

Tata Steel Technical Standard

S3105601 Corrosion controle by use of protective coatings

Author: PTC-CTY-KDT Corrosion Engineer
Date: 15-01-2019
Version: 6.2

The latest version of this document is available at <https://www.tatasteeleurope.com/ts/nl/gezondheid-en-veiligheid/toegang-en-veiligheid-ijmuiden/voorschriften> .

Information and changes

Document contents:
Standardisation:

KDT-COR@tatasteeleurope.com
ptc-adm@tatasteeleurope.com

+31 (0)251-493504
+31 (0)251-494443

<empty page>

Contents

Contents	3
1 General	4
1.1 Scope	4
2 Contract requirements.....	5
2.1 Conflicting or missing requirements	5
3 Company requirements.....	6
3.1 Quality system and outsourcing	6
3.2 Coating company staff.....	6
3.3 Catalogue parts / Manufacturing standard	6
4 Warranty on coating.....	7
4.1 Warranty period.....	7
4.2 Warranty conditions.....	7
4.3 Warranty exclusions	7
4.4 Repairs	8
5 Coating systems.....	9
5.1 Background	9
5.2 Design and steel preparation	9
5.3 Hot dip galvanising	10
5.4 Durability.....	11
5.5 Selecting a Tata Steel coating system	12
5.6 Coating systems.....	14
5.7 Surface preparation.....	18
6 Coating products and conditions.....	21
6.1 Base, hardening agents and thinners	21
6.2 Temperature during application.....	21
6.3 Mixing and application of coating	21
6.4 Welding and grinding on site	21
6.5 Transport, storage and assembly.....	22
7 Quality and quality control.....	23
7.1 General.....	23
7.2 Inspection & Test Plan	24
7.3 Mandatory tests	24
7.4 Optional tests	26
7.5 Coating application report	26
Appendix 1 Definitions.....	29
Appendix 2 Explanation of standards.....	30
Appendix 3 Coating system examples	31
Description of coating system in specifications	32
Appendix 4 Changes compared to v6.1	36

1 General

Tata Steel Technical Standard S3105601 describes the requirements for coating and coating activities. This comprises:

- the design
- steel preparation
- surface preparation
- application of the coating
- the execution of inspections

1.1 Scope

This Technical Standard is mandatory for all coating work performed worldwide for Tata Steel, location IJmuiden. The requirements contained in this Technical Standard apply to the coating of:

- carbon steel (CS)
- insulated stainless steel (SS)
- non-insulated stainless steel (SS) with colour requirement
- carbon steel that has been (hot-dip) galvanised, electroplated or provided with thermal spray aluminium (TSA) or thermal spray zinc (TSZ)

Different requirements apply to all other materials; these shall be included separately in the agreement between the Tata Steel client and the contractor.

1.1.1 Temporary structures or installations

Temporary structures or installations are objects with an expected service life of less than 7 years. These products shall be pretreated with system S-01 or S-xx (new structures / maintenance) and coated with system T-11 or T-31.

1.1.2 Additional Technical Standards and Directives

For installations for which Tata Steel has drafted special regulations, such as cranes, pressure vessels, rails, etc., see the specific regulations for these installations.

1.1.2.1 Railings in an outdoor situation

Railings in an outdoor situation shall be hot-dip galvanised in accordance with Tata Steel Standard S3298001 "Straight steel staircases – ladders – platforms and hand railing" and subsequently coated using system T-02+S-02. Application of coating on-site on newly delivered hot-dip galvanised railings is not permitted. Requirements for steel dressing and surface preparation of the hot-dip galvanised layer are set out in §5.3.

1.1.3 Deviations from the Technical Standard

This Technical Standard may be deviated from in specific situations. Anyone wishing to deviate from the Technical Standard shall submit a proposal stating the reason for the change and the pros and cons to the Tata Steel client. Deviations will only be permitted after explicit written permission from the Tata Steel client, after consulting the author of this Tata Steel Standard.

2 Contract requirements

Coating materials and coating systems shall always comply with Dutch and European legislation, applicable regulations such as REACH, the Working Conditions Decree and other applicable guidelines as well as the requirements set out in this Technical Standard and the data sheets of the coating supplier. Moreover, all coating products shall be free ($\leq 0.01\text{wt}\%$) from hexavalent chromium (Cr^{6+}) compounds including but not limited to chromates of zinc, strontium and lead. All listed Technical Standards, QHSEs and other standards refer to the most recent versions. The basis of this Technical Standard is the ISO 12944 standard series, in which a coating system has a minimum life expectancy of 15-25 years, unless described otherwise.

2.1 Conflicting or missing requirements

Conflicting and/or missing requirements shall be reported to the Tata Steel client as soon as they are known, using a Technical Query form.

3 Company requirements

3.1 Quality system and outsourcing

3.1.1 Subcontractor

Prior to outsourcing coating work in whole or in part to a subcontractor, the contractor shall request and obtain a written permission of the Tata Steel client. The subcontractor is subject to the same requirements as the contractor, as set out in this Technical Standard, including the certification requirements referred to. The Tata Steel client may refuse and/or set additional requirements for outsourcing of coating work.

3.2 Coating company staff

Coating work shall be carried out by demonstrably trained or instructed staff. Demonstrably trained implies that the competencies related to the work are tested every 3 years. The instruction is signed off by staff and recorded in a unique document that is included in the personnel file. These instructions and documents shall be presented to the Tata Steel inspector at their request during an audit or inspection.

The above demonstrability of the job profiles of a sandblaster, coating applicator/painter or spraypainter does not apply if the staff member in question has completed the training in accordance with the metal coating / preservation industry certification - Savantis or equivalent. Ultra High Pressure Water Jetting (UHP-WJ) is only performed by personnel that has been personally certified in accordance with "Stichting Industriële Reiniging" (SIR) or equivalent.

Any different or comparable training shall be submitted to the Tata Steel corrosion engineer for approval.

3.2.1 Responsibilities of the coating company's coating inspector

A coating inspector is responsible for ensuring that the specifications and the ITP are complied with. A coating inspector is also responsible for compliance with the product data sheets and use of calibrated measuring instruments. The contractor's coating inspector shall at least have completed NACE "Coating Inspection Program" level 1 or equivalent training. The inspector is supervised by an inspector who has completed at least NACE "Coating Inspection Program" level 2 or equivalent.

3.3 Catalogue parts / Manufacturing standard

All catalogue parts such as pumps, valves, motors, etc., may be delivered with an alternative coating system of the supplier, on the following conditions:

- the coating is suitable for the environment and the application, at least C3 (High) based on ISO 12944.
- coating systems based on alkyd, chlorinated rubber, vinyl or coal tar and/or coatings containing lead or chromium are not permitted.
- Shop and/or welding primers shall be completely removed before a complete system is applied.

If the above requirements are not met, the client shall rectify this. All coatings shall be removed and a suitable system applied that meets the above requirements or this Technical Standard.

4 Warranty on coating

The treated objects shall meet the warranty conditions (§4.1) throughout the warranty period (§4.2).

4.1 Warranty period

The contractor gives a warranty for a period of five (5) years for coating on new structures or for complete replacement of the coating as part of maintenance. Repair (touch up) of coating of new structures is covered by the warranty for new structures. In the event of maintenance or repair during maintenance of coated structures, the contractor warrants that the coating complies with the warranty conditions (§4.2) for a period of three (3) years. The warranty period starts on the day of completion of coating work by the contractor to the Tata Steel client.

4.2 Warranty conditions

4.2.1 Corrosion

During the warranty period, coated parts shall not have more corrosion than Ri1, or the entire surface area Ri0, of which no more than 5% of the surface area shows local corrosion up to Ri3. Corrosion is measured in accordance with ISO 4628-3. Exceptions are specified in §4.3.

4.2.2 Flaking / adhesion failures

During the warranty period, the coating system applied shall not show any adhesion failures from the surface or between different layers (class 0 in accordance with ISO 4628-5). Exceptions are specified in §4.3.

4.2.3 Blistering

During the warranty period, the coating system applied shall not show any blistering (in accordance with ISO 4628-2). Exceptions are specified in §4.3.

4.2.4 Cracking

During the warranty period, the coating system applied shall not show any form of cracking or crazing in the coating system as a whole or in the individual layers (class 0 in accordance with ISO 4628-4). Exceptions are specified in §4.3.

