PROTECTION OF STEELWORK AGAINST CORROSION

Contents

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NG 1901 Introduction

1 The Series 1900 Clauses 1901 to 1921 cater for workshop and site surface preparation and protective coating requirements for new steel in highway structures, from the start of fabrication to the completion of erection. The Series 1900 Clauses 1970 to 1984 cater for surface preparation and protective coating requirements for maintenance painting of steelwork for protection against corrosion.

The Clauses 1901 to 1921 are applicable to steel sections and fabricated steelwork in bridges, parapets, gantries and other highway structures, including bearings, CCTV masts, cantilever masts, steel lighting columns and bracket arms, (but excluding traffic sign posts), which are to be protected with the protective systems described in Clause 1911. Clause 1920 is concerned with requirements particular to steel in bearings only, and Clause 1921 is concerned similarly with CCTV masts, cantilever masts, steel lighting columns and bracket arms, (but excluding traffic sign posts), and bracket arms.

Reference has also been made, in other Series, to certain Clauses in Series 1900 when appropriate, e.g. Clauses 1902 and 1903 for surface preparation and Clause 1909 for hot dip galvanizing.

The main surface preparation work, usually by dry blast cleaning, together with local surface treatment will be carried out within the fabricator's works. After erection however, all surfaces of the workshop applied protective systems which protect the steelwork during delivery and erection, and the surfaces of patch coatings applied during erection will require cleaning before the application of the final overall coat(s); site connections and welded joints will require special treatment, also areas of mechanical damage will need to be made good. On small structures e.g. sign/signal gantries all paint coats, including the finish coat, may be applied in the workshop in order to reduce access time for completion at site. This may be necessary where, say, a new gantry is to be erected over a motorway during a night-time possession. In such cases the Contractor will need to ensure that damage to the paint system during handling and erection is kept to a minimum and that any minor damage is satisfactorily restored. On large structures, final site painting may not be undertaken for as long as two or even three years, and in these cases wet blast cleaning may be the most effective method of removing contamination.

2 The choice of protective systems will depend mainly on the environment and accessibility for maintenance painting. The detailed requirements for surface preparation, the coatings and their application are specified by means of appropriate Series 1900 Appendices. The format is flexible and can cater for a single component contract, e.g. from a length of parapet up to the involved requirements of a bridge strengthening and widening scheme.

Requirements for the quality assurance scheme and certification of paints are given in the NRA Addendum to BD 35. All paints to be used in the Works should have a current NSAI Agrément Certificate or equivalent.

Aluminium is the preferred thermally sprayed metal coating. Zinc metal spray is not advised for highway structures and is excluded from the protective systems.

Hot dip galvanizing is viable for components such as parapets, CCTV masts, cantilever masts, steel lighting columns and bracket arms. For larger components and structures, the validity of hot dip galvanizing, whether painted or not, should be assessed, and may be restricted by the size and weight of steel fabrication.

3 The information on environment, accessibility and durability provided in the Appendices will aid the Contractor in assessing the extent of the cleaning likely to be necessary on site. The 'Required Durability' is a means of alerting the paint manufacturer as to the performance expected from the protective system he is offering.

Substitute and Additional Clauses

4 Clauses 1901 to 1921 should be scrutinised to ensure that all aspects of the Contract can be covered satisfactorily. When, exceptionally, Substitute or Additional Clauses are required, the alterations should be made after agreement with the National Roads Authority.

Consultations on Health Hazards and Environmental Restrictions

5 Health hazards associated with pollution of the atmospheric environment have to be taken into account during surface preparation and the application of protective coatings. Unless necessary precautions are taken and any limitations on the Contractor's method of working (Appendix 1/23) are observed, people may be adversely affected, also the site ground area and waterways may become contaminated to an unacceptable extent. In the workshop the avoidance of hazards arising from blast cleaning steel with abrasives is usually a matter of protection against dust. The precautions to be taken during the application of protective coatings are usually stated by the suppliers, e.g. ventilation to remove strong solvent vapour. On site, in the case of blast cleaning with non-metallic abrasives, particularly if large surface areas are involved, plans should be discussed with the Relevant Authorities and other interested parties and clearance obtained for the proposals. The debris produced by combined wet and dry blast cleaning (see sub-Clauses 1903.14 and 15) can usually be contained satisfactorily. However, in some cases it may be necessary to use dry blast cleaning only, e.g. to clean up a thermally sprayed metal coating based system. This method is usually acceptable for a structure in an unpopulated area, even over a road.

