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Guidance Note

The use of protective coatings and sealants

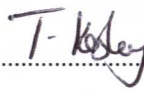
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Issue record

Issue	Date	Comments
5	December 2009	Derived from non-mandatory text given in RT/CE/C/002: <i>Application and reapplication of protective treatments to Railtrack infrastructure</i> [Issue 4: February 2004.]

Reference documentation

Network Rail standards

[NR/L3/CIV/040](#): *Specification for the use of protective coating systems.*

[NR/L3/CIV/039](#): *Specification for assessment and certification of protective coatings and sealants.*

British Standards

BS 381C: 1996	<i>Specification for colours for identification coding and specific purposes.</i>
BS 476-21: 1987	<i>Fire tests on building materials and structures. Methods for determination of the fire resistance of loadbearing elements of construction.</i>
BS 4756: 1988	<i>Specification for ready-mixed aluminium priming paints for wood.</i>
BS 4800: 1989	<i>Paint colours for building purposes.</i>
BS 6213: 2000	<i>Selection of construction sealants. Guide.</i>
BS 7664: 2000	<i>Specification for undercoat and finishing paints.</i>
BS 7671: 2008	<i>Requirements for electrical installations. IEE Wiring Regulations. (17th edition).</i>
BS 7719: 1994	<i>Specification for water-borne emulsion paints for interior use</i>
BS EN 351-1: 2007	<i>Durability of wood and wood-based products. Preservative-treated solid wood. Classification of preservative penetration and retention.</i>
BS EN 12329: 2000	<i>Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel.</i>
BS EN 12373-1: 2001	<i>Aluminium and aluminium alloys. Anodizing. Method for specifying decorative and protective anodic oxidation coatings on aluminium.</i>
BS EN 12476: 2000	<i>Phosphate conversion coatings of metals. Method of specifying requirements.</i>
BS EN 15457: 2006 [06/30152769 DC]	<i>Paints and varnishes. Laboratory method for testing the efficacy of film preservatives in a coating against fungi. [Draft out for public comment.]</i>
BS EN 15458: 2006 [06/30152772 DC]	<i>Paints and varnishes. Laboratory method for testing the efficacy of film preservative in a coating against algae. [Draft out for public comment.]</i>

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BS EN ISO 1461: 1999	<i>Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.</i>
BS EN ISO 2063: 2005	<i>Thermal spraying. Metallic and other inorganic coatings. Zinc, aluminium and their alloys.</i>
BS EN ISO 2808: 2007, BS 3900-C5: 2007	<i>Paints and varnishes. Determination of film thickness.</i>
BS EN ISO 8501-1: 2007	<i>Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.</i>
BS EN ISO 8502-6: 2006	<i>Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness. Extraction of soluble contaminants for analysis. The Bresle method.</i>
BS EN ISO 8503-5: 2004, BS 7079-C5: 2004	<i>Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates. Replica tape method for the determination of the surface profile.</i>
BS EN ISO 11600: 2003	<i>Building construction. Jointing products. Classification and requirements for sealants.</i>
BS EN ISO 11998: 2006	<i>Paints and varnishes. Determination of wet-scrub resistance and cleanability of coatings.</i>
BS EN ISO 12944-2: 1998	<i>Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments.</i>
BS EN ISO 12944-5: 1998	<i>Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Protective paint systems.</i>
BS EN ISO 14713: 1999	<i>Protection against corrosion of iron and steel in structures. Zinc and aluminium coatings. Guidelines.</i>
BS EN ISO 14922: 1999 [various parts]	<i>Thermal spraying. Quality requirements of thermally sprayed structures. [various parts]</i>
Other standards	
ASTM D3359-08	<i>Standard test methods for measuring adhesion by tape test.</i>
ISO 19840: 2004	<i>Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces. Corrosion protection of steel structures by protective paint.</i>
TX 772188340RAL 840 HRÜ2	<i>Übersicht über die RAL - Farbendes Farbregisters RAL 840 HR mit ihren Hilfsbezeichnungen.</i>

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Other publications

Control of Lead at Work Regulations (2002).