4.3 Warranty exclusions

4.3.1 Mechanical impacts

Damage that demonstrably occurred after delivery due to mechanical impact on the coating system are excluded from the warranty.

4.3.2 Accessibility and shape

Surfaces that cannot be treated and/or coated in accordance with the instructions because of their shape or poor accessibility should be excluded from the warranty. Coating staff shall report such surfaces to the Tata Steel client in writing, including photographs. Defects to parts of the coating system that are not reported in advance in this manner are not excluded from the warranty.

4.3.3 Circumstances with a negative impact on quality

The contractor is responsible for protecting the surface to be treated from circumstances that have a negative impact on quality. The client shall be consulted if a surface to be treated cannot be adequately protected. The client determines whether the work to be carried out in circumstances with a negative impact on quality, should continue. These parts are excluded from the warranty.

4.4 Repairs

All repairs covered by the warranty shall be performed by the contractor free of charge. All repairs covered by the warranty shall be performed no later than by the end of the year, following the last year of the warranty period, unless agreed otherwise. Tata Steel may instruct the contractor to perform the repairs at an earlier stage.

5 Coating systems

5.1 Background

An environment can have different classifications. ISO 12944-2 describes corrosion resulting from atmospheric aggressiveness (see Table 1). The different environments on the Tata Steel premises are classified as indicated in Table 1 and Table 2.

Table 1: Description of environment classification and corrosion activity

Classification	Corrosion activity	Location
≤C2	Very low - low	Very clean and dry environment. Office environment
C3	Medium	Indoors in production buildings and halls, without chemicals
C5	Very high	Outdoors situation, Tata Steel premises

Table 2: Description of immersion classification and location

Classification for immersion	Location of immersion*
Im 1	Fresh water
Im 2	Salt or brackish water
Im 3	Soil

*Immersion does not include the inside of tanks, drums, enclosed compartments or the inside of piping

Indoors in buildings and halls with environments containing chemicals, such as pickling lines and the cooling chamber, are not part of this environment classification due to their aggressive environment. A specific coating system (T-05/T-25) shall be arranged for these environments.

5.2 Design and steel preparation

The service life of the coating largely depends on the design of the structure. Standards ISO 12944-3, EN 1090-2 and EN 14879-1 outline the design choices that have a major impact on the service life of an object.

Suitable precautions include:

- design with sloping sides so that dust and dirt cannot accumulate
- removing open sections at the top
- preventing spaces and areas where water and dirt can accumulate
- drainage of water and corrosive liquids from the structure
- preventing poorly accessible spaces for a proper surface preparation and coating application

All new structures and installations or parts thereof shall be treated in accordance with ISO 8501-3 up to the minimum surface preparation grade stated in Table 3. Sharp edges shall be removed and rounded with a radius of at least 2 mm. If the structure is in a corrosive environment, it shall comply with EN 14879-1: Table 1 and class A2 of Table 4 and Table 5. Poorly accessible parts in a new construction situation shall be treated in accordance with EN 1090-2.

Table 3: Acceptance criteria for steel dressing of new structures

Steel preparation requirements	Minimum surface preparation grade
ISO 8501-3 §1.1	P2
ISO 8501-3 §1.2 to §1.6	P3
ISO 8501-3 §2.1	P3
ISO 8501-3 §2.2*	P3, with the exception of sheet material with a thickness ≤ 3 mm, bolt holes, slotted holes and flange edges. These are subject to P2
ISO 8501-3 §2.3	P2
ISO 8501-3 §3.1 to §3.6	P2

* The minimum size for rounding or bevelling an edge is presented in Figure 1

Figure 1: Minimum size for rounding or bevelling corners and edges in accordance with ISO 8501-3 §2.2 and ISO 12944-3.

5.2.1 Welds and other joints

Welds shall comply with Technical Standard S1450401. Post-treatment of the welds with a welding primer such as zinc spray is not permitted. Chain welds shall be prevented where possible. If chain welds cannot be prevented, suitable measures shall be taken to prevent the formation of cracks. The measures to be taken shall be discussed with the Tata Steel client.

Couplings of stainless steel to steel shall be treated in accordance with EN 1090. The coupling shall be coated up to at least 50 mm on both sides, including the coupling itself, with the coating system in accordance with this Technical Standard.

The bolts and nuts shall be coated with the repair system. Coating shall be applied by brush into all gaps and crevices of the bolt connection and the bolt connection itself. The above shall always be discussed with the Tata Steel client.

5.3 Hot dip galvanising

5.3.1 Galvanising material

Materials to be galvanised shall have a material certificate in accordance with EN 10204 type 3.1 to determine whether the zinc layer may cause pores and blisters in the organic coating layer. The following percentages of the elements silicon and phosphorus in accordance with NEN 5254 may cause thick, irregular, dull-grey zinc layers, where defects in the organic upper layer may be expected:

Silicon: $0.04\% < Si < 0.12\%$; $Si > 0.23\%$
 Phosphorus: $P > 0.045\%$
 Total: $Si + 2.5 \times P > 0.2\%$

5.3.2 Pretreatment prior to hot dip galvanising

Prior to hot dip galvanising, the surface shall be prepared so that all contaminations, such as grease, dirt and mill scale, are removed. Prior to galvanising, the material shall be treated in accordance with ISO 8501-3 up to the minimum preparation grades referred to in Table 4.

Table 4: Acceptance criteria for steel preparation for hot dip galvanising of new structures

Steel preparation requirements	Minimum preparation grade
ISO 8501-3 §1.1	P2
ISO 8501-3 §1.2 to §1.6	P2
ISO 8501-3 §2.1	P2
ISO 8501-3 §2.2*	P2 with the exception of sheet material with a thickness ≤ 3 mm, bolt holes, slotted holes and flange edges. These are subject to P1
ISO 8501-3 §2.3	P2
ISO 8501-3 §3.1 to §3.4	P2
ISO 8501-3 §3.5 to §3.6	P1

* The minimum size for bevelling an edge is presented in Figure 1

5.3.3 Hot dip galvanising requirements

The zinc layer shall comply with ISO 1461. The thickness of the zinc layer shall be equal to or greater than the minimum in accordance with ISO 1461. Zinc porosity shall be as low as possible (see §5.3.4). The supplier of galvanised materials is responsible for surface preparation before coating application

5.3.4 Duplex coating system

A duplex coating system consists of steel with a galvanic layer (e.g. hot dip galvanised) combined with an organic coating. The client shall inform the contractor whether a duplex coating system is required. The galvanic layer shall be prepared for coating application prior to coating application. This means that the surface is pretreated in accordance with NEN 5254, §6.2. This includes removal of thick parts, (zinc) drops, burrs and irregularities that may damage the coating film.

After application of the galvanic layer and before application of the organic coating, the coating contractor shall pretreat the surface in accordance with surface preparation S-02. The minimum thickness of the galvanic layer shall still be present after sandblasting.

A duplex system can be applied in indoor and outdoor situations. Indoors (office or conditioned environment $\leq C2$) in a non-aggressive or dry environment, a coating system consisting of a primer with finish coat for aesthetic colour finish suffices for a duplex system. For all other applications, the complete T-02 system shall be applied.

5.4 Durability

The durability of a coating is presented in three different categories in Table 5. The life expectancy is the time until the moment that major maintenance is expected. The durability of each system is described in §5.7 and largely depends on the surface preparation.

Table 5: Description of durability category and life expectancy

Durability category	Life expectancy
Low (L)	<7 years
Medium (M)	7-15 years
High (H)	15-25 years
Very high (VH)	25+ years

5.4.1 Laboratory tests

The specified coatings shall comply with ISO 12944-6. Specific test data have been assessed and are available for the sample systems included in this Tata Steel Standard. If a contractor wishes to deviate from these sample systems, the requested test data for each coating system shall be provided.

If a sample system as described in this standard has not been tested, the test results of an alternative system based on comparison shall be presented. Substantiation shall be given as to why the test results of the alternative system offered are considered representative. The Tata Steel corrosion engineer will assess these data.

5.5 Selecting a Tata Steel coating system

A coating system consists of a coating system combined with a surface preparation system. The structure is presented in Figure 2, with coating system T-01 and surface preparation system S-01 presented as coating system T-01+S-01 as an example.

