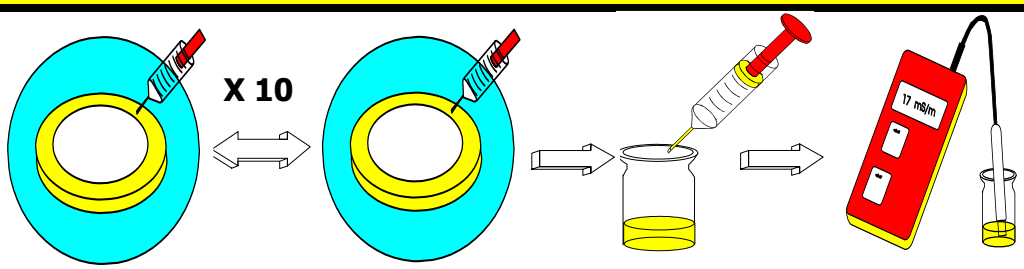


Fill in 10 ml distilled water into clean beaker using the syringe, ie. 2 x 5 ml

Measure conductivity µS/cm and note down.
Result = B

Remove protective backing and foam. Affix cell to dry surface and press firmly to create completely tight seal.

Inject approx. 3.5 ml distilled water from beaker with syringe through spongy foam perimeter. Hold perimeter of cell firmly to avoid leakage.



Leave water inside for 1 minute
(NB 1'st time only)

Retrieve water back into syringe. Last time as much as possible

Remove syringe and empty back into the original beaker

Measure conductivity of the approx 10 ml in the beaker in µS/cm
Result = A

Final conductivity result = (A - B - C) µS/cm

NOTE

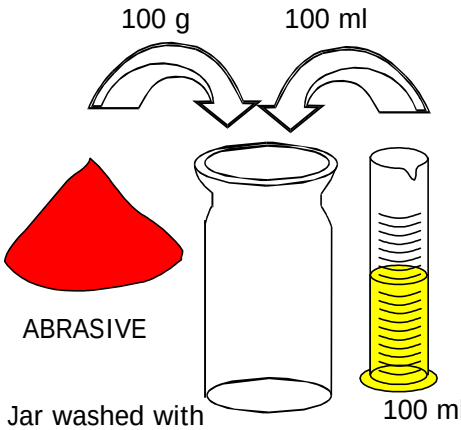
Temperature compensition is NOT necessary.The gauge does it automatically

This procedure complies with ISO 8502-9 when using table 1 on page R 6a for interpretation of results.

HEMPEL

HOW TO DETERMINE: CONDUCTIVITY of MINERAL ABRASIVES

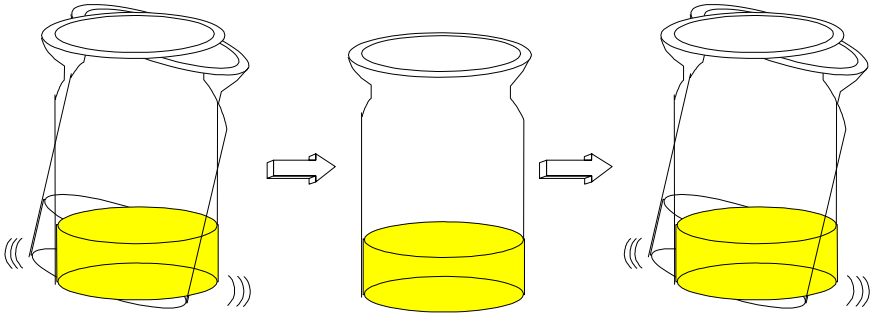
R 6d



ISO 11127-6

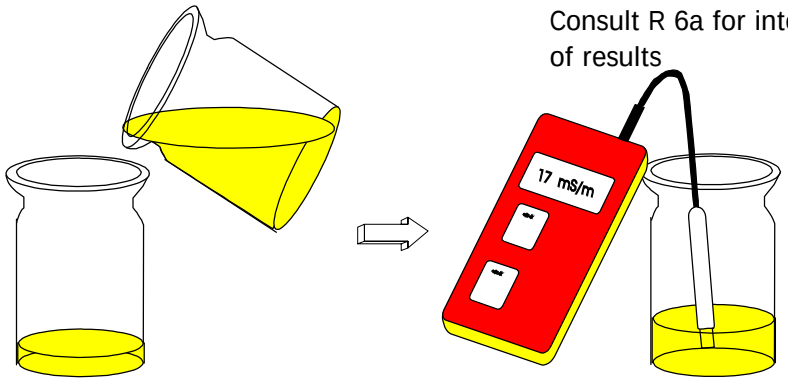
THIS YOU NEED:
- Electronic Conductivity Gauge
- Balance, ±0.1 g
- Measuring Glass, 100 ml
- 2 Clean Glass Jars, 250 ml
- 1 liter distilled/demineralised Water Conductivity less than 1 mS/m

TAKING THE SAMPLE:
- Collect samples at min 5 places in the abrasive at random. Mix them well and take the 100 g from the mix.



SHAKE 5 Minutes | Let stand 1 Hour | SHAKE 5 Minutes

Consult R 6a for interpretation of results



DECANT into CLEAN GLASS JAR washed with destilled water and dried out.

Measure conductivity with electronic CONDUCTIVITY GAUGE. (mS/m)

MAKE THE WHOLE ANALYSIS TWO (2) TIMES
If results are within ± 10%, report average
If results deviate >10%, make a third analysis and report average of two closest.

HEMPEL

SHOPPRIMERS R 7a

Shopprimers are special very quick drying primers intended to be applied in a very thin coat of 15-25 micron on automatic equipment and to protect steel plates and profiles during manufacturing and erection periods until the full coating system can be applied.

TYPES

Following types are available from reputable suppliers today (2003):

TYPE:	HEMPEL-Quality
PVB	HEMPEL'S SHOPPRIMER PVB 1525
EPOXY IRON OXIDE	HEMPEL'S SHOPPRIMER E 1528
ZINC RICH EPOXY	HEMPEL'S SHOPPRIMER ZE 1537
ZINCSILICATE, Medium zinc cont.	HEMPEL'S SHOPPRIMER ZS 1572
ZINCSILICATE, Low zinc content	HEMPEL'S SHOPPRIMER ZS 1589

Indicated HEMPEL Shopprimer may not necessarily be on the Standard Assortment list.

LIFETIME

Protective lifetime of a shopprimer depends so much on local conditions, that a guaranteed lifetime should never be given. Relative lifetime between the types in the same environment is as follows:

TYPE:	15 micron	25 micron
PVB		
EPOXY IRON OXIDE	not rec.	
ZINC RICH EPOXY		
ZINCSILICATE, Medium zinc cont.		
ZINCSILICATE, Low zinc content		

WELDING PROPERTIES MIG/MAG or CO2

Shopprimers unfortunately influence modern welding techniques and gas cutting. "Old" stick welding and modern plasmacutting is very little affected. Shopprimers influence as follows:

TYPE:	15 micron	25 micron	Remarks
PVB			Porosities
EPOXY IRON OXYDE			Porosities
ZINC RICH EPOXY			Poros.+Arc Inst.
ZINCSILICATE, Medium zinc cont.			Arc Instability
ZINCSILICATE, Low zinc content			

LATER EXPOSURE AND OVERCOATING:

Shopprimer can be over coated with most paints.
Note however the following indicative restrictions:

TYPE:	Immersion	Zn-silicates	Multi-Strength
PVB			
EPOXY IRON OXIDE			
ZINC RICH EPOXY			
ZINCSILICATE, Medium zinc cont.			
ZINCSILICATE, Low zinc content			

POOR / VERY SHORT

VERY SUITED / LONGEST

HEMPEL

SHOPPRIMERS R 7b

Before you can overcoat any shopprimer it must be clean, and rusted and damaged shopprimer must be mechanically cleaned or abrasive blasted according to specification. This is mandatory for any shopprimer before overcoating.

Additionally you may depending on later exposure and the coating to be applied have to do further SECONDARY SURFACE PREPARATION
Below is a chart giving some guidance for this:

SECONDARY SURFACE PREPARATION, Indicative:

TYPE:	Immersion	Zn-silicates	Multi-Strength
PVB		nr	
EPOXY IRON OXYDE			
ZINC RICH EPOXY			
ZINCSILICATE, Medium zinc cont.			
ZINCSILICATE, Low zinc content			

Abrasive blast completely away (Sa 3 appearance)

Hard abrasive sweeping.

Mechanically clean (avoid polishing) to remove zincsalts and contamination.

Light abrasive sweeping to roughen and to remove zinc salts

No extra secondary surface preparation.

NOTE: * For TANK LININGs with RESISTANCE GUIDES you must follow what is specified therein.

* Excessive oil spillage on zinc-rich shopprimers cannot be cleaned properly.
Therefore abrasive blast such areas and degrease afterwards.

SHOPPRIMER THICKNESS

Due to their requirements of extremely fast drying, shopprimers are inherently of low internal strength (cohesion). Therefore all above properties are based on the assumption, that the film thickness is correct, i.e. between 10 and 35 micron and evenly distributed over the plates.

If thickness is excessive (se Page R 7c on how to estimate) hard abrasive sweeping is necessary to reduce film thickness before overcoating except where more demanding requirements are set as indicated above.

SHOPPRIMERS

R 7c

MEASURING FILM THICKNESS

The dry film thickness of a shopprimer CANNOT be measured directly on an abrasive blasted steel surface, simply because the surface roughness is often higher than the thickness of the shopprimer.
Wet film thickness measurements are not possible either, as the shopprimer dries too fast.
Therefore special measures have to be taken when establishing shopprimer thickness.

Two cases may call for measurements of shopprimer thickness:

1/ During application of the shopprimer.
2/ When the suitability for overcoating needs to be decided.

DURING APPLICATION:

During application shopprimer dry film thickness must be established on smooth panels shopprimed together with the plates/profiles.

Since a smooth surface pr sqm represents a smaller surface area than an abrasive blasted surface, the same amount of shopprimer applied to a smooth surface will give a higher dry film thickness than when applied on an abrasive blasted surface.

As a rule of thumb following approximate relations exist:

Shopprimer Film Thickness			
Surface Roughness	Smooth	Rz = 40 micron	Rz = 75 micron
RUGOTEST, Approx:	-	N9	N10
micron	25	20	15
micron	20	15	12

BEFORE OVERCOATING:

Since direct DFT-Measurements cannot be used, an approximate method as described below must be used (Note that dry film thickness can in this connection only be too high or too low):

1/ Calibrate the DFT-Gauge (Electronic) on a piece of smooth steel.
2/ Select 5% of the plates/profiles as required to be checked
3/ Mark out an area of 1000 x 100 mm on each of the selected plates/profiles.

4/ Make 10 measurements in each of the marked areas and calculate the average for each area:

x x x x x x x x x x => AVERAGE

DECISIONS:	DFT is: OK	No decision can be made	Rejected
- No average values above 35 micron:	*		
- Maximum 10% of the average values above 35 micron. None above 40 micron:	*		
- No average values below 52 micron:			*
- Maximum 10% of the average values below 52 micron. None below 47 micron:			*
- All other outcome:		*	

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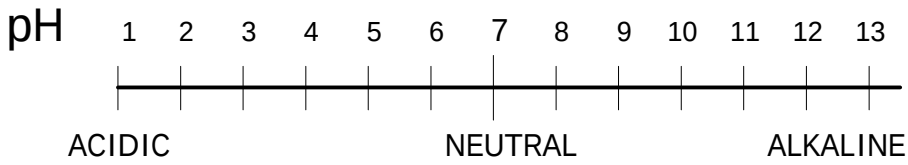
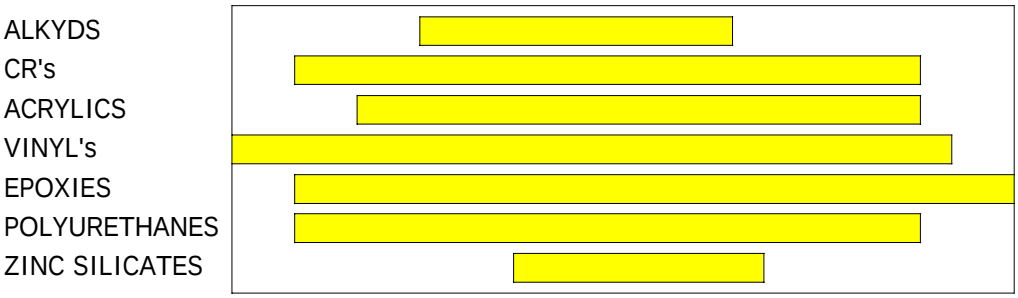
pH-VALUE

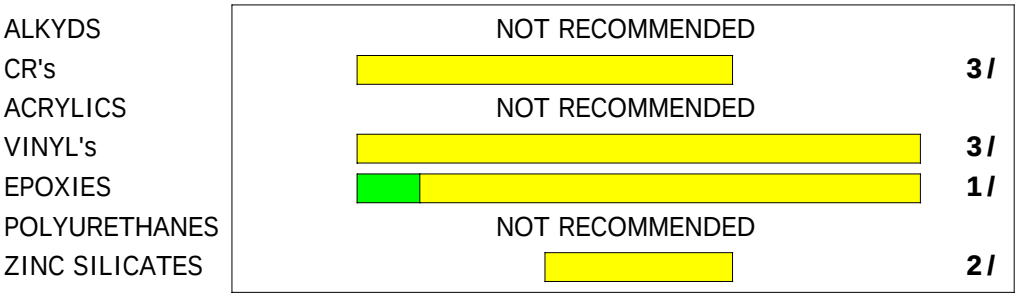
R 8



SPILLAGE



CONSTANT EXPOSURE

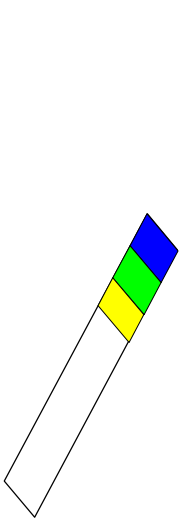


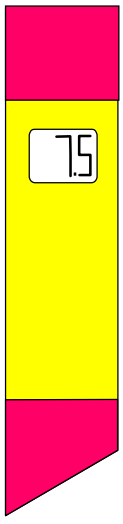
1 / Epoxy-polyamide and -amideadduct cured coatings are best for salt-containing water, e.g. seawater. They are less resistant to acids than amine cured epoxies.
Epoxy-polyamine and -amineadduct cured coatings are best for water contaminated with organic substance.