For a structure near or over a river, particularly near a water supply take off point or where fish stock is maintained, it will be necessary to prevent any debris from falling into the water or even on the ground nearby. In other areas, for example near a dust sensitive industrial process, the spreading of any dust in the atmosphere near the plant would be unacceptable.

On site also, although operators can usually be protected from the effects of spray application, it may be necessary in some cases to protect the immediate environment from overspray; it may even be expedient to specify brush application only.

If as a result of investigation it is clear that side sheeting or close boarded scaffolding is required to reduce or prevent dust and debris being released into the atmosphere or from falling into a river this should be stated in Appendix 19/5.

NG 1902 Surface Preparation – General Requirements

Workshop and Site Work

1 In most cases the use of a cleaning agent followed by rinsing is considered to be more effective than the use of a solvent. If traces of oil or grease remain after the first attempt, further cleaning may be necessary. However, if wetting of the surface is not permissible, use of a solvent may be necessary.

2 It should be ensured that, throughout the duration of the work, clean water is used for wet cleaning and rinsing. Generally, potable water will be satisfactory, but there should be a check that the water (or the cleaning agent) does not leave harmful residues on the surface. Warm water may be used where appropriate.

3 There should also be a check that the cleaning agents offered do clean satisfactorily and do not themselves leave harmful residues on the surface after final rinsing. Abrasives should be checked for freedom from impurities, which could contaminate the surface to be cleaned.

4 Dry blast cleaning in particular may have to be repeated if the steel to be used for the Works has become rusted and contaminated before fabrication as a result of being stored in the open in an industrial environment. In some cases the site coats may not be applied for a considerable time and repeated cleaning down may be required.

5 Blast cleaning will not remove all weld spatter; it should therefore be ensured that firmly adhering spatter is removed before blast cleaning. In most cases weld spatter can be removed before the application of a protective system. It will not, however, be possible inside some hollow sections, e.g. tubes, even if these are to be hot dip galvanized internally.

6 Except at site welded joints, dry methods of surface preparation should be specified for the inside of box girders otherwise excessive water will accumulate on the bottom surfaces especially between stiffeners, also surfaces may remain wet for some time and delay painting. The internal surfaces of hollow sections which are to be coated should be free from dust and debris as far as practicable.

7 Although the initial surface preparation may have been satisfactory, and all dust and debris

removed, further dust may well collect on the cleaned surface. In harsh environments further pollutants may also be deposited. It is essential therefore to check surfaces immediately before painting.

8 If particles of abrasive are allowed to fall onto a freshly painted surface they are likely to become embedded in the wet paint. Workshop coats in particular may also become contaminated by metallic dust from badly contained thermally sprayed metal coating operations. Embedded abrasive in fresh paint should be removed, and if necessary, the affected coat restored. Wet paint which has been contaminated by thermally sprayed metal coating dust should be removed completely. If dried films only have been affected, wet cleaning may prove effective in removing such surface dust, however, careful checks should be made. Thermally sprayed metal coating dust remaining on a micaceous iron oxide pigmented coat, for example, would be difficult to remove later and could cause early failure of site coats.

9 Cleaning of the workshop coats before painting on site will usually be necessary as it is not possible to check that all areas are free from contamination.

NG 1903 Surface Preparation – Materials and Methods

Dry Blast Cleaning in the Workshop

1 There should be a check that the grading and hardness of the abrasive used for the work complies with sub-Clauses 1903.1 and 1903. 2. It is important to realise that the restrictions on abrasive sizes necessary to keep the blast cleaning profile within the ranges covered by the Surface Profile Comparator will also reduce the number of 'rogue peaks'.

2 Samples should be taken from abrasive stored in the blast cleaning plant before the start and during the work to ensure that there are no oversize particles in the mix. All fresh supplies should also be checked before they are used to replenish abrasive in use. The inspector should have the necessary sieves in his possession in the workshop. Abrasive which does not comply with the Specification should be rejected. Oversize particles in excess of that allowed by the relevant standard, for example, are unacceptable. The performance of equipment and the technique of the operator can affect the attainment of a satisfactory profile or cleaning rate. A working mix with oversize particles will increase the frequency and size of 'rogue peaks' and affect the cover provided by the subsequent painting.