The systems are described in more detail in the following sections. Combinations other than those prescribed in Table 7 are possible, but only permitted with the written consent of the Tata Steel corrosion engineer **prior to** performance of the contract or assignment.

A coating system can be selected from the four categories presented in Table 6. By answering the questions, four figures are obtained that correspond to a coating system in Table 7. Based on that coating system, the surface preparation can subsequently be selected in §5.7, depending on durability. Complex structures may comprise multiple coating systems. In case of doubt or if a choice from the four categories results in system T-05, T-25 or an undefined coating system, contact the Tata Steel corrosion engineer.

Examples of approved coating systems and suppliers are listed in: "Appendix 3 Coating system examples". This appendix includes all approved coating systems from suppliers PPG and Jotun that can be used. This appendix can be changed separately from Tata Steel Standard S3105601. Interim changes may be made in this list without circulating an update. Coating products from other suppliers may be used but shall be requested for each individual project and coating system. If a supplier other than the suppliers mentioned above is used, the coating supplier shall provide information on the coating system to the Tata Steel corrosion engineer in accordance with the "Application protocol alternative coating supplier". Written approval is required before the approved coating system for that project may be supplied.

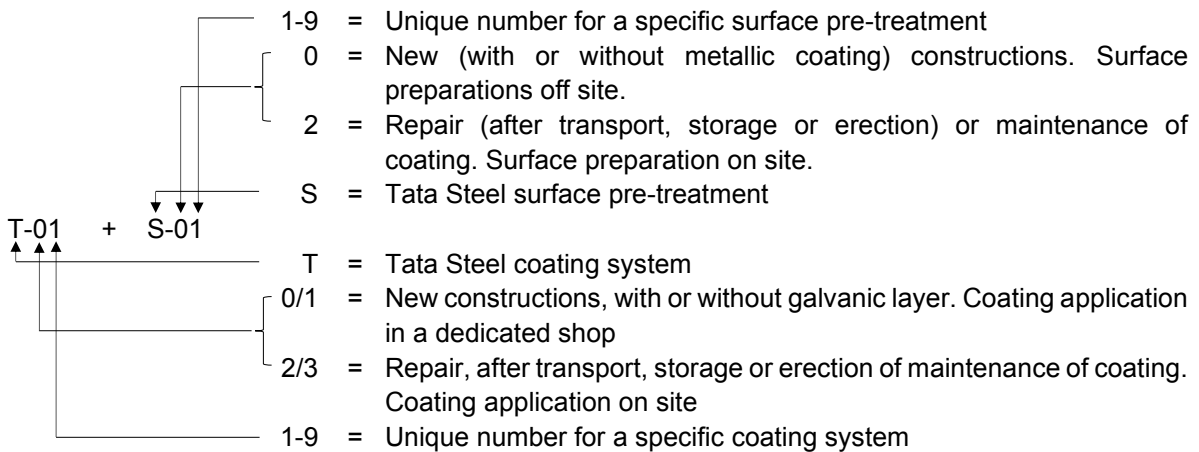


Figure 2: Example of a Tata Steel coating system

Table 6: Questions and system selection code

Type of work	A
New constructions	1
Maintenance or repair	2
Material	B
Carbon steel	1
Hot-dip galvanised	2
Stainless Steel (SS)	3
Protection against	C
Atmospheric load - C5 (outdoor atmosphere)	1
Atmospheric load - C3 (indoors in production building)	2
Immersion - Im 2	3
Corrosion under insulation (CUI)	4
Strong chemical load	5
Temporary structures	6
Operating temperature (continuous or cyclic)	D
-20 to 120°C (application temperature max. 40°C)	1
-20 to 200°C	2
-20 to 450°C	3

Table 7: Coating system selection using four-figure code after questions [ABCD]

New structure					Maintenance				
A	B	C	D	System	A	B	C	D	System
1	1	1	1	T-01	2	1	1	1	T-21
1	2	1	1	T-02	2	2	1	1	T-22
1	2	2	1	T-02	2	2	2	1	T-22
1	1	1	2	T-03	2	1	1	2	T-23
1	1	2	2	T-03	2	1	2	2	T-23
1	1	4	2	T-03	2	1	4	2	T-23
1	3	4	2	T-03	2	3	4	2	T-23
1	1	1	3	T-04	2	1	1	3	T-24
1	1	2	3	T-04	2	1	2	3	T-24
1	1	4	3	T-04	2	1	4	3	T-24
1	3	4	3	T-04	2	3	4	3	T-24

1	1	5	3	T-05*	2	1	5	3	T-25*
1	1	2	1	T-06	2	1	2	1	T-26
1	1	3	1	T-07	2	1	3	1	T-27
1	3	1	1	T-10	2	3	1	1	T-30
1	1	6	1	T-11	2	1	6	1	T-31

*Contact the Tata Steel corrosion engineer

5.6 Coating systems

Coating systems for new structures shall be applied in a hall equipped for that purpose. Application of a coating system for new structures on site is not permitted, unless agreed otherwise with the Tata Steel corrosion engineer. Maintenance coating systems are only applied on site.

For structures coated on site, the untreated surface of which is exposed to ambient conditions for a longer period of time not exceeding 1 year, the application of a shop or welding primer is permitted. However, the shop or welding primer shall be removed completely by means of sandblasting before the coating system as a whole is applied. The temporary coating system (T-11 or T-31) applies for construction periods longer than 1 year but not exceeding 7 years.

5.6.1 Coating system T-01

New structure coating system	T-01
Material	Carbon steel
Environment	Outdoor situation on location Tata Steel (C5 environment)
Max. temperature (dry load)	120°C
Life expectancy	15 – 25 years
Number of coating layers	3
Surface preparation	SP S-01
Repair system	T-21

5.6.2 Coating system T-02

New structure coating system	T-02
Material	Hot-dip galvanised carbon steel
Environment	Outdoor / indoor situation on location Tata Steel (C5 / C3 environment)
Max. temperature (dry load)	120°C
Life expectancy	15 – 25 years
Number of coating layers	3
Surface preparation	SP S-02
Repair system	T-22

5.6.3 Coating system T-03

New structure coating system	T-03
Material	Carbon steel / SS
Environment	Under insulation and up to higher temperature
Max. temperature (wet / dry load)	60°C / 200°C
Life expectancy	15 – 25 years
Number of coating layers	2
Surface preparation	SP S-01 (carbon steel) / S-03 (SS)
Repair system	T-23

5.6.4 Coating system T-04

New structure coating system	T-04
Material	Carbon steel / SS
Environment	Under insulation and up to very high temperature
Max. temperature (dry load)	450°C
Life expectancy	15 – 25 years
Number of coating layers	2 - 3
Surface preparation	SP S-01 (carbon steel) / S-03 (SS)
Repair system	T-24

5.6.5 Coating system T-05

New structure coating system	T-05
Material	Carbon steel
Environment	Very aggressive circumstances or special requirements
Max. temperature (dry load)	TBD
Surface preparation	TBD
Life expectancy	7 – 15 years
Number of coating layers	TBD
Repair system	T-25

5.6.6 Coating system T-06

New structure coating system	T-06
Material	Carbon steel
Environment	indoor situation on location Tata Steel (C3 environment)
Max. temperature (dry load)	120°C
Life expectancy	15 – 25 years
Number of coating layers	2
Surface preparation	SP S-01
Repair system	T-26

5.6.7 Coating system T-07

New structure coating system	T-07
Material	Carbon steel
Environment	Basin with salt or brackish water Non-enclosed systems
Max. temperature (wet / dry load)	40°C / 120°C
Life expectancy	15 – 25 years
Number of coating layers	2
Surface preparation	SP S-01
Repair system	T-27

5.6.8 Coating system T-10

New structure coating system	T-10
Material	SS
Environment	Outdoor / indoor situation on location Tata Steel (C5 / C3 environment). Aesthetic colour layer for SS
Max. temperature (dry)	120°C
Life expectancy	15 – 25 years
Number of coating layers	2
Surface preparation	SP S-03
Repair system	T-30

5.6.9 Coating system T-11

New structure coating system	T-11
Material	Carbon steel
Environment	Outdoor situation on location Tata Steel (C5 environment)
Max. temperature (dry)	120°C
Life expectancy	< 7 years
Number of coating layers	1
Surface preparation	SP S-01
Repair system	T-31

5.6.10 Coating system T-21

Maintenance coating system	T-21
Material	Carbon steel
Environment	Outdoor situation on location Tata Steel (C5 environment)
Max. temperature (dry / application)	120°C / 40°C
Number of coating layers	4 (brush/roller application) / 2 (spray application)

5.6.11 Coating system T-22

Maintenance coating system	T-22
Material	Hot-dip galvanised steel
Environment	Outdoor situation on location Tata Steel (C5 environment)
Max. temperature (dry / application)	120°C / 40°C
Number of coating layers	3

5.6.12 Coating system T-23

Maintenance coating system	T-23
Material	Carbon steel / SS
Environment	Under / without insulation up to high temperature
Max. temperature (dry / application)	200°C / 150°C
Number of coating layers	2

5.6.13 Coating system T-24

New structure coating system	T-24
Material	Carbon steel / SS
Environment	Under insulation and up to very high temperature
Max. temperature (dry / application)	450°C / 40°C
Number of coating layers	3 (brush/roller application) / 2 (spray application)
Remark	The zinc silicate can only be applied to Sa2½ sandblasted carbon steel (SP S-21). Zinc silicate shall not be applied to SS. In that case, the system only consists of the buildcoat and finish.

