

Recommendation 30

Corrosion protective surface treatment of transformers, arc-suppression-coils, etc.

1st edition 2022

Recommendation 30

Corrosion protective surface treatment of transformers,
arch-suppression-coils, etc.

1st edition 2022

Green Power Denmark

Vodroffsvej 59

1900 Frederiksberg C

Tlf.: +45 35 300 400

E-mail: info@greenpowerdenmark.dk

www.greenpowerdenmark.dk

© Green Power Denmark 2022

CONTENTS

1. SCOPE

Appendix 1	Specification of corrosion protective surface treatment by paint of transformers and transformer parts
Appendix 2	Specification of corrosion protection by hot-dip galvanization
Appendix 3	Coating report
Appendix 4	Inspection and test plan (ITP) for coating
Appendix 5	Inspection and test plan (ITP) for Hot-dip galvanization

1. SCOPE

This recommendation is intended to be used in conjunction with Green Power Denmark's technical recommendations 1, 3, 6A, 7 and 28, and can be used to specify the corrosion protection for transformers and transformer parts.

The recommendation consists of several appendices, where appendix 1 and appendix 2 contain the specifications for corrosion protective surface treatment. Appendix 1 deals with corrosion protective surface treatment by paint, including paints on galvanized surfaces, and Appendix 2 deals with corrosion protective surface treatment by hot-dip galvanizing.

In addition, the recommendation contains several informative appendices.

- Appendix 3: Provides an example of a coating report
- Appendix 4: Provides an example of an inspection and test plan (ITP) for coating.
- Appendix 5: Provides an example of an inspection and test plan (ITP) for a hot-dip galvanized item.

Note: Further reference is made to report, 121-31750 – Specifikationer for korrosionsbeskyttelse af transformere og transformerdele ved maling og/eller varmforzinking, Force Technology, 9th June 2022 (in Danish), prepared by Force Technology for Green Power Denmark, on which appendices 1 - 5 are based. This contains in-depth comments on selection of technical specifications.

The recommendation can be found in both a Danish and English translation. In case of discrepancies between the Danish and English versions, the Danish version shall prevail.

Appendix 1

Specification of corrosion protective surface treatment by paint of transformers and transformer parts

TABLE OF CONTENTS

STANDARDS

ABBREVIATIONS

1. CORROSION CATEGORY AND REQUIREMENTS FOR DURABILITY

2. REQUIREMENTS FOR THE STEEL

3. REQUIERMENTS FOR DESIGN

4. REQUIREMENTS FOR PRETREATMENT OF STEEL

5. REQUIREMENTS FOR PRETREATMENT OF GALVANIZED PARTS

6. CLIMATE REUIEREMENTS

7. REQUIREMENTS FOR PAINTING

8. REQUIREMENTS FOR DOCUMENTED QUALITY CONTROL

9. REQUIREMENTS FOR FINISH

In the following, the requirements for the corrosion protective surface treatment by paint are specified. Deviations from this must be approved in advance.

STANDARDS

The below list of standards is used in the specification

DS/EN ISO 12944-1

DS/EN ISO 12944-2

DS/EN ISO 12944-3

DS/EN ISO 12944-5

DS/EN ISO 12944-6

ISO 8501-1

DS/EN ISO 8501-3

ISO 8502-3

DS/EN ISO 8503-1

DS/EN ISO 8503-2

DS/EN ISO 8503-5

DS/EN ISO 8502-6

DS/EN ISO 8502-9

DS/ISO 19840

ASTM D4285

ABBREVIATIONS

DFT Dry film thickness – here dry film thickness of coating

NDFT Nominal dry film thickness – specified dry film thickness

ITP Inspection and Test Plan

SDS Safety data sheet – Safety data sheet from the supplier

TDS Technical data sheet – Technical data sheet from the supplier

1. CORROSION CATEGORY AND REQUIREMENTS FOR DURABILITY

The transformer's parts must have the marked durability according to DS/EN ISO 12944-1

L (low):	M (medium):	H (high):	VH (very high):
----------	-------------	-----------	-----------------

In the marked corrosion category according to DS/EN ISO 12944-2

C1:	C2:	C3:	C4:	C5:	CX:
-----	-----	-----	-----	-----	-----

2. REQUIREMENTS FOR THE STEEL

The steel used must be of quality A, B or C according to ISO 8501-1. Quality D is not allowed.