3 Contamination of abrasives is not generally a problem in the workshop when new steel is being blast cleaned. However, the whole mix may well have become contaminated if steel, which has been exposed to, say, oil, grease, sulfates or chlorides, has been put through the plant. Hence the importance of early and subsequent checks.

Abrading in the Workshop or on Site

4 Power wire brushing, whether or not preceded by chipping or scraping, is unlikely to achieve a satisfactory standard of cleanliness and is therefore considered as no more than an aid prior to abrading.

5 Abrading will be used mainly to repair mechanical damage and during restoration of local failure in the shop paint system. Water should not be allowed to come into contact with exposed thermally sprayed metal which is porous, nor if possible with bright steel. However, wet abrading can be usefully employed where hot dip galvanizing is present.

6 Only power tools which rotate at the relatively fast speeds necessary for power wire brushing or abrading should be used. Deposits of concrete are difficult to remove if allowed to harden, hence it is important that appropriate chipping and scraping tools are used otherwise the paint system is likely to be damaged. The use of hard grinding wheels is not permitted for abrading as their edges can easily cut into the surface.

7 Electric drill speeds are relatively slow, the use of hand-held drills as a power source for wire brushing often results in a polished appearance due to the formation of a patina of pollutants and corrosion products.

8 Sub-Clause 1903.8 caters for the protection of exposed areas of cleaned steel substrate or thermally sprayed metal coatings before they can be adversely affected by wetting or debris from adjacent surface preparation.

Wet Cleaning in the Workshop or on Site

9 Workshop coats which may have been exposed on site for a considerable time, particularly in a Marine environment, should be thoroughly cleaned. Scrubbing of flat surfaces is usually satisfactory, however, light wet blast cleaning

may be necessary to remove harmful contamination from areas difficult to clean. The selected cleaning agent should be used as recommended.

Dry Cleaning in the Workshop or on Site

10 Dry cleaning is usually satisfactory for internal surfaces as these are less likely to have become contaminated. Nevertheless these surfaces should be checked before painting and further cleaning carried out if necessary.

Dry Blast Cleaning on Site Using Dry Air/ Abrasive System

11 Copper slag can be used to blast clean steel surfaces which are to be painted only, also to remove unsound paint; however, if surfaces have become heavily contaminated, dry blast cleaning may not be adequate and wet blast cleaning may be necessary. Modern and efficient blast cleaning equipment, which will re-circulate metallic abrasive, is available. The requirements for fasteners are covered in Clause 1906.

Sand (or other substance) containing free silica is hazardous to health and may not be used as an abrasive for blast cleaning.

Wet Blast Cleaning Using Low Pressure Air/ Water/Abrasive System on Site

12 The main advantages of wet blast cleaning on site are that it keeps dust down and that it is the best method of removing heavy contamination. It should not be used to clean up thermally sprayed metal coatings because they are porous. Wet blast cleaning as a first time method will not produce a satisfactory profile for the application of thermally sprayed metal coating. It should only be used on bolted connections if dry blast cleaning is impractical, otherwise water will penetrate into the joint. It is, however, satisfactory for welded joints which are to be painted, also for cleaning up or removing paint over a steel substrate. It can also be used to clean up the surface only of a paint system applied over thermally sprayed metal coating, but no further, as wetting of thermally sprayed metal coating should be avoided.

13 Unless blast cleaned and adjacent surfaces are cleared of abrasive and debris within a short period, re-contamination is likely.

Wet Blast Cleaning Using High Pressure Water/Abrasive System or Ultra High Pressure Water System on Site

14 The efficiency of the equipment selected by the Contractor should be checked during the procedure trials. Wet blast cleaning will not produce a surface profile and should not be used as the only method of surface preparation of steel.

15 No flash rusting should occur after ultra high pressure water system cleaning.

Combined Wet/Dry Blast Cleaning on Site

16 When wet blast cleaning is used to prepare steel surfaces, flash rusting may occur if painting is delayed. The required standard of cleanliness should be restored by light dry blast cleaning and paint should be applied while the surfaces are still clean.