5.6.14 Coating system T-25

Maintenance coating system	T-25
Material	Carbon steel
Environment	Very aggressive circumstances or special requirements
Max. temperature (dry load)	TBD
Number of coating layers	TBD

5.6.15 Coating system T-26

Maintenance coating system	T-26
Material	Carbon steel / metallic layer / SS
Environment	indoor situation on location Tata Steel (C3 environment)
Max. temperature (dry / application)	120°C / 40°C
Number of coating layers	3 (brush/roller application) / 2 (spray application)

5.6.16 Coating system T-27

Maintenance coating system	T-27
Material	Carbon steel
Environment	Basin with salt or brackish water Non-enclosed systems
Max. temperature (wet / dry / application)	40°C / 120°C / 40°C
Number of coating layers	4 (brush/roller application) / 2 (spray application)

5.6.17 Coating system T-30

Maintenance coating system	T-30
Material	Carbon steel / SS
Environment	Outdoor / indoor situation on location Tata Steel (C5 / C3 environment). Aesthetic colour layer for SS
Max. temperature (dry / application)	120°C / 40°C
Number of coating layers	2

5.6.18 Coating system T-31

Maintenance coating system	T-31
Material	Carbon steel
Environment	Outdoor situation on location Tata Steel (C5 environment)
Max. temperature (dry / application)	120°C / 40°C
Number of coating layers	2

5.7 Surface preparation

5.7.1 General requirements for surface preparation of new structures

The following requirements apply to surface preparation systems S-01 to S-03:

- surface preparation shall be performed in a location protected against atmospheric influences (rain, contamination, dirt, etc.) equipped with a provision for discharging the sandblasting material. Coating application does not take place in the same room.
- no contaminations (oil, grease, dirt, dust and contaminations) shall be present on the surface before the start of the sandblasting work. Surface preparation in accordance with SSPC-SP1 or ISO 12944-4. The use of cloths with degreasing agent for cleaning purposes is not permitted for surfaces >10cm²
- blast nozzle machines are not permitted, unless project-specific permission is granted. This permission will be given by the Tata Steel corrosion engineer. Permission can only be obtained if the sandblasting agent used has a minimum hardness of 54 HRC or 570 HV (type GL grit)
- Dry or vacuum blasting shall be performed in accordance with ISO 8504-2 §5.1.2 or §5.1.3
- Additional requirements as described in Table 8 and Table 9.

Table 8: General requirements for surface preparation during construction

Subject	Value	Standard
Initial steel quality	A or B	ISO 8501-1
Surface finish	See chapter 5, Table 3 (steel), Table 4 (hot-dip galvanised steel)	ISO 8501-3
Surface cleanliness	Depending on surface preparation, see Table 9	ISO 8501-1
Sandblasting agent	Metallic sandblasting agent (steel base)	ISO 11124
	Non-metallic sandblasting agent (hot-dip galvanised / SS base)	ISO 11126
Quantity of dust (density / size)	rating / class 1 / 2	ISO 8502-3
Salt concentration	Depending on structure, see Table 16	ISO 8502-6
Roughness	Depending on surface preparation, see Table 9	ISO 8503-4

Table 9: Roughness and cleanliness per surface preparation system for new structures

Surface preparation	Material	Roughness	Cleanliness
S-01	Steel	R _z = 65±15µm	Sa2½
S-02	Hot-dip galvanised	R _z = 35±15µm	Uniformly matt appearance
S-03	SS	R _z = 40±10µm	Uniformly matt appearance

5.7.2 General requirements for surface preparation for repairs or maintenance

These general requirements apply to surface preparation systems S-21 to S-26:

- prior to surface preparation, rust layers and oil, grease, dirt, dust and contaminations shall be removed
- no contaminations (oil, grease, dirt, dust and contaminations) shall be present on the surface before the start of the surface preparation work. Surface preparation in accordance with SSPC-SP1 or ISO 12944-4. The use of cloths with degreasing agent for cleaning purposes is not permitted for surfaces >10cm²
- the specified surface is treated
- if a wet surface preparation method is performed, a maximum degree of flash-rust M is permitted, measured in accordance with SSPC-VIS 4 "white cloth" method. For higher values, the surface shall be treated again or the degree of rust reduced to an acceptable level by means of steam cleaning
- any remaining salts shall be removed by rinsing/steam cleaning. Surface preparation as prescribed shall be performed again after a single rinse.

- the transition to the old coating shall be feathered back, with a minimum overlap of 50 mm
- the salt test shall be repeated in accordance with ISO 8502-6 if coating layers are applied on different days, if the surface to be coated has been exposed to rainfall or has not been coated for longer than three (3) days. If the values exceed the limits listed in Table 16, cleaning shall be performed until the values are below the limits
- dry or vacuum blasting in accordance with ISO 8504-2 §5.1.2 or §5.1.3, subsequent blasting in accordance with ISO 8504-2 §5.2.2 or §5.2.3
- Additional requirements as described in Table 10 and Table 11

Table 10: General requirements for surface preparation during maintenance or repair

Subject	Value	Standard
Surface cleanliness	Depending on surface preparation, see Table 11	ISO 8501-1
Sandblasting agent	Non-metallic sandblasting agent (hot-dip galvanised / SS base)	ISO 11126
Quantity of dust (density / size)	rating / class 2 / 2	ISO 8502-3
Salt concentration	Depending on structure, see Table 16	ISO 8502-6
Roughness	Depending on surface preparation, see Table 11	ISO 8503-4
Adhesion	Old coating layers \geq 5MPa adhesion strength	ISO 4624

Table 11: Roughness and cleanliness per surface preparation system for maintenance

Surface preparation	Material	Roughness	Cleanliness	Standard
S-21 Blasting	Steel	$R_z = 65 \pm 15 \mu\text{m}$	Sa2½	ISO 8501-1
S-22 Blasting	Galvanised	$R_z = 35 \pm 15 \mu\text{m}$	Uniformly matt appearance	ISO 8501-1
S-23 Blasting	SS	$R_z = 40 \pm 10 \mu\text{m}$	Uniformly matt appearance	ISO 8501-1
S-24 UHP-WJ	All bases	$R_{\text{max}} > 35 \mu\text{m}$	Wa2½ / WJ-2	ISO 8501-4 / SSPC-SP 12
S-25 Manual rust removal		$R_{\text{max}} > 35 \mu\text{m}$	St3	ISO 8501-1
S-26 Sanding		Sanding grain 100 / 120	Sanded with seamless transition	ISO 8501-2

5.7.3 Method of repair or maintenance

As described in ISO 12944, there are a number of possibilities for pre-treating a structure to extend the service life of the coating. The different methods are presented below, combined with the surface preparation system and life expectancy.