3. REQUIREMENTS FOR DESIGN

The design must take the design details in DS/EN ISO 12944-3:2018 into consideration, which among other things means:

- That there can be no non-continuous welds.
- That no gaps into openings/hollow sections, which cannot be corrosion protected inside, are allowed.
- That hollow parts facing upwards which can collect water and dirt, or large horizontal flat plates where ponding may happen, must be avoided.
- Crevices must be avoided where it is possible, as they collect dirt and water.
- That contact faces between metals of different nobility must be isolated to avoid galvanic corrosion. For instance, by using synthetic or galvanized washers that has minimum 3 mm larger diameter than the bolt head for bolted connections. Furthermore, large diameter washers lower the risk of damaging the coating underneath.
- When using stainless steel bolts in coastal areas, A4 bolts must be used.
- Welded seams between noble (for instance stainless steel) and less noble metals (for instance low alloyed steel) must be paint coated at least 50 mm out on the most noble metal.
- That the parts must be designed with mutual distances, so that maintenance and repair of the coating are possible, see Annex A and C i DS/EN ISO 12944-3.
- Items/areas where maintenance is not possible must be produced from non-corrosive material or be corrosion protected from the beginning for all of the projected service life.

Furthermore:

- Flange faces must be corrosion protected before assembly – preferably with AluZinc spray metallization or a zinc rich primer under the top finish.

4. REQUIREMENTS FOR PRETREATMENT OF STEEL

4.1 Preparation grade

As a minimum the steel must be prepared in accordance with preparation grade P2 according to ISO DS/EN 8501-3. Edges must be prepared in accordance with preparation grade P3 according to DS/EN ISO 8501-3 – rounded to radius 2 mm.

4.2 Roughness

After abrasive blasting the steel surface must have a roughness corresponding to the requirements of the chosen primer according to the technical data sheet. Roughness is assessed according to the methods in DS/EN ISO 8503-1, DS/EN ISO 8503-2 or DS/EN ISO 8503-5.

4.3 Cleanliness

4.3.1 Oil and grease on the surface

Oil and/or grease contamination are washed of by a high-pressure hot water hosing, optionally added a mild industry soap – prior to blasting.

4.3.2 Salt contamination of the surface

The quantity of conductive salts on the surface must not exceed 50 mg/m². This is controlled by the Bressle patch method according to DS/EN ISO 8502-6 and DS/EN ISO 8502-9

4.3.3 Steel

The surface of the steel must be cleaned by abrasive blasting or other method, approved by the coating supplier, to the cleanliness required by the chosen primer according to the technical data sheet.

By use of pressurised air for abrasive blasting, the compressor air must be free from oil and water – to be controlled according to ASTM D4285-83R18.

4.3.4 Dust

Dust must be removed from the surface prior to coating application by vacuum cleaning. Maximum accepted dust level is grade 2 in particle size and grade 2 in quantity according to ISO 8502-3.

5. REQUIEMENTS FOR PRETREATMENT OF GALVANIZED PARTS

5.1 Hot-dip galvanized parts

Prior to the hot-dip galvanization, parts to be both hot-dip galvanized and painted must be prepared similarly to if it was only to be painted – that is rounding of sharp edges, smoothing of welds and removal of weld spatter etc.

After the hot-dip galvanization, the surfaces must be examined and local overaccumulation of zinc, zinc ashes, zinc burrs and zinc taps must be removed.