Council Directive 1999/13/EC of 11 March 1999 *on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations.*

Directive 2004/42/CE of the European Parliament and of the Councils of 21 April 2004 *on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC.*

Environmental Protection Act (1990): *Process Guidance Note 6/23(04): Secretary of State's Guidance for Coating of Metal and Plastic Processes.*

Galvanizers Association. *The Engineers and Architect's Guide to Hot Dip Galvanizing.*

Health and Safety Commission: Approved Code of Practice, Regulations and Guidance '*Control of Lead at Work*' (L132).

Health and Safety Executive EH 16: *Isocyanates: Health hazards and precautionary measures.*

Health and Safety Executive EH28: *Control of Lead Air Sampling Techniques.*

Health and Safety Executive EH29: *Control of Lead Outside Workers.*

Health and Safety Executive leaflet INDG 305 *Lead and You'*

Highways Agency. *Sector Scheme Document for Corrosion Protection for Structural Steelwork by Coatings (for New Works and Maintenance) - Scheme 19A.*

The Waste Management Licensing Regulations (1994).

UK Water Jetting Association (WJA): *Code of Practice for the use of high pressure and ultra high pressure water jetting.* (ISBN 1-874278-02-4). ('The Blue Book').

UK Water Jetting Association (WJA): *Code of Practice for the safe working and use of water jetting in drains and sewers.* ('The Illustrated Red Book'.)

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Comments

The applicability and content of this standard will be reviewed on a regular basis. Written comments on the accuracy and utility of this standard will be taken into account when assessing the need for a new issue of the standard; such comments should be sent to the Principal Policy and Assurance Engineering (Civil Engineering) at 40 Melton Street, London NW1 2EE.

Reference note

This standard is to be used in conjunction with [NR/L3/CIV/040](#): *Specification for the use of protective coating systems* and [NR/L3/CIV/039](#): *Specification for the assessment and certification of protective coatings and sealants*.

The Item Numbers of the material types defined in this suite of standards are referenced as *5.1.7* (for example): see Appendix [A](#). For ease of use, the same information on protective coating systems is provided in Appendixes of [NR/L3/CIV/040](#) and [NR/L3/CIV/039](#). The protective coating systems defined in this suite of standards are referenced as **N1** (for example).

For brevity, references to parts of [NR/L3/CIV/040](#) are given as **1.1** (for example) whilst those to other parts of this standard are given as **1.1**.

The standards governing the application and testing of protective coatings are subject to frequent change. Where necessary, the latest version of the standards listed in the Reference documentation (above) shall be followed.

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1 Purpose

The purpose of this standard is to support [NR/L3/CIV/040: Specification for the use of protective coating systems](#) by providing guidance and information on the selection, application and reapplication of such systems to Network Rail infrastructure.

The prime reason for applying and reapplying protective coatings is to preserve and protect the infrastructure so that it provides the required service life in the most cost-effective manner. Thus in most cases protective coating systems are used to prevent the deterioration of the infrastructure rather than to improve its appearance. However, in some cases the colour of the final coat has to meet requirements that govern the safe operation of the railway. Furthermore, there are instances, such as stations and bridges in prestigious locations and at heritage sites, where the need for protection and aesthetics will have more or less equal standing.

2 Scope

This standard applies to the application and reapplication of protective coating systems to Network Rail owned infrastructure (except rail and other track equipment) for protective and/or aesthetic purposes. This infrastructure includes;

- bridges,
- signal boxes, ground frames, signal equipment and their supporting structures,
- electrical equipment housings and enclosures, and cases for signalling apparatus,
- station structures and buildings,
- level crossing gates, barriers and cases for associated equipment.

This standard covers the use of coating systems for the corrosion protection and fire protection of structural steelwork, and for the protection of timber, concrete, and masonry structures.