2 / Zinc silicates are suitable for immersion only when they are NOT overcoated.

3 / Usually not relevant except for sea-water immersion

RESISTANCE VALUES are INDICATIVE





HEMPEL

TAKING

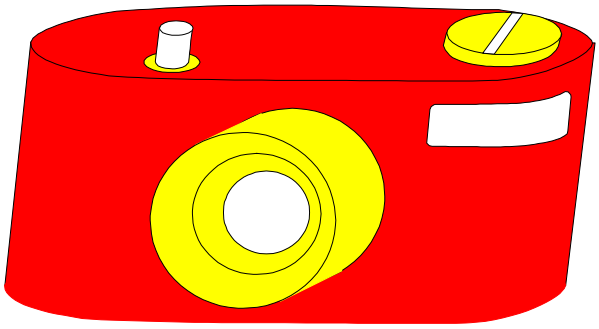
TECHNICAL PICTURES

R9a

GENERAL

Photo documentation is a very effective supplement to reporting.

Today's self-adjusting pocket size cameras with build-in flashlight makes the taking of the picture very easy.



BUT WHAT ABOUT THE MOTIVE?

Below is given some general guidelines for taking technical pictures:

1: Always make an overview picture, describing location and to which detailed photos can readily be referred.

2: Take pictures in necessary detail to describe the action or condition, you want to tell about. These pictures should be within the area of the overview picture

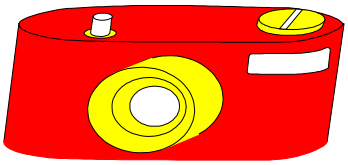
3: Pictures can easily disproportion a story, e.g. when a report of paint condition is to be made. Do not take pictures of defective areas only. This will lead the receiver to believe, that the whole area surveyed is totally broken down when in fact it may only be a few percent.
Try to balance pictures of good and bad according to the actual extent and type of breakdown.

4: Always note down immediately in your Notebook, what each picture is about, so that it is possible to make a good photo-legend to accompany the pictures. The receiver of the report must be able to - as quickly as possible - establish where and what the picture describes.

HEMPEL

TAKING TECHNICAL PICTURES **R9b**

at DRY DOCKINGS



For a normal Dry-docking 20 - 25 photos will usually suffice.

Follow the guidelines on page R9a

REFERENCE PHOTOS

As a condition survey - before start of the work - take four(4) overview photos from the points as shown on the sketch below.

The photos from the SB-side must indicate the condition of both the topside area and the A/F area as good as possible.

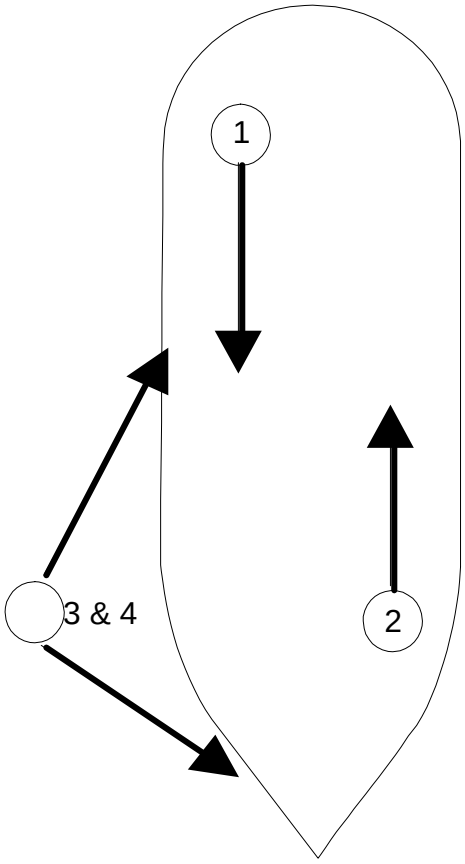


PHOTO POINTS:

1 DECK FROM AFT
2 DECK FROM FORECASTLE
3 TOPSIDE and BOTTOM
4 TOPSIDE and BOTTOM

HEMPEL

IDENTIFYING THE EXISTING COATING

QUICK REFERENCE

R 10

Sometimes you may need to identify the generic type of the existing coating used for a job, e.g. when repair has to be done and information on the existing coating HAS BEEN CHECKED NOT to exist.

NOTE:
This is a "suddenly on-site" guidance procedure. Precise determination will require lab-investigations.

EQUIPMENT:

You will need the following equipment:
THINNER 08080, THINNER 08460, TOOL CLEANER and pieces of cloth.

PROCEDURE:

* Clean the surface with emulsifier to remove dirt and chalking, note if the coating is chalking severely.
* **Rub the surface intensively for 2-10 minutes with a piece of cloth soaked in :**

THINNER 08080 ⇨	**THINNER 08460** ⇨	**TOOL CLEANER** ⇨	**STILL THERE**
The coating dissolves and can be removed right through	The coating dissolves and can be removed right through	The coating is severely affected, wrinkling and/or blistering.	Not or slightly affected only in 08460 and TOOL CLEANER
Chlorinated Rubber Acrylic, PVC (soft type). Bitumen Antifoulings	Vinyl (hard type). Vinyltar	Alkyd Modified alkyds Epoxyesters	Epoxy, Modified Epoxy Coal tar Epoxy Polyurethanes Zincsilicates

ADDITIONAL OBSERVATIONS:

* Coating soft and black, dark brown or aluminium: ===> Bitumen
* Coating hard, but black dark brown or alu, tar smell when scraped: ===> Coal tar epoxy
* Coating severely chalking: ===> Epoxy or Chlorinated Rubber
* Primer coat metal grey or greyish, metallic sheen when scraped: ===> Zincepoxy or Zincsilicate

HEMPEL

OVERCOATING INTERVALS

R 11

The TECHNICAL DATASHEET usually gives you the Overcoating Intervals at 20°C/68°F and for the indicated dry film thickness.

The ACTUAL overcoating intervals depends on the SPECIFICATION, i.e. the actual dft, what generic type is to be overcoated with, what layer and what coat number is it.

Finally when this is settled at 20°C, it has to be transferred to other temperatures.

All this normally appears in the WORKING SPECIFICATION.

If not available contact your HEMPEL-representative, who will assist in working out the necessary information.

HEMPEL

ANTIFOULING COMPATIBILITY CHART — R12

STATUS - November 2006

EXISTING ANTIFOULING	RECOATING WITH:	TIN FREE OCEANIC/ OLYMPIC	TIN FREE GLOBIC NCT		NOTES
INSOLUBLE MATRIX (Tin based as well as tin free)	**TIE COAT REQUIRED** High pressure cleaning, min 400 bar Note 1 & 3.2			1	Genuine insoluble binders are defined as based on vinyl or chlorinated rubber. Some "insoluble matrix" antifoulings not based on vinyl or chlorinated rubber should not be recoated without consulting the HEMPEL-representative for advise.
TIN FREE SELFPOLISHING	**HEMPEL:**			2	Only for antifouling systems to be applied in a dft higher than 250 micron If tie coat is required: HEMPATEX HI-BUILD 46330 in min 40 micron, or HEMPADUR 45182 in min 50 micron
	ROSIN BASED:	Note 2	Note 4		
	SILYLATED:	Note 2	Note 4	---> --->	NOF: Takata Quantum, Jotun: Sea Quantum CMP: Sea Grand Prix 1000 & 2000, Kansai: Nu Trim
	METAL ACRYLATES:	Note 2	Note 4		Akzo IP: Ecoloflex, Nippon Paints: Ecoloflex, Kansai Exion CMP: Sea Grand Prix 100 & 200, KCC: AF 795
	VINYL PYRROLIDONE:	Note 2	Note 4		Sigma: Alphagen
TIN BASED SELFPOLISHING	**NO TIE COAT REQUIRED** High pressure cleaning, min 400 bar Notes 3.1 & 3.2			3.1 3.2	AF must have been exposed to seawater for min 12 months. A very thorough high pressure fresh water hosing (HPFWH) is necessary in order to remove loose paint and leached binder.
				4	Certain market technologies tend to absorb too much water upon fresh water exposure. The strength and porosity of these (typically metalacrylate based) should be evaluated in the dock. Overcoating will require a flash coat technic during application of first A/F coat and depnding on condition a full tie coat may be required

TIE COAT REQUIRED

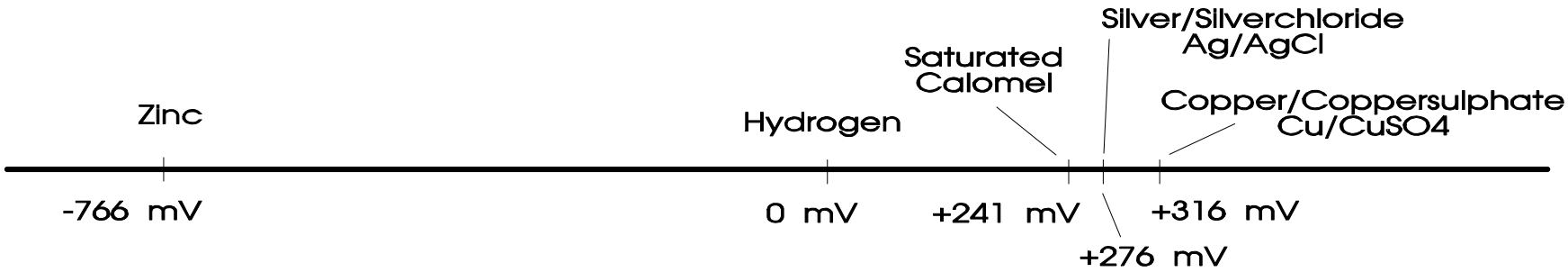
NO TIE COAT REQUIRED

HEMPEL

IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) — R13

When Impressed Current Cathodic Protection (ICCP) systems are used, the voltage necessary for passivating the hull is continuously measured by the use of reference anodes.
Several types of reference anodes may be used and since the potential is normally referred to the reference anode used it is important to know their relative positions.

For use in seawater they are shown on the line below:



When testing and specifying HEMPEL - unless otherwise appearing - use and refer to the saturated Calomel reference anode as basis.

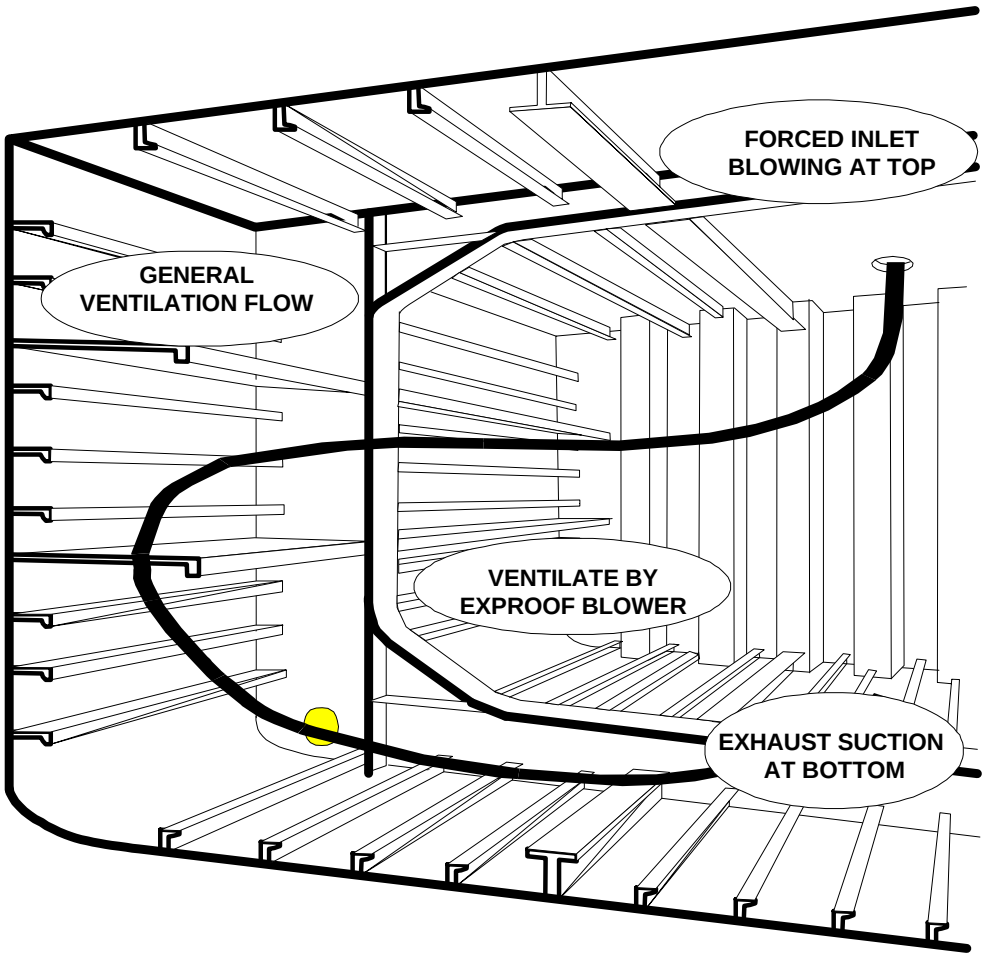
HEMPEL

TANKS - VENTILATION | R 14

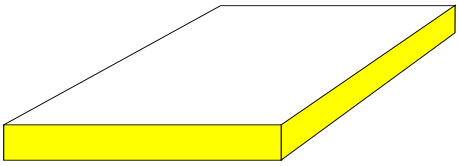
SOLVENT VAPOURS ARE MORE HEAVY THAN AIR.
Therefore they always tend to go to the bottom of confined spaces and consequently their removal must always take place by suction from the lower part of such areas.