Table 12: Method of repair or maintenance

Method	Surface preparation	Execution	Life expectancy
Coating repair of new structure	S-21, S-26	Local defects emerging during construction shall be pretreated with seamless transition (sanding or blasting) until a coating layer without defects is obtained. Then build up the system by applying missing layers with maintenance coating system.	High (15 - 25 years)
Coating repair in maintenance situations	S-25	Treat local defects to cleanliness grade PST3 (S-25). Coating is applied locally	Low (< 7 years)

Partial renovation in maintenance situation	S-21, S-22, S-23, S-24	Treat local defects. This can be done up to cleanliness grade PSa2½ (S-21, S-22 and S-23), P Wa2½ (S-24). A number of layers is only applied locally to the defects, after which the entire surface is coated. The difference between local layers and general layers is presented in Table 18.	Medium (7 -15 years)
Complete renovation in a maintenance situation	S-21, S-22, S-23, S-24	Complete surface treatment of the defined (part of the) object, after which the complete system is applied	High (15 - 25 years)

6 Coating products and conditions

6.1 Base, hardening agents and thinners

The coating products to be used for a project shall be stored in frost-free and dry conditions and always in the manner prescribed by the data sheet. The products shall not exceed their shelf life and the batch number shall be stated on the product packaging.

On new structures, only products from the same coating supplier shall be applied, unless agreed otherwise with the Tata Steel corrosion engineer. Repairs of coating defects in new structures shall be made with coating from the same coating supplier as used for the new structure. Combining products from different suppliers in a single coating system is not permitted.

To prevent compatibility problems, the use of universal thinners or solvents to dilute coating or clean a surface or tool is not permitted. Coating products of which the pot life has been exceeded shall not be used.

6.2 Temperature during application

The temperature range of the coating products referred to is between 10°C and 40°C. As soon as the temperature of the surface falls below the lower limit of 15°C, the winter version of the products can be applied, provided the other ambient conditions are within spec. Winter versions of products can be applied up to a maximum temperature of 25°C. The minimum temperature during application of the coating is 0°C. Only winter versions of the products specified are permitted.

As soon as the surface temperature of atmospherically loaded structures (coating system T-21) exceeds 40°C, coating system T-21 is no longer suitable for application and other coating products are required. An alternative coating system has been selected for application up to 80°C. More information about this coating system can be requested from the Tata Steel corrosion engineer.

6.3 Mixing and application of coating

The coating shall be mixed and applied in accordance with the supplier's relevant product data sheets. If not the entire content of the tins is mixed, effective means shall be used to measure the correct quantities. Coatings shall be mixed using electrical/pneumatic mixers.

The different coating layers may have different colours, allowing visual inspection. Every layer shall provide full coverage and sealing.

6.3.1 Materials

Coatings shall be applied using good quality materials (such as brushes and rollers), in accordance with ISO 12944-7. The use of rollers for application of anti-corrosion primers (systems T-01, T-04, T-06, T-21, T-24, T-26) is not permitted.

6.4 Welding and grinding on site

To prevent welding porosity and brittleness, the welding surface shall be clean and free from coatings, in accordance with Tata Steel Technical Standard S1450401.

For new structures, a surface of 100 mm on either side of the field weld shall be entirely covered with painter's tape before applying the coating system, but after surface preparation. All tape shall be immediately removed after coating application. If the object is pre-heated to a temperature over 120°C, the entire heated surface shall be taped or left uncoated.

If a structure is to be treated after completion of coating application, such as welding, grinding, sanding, etc., the coating shall be protected to prevent damage. Any damage that occurs shall be repaired by an approved coating company. Welding on installations with an internal coating or liner shall be avoided. If this is not possible, the coating or liner on the inside shall be repaired.

6.5 Transport, storage and assembly

During transport, storage and assembly, special precautions shall be taken (such as nylon stoppers, wooden support points or rubber strips) to prevent damage to the coating system. All damage that occurs as a result of moving, transporting, hoisting, welding, grinding or required destructive testing shall be repaired using the prescribed repair system. The coating shall only be repaired after all assembly work has been completed. Repairing the coating before the other work has been completed is not permitted. This prevents new damage to the coating, unless agreed otherwise with the Tata Steel client.

7 Quality and quality control

7.1 General

7.1.1 Inspections

The contractor is obliged to perform the tests described in §7.3. The results shall be reported to and signed off by the Tata Steel inspector.

The inspections by the coating company shall be performed by a certified inspector as set out in §3.2.

7.1.2 Cleanliness

The surface shall be free from oil, grease, water-soluble salts and other contaminations. These shall be removed from the surface to below the limit values by using hot or pressurised clean (drinking) water with a suitable biodegradable degreasing agent in accordance with ISO 12944-4 or SSPC-SP1. The solvent shall not contain any chlorine compounds, such as trichloroethylene. The entire cleaned surface shall be rinsed with clean (drinking) water to remove any remaining degreasing agent. The use of cloths to clean a surface is not permitted for surfaces larger than 10cm², unless agreed otherwise with the Tata Steel corrosion engineer.

7.1.3 Coating defects

All coating defects, such as runs, laminates, dry-spray, excess layer thickness, sanding planes, cracks, etc., are presented in Fitz's Atlas 2. All defects, except for chalking, shall be removed up to the next coating layer without defects, after which the system is built up from that layer without defects.

7.1.4 Non-conformity report

A Non-Conformity Report (NCR) shall be drawn up if work or working methods have not been performed in accordance with the specifications. An NCR shall clearly describe the cause, corrective and preventive measures. The NCR shall be presented to the Tata Steel client and the Tata Steel inspector for approval within 5 working days after the non-conformity was found. Continuing the work before the NCR has been approved by the Tata Steel client is not permitted, unless agreed otherwise with the Tata Steel client.

7.1.5 Critical scaffolding points

Where possible, scaffolds used for coating activities shall have double shoring to prevent critical scaffolding points. Any surface that cannot be coated directly shall be coated by the coating company during disassembly of the scaffold. This shall be done in consultation with the scaffolder.

7.1.6 Coating application after complete surface preparation

Tests shall be performed after complete surface preparation and before application of the coating, see §7.3. Coating application may be started if the results fall within the predetermined limits. The coating system should preferably be applied by means of airless spray. However, if the situation does not allow this, the coating can be applied using brushes or rollers. See §6.3.1 for a more detailed explanation.

It is not permitted to apply part of the system in the workshop and the remaining layers on site, unless agreed otherwise with the Tata Steel corrosion engineer.

7.1.7 Coating application after local surface preparation

The tests referred to in §7.3 shall be performed after local surface preparation and before application of the coating. Coating application may be started if the results fall within the predetermined limits. The transition from the pretreated surface to the old coating shall be feathered back with an overlap of at least

50 mm. It shall be clear when the assignment is granted how many locations shall be prepared. If this is not specified, it is assumed that 8% (Ri4 in accordance with ISO 4628-3) shall be prepared, with a maximum of 15% local coating defects of the total surface area. Local repairs shall be made in squares. The cleaned surface shall still be clearly visible immediately after application of the coating. If a complete covering layer is requested, the entire surface shall be prepared as specified in §5.7.3. Which local and which complete layers shall be applied is presented in Table 18.

7.1.8 Stripe coat and anti-corrosive primer

Corners, edges, welds, hard-to-reach locations, bolts and nuts shall be provided with a stripe coat. This shall be applied using a brush or airless spray for each coating layer. Photographs shall be taken of the stripe coat and added to the coating report.

The first layer of coating systems with an anti-corrosive primer shall be applied using a brush or airless spray. Use of a roller for application of this type of primer is not permitted, see 6.3.1.

7.2 Inspection & Test Plan

Prior to performance of the assignment, the contractor shall submit an Inspection & Test Plan (ITP) to the Tata Steel client for approval. An ITP shall contain the tests and inspection items listed in §7.3.

Coating application work shall not be started without an ITP approved by Tata Steel.

7.3 Mandatory tests

It is the contractor's responsibility to ensure that the mandatory tests described below are performed in accordance with the applicable requirements. The tests and the corresponding standards and criteria are described in §7.5.

7.3.1 Surface preparation of new structures

All surface defects shall have been repaired in accordance with ISO 8501-3 up to the values given in Table 3 or Table 4. The coating company should not accept any structures that have not been repaired up to this grade. All corrections shall be completed before the first coating layer is applied.

7.3.2 Surface cleanliness

Surface cleanliness of each object shall be visually checked.. Surface preparation shall comply with the requirements set out in §5.7.

UHP water jetting or wet blasting will produce flash rust. The quantity of flash rust shall not exceed grade M. This shall be determined using the white cloth method of SSPC-VIS 4. The test shall be performed within 30 minutes before coating application starts. The test shall be performed for the location worst affected by flash rust (worst-case scenario).