It should be recognised that the re-application of a protective coating system is just one aspect of infrastructure management, and an assessment of the whole life cost of an asset can require other solutions to be considered.

3 Definitions

Contractor

A company or organisation contracted directly or via a sub-contract to Network Rail.

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Engineer

A nominated representative of Network Rail assigned to the contract/project.

4 Safety

4.1 Lead-based coatings

Where existing protective coatings were applied prior to 1970, and/or there is a possibility that any of the existing coatings applied after this date contain Lead, the following should be determined when developing the method of working;

- The level of Lead on existing coatings, including those on adjacent surfaces that may be subject to damage by overblast or ricochet.
- The level of any Lead contamination in the surrounding environment due to other sources such as car exhausts.
- The noise levels that would be generated by abrasive blast cleaning and water jetting techniques.

All work to remove Lead-based coatings is required to be carried out in accordance with the Control of Lead at Work Regulations (2002). The Health and Safety Commission has '*Control of Lead at Work*' (L132), and Guidance Notes EH28: *Control of Lead Air Sampling Techniques*, and EH29: *Control of Lead Outside Workers*. To comply with the various Regulations a Contractor has to carry out suitable and sufficient risk assessments, taking into account the risks to both their personnel and others on Site, and implement controls and methods as necessary.

Contractors are therefore required to demonstrate that controls will be imposed when removing Lead-based coatings. Reliance on specialists to put in place safe methods of work has not always prevented excessively high blood lead levels being reached in operatives and for those operatives to be suspended from work. Cases where controls have been found to be lax and to have led to blood levels in excess of legal limits have been due to a combination of;

- over-reliance on the effectiveness of respiratory protective equipment in contained areas,
- inadequate precautions to avoid high concentrations of Lead dust developing in containment areas during blast cleaning - particularly in areas around the faces of operatives,
- site workers using less than perfect personal hygiene.

The guidance given in **7.2.2** on measures likely to be required for the removal of Lead-based coatings takes account of the above.

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All the above issues should be covered in the pre-tender Health and Safety Plan.

4.2 Other hazardous materials

The requirements to declare the composition of protective coatings (including the content of any hazardous materials) is prescribed in [NR/L3/CIV/039](#).

The use of materials containing the following is prohibited;

- cadmium, lead or chromium pigmentation,
- coal tar pitch,
- asbestos.

Industry is moving to replace coatings containing aromatic amine curing agents for epoxy resin, and phenols; and the use of coatings containing such materials should be avoided.

Although there are safety concerns about their use, coatings containing isocyanates have been widely used. There are non-isocyanate coating options available, particularly for finish and Topcoats; coatings based on polysiloxanes offer the most suitable alternative. Advice on compliance with the legislation applicable to isocyanates is given in the Health and Safety Executive publication EH 16: *Isocyanates: Health hazards and precautionary measures*.

4.3 Confined spaces

The likely effect of solvents on operatives working in confined spaces, such as within box girders, should be considered when selecting the protective coating system (see 5.11.1). The possibility of creating explosive mixtures should also be considered so that all possible sources of ignition can be identified and eliminated. Although water-based coatings may be used they do not provide the same performance levels as solvent-based and solvent-free (100% solids) coatings.

The heating and dehumidification process on the coatings applied to the internal surfaces of a box girder is quicker than for those applied to an external surface. Any additional air flow should further reduce the drying and overcoating times recommended by the manufacturer.

5 Contractor requirements

5.1 Work Package Plan

Prior to the commencement of any work, a fully detailed proposed Work Package Plan (with any accompanying Task briefings and Method

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statements etc.) is required to be submitted for Network Rail's acceptance. This Plan should provide the following information;

- Personnel involved in the work.
- Sub-contractors (such as paint applicators, inspectors, equipment manufacturers).
- Elements that are to be coated.
- Full details of protective coatings to be applied, with certification that confirms compliance with [NR/L3/CIV/039](#).
- Methods for preparing surfaces and for applying the coatings, and the equipment to be used.
- Methods to be taken to prevent coatings and ancillary materials from contaminating persons, property, equipment and other surfaces.
- How compliance with the Control of Lead at Work Regulations (2002) and the Environmental Protection Act (1990) will be met.