The zinc surfaces must be cleaned for oxides and roughened by a sweep blasting as follows:

- Blasting material: Corundum or aluminium silicate
- Grain size: 0.2 – 0.5 mm
- Nozzle diameter: 5 – 6.5 mm
- Nozzle pressure: 2 - 3 bar
- Blasting angle: ca. 45°
- Blasting distance: 30 - 50 cm
- Primer: To be applied 20-45 minutes after sweep blasting at the latest

After the sweep blasting the zinc surface must be fully matted, and no non-processed areas when examined with a magnifying glass with 8-10 times magnification are allowed.

Compressed air for sweep blasting must be free from oil and water – to be controlled according to ASTM D4285.

Deviations from the above can only be accepted after separate approval based on durability documentation.

5.2 Electrogalvanized parts

The electro galvanization and the subsequent treatment of the zinc surface must be suitable for subsequent painting. The following treatments of the zinc surface can be applied prior to painting:

- Chemical passivation suitable for the subsequent painting
- Chemical pre-treatment through zinc phosphate coating, zinc calcium phosphate coating

Good durability of the fully coated system must be documented at an accelerated test as for instance water condensation test and/or salt spray test according to DS/EN ISO 12944-6 or by documented references with experience from practical use.

5.3 Spray metallised parts

Spray metallised parts must be applied a flashcoat immediately after metallization prior to primer and full coating system.

6. CLIMATE REQUIREMENTS

It is not allowed to sand blast or paint if the relative humidity is above 85%, or if the temperature of the metal substrate is less than 3 °C higher than the dewpoint. These climatic conditions must be maintained from the beginning of sand blasting and until the paint is dust-dry. Paint must be applied immediately after sand blasting unless a relative humidity constantly <50 % can be documented – in that case the paint must be applied the following day at the latest.

7. REQUIREMENTS FOR PAINTING

The applied paint system must correspond to one of the systems which are prescribed for the chosen durability and corrosion category in DS/EN ISO 12944-5 in composition and dry coating thickness (NDFT).

Deviations from this can only be accepted after specific approval based on durability documentation according to DS/EN ISO 12944-6 from the coating supplier. TDS and SDS must be enclosed the quotation.

Batch numbers for the applied materials must be documented.

The paint materials must be stored according to the paint supplier's instructions.

Coating thicknesses are measured as Dry Film Thickness (DFT) according to DS/ISO 19840, with calibration on smooth plate, however without correction for roughness unless NDFT is less than 100 µm. The minimum acceptance criterion is the 80/20 rule according to DS/ISO 19840. The maximum acceptance criterion is 3 x NDFT unless the coating supplier prescribes a lower maximum DFT in the TDS.

Welds, edges and areas with difficult accessibility must be stripe coated by brush in each layer, except for the primer, to ensure sufficient coating thickness. The following paint must be applied by spray unless it is applied electrostatically or by dipping. If this is deviated, it must be approved by the client in each case. Overcoat intervals specified by the paint supplier must be adhered to. If they are exceeded, the surface is to be sanded lightly with abrasive paper prior to application of the next layer.

After paint application the coating must appear without application errors as for example: pinholes, orange peel, dry spray (lacking coherent film forming), dry spray, runners, embedded foreign objects etc.

8. REQUIREMENTS FOR DOCUMENTED QUALITY CONTROL

For large numbers of identical items an ITP (inspection and test plan) must be delivered with the quotation, demonstrating how the above requirements will be documented. For each control point the ITP must include:

- Control point
- Measurement/inspection method (standard)
- Acceptance criteria
- Frequency of test
- Description of the documentation of the results (typically a coating report)
- The rights in relation to inspection, that each of the parties have

Furthermore, an empty template for the coating report must be delivered with the quotation. This must show all the required controls in the present specification.

For single items an empty template of the coating report may serve as ITP.

At delivery, a completed coating report/documentation for all quality control must be enclosed.

9. REQUIREMENTS FOR FINISH

Avoid assembly of or moving the coated items around too much before they are to be used or the coating have had time to fully cure – typically 7-14 days.