Control both Inlet Air and Exhaust Air
Exhaust by suction is the normal way - but to fully control the ventilation flow, forced inlet blowing should always be used in cooperation with the suction.
Forced inlet blowing is also necessary when controlling the atmosphere in the confined space through dehumidifiers.

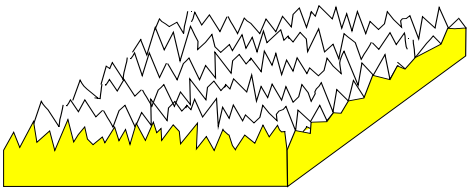
Sometimes general ventilation is not enough.
Local areas inside the confined space may not be sufficiently ventilated via the general ventilation installation.
To secure ventilation of the local areas ex-proof portable blowers can be put in these areas.



TRUE SURFACE AREA



PROJECTED SMOOTH" SURFACE AREA



TRUE "TOPOGRAPHIC" SURFACE AREA

SURFACE AREA RATIO (Estimated).

Rz micron	"SMOOTH"	"TOPOGRAPHIC"
30	1	1,27
40	1	1,36
50	1	1,45
60	1	1,54
70	1	1,63

You may think that this affects the paint consumption of the primer coat, but this is not the case with Standard HEMPEL specifications - i.e. if the surface roughness is specified in the specification, and if the guidance for DFT-measurements given in this booklet and in HEMPEL'S Code of Practice 0209-1 is followed

Only in three cases will compensation have to be considered:

A: When applying SHOPPRIMERS.
Reference is made to the TECHNICAL DATASHEETs and section R7 in this booklet.
When applying SHOPPRIMERS, their dry film thickness is often lower than the roughness of the substrate and they dry so quickly, that the film follows the contour of the roughness.

B: When surface roughness deviates from that specified.
In this case refer to page R15b.

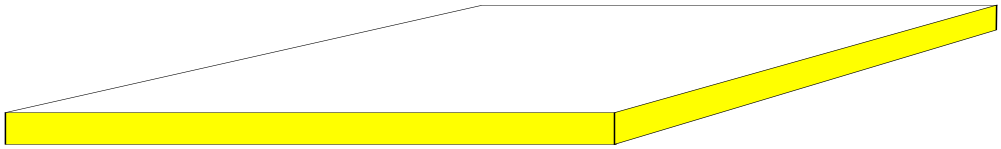
C: If PrEnISO 19840 is referred to in the specification including its normative reference section.
Then compensation will have to be done depending on substrate roughness.
Study the standard carefully if You meet it, also when responding to the specification.

HEMPEL

"DEAD VOLUME" R15b

WHAT IS IT?

The "DEAD VOLUME" is normally referred to the amount of paint needed to fill up the surface roughness created by abrasive blasting. The opinion is often that this is an extra amount of paint needed before the protective paint film can be build up over the peaks (Overpeak Protection).



The approx. relationship between roughness Rz and "Dead Volume" is:

Rz	micron	30	45	60	75	90	105
"Dead Volume":	(cm^3/m^2)	20	30	40	50	60	70

HOW TO CALCULATE THE PAINT REQUIRED?:

The paint can be calculated as follows:

$$\frac{\text{Area } (m^2) \times \text{"Dead Volume"} \ (cm^3/m^2)}{\text{Volume Solids } (\%) \times 10} \Rightarrow \text{Paint in liters}$$

IS IT NECESSARY TO CONSIDER "DEAD VOLUME"?:

The answer is: **GENERALLY NOT!**

provided that roughness is specified in the PAINTING SPECIFICATION and HEMPEL'S rules for calibration of the DFT-Gauge has been followed.
The latter calibrates to an imaginary line so close to the imaginary average paint line for the "Dead volume", that they can be considered the same.
Reference is made to HEMPEL'S Code of Practice 0209-1.

WHEN TO CONSIDER "DEAD VOLUME"?:

When surface roughness deviates from that specified. In this case use the difference between "Dead volume" in the specification and the "Dead volume" corresponding to the observed roughness to calculate the change in paint consumption..

WATER CLEANING

R 16a

DEFINITIONS & STANDARDS

Water for cleaning - not only for salt removal - but for removal of paint, rust, oil and debris is becoming a future surface preparation method.

It's environmental advantage, the benefit of not having abrasive material going into ballast pumps and not having to remove abrasive material from confined spaces makes it - not to mention the excellent salt removal ability - a clear winner in surface preparation of old rusty structures like e.g. ballast tanks.

The methods still lack proven definitions of terms and surface preparation standards, but activities to solve this are well under way.

The best result up to now seems to be the NACE/SSPC Joint Standard SP12: "SURFACE PREPARATION AND CLEANING OF STEEL AND OTHER HARD MATERIALS BY HIGH- AND ULTRA-HIGH PRESSURE WATER JETTING PRIOR TO RECOATING", quoted in the following:

DEFINITIONS:

* **Low-Pressure Water Cleaning (LP WC)**
  Pressures less than 340 bar/5.000 psi
* **High Pressure Water Cleaning (HP WC)**
  Pressures from 340 - 680 bar/5.000 - 10.000 psi
* **High-Pressure Water Jetting (HP WJ)**
  Pressures from 680 - 1.700 bar/10.000 - 25.000 psi
* **Ultrahigh-Pressure Water Jetting (UHP WJ)**
  Pressures above 1.700 bar/25.000 psi

WJ VISUAL PREPARATION GRADES:

Condition	Description (When viewed without magnification)
WJ-1	A WJ-1 surface shall be free of all previously existing visible rust, coatings, mill scale, and foreign matter and have a matte metal finish.
WJ-2	A WJ-2 surface shall be cleaned to a matte finish with at least 95% of the surface area free of all previously existing visible residues and the remaining 5% containing only randomly dispersed stains of rust, coatings, and foreign matter.
WJ-3	A WJ-3 surface shall be cleaned to a matte finish with at least two-thirds of the surface area free of all visible residues (except mill scale) and the remaining one-third containing only randomly dispersed stains of rust, coatings, and foreign matter.
WJ-4	A WJ-4 surface shall have all loose rust, loose mill scale, and loose coatings uniformly removed.

WATER CLEANING
DEFINITIONS & STANDARDS

R 16b

SC NON-VISUAL PREPARATION GRADES:

Condition	Description
SC-1	An SC-1 surface is free of all detectable levels of contaminants as determined using available field test equipment whose sensitivity approximates laboratory equipment. Contaminants for purposes of this standard are chlorides, iron-soluble salts, and sulfates.
SC-2	An SC-2 surface has less than 7 µg/cm² chloride contaminants, less than 10 µg/cm² of soluble ferrous ion levels, and less than 17 µg/cm² sulphate contaminants as verified by field or laboratory analysis using reliable, reproducible test equipment.
SC-3	An SC-3 surface has less than 50 µg/cm² chloride and sulphate contaminants as verified by field or laboratory analysis using reliable, reproducible test equipment.

The SPECIFICATION Example:

The Standard gives the following example of specifying:

"All surface to be recoated shall be cleaned as per NACE/SSPC SP12: WJ-2/SC-1 using either HP WJ or UHP WJ; the method ultimately selected by the contractor will be based on his confidence in the capabilities of the equipment and its components."

HEMPEL has issued a Photo Reference: *HMP-STD * WJ PHOTO * 01-97* complying with NACE 5 / SSPC-SP 12, 1995.

Further to illustrating the Preparation Grades for various substrates the photo reference also deals with the degree of Flash Rusting, dividing the flash-rusted condition into three (3) levels:

* FR-1
* FR-2
* FR-3

The Photo Reference can be purchased via HEMPEL-Headquarters, Copenhagen

An ISO-standard is being drafted. When finished, the number will be: ISO 8501-4

HEMPEL

DFT-RULES | R 17a

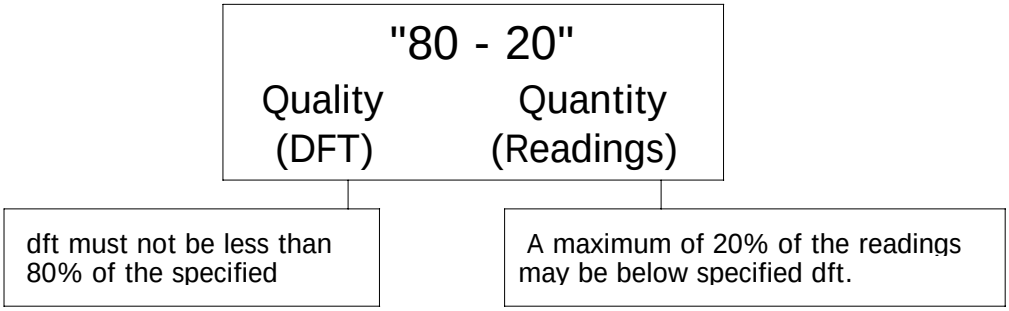
WHY:

How to control that specification is met? How many measurements should be taken? How to decide after having taken the measurements? What is max. DFT?	**VERY RELEVANT QUESTIONS**

The customer buys a certain dry film thickness according to the specification. Ideally he should not get less.
In practice we know that a job is never perfect, but on the other hand insufficiencies should not be too large neither in quantity (Area) nor in quality (DFT).

Here decision rules come in e.g. the so-called "80-20", "90-10" or similar rules.

HOW DO THEY WORK?



Many other combinations of figures for the rule can be used and the sum does not necessarily have to be 100.
When employed, the usual figures for various segments and areas are:

"80-20"	Shipbuilding including tank coatings with Resistance Guides. Offshore and Onshore constructions.
"90-10"	Containers.

The Rules are good for general surfaces, - but it is always recommendable to check areas difficult to paint e.g. rear sides of bulb-profiles etc. separately.

HOW MANY MEASUREMENTS TO TAKE?

The accuracy of making the correct decision is invariably linked to taking a certain amount of readings at random.
Guidelines to how many readings to take are indicated on page R17b.

HOW TO DECIDE:

Example by the "80-20"-Rule:

80-: No reading may be below 80% of that specified without repair being undertaken.

-20: Not more than 20% of the measurements may be in the range from 80 - 100% of that specified without repair being undertaken.

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DFT-RULES | R 17b

HOW MANY MEASUREMENTS TO TAKE?

Several international as well as local standards are now paying interest to statistical methods, when checking dft.
Today both ISO and SSPC has issued standards.

Below is quoted the sampling plan described in ISO 19840.
For details please refer to the standard.

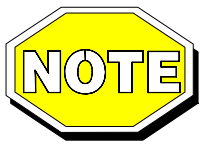
Area/length of inspection area m² or m	Minimum number of measurements	Maximum number of measurements allowed to be repeated
up to 1	5	1
above 1 to 3	10	2
above 3 to 10	15	3
above 10 to 30	20	4
above 30 to 100	30	6
above 100*	add 10 for every additional 100 m² or 100 m or part thereof	20% of the minimum number of measurements
Area above 1000 m² or m should be divided into smaller areas		

Please further refer to the standards acceptance and rejection criteria. as well as the standards special correction values for steel surface roughness.

Containers

Checking container-dft is very important because of the general low dft specified for these and the intense manufacturing procedures.
Therefore very frequent checks, many measurements and the use of the "90 - 10" Rule are necessary.
A different measurement procedure - taking full advantage of modern electronic equipment - is used as a part of an integrated reporting system.

Chemically Resistant Tank Coatings



Also here correct dry film thickness is very important.
1 reading pr every 2 sqm is recommended.

Other important standards

SSPC-PA 2 should be noted. When specified, please refer to the standards specific text for procedures and decision rules.