In addition, the Work Package Plan should describe;

- The precautions that will be taken to contain blast cleaning abrasive, dust, contamination, overspray etc. and how contamination of water courses by dust, debris etc. will be prevented.
- The removal of permanent protective boarding etc. (installed to maintain the protection and safety of persons) and for temporary boarding to be provided and maintained, removed and repositioned to allow the work to proceed whilst maintaining an adequate safety barrier at all times.

5.1.1 Inspection and Quality Plan

As specified in [5.1](#), an Inspection and Quality Plan is to be provided in addition to the Work Package Plan. The former should define;

- all hold and witness points,
- what is being inspected or tested,
- the methods to be used,
- the acceptance criteria.

5.1.2 Waste disposal

The disposal of debris arising from surface preparation is governed by The Waste Management Licensing Regulations (1994). The responsibility for the disposal of waste material lies with its producer, even if the disposal is carried out by a Third Party. As the structure owner, Network Rail could be considered to be the producer of waste generated on site and so checks should be made

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on its disposal: evidence that waste is sent to a tip licensed for disposal should be sought from the Contractor(s).

5.2 Operatives

Network Rail should obtain (a) confirmation that the Contractor is registered under the ICATS Scheme, (b) copies of the training records of the operatives and, (c) confirmation that in-house trainers have completed the 'Training the Trainer' course. The ICATS Scheme (described in 5.3) requires Contractors to be audited, and the Engineer should obtain copies of such audits.

Ideally, for a particular contract, operatives should have at least 5 years experience in the relevant area of expertise, and 70% of the operatives should have been employed by the Contractor for at least 3 years. However it should be appreciated that some operatives work on a contract by contract basis and so they may have been employed by a number of Contractors.

For a particular contract, except where there are less than 5 operatives, up to 20% of the operatives may be undergoing training. It is recommended that the Engineer checks that Contractors are employing the required percentage of certified operatives.

5.3 The ICATS Scheme

The ICATS Scheme has a Basic module and a number of Specialist modules.

Industrial Coatings Applicator (Basic module)

- 1 The organization must be registered with the Institute of Corrosion (ICorr)/Correx Ltd¹ as an ICATS corporate scheme member.
- 2 The organization nominates experienced staff to be trained, as Trainers, at the ICorr Training Centre.
- 3 The organization registers the Trainees with Correx Ltd, who are then trained in-house, or training centre, by a Certificated Trainer.
- 4 The Certificated Trainer submits the results of the course to Correx Ltd who then issue Certification.

Specialist modules

- 1 The organization must be registered with ICorr/Correx Ltd as an ICATS corporate scheme member.
- 2 The organization nominates experienced staff who;
either have 10 years experience in training operatives for the particular specialist activity,

¹ Correx Ltd. is the wholly-owned trading subsidiary of the Institute of Corrosion.

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or have 5 years experience in the use of the particular specialist activity plus 120 hours as a Trainer for the Basic Module. On receipt of evidence and/or experience and training record, Correx Ltd will issue Certification.

- 3 The organization registers the Trainees with Correx Ltd, who are trained in-house or at a training centre by the certificated Specialist Trainer.
 - (a) As a pre-requisite, a Trainee for Abrasive Blast Cleaning Operative, or Paint Sprayer and Thermal (Metal) Sprayer, must be certificated as an Industrial Coatings Applicator (Basic module).
 - (b) A Trainee for Water Jetting Operative does not require prior certification as an Industrial Coating Applicator, but in such cases they shall only be permitted to undertake water jetting.
- 4 The certificated Specialist Trainer submits the results of the courses to Correx Ltd who then issue Certification.

Correx Ltd maintains a list of personnel who have attended and passed the training and assessment requirements of the modules.

5.4 Coating materials

Coating materials are used in combination to form a protective coating system, which may also have a decorative function.