17 As already mentioned, one of the main advantages of wet blast cleaning is its effectiveness in removing contamination; however, if this is not achieved using wet blast cleaning, any subsequent light dry blast cleaning, although it may restore a clean appearance, is unlikely to remove contamination remaining on the surface or in the blast cleaned profile. For very heavy contamination ultra high pressure water/ abrasive system cleaning should be considered, as in this method heat is generated by the impact energy of the water on the steel, which will assist in contamination removal.

Other Requirements

18 Sub-Clause 1903.17 is an important sub-Clause as it informs the Contractor of the sequence of operations necessary to keep contamination of adjacent surfaces to a minimum when different methods of surface preparation are used.

Grinding After Surface Preparation in the Workshop or on Site

19 Visible surface defects should have been rectified by grinding during fabrication and before blast cleaning in the workshop. Blast cleaning may reveal further defects and these should be dealt with before workshop painting. Heavy mechanical damage or scoring caused during transport or during erection should also be rectified by grinding but subject to thickness limitations specified in Series 1800. Grinding has to be carried out with minimum damage to the surface and only skilled

operators should be allowed to carry out this work.

NG 1904 Workmanship Standards for the Surface Preparation of Steel by Blast Cleaning, Abrading, Grinding and Cleaning

1 If the type of abrasive is not specified, the Contractor may use any of the abrasives described in sub-Clause 1903.1 in the workshop. Steel shot is satisfactory for blast cleaning surfaces to be painted only.

2 The Surface Profile Comparator is an 80 mm square stainless steel plate showing agreed ranges for fine, medium and coarse blast cleaning profiles. There are separate Comparators for assessing profiles produced by grit and by shot abrasives.

3 The amplitude of the blast cleaning profile on new steel is largely controllable by the size of abrasive used. Although the size and incidence of 'rogue peaks' are also related to the size of abrasive, faulty manual blast cleaning techniques can greatly increase the problem. Regular use should be made of the Comparator and frequent checks of the abrasive should be carried out to ensure compliance with sub-Clauses 1903.1 and 2.

4 'Hackles' ranging from small spikes, some just visible to the unaided eye to those which have to be pulled from the surface and leave fissures which require treatment by grinding, show up as a result of blast cleaning, even when fine grades of abrasive are used. It is difficult to distinguish between 'rogue peaks' and small hackles, and because the latter can appear at any time during blast cleaning, even if the process is well controlled, continuous checking is necessary. If thermally sprayed metal coating, in particular, is to be applied, then the remainder of the component as well as the dressed areas may have to be blast cleaned in order to comply with IS EN 2063.

Even if paint only is to be applied, re-blast cleaning may be required if the dressed areas are large, viz. such that the surface preparation by blast cleaning overall can no longer be claimed to exist.

5 Generally, dry blast cleaning to Sa3 or Sa2½ quality, of lightly rusted surfaces which may be contaminated to a minor extent, will reduce contamination to negligible quantities. However, as the levels of rust and contamination on stock steel increase, so will the quantity of soluble salts remaining after blast cleaning increase; these will be unevenly distributed, making inspection difficult. The abrasive in use is also likely to become contaminated and may spread salts over otherwise clean surfaces.

Surfaces should therefore be checked for contamination before and after blast cleaning particularly in the case of more heavily rusted stock steel. If blast cleaned steel is still contaminated to an unacceptable level it should be rejected immediately; the abrasive should also be checked, see sub-Clause 1903.3. The Contractor may decide to pre-clean steel so that it can be finally dry blast cleaned satisfactorily; some blast cleaning plants include a washing stage for this purpose.

6 The requirements for Sa3, Sa2½ and Sa2 to be achieved by blast cleaning are described in sub-Clause 1904.5, those for freedom from 'harmful residues' or 'detrimental contamination' are described in sub-Clause 1904.7. See also Clause 1905.

It will be seen that Sa3 or Sa2½ quality can only be achieved by blast cleaning the surface. 'Bright steel' can be chemically clean if the steel surface was chemically clean originally. However, there may be cases where an 'overall bright appearance' will be obtained in a contaminated area, in which case any remaining detrimental contamination will have to be removed. 'Bright steel' however, can be accepted for final dressing of small areas, such as sharp corners and other surface defects prior to painting or hot dip galvanizing.