Transport damages must be repaired by the supplier. The above specification must be adhered to during repair – only cleaning of smaller areas (below 100 mm²) can be done with bristle blaster or grinder to cleanliness St3 according to ISO 8501-1 instead of sand blasting, and brush and roller application instead of spray application can be allowed, as long as total DFT is in accordance with the specification. Edges on adjoining intact coating must be feathered before the coating is rebuilt with the original coating system.

Appendix 2
Specification of corrosion protection by hot-dip galvanization

TABLE OF CONTENTS

STANDARDS

SPECIFICATION

1. HOT-DIP GALVANIZATION

2. ZINK COATING THICKNES

3. STEEL FOR HOT-DIP GALVANIZATION

4. REQUIREMENTS FOR CONSTRUCTION DESIGN

5. QUALITY CONTROL

6. INSPECTION AND TEST PLAN

7. FINISHING

STANDARDS

The below list of standards is used in the specification.

DS/EN ISO 12944-1

DS/EN ISO 12944-2

DS/EN ISO 1461

DS/EN ISO 10684

DS/EN ISO 2178

DS/EN ISO 2064

DS/EN ISO 14713-2

Unless something else is specified, it is the valid version of the standards which are to be used.

SPECIFICATION

Requirements for hot-dip galvanization of steel are specified in the following, and deviations must be approved in advance after the customer's written acceptance.

1. HOT-DIP GALVANIZATION

The hot-dip galvanization is performed according to DS/EN ISO 1461 with the exception of bolts and threaded items. Bolts and threaded items from dimension M8 or larger are hot-dip galvanized by hot-dip spun galvanization according to DS/EN ISO 10684.

At the time of ordering, the Galvanizer must be informed, if the steel constructions are to be painted after the hot-dip galvanization.

2. ZINC COATING THICKNESSES

The transformer's parts must have the marked durability according to DS/EN ISO 12944-1

L (low):	M (medium):	H (high):	VH (very high):
----------	-------------	-----------	-----------------

In the marked corrosion category according to DS/EN ISO 12944-2

C1:	C2:	C3:	C4:	C5:	CX:
-----	-----	-----	-----	-----	-----

Zinc layer thickness on the construction is chosen in accordance with the corrosion category and durability. If the durability (zinc layer thickness) cannot be attained with the present material thicknesses, the silicon content of the steel and/or additional surface treatment must be discussed with the client before start.

Minimum requirements for zinc thickness on bolts and thread materials are 40 µm local zinc thickness and minimum 50 µm average zinc thickness according to DS/EN ISO 10684.

3. STEEL FOR HOT-DIP GALVANIZATION

The steel must be hot rolled or normalised steel, and the surfaces have to be suitable for hot-dip galvanization and free from surface errors, which are harmful for the zinc coating and its corrosion protective properties.

The steel must have a composition which is suitable for hot-dip galvanization and must adhere to the following requirements for silicon (Si) and phosphorus (P) content:

- 1) $Si + P < 0.03$ weight %
- 2) $0,15 \leq Si \leq 0.25$ weight %

Cold formed or cold rolled steel which is not normalised can only be used for hot-dip galvanization after the customer's written acceptance, and only after test plates from the present steel charge has been hot-dip galvanized and tested for LME damages (Liquid Metal Embrittlement, zinc penetration).

Steel for hot-dip galvanization must have a tensile strength below 1,000 MPa to be sure to avoid hydrogen embrittlement.

4. REQUIREMENTS FOR CONSTRUCTION DESIGN

Hot-dip galvanization is performed in a line of dipping processes, which defines the size of the steel elements and the design:

- The item size is limited by the size of the process baths available for the treatment.
- All welds must be fully welded.
- Open crevices between steel elements are not allowed.
- Closed hollow sections are not allowed.
- Fully or partly blocked hollow sections must be provided with ventilation and outlet holes in a suitable size so that spots without zinc or with zinc accumulations do not arise inside in the hollow sections.
- Steel constructions which, after the hot-dip galvanization, are also to be painted must have a design which is in compliance with the requirements for painting, as for instance requirements for the accessibility of the surfaces as well as rounding of sharp edges to minimum 2 mm radius.