Coating materials may be placed in one of three categories;

- metal coatings,
- inorganic and chemical conversion coatings,
- organic coatings.

Inorganic or chemical conversion coatings, such as phosphating, are normally used for the passivation of newly galvanized surfaces.

An organic coating is often used in conjunction with a metal coating to provide a durable low-maintenance protection system for structural steelwork. This combination, often referred to as a “duplex” system, is synergistic - its service life is greater than the sum of the individual service lives of the two coatings. Information on coatings is provided in Appendix A, and data on organic coatings are given in BS EN ISO 12944-5.

Only coating materials complying with the requirements of [NR/L3/CIV/039](#) and registered in the Parts and Drawings database (PADS) should be used. The use of non-compliant materials can mean that they have not been tested by an independent Third Party, and so they may not provide adequate performance and durability: the premature failure of a coating can have a substantial impact on the cost of maintaining the infrastructure.

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5.5 Preparatory and ancillary materials

Whenever possible, preparatory and ancillary materials, which include thinners and cleaning solvents, should (a) be sourced from the manufacturer of the coating system that they are being used with, and (b) be of the type recommended on the data sheet for that system. Any specific requirements stated by the coating manufacturer regarding, for example, surface preparation items should be followed or further technical advice sought from the manufacturer.

5.6 Inspection and quality control

Certificates issued to Inspectors by ICorr should be available for verification. The minimum requirement for an Inspector is Level 1, but Level 2 is preferred; a Level 3 Inspector is not deemed competent to supervise the works and other Inspectors. Guidance on inspection methods and quality control is provided in 9.

The Highways Agency operates a Quality Management scheme (known as a Sector Scheme for coating works): the title of the controlling document is: *Sector Scheme Document for Corrosion Protection for Structural Steelwork by Coatings (for New Works and Maintenance) - Scheme 19A*. That Scheme may be adopted for coating works undertaken for Network Rail.

5.7 Handling, storage and transportation of coated steelwork

Following the application of the final shop applied coat a suitable period, as recommended by the coating manufacturer, should elapse before structural steelwork is stacked or transported. Steel should not be stored outdoors until all the specified shop coats have been applied.

Newly applied coatings can be damaged by ponding water; in particular a finish coat can be damaged by water marks - where this occurs it will be necessary to apply a further finish coat.

5.8 Protection

It is important to protect sound and newly applied coatings from preparation and coating works undertaken in their vicinity; temporary boarding is usually adequate.

A particular concern is overspray. When there is no physical barrier (permanent or temporary) to contain overspray, wet coatings can be wind blown a considerable distance. The cost of removing dried and cured two pack coatings from cars and buildings is high, and overspray can be a hazard to the public.

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Newly applied coatings can be adversely affected by poor weather conditions (in particular by rain and condensation) and so (as a minimum) the provision of local containment/protection is advisable during and immediately after application. Epoxy coatings, in particular, can be affected by a surface effect called 'amine bloom'; this is caused by early water contact with the coating and if it is not removed it can substantially reduce the adhesion of the subsequent coat.

5.9 Compatibility with existing coatings

Ideally, existing coatings should be removed where there is widespread breakdown but this may not always be economically justified or possible within the time available for the work.

Where the existing coating system is to be patch primed and overcoated it is essential to check that the proposed coatings are compatible with the existing ones. The compatibility of the coatings should be checked through a survey or by a feasibility trial undertaken at least 3 months prior to the commencement of the main works.

A feasibility trial should follow the method defined in the Work Package Plan for the main works, and all activities should be fully documented. The trial should be supervised by the coating manufacturer or an experienced and qualified coating Inspector. The adhesion and general appearance of the trial area should be assessed no sooner than 3 months after its completion. Ideally, for comparative purposes, the trial should involve at least one other option to the proposed coating system so that an alternative can be considered should the originally proposed system prove to be incompatible.