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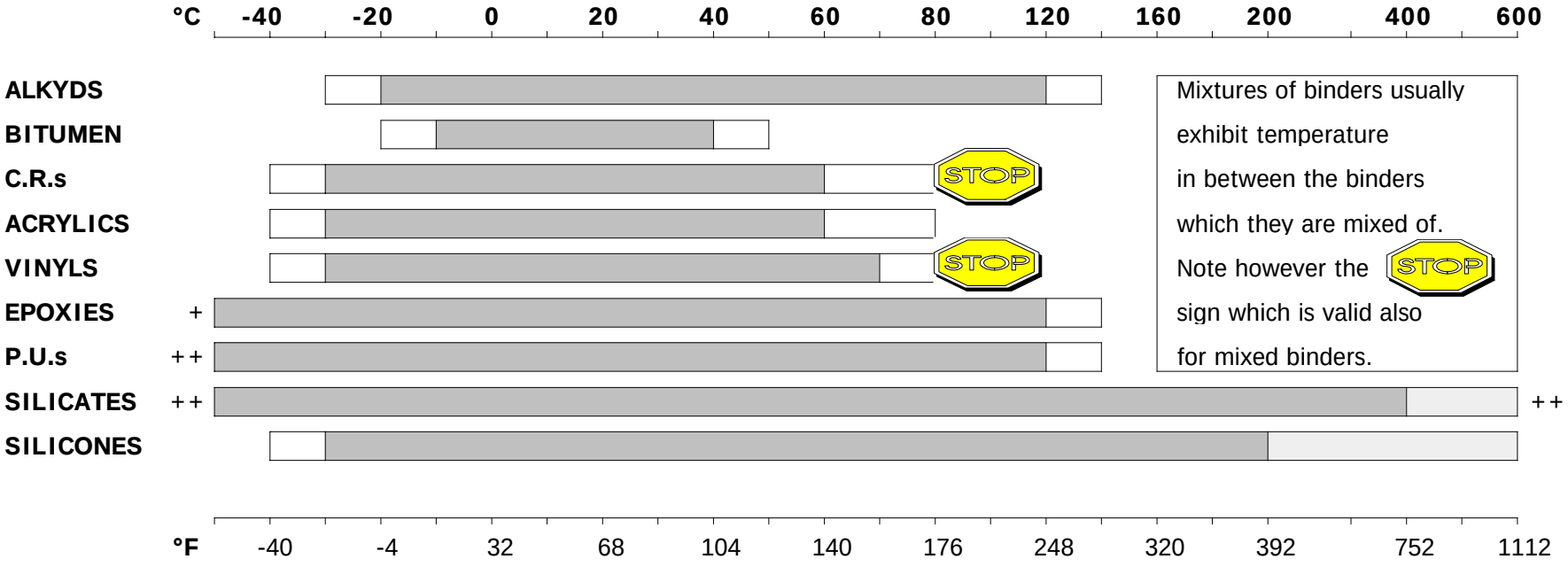
INDICATIVE TEMPERATURE RESISTANCE OF PAINTS (Dry Service)

R 18



Mixtures of binders usually exhibit temperature in between the binders which they are mixed of. Note however the STOP sign which is valid also for mixed binders.

Suitable for continuous dry service

Suitability will depend on pigmentation. Above 400°C only aluminium pigment is suitable.

Suitable for short temporary service only

STOP Do not exceed maximum temperature. Binder decomposes.

Also consult TECHNICAL DATASHEET's for specific information on temperature resistance for the products in question.

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ESTIMATING SIZE OF AFFECTED AREAS.

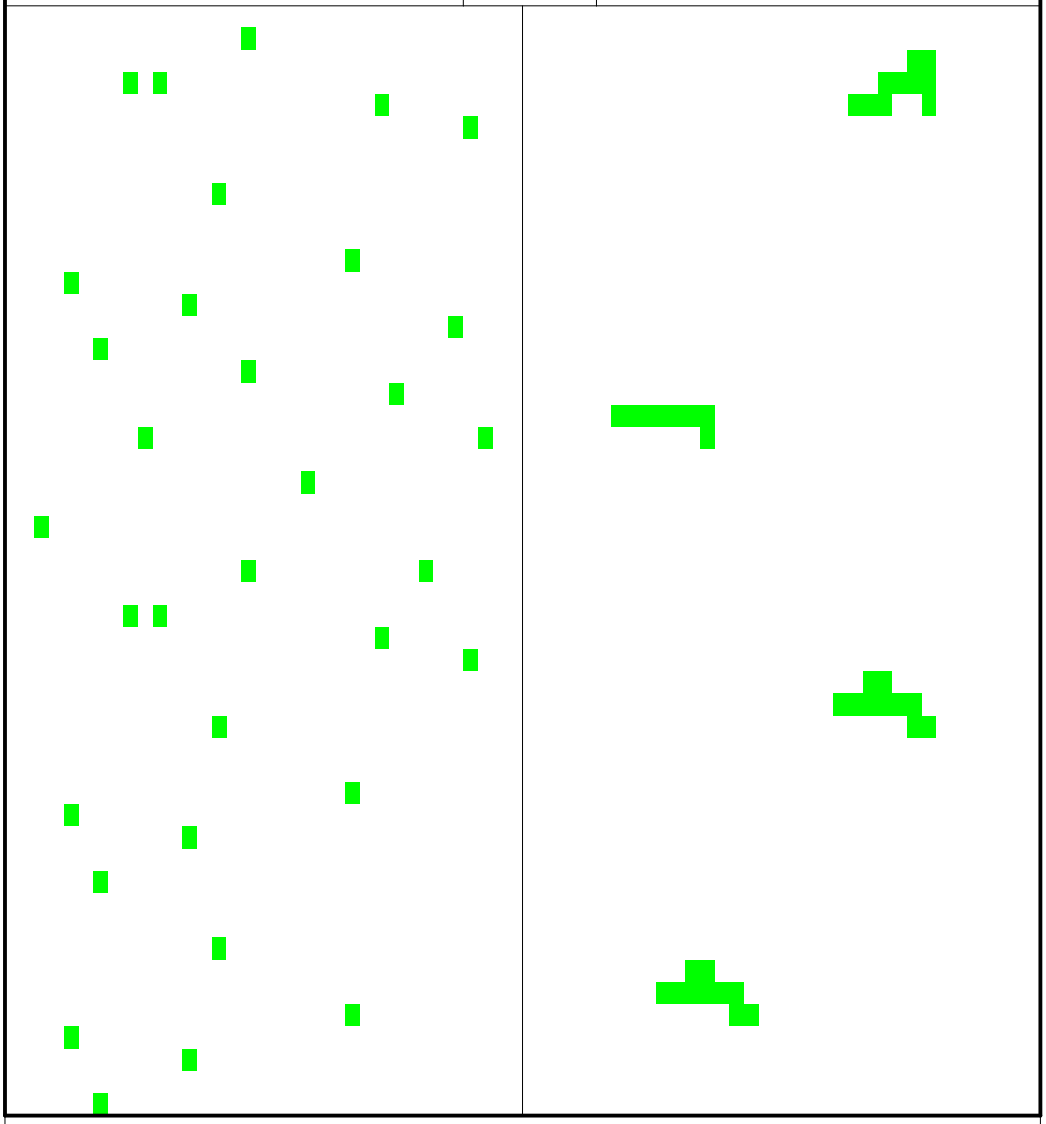
R19a

HEMPEL'S "SHIP-DATA" system makes often use of an area estimation system using few, but easy to estimate ratings:

This system divides into a simple 5 groups:

GROUP	DEFECTIVE AREA %	EXAMPLES:
0	0	2L means 2-5 % defective
1	<2	area with local occurring
2	2-5	defects.
3	6-25	1S means 0-2 % defective
4	>25	area with scattered defects.
5	100	

SCATTERED	**2 %**	LOCAL



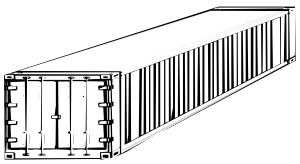
HEMPEL

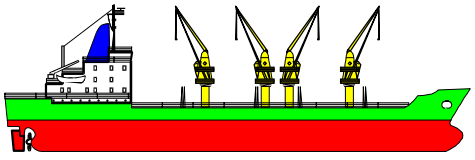
ESTIMATING SIZE OF AFFECTED AREAS

R19b

HEMPEL'S "SHIP-DATA" system makes often use of an area estimation system using few, but easy to estimate ratings:

SCATTERED	5%	LOCAL





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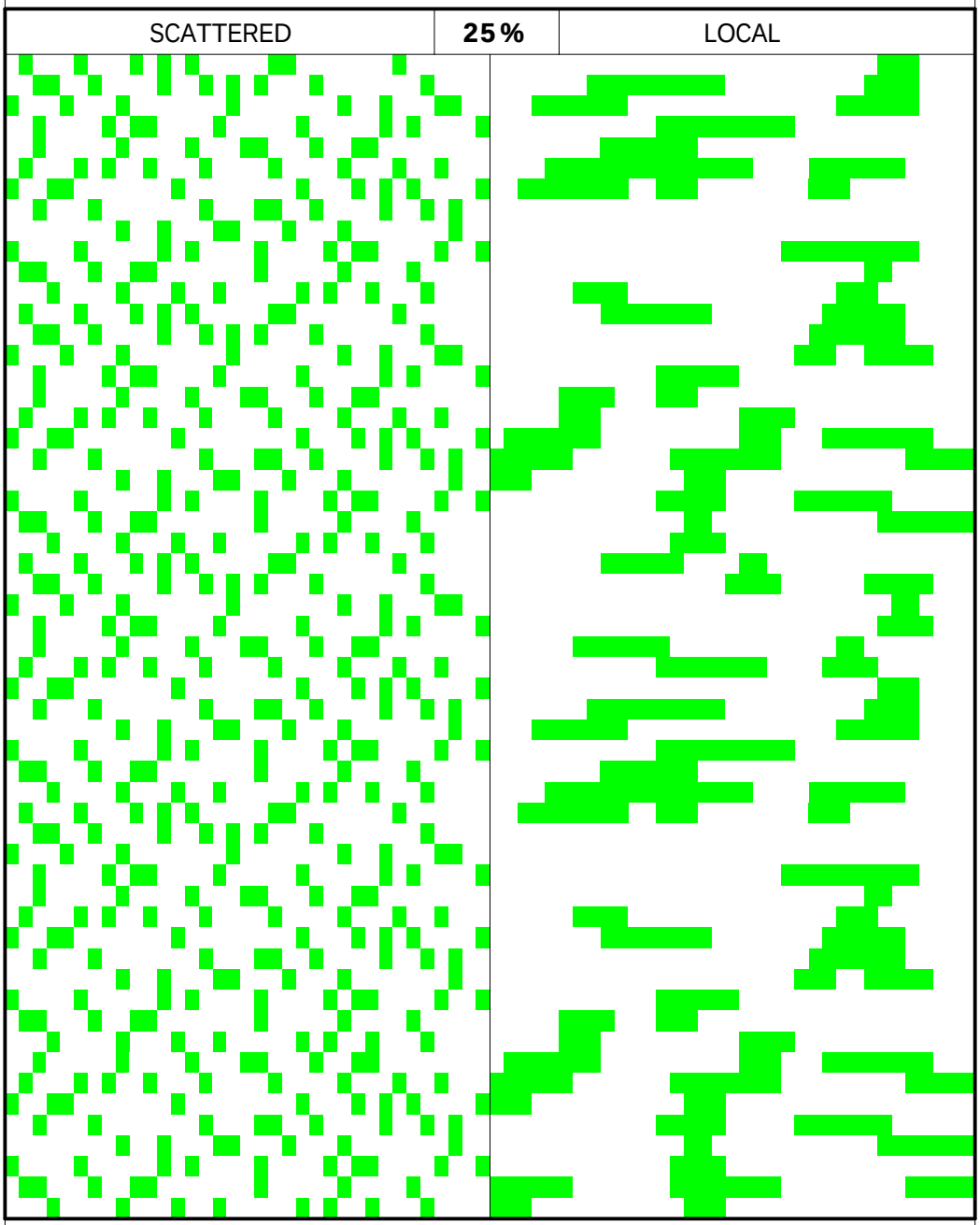
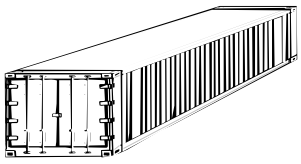
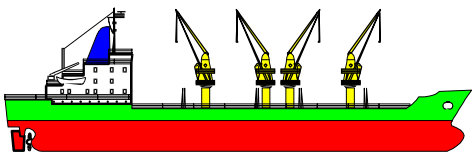
ESTIMATING SIZE OF AFFECTED AREAS

R19c

HEMPEL'S "SHIP-DATA" system makes often use of an area estimation system using few, but easy to estimate ratings:







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CORROSION CATEGORIES

R 20

ISO 12944 Section 2

The standard ISO 12944 has introduced a characterisation system for the corrosivity of environments. You may find many environments characterised by a simple abbreviation as follows:

CATEGORIES FOR ATMOSPHERIC EXPOSURE

Corrosivity Category	Low carbon steel thickness loss micron	Examples of typical environments in a temperate climate (informative only)	
		Exterior	Interior
C1 very low	=< 1.3	-	Heated buildings with clean atmospheres, e.g. offices, shops, schools, hotels
C2 low	>1.3 to 25	Atmospheres with low level of pollution. Mostly rural areas	Unheated buildings where condensation may occur, e.g. depots sports halls
C3 medium	>25 to 50	Urban and industrial atmospheres, moderate sulphur dioxyde pollution. Coastal areas with low salinity.	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries, dairies.
C4 high	>50 to 80	Industrial areas and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal ship- and boatyards.
C5-I very high (industrial)	>80 to 200	Industrial areas with high humidity and aggressive atmosphere	Buildings or areas with almost permanent condensation and with high pollution.
C5-M very high (marine)	>80 to 200	Coastal and offshore areas with high salinity.	Buildings or areas with almost permanent condensation and with high pollution.

CATEGORIES FOR WATER AND SOIL

Category	Environment	Examples of environments and structures
Im1	Fresh water	River installations, hydro-electric power plants
Im2	Sea or brackish water	Harbour areas with structures like sluice gates, locks, jetties; Off-shore structures.
Im3	Soil	Buried tanks, steel piles steel pipes.