7.3.3 Grit and surface roughness

The name and batch number of the grit shall be recorded. The grit shall comply with ISO 11124 or ISO 11126, see Table 15 for an overview. Blast nozzle machines are not permitted, unless project-specific permission is granted. This permission will be given by the Tata Steel corrosion engineer. Permission can only be obtained if the sandblasting agent used has a minimum hardness of 54 HRC or 570 HV (type GL grit).

The method for checking surface roughness shall be performed in accordance with ISO 8503. The comparator method (ISO 8503-1) shall only be used to estimate the roughness. Two roughness tests shall be performed per 100m² using the replica tape method (ISO 8503-5) or the stylus instrument

method (ISO 8503-6). Only the stylus instrument method shall be used to check the blasting roughness of new structures.

7.3.4 Dust class

The dust class shall be measured after surface preparation and before coating application, in accordance with ISO 8502-3.

7.3.5 Water-soluble salts

The water-soluble salt content shall be measured in accordance with ISO 8502-6, before the coating is applied. The salt test shall be repeated if coating layers are applied on different days, if the surface to be coated has been exposed to rainfall or has not been coated for longer than three (3) days. If the values exceed the limits listed in Table 16, cleaning shall be performed until the values are below the limits. At least two tests shall be performed per 100 m².

7.3.6 Ambient conditions

During and after blasting, as well as during application of the coating and throughout the coating drying period, the relative humidity shall be lower than 85% and the surface temperature shall be at least three degrees Celsius (3°C) above the dew point of the ambient air. The coating shall only be applied if the surface temperature is higher than 0°C. Ambient conditions shall be measured in accordance with ISO 8502-4, see Table 19 for the minimum condition requirements. If these conditions are not present, climate conditioning shall be applied. Note: during UHP water jetting and wet blasting, the surface will be wet, which is why these limits only apply as soon as the surface has dried.

7.3.7 Dry film thickness measurements

The dry film thickness (DFT) is measured in accordance with ISO 19840. Because of the depth of the surface roughness, the measured film thickness shall be corrected in accordance with Table 17. The film thickness measurements shall be performed for each individual film. Coating layers shall not exceed the maximum DFT.

Coating systems with a polyurethane or polysiloxane upper layers shall be measured before application of the final layer. If the system has not reached the specified film thickness yet, the required film thickness shall first be created before the next film is applied. The required film thickness of the system shall not be created by means of a topcoat.

7.3.7.1 Acceptance criteria

The number of measurements shall be representative for the object. Per square metre, at least the number of measurements set out in ISO 19840 shall be performed, but preferably >5 measurements/m². In addition to ISO 19840, all individual measurements shall not be more than 2.5x the specified NDFT, and the maximum NDFT shall not be exceeded. This should take into account that the maximum specified NDFT shall be lower than the 2.5x NDFT limit.

7.3.8 Curing of zinc silicate

The degree of cure of zinc silicate shall be assessed by means of the MEK rub test in accordance with ASTM D4752. The result shall be at least class 4. A minimum of 2 tests shall be performed for each object.

7.3.9 Pore detection

A low-voltage wet sponge detector (for film thicknesses up to 500µm) or high-voltage detector (for film thicknesses from 500µm) in accordance with ISO 29601 shall be used to detect pores and holidays. This detection is mandatory for underground and internally applied new systems. This includes newly applied coating in existing systems. Underground or internal systems are:

- coating in a pipeline
- coating in a tank or vessel
- other enclosed medium-load installations where coating has been applied
- external coating of underground piping systems

7.3.10 Existing coating

The existing coating shall be tested before coating is applied to an existing coating during maintenance work. The existing coating shall comply with the following conditions:

- adhesion shall comply with the requirements set out in §7.4.1
- the coating around a defect shall be sanded with seamless transition with a 50 mm overlap
- existing coating shall not contain alkyd, chlorinated rubber, vinyl, coal tar, lead or chromium compounds. If such coatings are found, the Tata Steel corrosion engineer shall be contacted to discuss follow-up actions.

7.4 Optional tests

The tests and the corresponding standards and criteria are described in §7.5.

7.4.1 Adhesion

The coating system or the individual films shall comply with the adhesion criteria specified below. Adhesion of the coating film shall be determined on the basis of the following tests and criteria:

- x-cut test for film thicknesses up to 250µm DFT in accordance with ISO 16276-2
 - at least class 1
- pull-off test for film thicknesses $\geq 250\mu\text{m}$ DFT in accordance with ISO 16276-1
 - tensile strength $\geq 5\text{MPa}$

7.4.2 Film structure test (PIG)

If there is doubt about the film structure or film thickness of underlying films in a coating system, the coating shall be inspected using a Paint Inspection Gauge (PIG), in accordance with ISO 2808 method 6B.

7.4.3 Colour

The colour of the coating shall correspond to the Tata Steel Standards S1768101 and S1917301, unless agreed otherwise with the Tata Steel client. The colour shall be tested using a RAL colour chart.

7.5 Coating application report

A coating application report shall comprise the following elements. These reports shall, upon request, be presented to the Tata Steel inspector. The elements shall be reported as set out in the relevant standard. Moreover, the following additional information shall be provided in the report.

Table 13: Tests, standards and criteria

Element	Standard	Presentation of results / remark	Criteria
Grit	ISO 11124 / ISO 11126	Product data sheet of the grit used with confirmation of standard	ISO 11124 / 11126
Roughness	ISO 8503-4	Photograph of device with measured value clearly legible on the object under properly lit conditions.	Table 9 or Table 11
	ISO 8503-5	Photograph of test location with replica tape, with replica tape marked. The replica tape shall remain available during the project so that the Tata Steel inspector can verify the measurements.	Table 9 or Table 11
Cleanliness	ISO 8501-1	General view photograph of the object under properly lit conditions from which cleanliness can be clearly assessed.	ISO 8501-1 – Sa2½ or better
	ISO 8501-4	General view photograph of the object under properly lit conditions from which cleanliness can be clearly assessed.	ISO 8501-4 – Wa2½ or better, with maximum degree of flash rust M
	ISO 8501-1	General view photograph of the object under properly lit conditions from which cleanliness can be clearly assessed.	ISO 8501-1 – PSt3
Soluble salt concentration	ISO 8502-6	<ul style="list-style-type: none"> - Listing of equipment - Description of procedure - Blank value liquid - Test measurement value - Calculation of measurement value - blank value - Multiplication factor applied 	See Table 16
Dust concentration	ISO 8502-3	The tape shall remain available during the project so that the Tata Steel inspector can verify the measurements.	New constructions: Table 8 Maintenance: Table 10
Ambient conditions	ISO 8502-4	<ul style="list-style-type: none"> - Air temperature (T_i) - Relative humidity (RH) - Steel temperature (T_s) - Dew point temperature (T_d) - Delta T (T_s – T_d) - minimum temperature before application of coating 	See Table 19
DFT measurements	ISO 19840	<ul style="list-style-type: none"> - Number of measurements - Average film thickness - Lowest value measured - Highest value measured - Number of measurements below minimum - Number of measurements above maximum - Coefficient of variation - Correction value if roughness is out of spec, see Table 17 	See ISO 19840
Batch numbers	n/a	Include batch numbers of products used, such as base, hardening agent, thinner and cleaners	In accordance with supplier's data sheet

Element	Standard	Presentation of results / remark	Criteria
Photographs of stripe coats	n/a	General view photographs of the object under properly lit conditions from which stripe coats can be clearly assessed.	Stripe coat on all corners and edges
MEK rub test	ASTM D4752:2003	<ul style="list-style-type: none"> - Relative humidity (RH) during drying (at least 50%) - Drying time if < 24 hours - List of extra actions to introduce moisture 	Resistance rating min. 4.
Spark test	ISO 29601	Curing time between application of last film (including repairs) and performance of test	No penetration of coating
Adhesion	ISO 16276-1	Test panel thickness $\geq 10\text{mm}$. Film thickness $> 250\mu\text{m}$	Adhesion $\geq 5\text{MPa}$ ISO 16276-1
	ISO 16276-2	Film thickness $\leq 250\mu\text{m}$.	Adhesion max. level 1 or better ISO 16276-2

Appendix 1 Definitions

Coating company

Contractor responsible for pretreating the surface and applying the upper layers for corrosion control

Company

Contractor or subcontractor responsible for the assigned work

Manufacturing standard

Universal catalogue items that have not been / are not produced specifically for Tata Steel.