5.10 Remedial work and repairs

Just prior to final site demobilization, it is advisable to check all newly applied coatings for any obvious defects: in particular, for signs of rust staining and flaking. Where the normal 12 month Defects Liability period applies, a thorough visual check of the coating works should be made about 2 months before the end of that period.

Areas of coatings damaged at any stage of the work, including that caused in transit, erection, or by site welding, and areas masked by scaffolding should receive the necessary preparation and coating works to restore the surface to the specified finish.

To produce a corrosion-free surface, it is recommended that the damaged areas are prepared by spot blast cleaning to a minimum surface standard Sa2½ in accordance BS EN ISO 8501-1 but, where this method is not practicable, hand or power tools could be used to produce a surface standard St3 minimum to that standard.

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Following preparation of the damaged areas, the edges should be feathered for at least 50 mm into the adjacent area of sound undamaged coating to eliminate hard edges and the damaged areas then cleaned. A further 50 mm wide band of the adjacent sound protective coatings should be abraded or flash blast-cleaned, as necessary, to provide a key for adhesion of the repair coats. Prior to the application of the new coatings, the prepared area and surrounding sound coating should be cleaned to remove all dust and loose material.

Careful touching in with each coat of the coating system should be carried out to provide a thickness not less than that specified and to overlap the edges of the abraded sound existing coating by 50 mm.

It should be appreciated that a repair can be visible when the repair materials are brush applied to a previously sprayed applied coating.

5.11 Environmental and other responsibilities

5.11.1 Solvent emissions

When selecting the protective coating system for the inside of a box girder, the effect of solvents on applicators working in the confined spaces should be considered. When solvent-based coatings are to be used for such works, an air extraction and replacement system or positive air respirators should be used within the void.

The solvents used in coatings are known as Volatile Organic Compounds (VOCs), and such compounds can promote the production of ozone in the lower atmosphere (troposphere). When present at elevated concentrations for prolonged periods, ozone can damage the health of humans, animals and vegetation. In reacting with UV radiation from the sun, nitrogen oxides emitted from vehicle exhausts and from combustion processes, such as power generating plants and domestic boilers, react to form ozone. The presence of VOCs accelerates the rate of ozone production.

Various substances, including VOCs, have been implicated in the depletion of ozone in the upper atmosphere (stratosphere). However, according to the British Coatings Federation, although many organics solvents have been examined none of those used in coatings and printing inks has been identified as a contributor to this depletion.

Within Europe, the control of solvent emissions comes under: EC Directive 1999/13/EC. The purpose of this Directive is to reduce emissions of organic compounds generated by the use of organic solvents within certain processes and industrial installations. The Directive targets (a) the use of VOCs, and hydrocarbons in general,

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because of their contribution to the generation of ozone and other photochemical oxidants, and (b) specific compounds because of their hazardous properties.

In the UK the controlling document for the coatings sector is Process Guidance Note 6/23(04). This Note covers the application of coatings within a shop environment, but it can also apply to large site works. The basis of control is now solvent management rather than the previous method of using 'compliant coatings'.

5.11.2 Enclosures

Containment in the form of enclosures should be used on site to give protection from the weather and also to prevent the escape of dust and harmful debris from blast cleaning and other forms of surface preparation.

5.12 Procedure trial

A procedure trial undertaken in advance of the main works is a sound way of checking that no unforeseen problems should arise during the main works. Such a trial enables methodology to be refined and standards of work to be agreed by all parties.

The trial(s) should be undertaken on areas totalling between 2 and 10 m² that are representative of those to be coated or recoated. Ideally, the trial should use the same labour and equipment proposed for the main works. In completing the trial the Contractor should demonstrate the ability to carry out the agreed methods of surface preparation to the standard required and apply the coatings in accordance with the contract specification.

The trial area(s) can be used as reference panels for settling disputes concerning standards of work. They can also be used to test adhesion of coatings and the compatibility of new coatings and existing coatings.

6 Protective coating systems

6.1 New structural steelwork and ironwork

6.1.1 General

The inclusion of metal coatings eliminates the need for very high build coating films, and so the **N1** system should always be preferred.