For exact details of this extensive ISO-standard, including 8 sections comprising all aspects of corrosion protection by coatings, please consult the standard itself.

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WIND SCALES R21

Can we paint today?.

Not only the humidity and air temperature decides this, but for painting in the open also wind may become an important factor:

Below is given the standard wind scales used and comments regarding suitability for airless spray application.

Beaufort number (force)	Wind Speed				WMO Description	Comments
	s	mph	m/s	km/h		
0	<1	<1	0	<1	Calm	Painting possible with standard consumption factor.
1	1-3	1-3	1	1-5	Light air	
2	4-6	4-7	2-3	6-11	Light breeze	Painting may be possible
3	7-10	8-12	4-5	12-19	Gentle breeze	Excessive consumption factor
4	11-16	13-18	6-7	20-28	Moderate breeze	Severe risk of dry spray
5	17-21	19-24	8-10	29-38	Fresh breeze	Painting not possible
6	22-27	25-31	11-13	39-49	Strong breeze	
7	28-33	32-38	14-16	50-61	Near gale	
8	34-40	39-46	17-20	62-74	Gale	
9	41-47	47-54	21-24	75-88	Strong gale	
10	48-55	55-63	25-28	89-102	Storm	
11	56-63	64-72	29-32	103-117	Violent storm	
12	>=64	>=73	>32	118 -	Hurricane	

Even at lower wind speeds, then local conditions e.g. in between tanks may create stronger winds than average and make spray application in these areas critical.
Suitable shields can reduce the effect of winds, they should be maintained during the whole drying process as well as strong winds also tend to skin dry freshly applied coatings and thereby cause solvent retention.

Brush and roller application are much less affected by wind.

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DESINFECTION OF TANKS | R22

Desinfection of tanks and the use of desinfection chemicals for cleaning of cargo holds is becoming more frequent.

Potable water tanks are desinfected and the water often needs additional conservation, but also cargo holds and chemical tanks may need desinfection before the next cargo

Further discussions are coming up as to desinfection of ballast tanks in order to avoid transportation of biological flora around the world.

Most commonly used desinfection chemicals are based on chlorine, e.g. sodiumhypochlorite or chloramine, but also hydrogenperoxyde is more frequently met as it does not need to be removed again after desinfection - but just filled up with water.

Desinfection chemicals are all dangerous for coatings - and to avoid coating damage certain rules have to be obeyed:

Rules to respect:

* Mix the paint carefully before application and allow for sufficient induction time. Do not overapply thickness and allow proper time and ventilation between coats especially for solvent containing paints.
* Respect limits of temperature during application and drying/curing to avoid risk of exudation.
* The coating must be fully cured and completely free of solvents before desinfection is carried out, i.e. min 7 - 10 days at 20 DegC and proper ventilation.
* Desinfection at intervals less than 1 month should be avoided whenever possible.
  Make sure the whole system including valves, pipes and hoses is included.

Recommended Maximum Concentrations for use in tanks and cargo holds (Max. 35°C/95°F):

	Sodiumhypochlorite			Hydrogenperoxyde	
Chemical resistent	DESINFECTION		CONSERVATION	DESINFECTION	
COATING SYSTEM (Generic)	Max. Conc ppm	Max. hours	Max. Conc ppm	Max. Conc percent	Max. hours
Coal tar epoxy	50	4	not relevant	0,25	0,5
Modified epoxy	50	4	1	0,25	0,5
epoxy-polyamide	50	12	3	0,5	1
epoxy-polyamine	100	12	6	1	1
Phenolic epoxy	100	24	6	1	1

Amount of Sodiumhypochlorite (10-15% solution) to be added to 1000 litre of fresh water to form a solution of:

DESINFECTION		CONSERVATION	
To obtain a Conc. of:	Add	To obtain a Conc. of:	Add
50 ppm	330 ml	1 ppm	7 ml
100 ppm	660 ml	3 ppm	20 ml
		6 ppm	40 ml

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PHONETIC ALPHABET R23

There are actually many phonetic alphabets, but the most commonly used today for technical communication is the so-called NATO Phonetic Alphabet.

It was developed in the 1950s to be pronounceable for all NATO allies.

Letter	Pronounce
A	Alpha
B	Bravo
C	Charlie
D	Delta
E	Echo
F	Foxtrot
G	Golf
H	Hotel
I	India

Letter	Pronounce
J	Juliet
K	Kilo
L	Lima
M	Mike
N	November
O	Oscar
P	Papa
Q	Quebec
R	Romeo

Letter	Pronounce
S	Sierra
T	Tango
U	Uniform
V	Victor
W	Whiskey
X	X-ray
Y	Yankee
Z	Zulu

Digit	Pronounce
0	Zero
1	Wun (One)
2	Two
3	Tree (Three)
4	Fower (Four)

Digit	Pronounce
5	Fife (Five)
6	Six
7	Seven
8	Ait (Eight)
9	Niner (Nine).

Mark	Pronounce
,	decimal (point)
.	(full) stop

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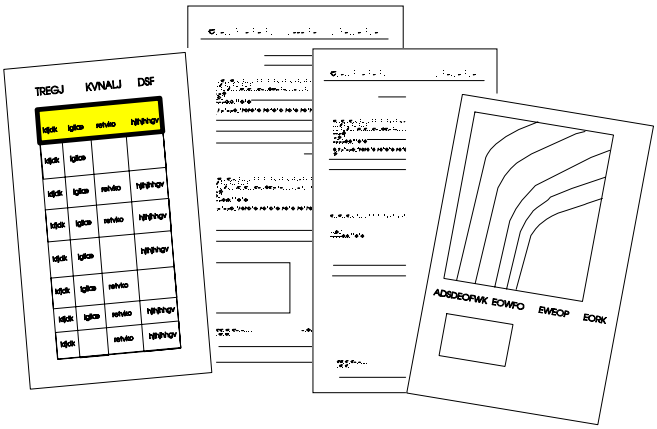
TABLES
of CONVERSIONS TRANSFORMATIONS and CALCULATIONS



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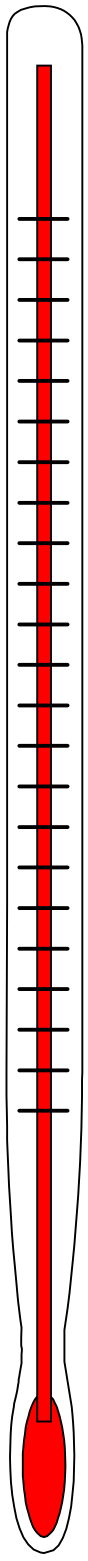
TEMPERATURE

T1

TEMPERATURE CONVERSION TABLE

°C	°F	°C	°F	°C	°F
-10	14	20	68	130	266
-9	16	21	70	140	284
-8	18	22	72	150	302
-7	19	23	73	160	320
-6	21	24	75	170	338
-5	23	25	77	180	356
-4	25	26	79	190	374
-3	27	27	81	200	392
-2	28	28	82	225	437
-1	30	29	84	250	482
0	32	30	86	275	527
1	34	32	90	300	572
2	36	34	93	325	617
3	37	36	97	350	662
4	39	38	100	375	707
5	41	40	104	400	752
6	43	42	108	425	797
7	45	44	111	450	842
8	46	46	115	475	887
9	48	48	118	500	932
10	50	50	122	525	977
11	52	55	131	550	1022
12	54	60	140	575	1067
13	55	65	149	600	1112
14	57	70	158	625	1157
15	59	75	167	650	1202
16	61	85	185	675	1247
17	63	95	203	700	1292
18	64	100	212	725	1337
19	66	110	230	750	1382
20	68	120	248	775	1427

To convert	From	To	Calculate
	elsius	Fahrenheit	(9/5 * °C) + 32
	renheit	Celsius	5/9 * (°F - 32)



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CONVERSION TABLES T2

To convert			Multiply by →	Multiply by ←
Distance:	micron	mil	0,04	25
	centimeters (cm)	inches	0,3937	2,54
	meter	feet	3,2808	0,304
	meter	yards	1,09361	0,9144
	km	nautic mile	0,5396	1,853
	km	mile	0,621	1,609
Area:	sq.meter(m^2)	sq.ft	10,764	0,0929
Volume:	liter	US gallon	0,264	3,785
	liter	Imp.gallon	0,22	4,55
	m^3	ft^3	35,315	0,0283
Area/Volume:	m^2/liter	sq.ft/US gallon	40,74	0,024
	m^2/liter	sq.ft/Imp.gallon	48,93	0,020
Weight:	kg	lbs	2,205	0,4536
Density	g/cm^3	lb/in^3	0,036	27,68
	kg/liter	lbs/US gallon	8,344	0,11985
Pressure:	atm.	bar	1,013	0,987
	atm.	kgf/cm^2	1,033	0,968
	atm.	p.s.i.	14,7	0,068
	bar	kgf/cm^2	1,02	0,98
	bar	p.s.i.	14,5	0,069
	kgf/cm^2	p.s.i.	14,22	0,07
	kgf/cm^2	MPa	0,098	10,2041
	N/mm^2	MPa	1	1
Speed	m/s	ft/s	3,281	0,305
	km/h	mile/h	0,621	1,609
	km/h	knots	0,54	1,852
Power	N	lbf	0,225	4,448
Effect	kW	Horsepower	1,341	0,746
	kW	kcal/h	859,9	0,0012
Energy	kWh	Btu	3412	0,0003
	kWh	Kcal	859,9	0,0012
	kcal	Btu	3,968	0,252
V.O.C.:	g/liter	lbs/US gallon	0.00834	119,904

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WET FILM THICKNESS T3

Wet film thicknesses given below correspond exactly to dry film thicknesses. In practice, always use the tooth on your wft-gauge which is the first above the indicated wft.

THINNING: Thinning affect the volume solids of the paint. Calculate the volume solids after the thinning before you use the tables below.

Calculate as follows: $\text{DATASHEET VS\%} * \frac{100}{(100 + \%\text{THINNING})}$

HIGH BUILD & HIGH SOLIDS PAINTS

MICRON DRY	VOLUME SOLIDS % 50	55	60	65	70	75	80	85	90	95	100
40	80										
45	90										
50	100	91									
55	110	100									
60	120	109	100								
65	130	118	108								
70	140	127	117	108	100						
80	160	145	133	123	114	107	100				
90	180	164	150	138	129	120	113	106	100		
100	200	182	167	154	143	133	125	118	111	105	100
125	250	227	208	192	179	167	156	147	139	132	125
150	300	273	250	231	214	200	188	176	167	158	150
175		318	292	269	250	233	219	206	194	184	175
200			333	308	286	267	250	235	222	211	200
225				346	321	300	281	265	250	237	225
250				385	357	333	313	294	278	263	250
275					393	367	344	324	306	289	275
300					429	400	375	353	333	316	300
350						467	438	412	389	368	350
400							500	471	444	421	400
450								529	500	474	450
500									556	526	500

WET FILM THICKNESS MICRON

ENAMELS AND SHOPPRIMERS

MICRON DRY	VOLUME SOLIDS % 15	20	25	30	35	40	45	50	55	60
15	100	75	60	50	43					
20	133	100	80	67	57					
25	167	125	100	83	71	63	56			
30	200	150	120	100	86	75	67	60	55	
35		175	140	117	100	88	78	70	64	58
40		200	160	133	114	100	89	80	73	67
45			180	150	129	113	100	90	82	75
50			200	167	143	125	111	100	91	83

WET FILM THICKNESS MICRON

HEMPEL

VOLUME SOLIDS by THINNING

T4

The volume solids of a paint is affected by thinning. The more thinning - the lower volume solids of the affected paint.
Below is given the resulting volume solids for typical thinning ratios:

DATASHEET VOLUME SOLIDS (%)	% THINNING							
	2,5	5	7,5	10	12,5	15	17,5	20
	RESULTING VOLUME SOLIDS (%)							
20	20	19	19	18	18	17	17	17
25	24	24	23	23	22	22	21	21
30	29	29	28	27	27	26	26	25
35	34	33	33	32	31	30	30	29
40	39	38	37	36	36	35	34	33
45	44	43	42	41	40	39	38	38
50	49	48	47	45	44	43	43	42
55	54	52	51	50	49	48	47	46
60	59	57	56	55	53	52	51	50
65	63	62	60	59	58	57	55	54
70	68	67	65	64	62	61	60	58
75	73	71	70	68	67	65	64	63
80	78	76	74	73	71	70	68	67
85	83	81	79	77	76	74	72	71
90	88	86	84	82	80	78	77	75
95	93	90	88	86	84	83	81	79
100	98	95	93	91	89	87	85	83

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DEW POINT TABLE T5

Below is given dew points in °C for a number of situations, as determined by your Slingpsykrometer.

If you cannot find exactly your readings on the slingpsykrometer, find the one one step higher in both %RH and temperature and the one correspondingly one step lower and interpolate straight forward between them.