KDT

Tata Steel "Kwaliteitsdienst Techniek" department, part of PTC, department code SPME.PTC.CTY.KDT

Tata Steel corrosion engineer

The NACE CIP level 1- or NACE CIP level 2-certified Tata Steel expert appointed by KDT.

Tata Steel inspector

The person appointed by KDT who performs inspections on behalf of Tata Steel

Tata Steel client

The contact appointed by Tata Steel in the Tata Steel organisation responsible for the contract

Table 14: Definitions used in this document

Term	Definition
Supplier	Producer of coating products
Coating	Organic or inorganic upper layer for corrosion control
Primer	First layer in a coating system directly on top of the substrate
Buildcoat	Layer on top of a previous coating layer
Finishcoat	Last layer of a coating system
Topcoat	This is a finishcoat with a high resistance to UV degradation, such as polyurethane (PUR) or polysiloxane
NDFT	Nominal dry film thickness
MNOC	Minimum number of coats
EP	Coating based on two-component epoxy
PUR	Coating based on two-component polyurethane
ESI	Coating based on ethyl silicate
Sil	Coating based on silicone
ICP / IMP	Coating based on inorganic copolymer or similar binders
SP	Surface preparation

Difference local/generalised

Local coating defects are such that the repair surface of the coating defects do not or hardly touch. Generalised coating defects are defined such that as soon as coating repairs are made the entire specified surface or large parts thereof (>50% of the surface) are coated.

Appendix 2 Explanation of standards

Table 15: Sandblasting agent for manual sandblasting

Standard	Standard section	Material		Shape	Hardness
ISO 11124	2	M	CI	G	
ISO 11124	3	M	HCS	G	570-710HV
ISO 11126	3	N	CU	G	
ISO 11126	4	N	CS	G	
ISO 11126	5	N	NI	G	
ISO 11126	6	N	FE	G	
ISO 11126	7	N	FA(W)A	G	
ISO 11126	8	N	OL	G	
ISO 11126	10	N	GA	G	

Table 16: Limit value water-soluble salts

Location	Value	Standard
Atmospheric load	75 mg.m ⁻²	ISO 8502-6
Medium load or under insulation	20 mg.m ⁻²	

Table 17: Correction values for DFT measurements

Profile	Profile value (ISO 8503-01)	Tata Steel Standard	Correction value (ISO 19840)
Fine	25±3µm	35±15µm	n/a
		40±10µm	n/a
Medium	60±10µm	65±15µm	n/a
Coarse	100±15µm	>80µm	40µm

Table 18: Locally and generally applied layers for local surface preparation

Repair system	Locally applied coating	Generally applied coating
2-layer system	1st layer	2nd layer
3-layer system	1st, 2nd layer	3rd layer
4-layer system	1st, 2nd layer	3rd, 4th layer

Table 19: Ambient conditions limit values

Unit	Symbol	Limit / criteria
Relative humidity	RH	RH < 85%
Air temperature	T _a	-
Surface temperature	T _s	T _s > 0°C
Dew point temperature	T _d	-
Dew point temperature difference (T _s – T _d)	ΔT _d	ΔT _d > 3°C

Appendix 3 Coating system examples

Version: 1.0
Date: 1 January 2019

This appendix includes all approved coating systems from suppliers PPG and Jotun that can be used. This appendix can be changed separately from Tata Steel Standard S3105601. Interim changes may be made in this list without circulating an update. Coating products from other suppliers may be used but shall be requested for each individual project and coating system. If a supplier other than the suppliers mentioned below is used, the coating supplier shall provide information on the coating system to the Tata Steel corrosion engineer in accordance with the "Application protocol alternative coating supplier". Written approval is required before the approved coating system for that project may be supplied.

The coating systems are presented per system and per supplier. The coating company should make their own choice of supplier. This decision shall take into account that for repair of new structure coating products from the same supplier as used for new structures shall be used. This requirement will no longer be valid after the warranty period.

The "repaintable after" time is the time that the specified film thickness is dry to apply a next film, at a temperature of 10°C. At low temperatures (<10°C to max. 20°C) the winter version of the product shall be used, if available.

Products can be applied up to a surface temperature of 40°C, with the exception of T-03 / T-23. Above this temperature, other products shall be used. Consult the Tata Steel corrosion engineer about this.

Below is an overview of sample coating systems:

System T-01	32	System T-21	33
System T-02	32	System T-22	34
System T-03	32	System T-23	34
System T-04	32	System T-24	34
System T-06	33	System T-26	34
System T-07	33	System T-27	34, 35
System T-10	33	System T-30	35
System T-11	33	System T-31	35

Description of coating system in specifications

Coating system			
Surface preparation and coating application in accordance with Tata Steel Standard S3105601			
New structure coating system	T-__ + S-0__		
Coating system for maintenance	T-__		
Surface preparation for maintenance	S-2__		
Surface preparation method	Repair during:	new construction / maintenance*	
	Renovation during maintenance:	Partial / overall*	
Life expectancy	<7 years / 7 – 15 years / 15 – 25 years*		

* delete where not applicable

System T-01: Coating system for outdoor applications

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmazinc 109HS	8 hours	max 2x NDFT
Buildcoat	120 µm	Sigmafast 278 MIO	4 hours	
Finish	120 µm	Sigmafast 278	4 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Barrier 80	2 hours	max 2x NDFT
Buildcoat	120 µm	Penguard Express MIO	4 hours	
Finish	120 µm	Penguard Express CF	4 hours	

System T-02: Coating system for hot-dip galvanised material

Layer	DFT	PPG	Repaintable after	Comments
Primer	50 µm	Sigmacover 280	16 hours	
Buildcoat	130 µm	Sigmafast 278 MIO	4 hours	
Finish	60 µm	Sigmadur 550H	16 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	50 µm	Penguard Tiecoat 100	18 hours	
Buildcoat	130 µm	Penguard Express MIO	4 hours	
Finish	60 µm	Hardtop AX	10 hours	

System T-03: Coating system for under / without insulation up to 200°C

Layer	DFT	PPG	Repaintable after	Comments
Primer	125 µm	Sigmashield 400	36 hours	max 2x NDFT
Finish	125 µm	Sigmashield 400	36 hours	max 2x NDFT

Layer	DFT	Jotun	Repaintable after	Comments
Primer	125 µm	Jotatemp 250	24 hours	max 2x NDFT
Finish	125 µm	Jotatemp 250	24 hours	max 2x NDFT

System T-04: Coating system for under / without insulation from 200°C to 450°C

Layer	DFT	PPG	Repaintable after	Comments
Primer	75 µm	Dimetcote 9	36 hours	max 1.5x NDFT
Finish	200 µm	Hi-temp 1027	24 hours	max 1.5x NDFT

Layer	DFT	Jotun	Repaintable after	Comments
Primer	75 µm	Resist 86	13 hours	max 1.5x NDFT
Finish	200 µm	Jotatemp 1000	24 hours	max 1.5x NDFT

System T-06: Coating system for indoor applications

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmazinc 109HS	8 hours	max 2x NDFT
Finish	120 µm	Sigmafast 278	4 hours	
Topcoat	60 µm	Sigmadur 550H	16 hours	Optional, mandatory for colour requirement

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Barrier 80	2 hours	max 2x NDFT
Finish	120 µm	Penguard Express (CF)	4 hours	CF version if no topcoat
Topcoat	60 µm	Hardtop AX	10 hours	Optional, mandatory for colour requirement

System T-07: Coating system for immersion in fresh or brackish water

Layer	DFT	PPG	Repaintable after	Comments
Primer	200 µm	Sigmashield 880	7 hours	
Finish	200 µm	Sigmashield 880	7 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	200 µm	Jotamastic 90	12 hours	
Finish	200 µm	Jotamastic 90	12 hours	

System T-10: Coating system for use on SS

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmacover 350	9 hours	
Finish	80 µm	Sigmadur 550H	16 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Hardtop AX	10 hours	

System T-11: Coating system for temporary situation (< 7 years)

Layer	DFT	PPG	Repaintable after	Comments
Finish	160 µm	Sigmafast 278 MIO	4 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Finish	160 µm	Jotamastic 90	6 hours	