Blast cleaning to Sa3 quality with chilled iron grit or aluminium oxide grit is necessary for the successful overall adhesion of thermally sprayed metal coatings. Sa3 quality should also be specified for exposed steelwork when minimum maintenance is required, that is without any rusting through from the substrate having occurred.

Note: For the extent and depth of surface defects permitted in steel, reference should be made to the thickness limitations specified in Series 1800.

7 At present, NSAI, BSI or ISO specifications or accepted Codes of Practice setting limits on embedment of particles of abrasive are not available. Some small particles may remain

embedded in the profile. Faulty blast cleaning techniques, e.g. too high an air pressure, and large sharp particles, will exacerbate the problem. Sharp particles projecting above the blast cleaning profile will be harmful, as will large quantities of abrasive particles lodged in the profile. Acceptable limits shall be agreed with the National Roads Authority.

8 For protective systems for difficult access structures the limits for harmful residues and detrimental contamination will be 'virtually nil'. Where 'bare steel' has been specified, checking surfaces for detrimental contamination is most unlikely to be necessary.

The same principle also applies to protective coatings.

NG 1905 Workmanship Standards for the Surface Preparation of Coated Steelwork by Blast Cleaning, Abrading, Grinding and Cleaning

1 The standards of workmanship described in sub-Clause 1905.1 are for remedial work carried out in accordance with Clauses 1907 and 1908.

2 The terms listed in sub-Clause 1905.2 are in use for maintenance contracts as well as for new works.

3 The term 'restored' is now a defined term; lower standards for replaced coatings are not acceptable.

4 In the workshop, the most frequent cause for having to remove a thermally sprayed metal coating is lack of adhesion. Subject to proper control, dry blast cleaning will remove a thermally sprayed metal coating completely, this being necessary in the case of adhesion failure. Wetting of the surface, over say 1.0 m², at regular intervals is a practical method of checking that the thermally sprayed metal coating is being removed. The wetted area should show even rusting.

On site, prolonged exposure in a harsh environment is likely to cause corrosion of a thermally sprayed metal coating. In severe cases all but traces of the coating allowed under sub-Clause 1905.4 should be removed, wet blast cleaning may have to be used in such cases followed finally by dry blast cleaning. Only dry blast cleaning should be used to remove a damaged or failed paint system over thermally sprayed metal coating or to clean up the surface of the metal coating itself; this is because thermally sprayed metal coatings are porous, retained moisture may cause early failure of a restored paint system.

NG 1906 Procedures for Treatment at Joints

General

1 The treatment specified at joints prior to assembly or welding, covers both workshop and site conditions.

Most erection joints are prepared in the workshop for completion later on site. In these cases particular attention has to be given to limiting the application of the primers and to stepping back the undercoats on the parent material.

Treatment at completed joints includes sealing against the ingress of water, this should be carried out concurrently with the painting of either workshop or site joints.

The requirements are also adequate in the case of joints which have to be prepared and made entirely on site e.g. in permanent strengthening of steelwork. Generally, contact surfaces at high strength friction grip and tension control bolted joints are blast cleaned only or blast cleaned and metal aluminium sprayed.

Any metal coatings to be applied to fasteners in painted only joints, thermally sprayed metal coated joints or thermally sprayed metal coated and painted joints or where uncoated fasteners are to be provided, should be specified in Appendix 19/2. (see sub-Clause NG 1906.4).

Fasteners, Joint Material and Parent Material in Joints, Before Assembly or Welding in the Workshop or on Site

Fasteners, including bolts, nuts and washers

2 Uncoated high strength friction grip and tension control fasteners are usually delivered with oiled threads or with all the surfaces lightly oiled. Blast cleaning should remove traces of light oil remaining after assembly of the joint. Heavier oil or grease should be removed before assembly.

3 Hot dip galvanized fasteners should generally be specified for joints in hot dip galvanized and painted steelwork. However, stainless steel fasteners may have an application in some cases.