The standard DS/EN ISO 14713-2 gives further instructions for construction design of steel constructions for hot-dip galvanization.

5. QUALITY CONTROL

The quality control of the hot-dip galvanization includes visual control and control of zinc thicknesses according to DS/EN ISO 1461. The measurements of the thickness are conducted by means of an electromagnetic thickness meter in accordance with DS/EN ISO 2178 and DS/EN ISO 2064.

5.1 Visual inspection

All surfaces must be free from bare spots (areas without zinc coating), sharp taps and burrs of zinc, accumulations of zinc, flux and zinc ash which might be harmful for the assembly and use of the parts.

5.2 Control of zinc thicknesses

The requirements of coating thickness only include minimum requirements for local zinc thickness and average zinc thickness according to DS/EN ISO 1461.

Measurement is conducted in a distance of minimum 100 mm from material ends and minimum 10 mm from material edges.

Measurement of construction parts:

- Local zinc thickness: Is the local zinc thickness for a defined section of the hot-dip galvanized item and determined as the average value of minimum 5 thickness readings on the different faces of the section.
- Average zinc thickness: Is the average value of several local zinc thicknesses determined on one large item (above 2 m² surface area) or of several local zinc thicknesses determined on several small items (items with up to 2 m² surface area).

Measurements on bolts and nuts:

- Local zinc thickness: Is specified as the average value of 5 thickness readings on the flat surfaces of the bolt head or on the flat surfaces of the nut.
- Average zinc thickness: Is specified as the average value of the local thicknesses determined in a batch of bolts or nuts.

For a more detailed description of how average zinc thicknesses are to be determined, please be referred to DS/EN ISO 1461.

6. INSPECTION AND TEST PLAN

The contractor must prepare a quality control plan for the contract which must state how the above requirements are documented at each control:

- Method of inspection, description
- Acceptance criteria
- Frequency of inspection
- Description of the test report where the results are documented
- The rights in relation to inspection, that each of the parties have

The contractor must deliver an empty template for an inspection report which must include the visual control of surfaces and coating thickness control as well as control results.

At delivery the completed inspection report for performed quality control must be enclosed.

7. FINISHING

Droplets and sharp edges are abraded prior to delivery.

Appendix 3
Coating report

Documentation report for paint application			
Client:		Project:	
	Operating party	Responsible	
Pre-treatment			
Paint			
Paint supplier			
Pre-treatment			
Original condition on the surface if steel (ISO 8501-1):			
Corrosion grade A:	Corrosion grade B:	Corrosion grade C:	Corrosion grade D:
Galvanized surface, if relevant:		White corrosion products:	
		Yes:	No:
Hot-dip galvanized:	Spray metallised:	Electro-galvanized:	
Previously coated surface, if relevant – Type, thickness and age, if known:			
Blistering grade (ISO 4628-2):	Corrosion grade (ISO 4628-3):	Cracking grade (ISO 4628-4):	Flaking grade (ISO 4628-4):
Design – Are there areas which cannot be coated optimally?		Salt contamination (DS/EN ISO 8502-6):	
YES: NO:		mg/m ²	
Control of compressed air (ASTM D4285):		Oil/grease contamination of the steel:	
Stains: No stains:		YES: NO:	
Preparation grade (DS/EN ISO 8501-3):		Edges rounded to radius 2 mm:	
P1: P2: P3:		YES: NO:	
Cleanliness after cleaning/blasting (ISO 8501-1 / ISO 8501-2 / ISO 8501-4):			
Sa2: P-Sa2½: Wa1:	Sa2½: P-Ma: Wa2:	Sa3: : Wa2½:	St2: : Other pre-treatments:
Roughness (DS/EN ISO 8503-1 / DS/EN ISO 8503-2 / DS/EN ISO 8503-5):			
Dust (ISO8502-3):			
Quantity grade:		Particle size grade:	
Remarks:			