Table 1 provides guidance on the selection of protective systems incorporating organic coatings for new structural steelwork (in accordance with Appendix **B**). As a general rule, any structure

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within 5 km of the coast should be considered to be within a coastal environment.

Environment as defined in BS EN ISO 12944-2	Description	Preferred System	Acceptable Systems
C2 low (external) and C3 medium	Atmospheres with a low level of pollution. Mostly rural areas. Urban and light industrial atmospheres, moderate sulphur dioxide pollution. Coastal areas with low salinity.	N1	N2, N4, N9
C4 high	Industrial areas and coastal areas with moderate salinity.	N1	N2, N4, N9
C5 - 1 very high and C5 - M very high	Industrial areas with high humidity and aggressive atmosphere. Coastal areas with high salinity.	N1	N2*, N4*, N9
Im2 Sea or brackish water	Areas totally immersed in water, tidal and splash zones.	Consult Specialist	
Sub surface Stations	Enclosed areas, normally underground or under raft construction.	N7	N6, N8
C2 (Internal)	Interior surfaces of box girders.	N11	N12
C2 (Internal)	Interior areas subject to condensation and moisture vapour.	N13	N9, N10
* As defined in NR/CE/S/039: Specification RT98 - protective treatments for Railtrack infrastructure [Issue 4: February 2002].			

Table 1: Systems for new structural steelwork and ironwork

When the fabricator is supplied with structural steelwork that is blast-cleaned and primed with a weldable primer, consideration should be given to complete removal of this primer by blast cleaning. Where the weldable primer is to be retained, the subsequent coat of the selected protective system should be compatible with the Primer.

A coating system other than those listed in Appendix **B** may be proposed, but only if the system is (a) certificated as being compliant with [NR/L3/CIV/040](#) by an Independent Test House, (b) registered in PADS, (c) is compliant with the particular contract performance requirements and (d) accepted for use by the Engineer.

Where metal coatings are not included in the coating system, the system film build should be greater and, as a minimum, the system should include a Primer (normally a blast or holding type), a Stripe coat, an Intermediate coat (normally a glass flake epoxy) and a durable two pack Topcoat.

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6.1.2 Metal sprays

Metal coatings protect ferrous substrates from atmospheric corrosion by providing a resistant barrier and also acting sacrificially - with zinc even where the substrate is exposed.

In recent years it has become normal practice to specify aluminium rather than zinc sprayed coatings regardless of the circumstances. However, problems have arisen with aluminium sprayed metal coatings where a structure has been subject to contamination by salt, and on current evidence zinc is preferable in such conditions. This does not however preclude the use of aluminium in coastal areas.

Furthermore, zinc rather than aluminium should be used where the structure could be subject to impact (such as a bridge strike) because when damage occurs zinc will corrode before the base steel, even where it is exposed, and so provide better protection.

When a thermally sprayed metal coating is specified for the faying surfaces of HSFG bolted, or similar friction grip connections, aluminium sprayed metal should be used because zinc sprays do not have a sufficiently high slip factor.

Metal coatings which are anodic to steel (such as zinc and aluminium) are suitable for application to new structures or elements under factory conditions, but not for general application on site. Application on site is possible only for small areas under well controlled conditions. The technique is generally unsuitable for site application because;

- the equipment required is bulky and cumbersome,
- on site the required surface standard would be difficult to maintain for the period between the preparation of the surface and the application of the metal coating.

The technique involves the projection of an atomized stream of molten metal particles from a special gun (fed by wire or powder) onto the substrate where the particles cool to form a continuous but porous coating. To achieve a strong mechanical bond it is necessary to prepare the substrate by blast-cleaning using chilled iron angular grit grade G24 to achieve the surface standard Sa3 BS EN ISO 8501-1 with a mean peak to valley height (R_{tm}) surface profile of 75 to 100 microns. The required surface standard can also be achieved using bauxite abrasive.