System T-21: Coating system for maintenance in an outdoor application

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmacover 350 ALU	9 hours	
Buildcoat	80 µm	Sigmacover 350 ALU	9 hours	
Buildcoat	80 µm	Sigmacover 350	9 hours	
Finish	80 µm	Sigmacover 350	9 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	80 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Jotamastic 90	6 hours	

System T-22: Coating system for maintenance of hot-dip galvanised material

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmacover 350 ALU	9 hours	
Buildcoat	80 µm	Sigmacover 350	9 hours	
Finish	80 µm	Sigmadur 550H	16 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Hardtop AX	10 hours	

System T-23: Coating system for maintenance under / without insulation up to 200°C

Layer	DFT	PPG	Repaintable after	Comments
Primer	125 µm	Sigmashield 400	36 hours	max 2x NDFT
Finish	125 µm	Sigmashield 400	36 hours	max 2x NDFT

Layer	DFT	Jotun	Repaintable after	Comments
Primer	125 µm	Jotatemp 250	13 hours	max 2x NDFT
Finish	125 µm	Jotatemp 250	13 hours	max 2x NDFT

System T-24: Coating system for maintenance under / without insulation from 200°C to 450°C

Layer	DFT	PPG	Repaintable after	Comments
Primer	75 µm	Dimetcote 9	36 hours	SP S-21; max 1.5x NDFT
Buildcoat	100 µm	Hi-temp 1027	24 hours	max 1.5x NDFT
Finish	100 µm	Hi-temp 1027	24 hours	max 1.5x NDFT

Layer	DFT	Jotun	Repaintable after	Comments
Primer	75 µm	Resist 86	13 hours	SP S-21; max 1.5x NDFT
Buildcoat	100 µm	Jotatemp 1000	24 hours	max 1.5x NDFT
Finish	100 µm	Jotatemp 1000	24 hours	max 1.5x NDFT

System T-26: Coating system for maintenance in indoor application

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmacover 350 ALU	9 hours	
Buildcoat	80 µm	Sigmacover 350	9 hours	
Finish	80 µm	Sigmacover 350	9 hours	
Topcoat	60 µm	Sigmadur 550H	16 hours	Optional, mandatory for colour requirement

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Jotamastic 90	6 hours	
Topcoat	60 µm	Hardtop AX	10 hours	Optional, mandatory for colour requirement

System T-27: Coating system for maintenance in immersion in fresh or brackish water

Layer	DFT	PPG	Repaintable after	Comments
Primer	100 µm	Sigmacover 2 ALU	12 hours	
Buildcoat	100 µm	Sigmacover 2 ALU	12 hours	
Buildcoat	100 µm	Sigmacover 2	12 hours	
Finish	100 µm	Sigmacover 2	12 hours	

System T-27: Coating system for maintenance in immersion in fresh or brackish water

Layer	DFT	Jotun	Repaintable after	Comments
Primer	100 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	100 µm	Jotamastic 90 ALU	6 hours	
Buildcoat	100 µm	Jotamastic 90	6 hours	
Finish	100 µm	Jotamastic 90	6 hours	

System T-30: Coating system for maintenance on SS

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmacover 350 ALU	9 hours	
Finish	80 µm	Sigmadur 550H	16 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Hardtop AX	10 hours	

System T-31: Coating system for maintenance in a temporary situation (< 7 years)

Layer	DFT	PPG	Repaintable after	Comments
Primer	80 µm	Sigmafast 278 MIO	4 hours	
Finish	80 µm	Sigmafast 278 MIO	4 hours	

Layer	DFT	Jotun	Repaintable after	Comments
Primer	80 µm	Jotamastic 90	6 hours	
Finish	80 µm	Jotamastic 90	6 hours	

Appendix 4 Changes compared to v6.1

Table 1: Changes compared to Tata Steel Standard S3105601 v6.1

Chapter	Change
1.1 Scope	Non-insulated SS with colour requirement added
1.1.1 Temporary structures or installations	Own coating system regulation added
1.1.2.1 Railings in an outdoor situation	Newly added
2 Contract requirements	Specific mention of Dutch legislation and other regulations that shall be complied with. Inclusion of the minimum life expectancy of a coating system (15 - 25 years)
3.2 Blasting and coating facilities	Description of requirements for sandblasting cabins
3.3 Coating company staff	Demonstrability more clearly described so that it can be tested during an audit
3.4 Catalogue parts	Minimum service life based on ISO 12944 included Addition that welding primers are not permitted either
4.2.4 Blistering	Title changed to blistering Not just density class deleted. There is no class 0. There shall be no blisters during a warranty inspection.
4.3.1. Mechanical impacts	Sentence structure changed
4.3.2. Accessibility and shape	"Surfaces that cannot be treated and/or coated in accordance with the instructions because of their shape or poor accessibility...". Change: treated instead of pretreated.
5.1 Background	Change Table 1 of environmental classifications
5.1.1 Design	Requirements for grade of surface preparation in accordance with ISO 8501-3 changed. Treat hard-to-reach elements in accordance with EN 1090-2.
5.1.3.2 Surface preparation prior to hot dip galvanising	Alternative requirements set for steel preparation in accordance with ISO 8501-3.
5.1.3.3 Hot dip galvanising requirements	Requirement of max. 150µm zinc film thickness deleted.
5.1.3.4 Duplex coating system	Deleted: "shall be removed during surface preparation." Added: The minimum thickness of the galvanic layer Indoor (office or ... colour finish suffices". Environment changed to "≤C2".
5.1.3 Hot dip galvanising	Numbering of chapters changed.
5.1.4 Durability	Numbering of chapters changed. Table 5 changed to reflect new life expectancy as stated in ISO 12944 [2018].
5.1.5 Laboratory tests	Numbering of chapters changed. Content changed so that provision of tests for the sample systems is mandatory.
5.3.2	Added.
5.4.5.4 Selecting a Tata Steel coating system	Table 6 and Table 7 changed, new selection options added. Table 7 deleted (Coating system for surface preparation).
5.5 Coating system	Chapter added for specification information
5.5 Coating systems	Tables modified + application temperature included
5.6.1 General requirements for surface preparation of new structures	Changes to limit values and new structure by means of tables.

Chapter	Change
5.6.2 General requirements for surface preparation for repairs or maintenance	Changes to limit values and new structure by means of tables.
5.6.3 Method of repair or maintenance	Added
6.2 Ambient temperature	Title changed and chapter content extended to include clearer limits within which coating products can be applied.
6.3 Mixing and application of coating	Mechanical mixers replaced by electrical mixers
6.3.1 Materials	Added: Rollers not permitted for application of anti-corrosive primers
6.4 Heat-affected zone	Title changed and chapter content made more specific.
6.5 Transport, storage and assembly	Minor textual changes.
7.1.2 Cleanliness	"These shall be entirely ... SSPC-SP1" changed into These shall be removed until the acceptable limit values
7.1.7 Coating application after local surface preparation	If this is not specified ... the total surface area. Percentage of 10% changed. Changed into Ri4, which equals 8% coating defects, whereas 10% defects is assumed (Ri4).
7.1.8 Stripe coat and primer	Title changed and contents changed to reflect title. Also moved parts of chapter to Coating application after complete surface preparation
7.2 Inspection & Test Plan	Sentence structure changed. Sentence about sample ITP deleted
7.3.1 Surface preparation of new structures	Requirement for P3 changed to tables
7.3.1. Grit and surface roughness	Only the stylus instrument method shall be used during new construction
	Blast nozzle machines are permitted provided the right grit is used and approval is given by the Tata Steel corrosion engineer
7.3.7 Dry film thickness measurements	Roughness compensation deleted. No inclusion of specific coating systems for which a PU topcoat is required
7.4.1. Adhesion	Standardisation changed
7.4.3 Copper sulphate test	Cancelled
7.4.4 Colour	The Tata Steel Standards S1768101 / S1917301 are normative, instead of previously QHSE 3.30
7.5 Daily report	Title changed and contents changed to reflect title. Perform dust measurement in accordance with the standard
Table 17	Changed to match text
Table 19	Limits changed to "greater than" (>) or "smaller than" (<), instead of "greater than or equal to" (\geq) or "smaller than or equal to" (\leq)
Appendix 3 Coating systems	Title changed and contents changed
Appendix 4 References	Cancelled