Application of paint								
	Primer		Intermediate coat		Intermediate coat		Top coat	
Paint - supplier - label - batch number								
Colour code								
Application method								
Thinner, if applied - name - amount								
Date of application								
Time of application	Start	End	Start	End	Start	End	Start	End
Air temperature °C								
Surface temperature °C								
Dewpoint °C								
Relative humidity %								
Specified thickness (NDFT)								
Number of measurements (according to DS/ISO 19840)								
Average thickness								
Minimum thickness								
Maximum thickness								
Percentage ≥NDFT								
Percentage between 80 and 100 % of NDFT								
Percentage < 80 % of NDFT								
Location of application:								
Company name of inspector:								
Name and signature Inspector:						Date		

Appendix 4

Inspection and test plan (ITP) for coating

Inspection and test plan (ITP) for coating

Project no. (Client):	Project no. (Subcontractor):	Document no.:
Item(s):	Serial no./Order no.:	Document version/date:
Client:	Project manager:	

Document references:

The inspection and test plan are outlined in accordance to....

Note:

- *Product standards*
- *The specification*
- *Own quality standards*

Review status		
Review number		
Review date		
Approval status		
Prepared by		Rolle:
Proofread by		Rolle:
Approved by		Rolle:

Review log		
Review	Section	Change
A	<i>e.g. 3.0</i>	<i>Implemented control by..... changed acceptance criteria to....</i>
B		
C		

Note:

- *The ITP can be sent back and forth and have some changes before an agreement on the final version is reached, especially if there are many involved parties.*

Definitions

Hold point (H)	A Hold point means that the work cannot continue before an inspection is completed by the part who has been appointed to it in the ITP. The client can require to be warned before a holding point.
Witness point (W)	A Witness point means that the party who has been appointed this in the ITP has to be invited to inspect but that the process and the work continue, regardless of whether they make use of the possibility or not.
Review Point (R)	A Review point means access for inspection of documents.
Monitor (M)	Monitor means that the party who has been appointed this in the ITP may be present and make inspections which do not affect the process.

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
1.0 Coating procedure								
1.1	Delivery of coating procedure	According to specification	Approval by... <i>Orderer</i>	Before production start		R	R	H
2.0 Control of equipment and certificates								
2.1	Calibration of test instruments		Latest calibration must have taken place less than one month ago	Before production start	Certificates	H	R	R
3.0 Control of materials and equipment								
3.1.	Reception control of steel blasting materials and paint	Visual	The delivered items must comply with the specification in the order. No damages of the packaging and the blasting material must be dry	At every receipt	Batch numbers are noted in the coating report. The steel grade (A, B, C or D) is noted in the coating report	M	M	M
3.2	Storage and handling of materials	According to the supplier's instructions	According to the supplier's instructions	Before production start		M	M	M
3.3	Control of the cleanliness of the compressed air	ASTM D4285	No stains or droplets	Once per shift	Coating report	M	M	M

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
4.0	Inspections of pre-treatment and coating							
4.1	The inspector's/foreman's qualifications		FROSIO level III, NACE level III Or other documentation of qualifications	Before production start	Certificates or other documentation	R	R	R
4.2	Control of design	Visual according to the specification as well as DS/EN ISO 12944-3	No openings which cannot be surface treated inside	Before abrasive blasting	Coating report	H	H	W
4.3	Control of oil or grease contamination	Visual	No grease stains	Before abrasive blasting	Coating report	W	W	M
4.4	Control of salt contamination on the surface	DS/EN ISO 8502-6	< 50 mg/2.	Just after abrasive blasting	Coating report	W	W	M
4.5	Climate control	Specification and technical data sheet	Steel temperature minimum 3 °C above the dewpoint. Relative humidity below 85 %	Indoors minimum 4 times a day. Outdoors continuous logging	Coating report	W	W	M
4.6	Control of the steel for surface defects after blasting	DS/EN ISO 8501-3	Preparation grade P2 – except for edges which must be rounded to a radius of 2 mm (P3)	All parts	Coating report	W	W	M
4.7	Control of cleanliness after blasting	DS/EN ISO 8501-1	<i>Sa2½, Sa3 or St3 – in accordance with requirements in technical data sheet for primer</i>	All surfaces	Coating report	W	W	M
4.8	Control of roughness after blasting	DS/EN ISO 8503-1, DS/EN ISO 8503-2 or DS/EN ISO 8503-5.	<i>Insert roughness value from the supplier's technical data sheet</i>	Spot checks 3 times daily. Visual on all materials	Coating report	W	W	M
4.9	Control of dust before primer is applied	ISO 8502-3	Grade 2 in both particle size and quantity	Spot checks 3 times daily	Coating report	W	W	M