RELATIVE HUMIDITY	DRY BULB TEMPERATURE °C										
%RH	0	2,5	5	7,5	10	12,5	15	17,5	20	22,5	25
20	na	na	na	-14	-12	-9,8	-7,7	-5,6	-3,6	-1,5	0,5
25	na	na	na	-11	-9,1	-6,9	-4,8	-2,7	-0,6	1,5	3,6
30	na	na	na	-8,9	-6,7	-4,5	-2,4	-0,2	1,9	4,1	6,2
35	na	na	-9,1	-6,9	-4,7	-2,5	-0,3	1,9	4,1	6,3	8,5
40	na	na	-7,4	-5,2	-2,9	-0,7	1,5	3,8	6,0	8,2	10,5
45	na	na	-5,9	-3,6	-1,3	0,9	3,2	5,5	7,7	10,0	12,3
50	na	na	-4,5	-2,2	0,1	2,4	4,7	7,0	9,3	11,6	13,9
55	na	na	-3,3	-0,9	1,4	3,7	6,1	8,4	10,7	13,0	15,3
60	na	-4,4	-2,1	0,3	2,6	5,0	7,3	9,7	12,0	14,4	16,7
65	na	-3,4	-1,0	1,4	3,7	6,1	8,5	10,9	13,2	15,6	18,0
70	na	-2,4	0,0	2,4	4,8	7,2	9,6	12,0	14,4	16,8	19,1
75	na	-1,5	1,0	3,4	5,8	8,2	10,6	13,0	15,4	17,8	20,3
80	na	-0,6	1,9	4,3	6,7	9,2	11,6	14,0	16,4	18,9	21,3
85	na	0,2	2,7	5,1	7,6	10,1	12,5	15,0	17,4	19,9	22,3
90	na	1,0	3,5	6,0	8,4	10,9	13,4	15,8	18,3	20,8	23,2
95	na	1,8	4,3	6,8	9,2	11,7	14,2	16,7	19,2	21,7	24,1
100	0,0	2,5	5,0	7,5	10,0	12,5	15,0	17,5	20,0	22,5	25,0

RELATIVE HUMIDITY	DRY BULB TEMPERATURE °C										
%RH	25	27,5	30	32,5	35	37,5	40	42,5	45	47,5	50
20	0,5	2,6	4,7	6,7	8,8	10,8	12,9	14,9	17,0	19,0	21,0
25	3,7	5,8	7,9	10,0	12,1	14,2	16,3	18,4	20,5	22,6	24,7
30	6,3	8,5	10,6	12,8	14,9	17,1	19,2	21,4	23,5	25,7	27,8
35	8,5	10,7	13,0	15,1	17,3	19,5	21,7	23,9	26,1	28,3	30,5
40	10,5	12,8	15,0	17,2	19,5	21,7	23,9	26,2	28,4	30,6	32,8
45	12,3	14,6	16,8	19,1	21,4	23,6	25,9	28,2	30,4	32,7	34,9
50	13,9	16,2	18,5	20,8	23,1	25,4	27,7	30,0	32,3	34,5	36,8
55	15,4	17,7	20,0	22,4	24,7	27,0	29,3	31,6	33,9	36,3	38,6
60	16,7	19,1	21,4	23,8	26,1	28,5	30,8	33,2	35,5	37,8	40,2
65	18,0	20,4	22,8	25,1	27,5	29,9	32,2	34,6	36,9	39,3	41,7
70	19,2	21,6	24,0	26,4	28,8	31,1	33,5	35,9	38,3	40,7	43,1
75	20,3	22,7	25,1	27,5	29,9	32,4	34,8	37,2	39,6	42,0	44,4
80	21,3	23,8	26,2	28,6	31,1	33,5	35,9	38,3	40,8	43,2	45,6
85	22,3	24,8	27,2	29,7	32,1	34,6	37,0	39,5	41,9	44,4	46,8
90	23,3	25,7	28,2	30,7	33,1	35,6	38,1	40,5	43,0	45,5	47,9
95	24,1	26,6	29,1	31,6	34,1	36,6	39,1	41,5	44,0	46,5	49,0
100	25,0	27,5	30,0	32,5	35,0	37,5	40,0	42,5	45,0	47,5	50,0

°C	0	5	10	15	20	25	30	35	40	45	50
°F	32	41	50	59	68	77	86	95	104	113	122

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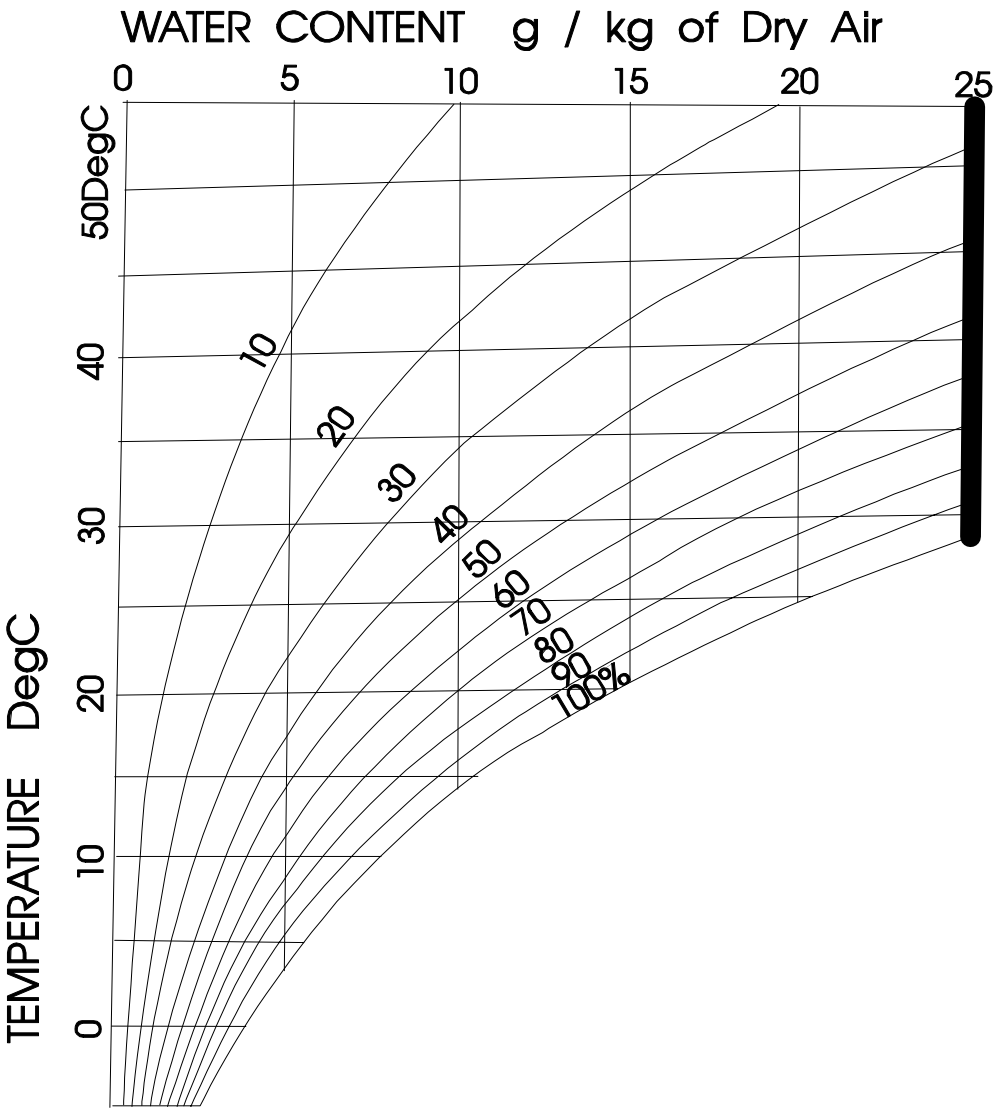
The MOLLIER-(ix) DIAGRAMME T6

The MOLLIER or ix-Diagramme is a very useful diagramme for determining humidity conditions.

It can be used for dew-point calculations. It can also be used for calculating how much water is in the air - and how much need to be removed to achieve a required relative humidity.

These latter properties can be very helpful, when doing tank-coating work.



For the correct use of the diagramme please study relevant literature

HEMPEL

INTERCHANGE TABLE FOR AIRLESS SPRAY NOZZLES (Indicative)

T7a

FAN ANGLE	EQUIV. ORIFICE	GRACO	DeVILBISS	BINKS	SPRAYING SYSTEMS	ATLAS COPCO	SPEE-FLO	DELAVAN	NORDSON	WAGNER
95°	.024"	924						c2495		
	.026"	926	JAC-44	9-2690	9501TC	6895-0001		c2695		
	.029"	929						c2995	0045/20	
	.031"	931		9-3190	95015TC	6895-0015		c3195		
	.036"	936		9-3690	9502TC	6895-0002		c3695	0068/20	
80°	.017"	817							0014/16	
	.018"		JAC-41	9-1880	800050TC	6880-0050	702-188	c1880		818
	.019"	819								
	.021"	821		9-2180	800067TC	6880-0067	702-218	c2180	0020/16	821
	.023"	823						c2480	0030/16	
	.026"	826		9-2680	8001TC	6880-0001	702-268	c2680		826
	.029"	829						c2980	0045/16	
	.031"	831		9-3180	80015TC	6880-0015	702-318	c3180		831
60°-65°	.017"	617							0014/12	
	.018"		JAC-31	9-1860	650050TC	6865-0050		c1865		618
	.019"	619							0020/12	
	.021"	621		9-2160	650067TC	6865-0067		c2165		621
	.023"	623							0030/12	
	.026"	626		9-2660	6501TC	6865-001		c2665		626
	.029"	629						c2965	0045/12	
	.031"	631		9-3160	65015TC	6865-0015		c3165		631
	.036"	636		9-3660	6502TC	6865-0002		c3665	0068/12	636

(Continues)

HEMPEL

INTERCHANGE TABLE FOR AIRLESS SPRAY NOZZLES (Indicative)

T7b

FAN ANGLE	EQUIV. ORIFICE	GRACO	DeVILBISS	BINKS	SPRAYING SYSTEMS	ATLAS COPCO	SPEE-FLO	DELAVAN	NORDSON	WAGNER
50°	.017"	517							0014/08	
	.018"		JAC-44	9-1850	500050TC	6850-0050	702-185	c1850		518
	.019"	519								
	.021"	521		9-2150	500067TC	6850-0067	702-215	c2150	0020/08	521
	.023"	523							0030/08	
	.026"	526		9-2650	5001TC	6850-0001	702-265	c2650		526
	.029"	529	JAC-41						0045/08	
	.031"	531		9-3150		6850-0015	702-315	c3150		531
40°	.015"	415	JAC-29	9-1540	400033TC	6840-0033	702-154	c1540		415
	.017"	417							0014/06	
	.018"			9-1840	400050TC	6840-0050	702-184	c1840		418
	.019"	419								
	.021"	421		9-2140	400067TC	6840-0067	702-214	c2140	0020/06	421
	.026"	426	JAC-43	9-2640	4001TC	6840-0001	702-264	c2640		426
	.029"	429						c2940	0045/06	
	.031"	431		9-3140	40015TC	6840-0015	702-314	c3140		431
20°-25°	.015"	215		9-1530	250033TC	6825-0033		1525		215
	.017"	217							0014/02	
	.018"			9-1830	250050TC			c1825		218
	.019"	219								
	.021"	221		9-2130	250067TC	6825-0067		c2125		221

(Continued)

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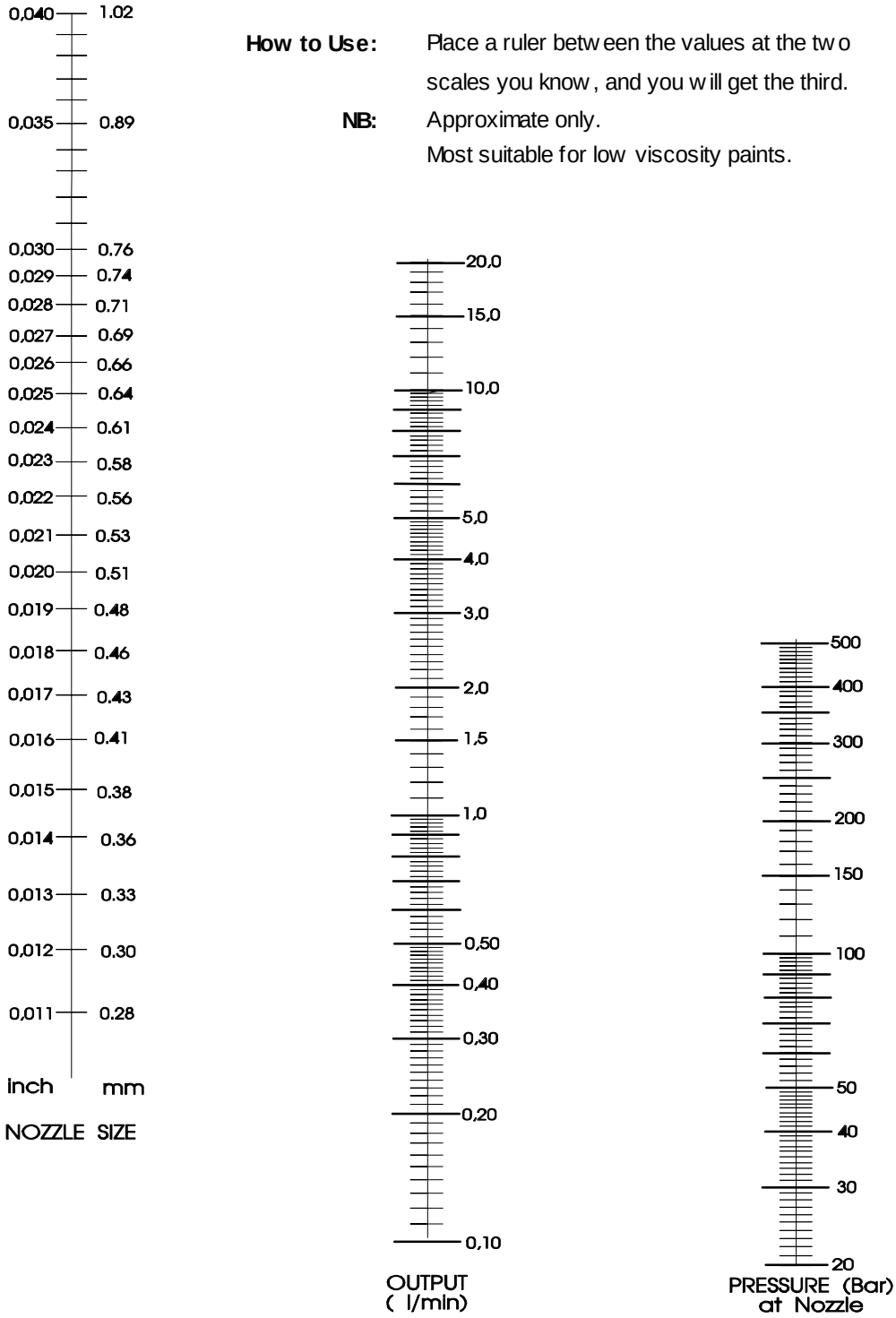
AIRLESS SPRAY NOZZLES OUTPUT

T 7c

How to Use: Place a ruler between the values at the two scales you know, and you will get the third.