There is no limit on the size of a component and most grades of steel can be coated using this method. The steel surface remains cool and there is no distortion during spraying, nor is there any

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effect on the metallurgical properties of the steel. Further information may be obtained from the Thermal Spraying and Surface Engineering Association, and from BS EN ISO 2063 and BS EN ISO 14713, and the various parts of BS EN ISO 14922 are useful references for checking quality requirements.

The service life of a coating system that includes a metal coating will increase with increasing thickness of the metal coating. Generally a minimum coating thickness of 100 microns is satisfactory, but consideration should be given to increasing this to 150 microns for structures in coastal areas. A thickness in excess of 250 microns should be avoided as the residual stresses in a metal coating of such thickness will break the adhesion bond to the substrate. In addition a thick coating, particularly of aluminium, is difficult to seal effectively and without this the coating will fail prematurely.

Metal coatings are used in conjunction with a low viscosity sealant. The sealant prevents penetration of the pores of the metal coating by moisture or electrolytes that could cause corrosion, and it provides a sound base for the subsequent coat of the protective system. As noted above, thorough sealing of the pores is important, particularly for aluminium metal spray, as incomplete sealing can result in an early failure of the coating system.

6.1.3 Galvanizing

The application of organic coatings to new galvanized structural steelwork will provide additional protection against corrosion (and it can be also carried out for aesthetic or decorative purposes), but where visual considerations are not important and the size of the structural steelwork is suitable, consideration of whole life costs may allow a galvanized metal coating to be the sole protective treatment. Advice on the use of galvanizing is provided in *The Engineers and Architect's Guide to Hot Dip Galvanizing*.

A hot dipped galvanized coating could be used as the sole protective treatment for signal posts, electrification masts and similar structures, for the life of the structure or for a maintenance-free period prior to the application of an additional coating.

The use of a hot dip galvanized coating as the sole protective coating will avoid the production of smoke and toxic fumes in a fire - which are produced by other coatings. Accordingly, galvanized products can be suitable for use in sub surface Stations.

For hollow section structural steelwork, such as lighting columns, where there is a risk of internal corrosion, hot dip galvanizing is

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preferred to other treatments including a thermally sprayed metal coating. For hollow sections, advice should be sought by the designer, or fabricator, from the galvanizer regarding the necessary position, size and number of breather and drain holes. Care is required so that heavy deposits are not built up in the corners of stiffeners and similar locations; this could require the provision of drain holes.

As specified in **6.9.1**, structural steelwork that is to be encased fully in concrete shall not be hot dip galvanized.

Galvanizing can only be carried out in a workshop environment: 'cold galvanizing' through the application of zinc rich paint is not an acceptable alternative.

Galvanising involves the immersion of cleaned steel in a bath of molten zinc to produce, by alloying, a metallurgically bonded coating. The size of the structural assembly that can be galvanized is limited only by the size of the bath. The process operates at 450°C and this can distort certain types of structural member. Guidance from the Galvanizers' Association should help minimise or eliminate the distortion of fabrications.

All other matters being equal, the coating weight will increase with increasing thickness of steel to be coated. The coating weight and appearance of the coating is also dependent upon the surface roughness and the silicon and phosphorus contents of the steel.

For many applications a coating weight of zinc of 610 g/m² is specified; this is equivalent to a mean thickness of zinc of 86 microns. However, a heavier coating of 1000 g/m² (which is in excess of the recommendations set out in BS EN ISO 1461) is normally specified for aggressive environments where galvanizing is the sole protective coating. A coating weight of 1000 g/m², equivalent to a mean thickness of 140 microns, can be achieved either by;

- 1 Blast-cleaning the surface with chilled iron angular grit grade G24 prior to galvanizing, (common increases are between 15 to 20% and the maximum practicable increase is 50%).
- 2 Selecting a steel with a high silicon content (typically greater than 0.3%).

The advice of the galvanizer or the Galvanizers Association should be sought prior to specifying thicker galvanized coatings.