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
4.10	Control of primer	DS/ISO 19840 And visual inspection	Minimum 80 % of NDFT and maximum 20 % of the measurements between 80 and 100 % of NDFT. Maximum 3xNDFT. Covering and without errors	All surfaces	Coating report	W	W	M
4.11	Visual control of stripe coating - intermediate coat		Covers all edges and fills all notches and cavities along the edges without forming pinholes	All edges and welds	Coating report	W	W	M
4.12	Control of intermediate coat	DS/ISO 19840 And visual inspection	Minimum 80 % of NDFT and maximum 20 % of the measurements between 80 and 100 % of NDFT. Maximum 3xNDFT. Covering and without flaws	All surfaces	Coating report	W	w	M
4.13	Visual control of stripe coating – topcoat		Covers all edges and fills all notches and cavities along the edges without forming pinholes	All edges and welds	Coating report	W	W	M
4.14	Control of topcoat	DS/ISO 19840 And visual inspection	Minimum 80 % of NDFT and maximum 20 % of the measurements between 80 and 100 % of NDFT. Maximum 3xNDFT. Covering and without flaws	All surfaces	Coating report	W	W	W
5.0	Documentation							
5.1	Coating report	According to ITP and specification	Contains all the issues which must be documented according to this ITP	Covering all painted parts	Coating report	R	H	H

Note:

- *The above assignment of inspection points reflects a typical ITP, but more hold points (H) can be added, if desired – however, it should be noted that it might influence the price, as it gives the operating subcontractor poorer possibilities to organize the tasks.*
- *Both client and contractor may choose to apply a third part's inspector to carry out their inspections.*
- *The client is the net company while contractor is the direct supplier.*
- *If some materials require that a certifying company has access for inspection, then a column for them is added.*
- *For very critical items, to be produced in large amounts, the first 3 parts can represent a pre-production test (PPT) where the operating subcontractor must demonstrate that they can execute the task and all the associated tests. In that case this will also be a holding point.*
- *Often, the ITP can contain a template for the coating report so there is an agreement about the appearance of this before the start of the task.*
- *The ITP is prepared by the contractor and is mainly used at large tasks with many items produced according to the same procedure.*
- *The coating procedure must contain technical data sheets as well as safety data sheets for the applied products.*

Appendix 5

Inspection and test plan (ITP) for Hot-dip galvanization

Inspection and test plan (ITP) for Hot-dip galvanization

Project no. (Client):	Project nr. (Subcontractor):	Document no.:
Subject:	Serial no./Order no.:	Dokument version/dato:
Client:	Operating Subcontractor:	

Document references:

Inspection and test plan are set up according to

Note:

- *Product standards*
- *Specification*
- *Own quality standards*

Revision status		
Revision number		
Revision date		
Approval status		
Prepared by		Role:
Proofreading by		Role:
Approved by		Role:

Revision log		
Revision	Section	Change
A	<i>e.g. 3.0</i>	<i>Implemented control by..... changed acceptance criteria to</i>
B		
C		

Note:

- *The ITP can be sent back and forth and have some changes before an agreement on the final version is reached, especially if there are many involved parties.*

Definitions

Hold point (H)	A Hold point means that the work cannot continue before an inspection is completed by the part who has been appointed to it in the ITP. The client can require to be warned before a holding point.
Witness point (W)	A Witness point means that the party who has been appointed this in the ITP has to be invited to inspect but that the process and the work continue, regardless of whether they make use of the possibility or not.
Review Point (R)	A Review point means access for inspection of documents.
Monitor (M)	Monitor means that the party who has been appointed this in the ITP may be present and make inspections which do not affect the process.