NB: Approximate only.
Most suitable for low viscosity paints.



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AIRLESS SPRAY
PRESSURE LOSS IN AIRLESS HOSES

T 7d

Pressure loss or pressure drop in airless hoses can be very significant.
It depends on the flow rate of the paint through the hose, i.e.. faster flow equals higher pressure drop
Below is given the approximate pressure loss pr 10 m spray hose for three types of paint:

Paint A: Low viscosity e.g. shopprimers

Paint B: Medium viscosity e.g. alkyds, waterborne acrylics and enamels in in general.

Paint C: High viscosity e.g. most high build paints and solventless paints

Pressure loss in bars (indicative) pr 10 m hose length

Hose iD	Pressure bar	Nozzle size .019"	.023"	.027"	.035"
1/4"					
Paint A	100	2	3	4,5	7,5
	150	2,5	4	5,5	9
	200	3	4,5	6,5	11
Paint B	100	20	30	45	75
	150	25	35	50	90
	200	30	45	60	110
Paint C	100	45	65	95	na
	150	55	80	120	na
	200	65	95	140	na
3/8"					
Paint A	100	0,5	0,6	0,9	1,5
	150	0,5	0,7	1,1	1,8
	200	0,6	0,9	1,2	2,1
Paint B	100	4	6	8,5	15
	150	5	7,5	11	18
	200	6	10	12	22
Paint C	100	10	15	20	35
	150	10	15	25	40
	200	15	20	30	50
1/2"					
Paint A	100	0,2	0,2	0,3	0,5
	150	0,2	0,25	0,35	0,6
	200	0,2	0,3	0,4	0,7
Paint B	100	1,5	2	3	5
	150	1,5	2,5	3,5	6
	200	2	3	4	7
Paint C	100	3	4,5	6	11
	150	3,5	5	7,5	13
	200	4	6	8,5	15

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ESTIMATING SIZE OF SURFACES | T 8a

SHIPS

Bottom (Incl Boottop)

$A = ((2 \times d) + B) \times Lpp \times P$

Where
- d = draught maximum (as per Lloyd's)
- B = breadth extreme (as per Lloyd's)
- Lpp = length between perpendiculars (as per Lloyd's)
- P = 0.90 for big tankers
  0.85 for bulk carriers
  0.70-0.75 for dry cargo liners

or

$$A = Lpp \times (Bm + 2 \times D) \times \frac{V}{Bm \times Lpp \times D}$$

Where
- D = Mean draft at paint line (m)
- Bm = Breath molded (m)
- Lpp = length between perpendiculars
- V = Displacement (cubic metre) corresponding to the draft.

Boottop:

$A = 2 \times h \times (Lpp + 0.5 \times B)$

Where
- h = width of boottop (to be informed by owner).
- Lpp = length between perpendiculars (as per Lloyd's)
- B = breadth extreme (as per Lloyd's)

Topsides:

$A = 2 \times H \times (Loa + 0.5 \times B)$

Where
- H = Height of topsides (depth - draught (as per Lloyd's)
- Loa = Length over all (as per Lloyd's)
- B = breadth extreme (as per Lloyd's)

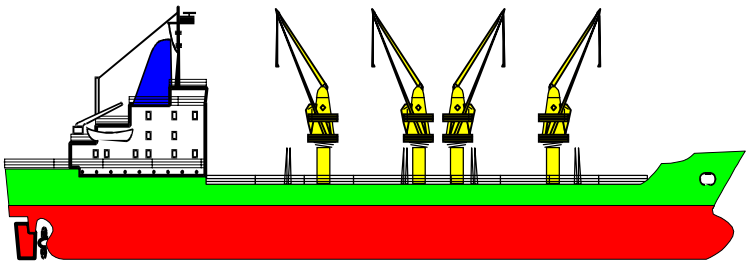
Weather Decks:

incl. upper decks on superstructure foundations, hatches and top of deck houses.

$A = Loa \times B \times N$

(The accuracy depends of your choice of N which indicate the actual area in relation to its circumscribed rectangular).

Where
- Loa = Length over all (as per Lloyd's)
- B = breadth extreme (as per Lloyd's)
- N = 0.92 for big tankers and bulk carriers
  0.88 for cargo liners
  0.84 for coasters, etc.



HEMPEL

ESTIMATING SIZE OF SURFACES | T 8b

SHIPS BALLAST TANKS

Below figures are approximate only and will in practice depend on construction of the tank.

Tank Volume cbm	Approx. Area in sqm			
	Double bottom tanks			F.P.T./
	SB & P	C & Deep T	T.S.T	A.P.T.
200	-	950	550	950
400	2150	1800	1050	1650
600	3000	2650	1500	2200
800	3850	3400	2000	2600
1000	4650	4050	2450	3000
1200	5400	4700	2950	3300
1400	6100	5300	3400	3650
1600	6800	5900	3800	3950
1800	7500	6500	4300	4300
2000	8150	7100	4750	4600
2200	8900	7650	5150	4950
2400	9600	8250	5600	5350
2600	10300	8800	6050	5700
2800	11000	9400	6500	6100
3000	11700	10050	6950	6350
3200	12300	10600	7400	6800
3400	12950	11200	7850	7150
3600	12600	11800	8300	7550
3800	14300	12400	8700	7950
4000	15000	12950	9100	8300
4200	15650	13500	9600	8750
4400	16300	14100	10050	9200
4600	16950	14750	10500	9600
4800	17600	15400	10900	10100
5000	18200	16050	11350	10500

NOTE: Single hull oil tankers may have a lower area/volume ratio on their topside tanks, typically 1.2 - 1.5.

Some special tanks like e.g. fresh water tanks may also have a lower area/volume ratio, often 1.5-2.

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ESTIMATING SIZE OF SURFACES | T 8c

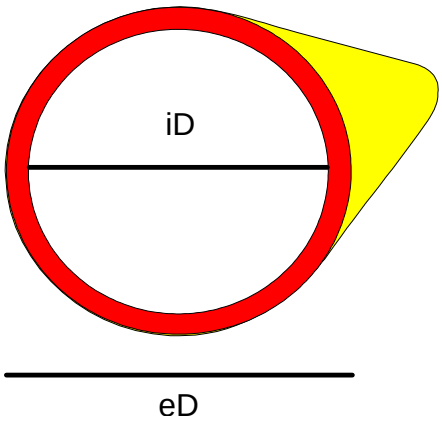
PLATES

PLATE THICKNESS mm	sqm/t
1	254.5
2	127.2
3	84.8
4	63.6
5	50.9
6	42.4
7	36.4
8	31.8
9	28.3
10	25.4
11	23.1
12	21.2
13	19.6
14	18.2
15	17.0

PLATE THICKNESS mm	sqm/t
16	15.9
17	15.0
18	14.1
19	13.4
20	12.7
21	12.1
22	11.6
23	11.1
24	10.6
25	10.2
26	9.8
27	9.4
28	9.1
29	8.8
30	8.5

Indicated value are for BOTH sides. If one side only reduce by half.

PIPES



Exterior Area (Sqm/m):

pi * eD

pi = 3.14
eD = Exterior Diameter in meters.

Interior Area (Sqm/m):

pi * iD

pi = 3.14
iD = Interior Diameter in meters.

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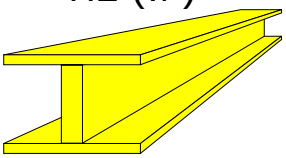
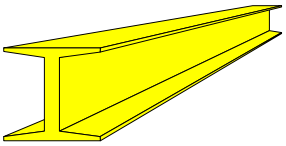
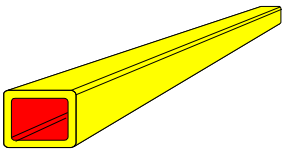
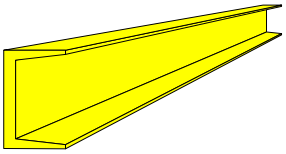
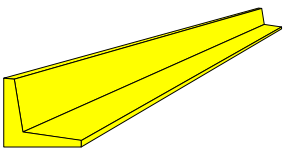
ESTIMATING SIZE OF SURFACES | T 8d

BEAMS and PROFILES

Designation / Shape	Size	Weight kg/m	Surface Area sqm/m	Surface Area sqm/ton
HE (IP) 	100	20.4	0.57	27.8
	160	42.6	0.92	21.5
	220	71.5	1.27	17.8
	280	103.0	1.62	15.7
	360	142.0	1.85	13.0
	600	212.0	2.32	10.9
INP 	80	5.94	0.30	51.2
	140	14.3	0.50	35.1
	200	26.2	0.71	27.1
	260	41.9	0.91	21.6
	340	68.0	1.15	16.9
	400	92.4	1.33	14.4
RHS 	20x20	1.1	0.08	70.8
	30x30	1.8	0.12	68.6
	40x40	2.4	0.16	67.2
	60x60	3.6	0.24	66.0
	80x80	7.3	0.32	44.1
UNP 	30	4.3	0.17	40.7
	50	5.6	0.23	41.5
	80	8.6	0.31	36.1
	180	22.0	0.61	27.8
	280	41.8	0.89	21.3
	400	71.8	1.18	16.4
	20x3	0.88	0.08	87.5
	25x4	1.5	0.10	66.9
	30x4	1.8	0.12	65.2
	40x4	2.4	0.16	64.1
	50x6	4.5	0.19	43.4
	50x9	6.5	0.19	30.0
	75x7	7.9	0.29	36.7
	75x10	11.1	0.29	26.2
	100x10	15.1	0.39	25.8
	100x16	23.2	0.39	16.8
	150x15	33.8	0.59	17.3

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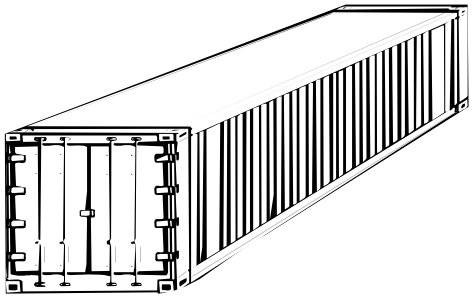
ESTIMATING SIZE OF SURFACES | T 8e

CONTAINERS



Approx. size of 20' Container parts (Sqm):

	Dry Cargo		Dry Cargo High-Cube	Open Top	
Corrugation Angle:	**45°**	**90°**		**45°**	**90°**
Exterior excl. roof:	51	59		51	59
Roof:	16	16	Not	na	na
Interior:	67	75	Applicable	51	59
Base excl. floor:	22	22		22	22
Total:	156	172		124	140

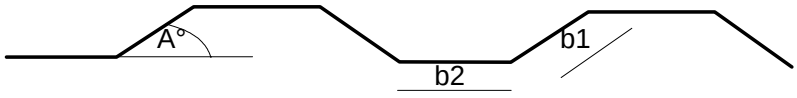
Approx. size of 40' Container parts (Sqm):

	Dry Cargo		Dry Cargo High-Cube		Open Top	
Corrugation Angle:	**45°**	**90°**	**45°**	**90°**	**45°**	**90°**
Exterior excl. roof:	84	102	95	115	84	103
Roof:	32	32	32	32	na	na
Interior:	118	134	130	147	86	102
Base excl. floor:	44	44	44	44	42	44
Total:	278	312	301	338	212	249

Approx. size of Steel Frame Container parts (Sqm):

Size of Frame:	**20'**	**40'**	**45'**	**48"**
Area (Sqm):	25	40	56	66

Calculation of Area of Corrugated Sheets:



$$\text{Area} = \text{Height} * \text{Linear Length} * \frac{b1 + b2}{(b1 * \cos A°) + b2}$$

NOTE

Sizes are depending on construction and corrugation angle.
If exact sizes are critical , e.g. for consumption calculations, consult Container Manufacturers drawings.

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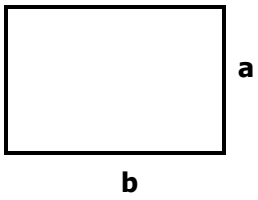
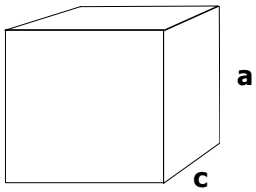
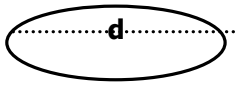
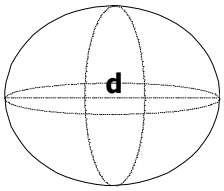
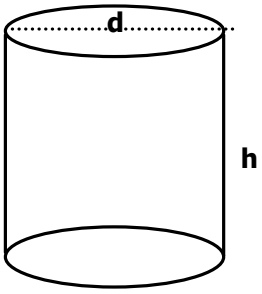
ESTIMATING SIZE OF SURFACES | T 8f

SIMPLE SHAPES

Designation	Shape	Area
Squares Rectangles		**a * b** (if coating on both sides, multiply by 2)
Cubes		**[(a * b) + (a * c) + (b * c)] * 2** (if coating on both sides, multiply by 2)
Circular Flat		**3.14 * r * r** r = d/2 (if coating on both sides, multiply by 2)
Spheres		**3.14 * d * d** (if coating on both sides, multiply by 2)
Cylindrical Tanks		**3.14 * d * h + 3.14 * r * r** r = d/2 (if coating on both sides, multiply by 2)

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FILTERS, MESH SIZES | T 9

When you put in a filter in the paint line most commonly used filters are 60 mesh or 100 mesh, but how big are they actually?
or
When we perform an sieve analysis for grain size distribution of abrasives the sieve sizes are some times indicated in mesh. How big are the openings in the sieves?

Below is given the relation between commonly used mesh sizes and the corresponding size of the openings in the filters/sieves:

MESH Size mm	**BS410/1962** mesh/inch	**ASTM E 11-61** mesh/inch	**Tyler** mesh/inch
0.100	-	-	-
0.105	150	140	150
0.125	120	120	115
0.149	-	100	100
0.150	100	-	-
0.160	-	-	-
0.177	-	80	80
0.180	85	-	-
0.200	-	-	-
0.210	72	70	65
0.250	60	60	60
0.297	-	50	48
0.300	52	-	-
0.315	-	-	-
0.354	-	45	42
0.355	44	-	-
0.400	-	-	-
0.420	36	40	35
0.500	30	35	32
0.595	-	30	28
0.600	25	-	-
0.630	-	-	-
0.707	-	25	24
0.710	22	-	-
0.800	-	-	-
0.841	-	20	20
1.00	16	18	16
1.19	-	16	14
1.20	14	-	-
1.25	-	-	-
1.41	-	14	12
1.60	-	-	-
1.68	10	12	10
2.00	8	10	9

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FACTORS

T10

CALCULATION OF PRACTICAL PAINT CONSUMPTION

There are various ways of expressing the relation between the theroretically calculated amount of paint needed to exactly match the dry film thickness specified and the practical amount of paint to be applied taking application conditions and application skills into consideration.

HEMPEL use the "Consumption Factor" to express this relation, but some other paint manufacturers and customers use the terms "Loss" or "Loss Factor".

The consumption factor is always greater than 1, because:

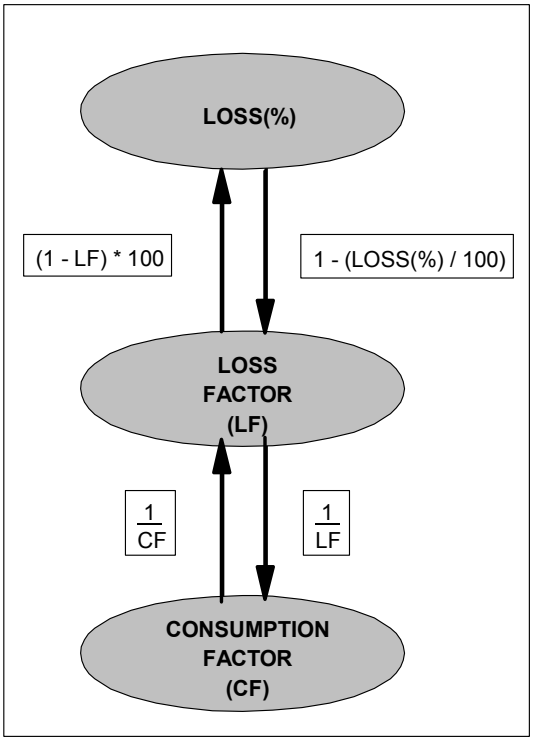
* The result of a spray application will generally result in an average DFT greater than the specified DFT. Typically: Average DFT approx. 1.4 times Specified DFT.
* By any practical application, there will be some paint taken into use, which does not end up on the surface.

The resulting consumption factor is typically around 1.8

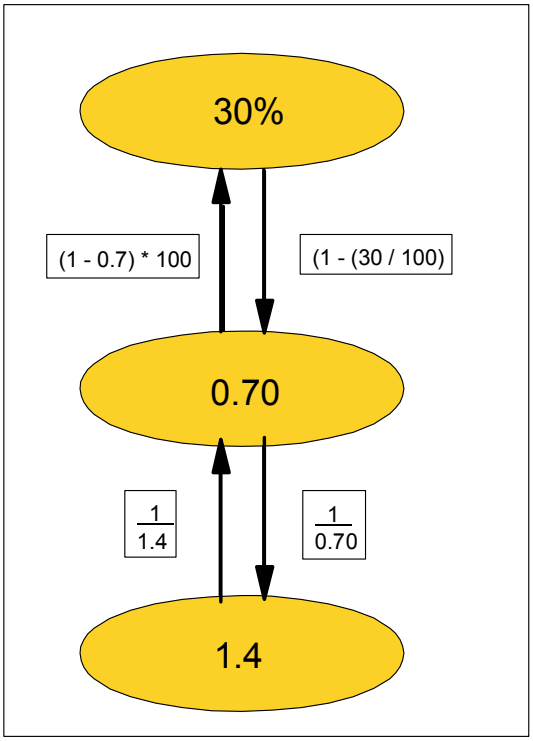
The term "Loss" is to be understood as the deviation between the consumption calculated by use of the specified dft, and the actual consumption.

At the end of the day the practical amount of paint used on the construction will be the same no matter which factor is being used for the calculation, because they are related - and the relations are shown below:

CONVERSION FORMULAS



EXAMPLE



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COMMUNICATIONS

HEMPEL

HOW TO GET AROUND TO HEMPEL OFFICES

COM1
2006

International Code from:	COUNTRY	International Code to:	HEMPEL MAIN OFFICE	GMT */
00	DENMARK	45	COPENHAGEN	+1
00	ARGENTINA	54	BUENOS AIRES	-3
0011	AUSTRALIA	61	MELBOURNE	+10
00	BAHRAIN	973	BAHRAIN	+3
00	BELGIUM	32	ANTWERP	+1
011	CANADA	1	VANCOUVER	-8
00	CHILE	56	VINA DEL MAR	-4
99	CROATIA	385	UMAG	+1
119	CUBA	53	La HABANA	-5
00	CYPRUS	357	LIMASSOL	+2
00	CZECH REPUBLIC	420	BRNO	+1
00	EQUADOR	593	GUAYAQUIL	-5
00	ESTONIA	372	TALLINN	+3
00	FINLAND	358	HELSINKI	+2
00	FRANCE	33	ST. CREPIN	+1
00	GERMANY	49	PINNEBERG	+1
00	GREAT BRITAIN	44	CWMBRAN	0
00	GREECE	30	PIRAEUS	+2
00 60	HONG KONG/CHINA	852	HONG KONG	+8
00	ICELAND	354	REYKJAVIK	0
00	INDONESIA	62	BEKASI	+7
00	IRELAND	353	DUBLIN	0
00	ITALY	39	GENOA	+1
001	KOREA	82	PUSAN	+9
00	KUWAIT	965	KUWAIT	+3
8*10	LATVIA	371	RIGA	+3
00	MALAYSIA	60	S. DARUL EHSAN	+8
00	MALTA	356	VALETTA	+1
00	The NETHERLANDS	31	ROTTERDAM	+1
00	NORWAY	47	BERGEN	+1
00	PRC	86	SHANGHAI	+8
00	POLAND	48	GDANSK	+1
00	PORTUGAL	351	PAMELA	+1
0	QATAR	974	QATAR	+4
00	ROMANIA	40	BUCHAREST	+2
8*10	RUSSIA	7	St. PETERSBUTG	+4
00	SAUDI ARABIA	966	DAMMAM	+3
001	SINGAPORE	65	SINGAPORE	+8
00	SLOVAK REPURBLIC	421	ZVOLEN	+1
00	SPAIN	34	BARCELONA	+1
00	SWEDEN	46	GOTHENBURG	+1
002	TAIWAN	886	TAIPEI	+8
001	THAILAND	66	BANGKOK	+7
00	TURKEY	90	ISTANBUL	+2
00	U.A.E.	971	SHARJAH	+4
011	U.S.A.	1	HOUSTON	-6

*/ Time may vary 1 hour in contries using daylight saving.

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HOW TO GET AROUND TO HEMPEL OFFICES

COM 2
2006

For COUNTRY-Codes please see page COM1

COUNTRY	OFFICE	PHONE	FAX
DENMARK	COPENHAGEN	45 93 38 00	45 88 55 18
ARGENTINA	BUENOS AIRES	11 4816 3137	11 4812 7450
AUSTRALIA	MELBOURNE	3 9360 0933	3 9360 0894
BAHRAIN	BAHRAIN	17 456 191	17 732 191
BELGIUM	ANTWERP	3 220 6160	3 220 6179
CANADA	VANCOUVER	604 273 3200	604 273 6110
CHILE	VINA DEL MAR	32 639006	32 632752
CROATIA	UMAG	52 741 777	52 741 352
CUBA	La HABANA	7 338 128	7 338 127
CYPRUS	LIMASSOL	25 385 873	25 731 672
CZECH REPUBLIC	BRNO	545 423 611	545 215 035
EQUADOR	GUAYAQUIL	42 11 14 44	42 11 08 54
ESTONIA	TALLINN	6 398 793	6 398 794
FINLAND	HELSINKI	9 4780 6200	9 4780 6201
FRANCE	ST. CREPIN	3 44 08 28 90	3 44 08 28 99
GERMANY	PINNEBERG	4101 707 0	4101 707 131
GREAT BRITAIN	CWMBRAN	1633 874 024	1633 489 089
GREECE	PIRAEUS	210 41 43 400	210 41 43 500
HONG KONG/CHINA	HONG KONG	2857 7663	2517 6311
ICELAND	REYKJAVIK	588 80 00	568 92 55
INDONESIA	BEKASI	21 884 3385	21 884 0820
IRELAND	DUBLIN	1 826 1822	1 826 1823
ITALY	GENOA	010 835 6947	010 835 6950
KOREA	PUSAN	51 647 5854	51 647 6234
KUWAIT	KUWAIT	481 33 66	484 33 07
LATVIA	RIGA	7 336 688	7 336 689
MALAYSIA	S. DARUL EHSAN	3 7845 3037	3 7845 6016
MALTA	VALETTA	21 822 268	21 822 273
The NETHERLANDS	ROTTERDAM	10 445 4000	10 460 0883
NORWAY	BERGEN	55 95 80 00	55 95 80 50
P.R.C	SHANGHAI	21 5298 1258	21 5298 1088
POLAND	GDANSK	58 521 8900	58 521 8902
PORTUGAL	PALMELA	212 351 022	212 352 292
QATAR	DOHA	460 0881	460 0901
ROMANIA	BUCHAREST	722 540 703	21 323 00 34
RUSSIA	St. PETERSBURG	812 242 0113	812 325 2635
SAUDI ARABIA	DAMMAM	3 847 1616	3 847 1816
SINGAPORE	SINGAPORE	6 799 8383	6 799 8400
SLOVAK REPUBLIC	ZVOLEN	455 400 290	455 323 023
SPAIN	BARCELONA	937 130 000	937 130 368
SWEDEN	GOTHENBURG	31 69 52 50	31 69 47 20
TAIWAN	TAIPEI	2 2706 55 35	2 2706 56 90
THAILAND	BANGKOK	2 260 3325 7	2 261 1932
TURKEY	ISTANBUL	216 585 10 10	216 585 10 11
U.A.E.	SHARJAH	6 528 3307	6 528 1491
U.S.A.	HOUSTON	936 523 6000	936 523 6073

Many countries have local offices at different locations. Phone the number for the country for further advice. .

HEMPEL

Replacing LOST LUGGAGE

COM3

NOTE: Size equivalents are approximate.

MEN's							
Suits and Coats							
British	36	38	40	42	44	46	48
American	36	38	40	42	44	46	48
Continental	46	48	50	52	54	56	58
Shirts							
British	14	14½	15	15½	16	16½	17
American	14	14½	15	15½	16	16½	17
Continental	36	37	38	39	40	41	42
Shoes							
British	7	7½	8	9	10	11	12
American	7½	8	8½	9½	10½	11½	12½
Continental	7	8	9	10	11	11	12
Scandinavia	40	41	42	43	44	45	46
Socks							
British	9½	10	10½	11	11½	12	
American	9½	10	10½	11	11½	12	
Continental	39	40	41	42	43	44	

WOMEN's						
Dresses and Suits						
British	32	33	35	36	38	39
American	10	12	14	16	18	20
Continental	40	42	44	46	48	50
Scandinavia	38	40	42	44	46	48
Shoes						
British	4½	5	6	7	7½	8
American	6	6½	7½	8½	9	9½
Continental	3	4	5	6	7	8
Scandinavia	36	37	38	39	40	41