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
1.0 Hot-dip galvanization procedure								
1.1	Delivery of hot-dip galvanization procedure	According to specification	Approval by... <i>Client</i>	Before production start		R	H	W
2.0 Control of equipment and certificates and materials								
2.1	Calibration of test instruments		Latest calibration must have taken place less than six months ago	Before production start	Certificates	H	R	R
2.2	Control of bath chemistry in degreasing, pickling and flux	According to system instructions	<i>These the operating party must be able to register</i>	Before production start and additionally with a frequency according to system instruction (depends on types of bath)	Analysis reports	H	H	R
2.3	Control of hot-dip galvanization bath?	DS/EN ISO 752 DS/EN 1179	≤ 1.5% foreign elements in the molten zinc bath	Before start-up of a large series, otherwise yearly	Analysis report	H	R	R

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
3.0	Control of item for hot-dip galvanization							
3.1	Control of steel	According to specification	Hot-rolled or normalised. Requirement to composition: Si + P < 0.03 weight% 0.15 ≤ Si ≤ 0.25 weight%	Before production start	Material certificate of all steel materials which are to be hot-dip galvanized	H	H	W
3.2	Control of design construction	Visual according to drawing and the specification. Ventilation and circulation holes according to DS/EN ISO 14713-2	No openings which cannot be surface treated inside. All welds done as tight continuous welds Position and dimensioning of ventilation and circulation holes for possible cavities are degreed upon with operating subcontractor in advance and according to standard. Lifting points are available. Size and weight of items are degreed upon in advance with operating subcontractor.	Before production start		H	H	W
4.0	Inspections of pre-treatment and hot-dip galvanization							
4.1	Control of surface condition	Visual	Items must be free from surface defects which are detrimental for zinc coating, e.g.: pitting corrosion, oxide scale, old zinc coating, paint, varnish, oil, grease. Free from burrs, laminations, weld slag and weld spatter	Before hot-dip galvanization	Inspection report	H	W	W

No.	Description	Reference/method	Acceptance criteria	Frequency	Documentation	Inspection activity		
						Operating subcontractor	Contract or	Client
4.2	Control of pickling	Visual	Surface must be metallicly clean	First item in a series	Inspection report	H	M	M
4.3	Visual control after hot-dip galvanization	DS/EN ISO 1461	At normal sight and distance > 1 m the surface must be free from local overthickness, bubbles, sharp edges and bare areas. Deposits of flux remnants and zinc ash is not allowed.	After hot-dip galvanization (it may be a random spot check according to DS/EN ISO 1461 section 5)	Inspection report	H	W	M
4.4	Control of zinc thickness	DS/EN ISO 1461	Measurement of local zinc thickness and medium zinc thickness according to standard. The zinc thickness must be in accordance with the stated corrosion category.	After hot-dip galvanization (it may be a random spot check according to DS/EN ISO 1461 section 5)	Inspection report	H	W	W
5.0	Documentation							
5.1	Conformity report	According to ITP and specification as well as DS/EN ISO 1461 section 7	Contains all the items which must be documented according to this ITP	Covering all items		H	H	W

Note:

- The above assignment of inspection points reflects a typical ITP, but more hold points (H) can be added, if desired – however, it should be noted that it might influence the price, as it gives the operating subcontractor poorer possibilities to organize the tasks.
- Both client and contractor may choose to apply a third part's inspector to carry out their inspections.
- The client is the net company while contractor is the direct supplier.
- If some items require that a certifying company has access for inspection, then a column for them is added.
- For very critical items, to be produced in large amounts, the first 3 parts can represent a pre-production test (PPT) where the operating subcontractor must demonstrate that they can execute the task and all the associated tests. In that case this will also be a holding point.
- The ITP is prepared by the contractor and is mainly used at large tasks with many items.