4 The usual metal coatings for fasteners are hot dip galvanizing, zinc electro-plating and sherardizing. In order to prevent rust staining of fasteners to be aluminium metal sprayed after assembly either in the workshop or on site, zinc electroplating, as a temporary coating, should be specified, but this will be blast cleaned off preparatory to thermally sprayed metal coating. In the case of small structures stainless steel fasteners may be considered as an alternative. Hot dip galvanizing applied before assembly (seldom after), and thermally sprayed metal coating applied to fasteners after assembly provide long term protection. Other than hot dip galvanizing, metal coatings applied before assembly, including zinc electro-plating and sherardizing, only provide short-term protection and will require a full protective paint system. Item 155 should not be applied to fasteners in assembled site joints as it is likely to penetrate into the joint. It can also run down on to painted surfaces, and cause problems if splashed on to other surfaces, as it is a weak acid.

5 Coated fasteners are usually delivered free of oil. As the threads are dry, difficulty in tightening may occur if the fasteners have been exposed outside in conditions where the nut and bolt threads have become corroded, this applies particularly to hot dip galvanized fasteners. Fasteners affected to this extent should be replaced.

Joint material and parent material in joints

6 Steel contact surfaces or steel surfaces which are to be painted on site need only be restored to Sa2½ quality. Surfaces of thermally sprayed metal coating should be restored by blast cleaning to sound metal. Hot dip galvanized surfaces are only likely to need wet cleaning. The Contractor may opt to use abrading, grinding or sometimes blast cleaning to restore a clean surface at weld preparation areas.

Wire brushing of even lightly rusted previously blast cleaned surfaces is not acceptable.

At joints made with high strength friction grip and tension control bolts

7 It is important that paints other than a primer or sealer should not be taken into the contact surface area, and that the primer should not be applied further than specified. High strength friction grip and tension control bolted joints in hot dip galvanized steelwork are unusual.

8 When paint is applied to the outer faces of joint material at high strength friction grip and tension control bolted joints, a check should be made that joint plates are not reversed during assembly; also if the maximum of 20 microns of paint is exceeded the whole coat should be taken off before the joint is made, otherwise the load carrying capacity of the joint may not be achieved. This also applies to sealer.

At non friction bolted joints

9 There are instances where high strength friction grip and tension control or other high tensile fasteners may be used in shear and bearing rather than the more usual mild steel fasteners. As friction is not a criterion, paint may be taken over the joint surfaces. It is usually impracticable to apply the full workshop system to the contact surfaces, but at least the primer and first undercoat should be applied.

10 Sealing of joints by assembling the plies on wet paint is not necessary for hot dip galvanized steelwork.

At welded joints

11 It is only necessary that surfaces to be welded should have a bright clean appearance. A check should be made, however, to ensure that they are free of metal coating, and other protective coatings, otherwise the weld could be impaired.

Parent Material, Workshop Treatment Adjacent to Joints Which Are to be Assembled or Welded Later at Site

At high strength friction grip and tension control bolted joints

12 Paint coats should be stepped back at breaks in the system, viz. at joints, otherwise the break will show on completion and a potential weakness in the protective coating may result.

At non friction bolted joints

13 It will usually be practical to take the full workshop system over the joint surfaces.

At welded joints

14 Thermally sprayed metal coating and paint should be kept back from weld areas not only to avoid degradation of the weld, but also to prevent damage to the coating by heat and the possible production of toxic fumes. Hot dip galvanizing should be removed from the prepared joint area otherwise fumes and spatter may be excessive.

At Completed Joints

15 It should be checked that bad weather conditions or a severe environment have not affected unprotected bolted joints adversely; if adverse conditions are likely the Contractor should seal any gaps and apply sufficient protection within 48 hours, or earlier if possible, of a joint being made.

The protective system on adjacent parent material will usually be satisfactory for all types of joints. However, because of varying requirements for the protection of welded site joints, e.g. internal welds and joints in thermally sprayed metal coating or hot dip galvanised steelwork, the appropriate surface preparation for site welded joints, if different from that shown in sub-Clause 1911.6 Table 19/2A, should be specified in Appendix 19/2. See NG 1906.18 below.

At bolted joints

16 Dry blast cleaning is preferable at newly-made joints as wet cleaning and wet blast cleaning in particular will lead to difficulties if water penetrates into the joints. If the registered priming coat on the outer surfaces is sound, dry cleaning may be adequate provided that the surfaces are checked finally for freedom from detrimental contamination.

17 Wet cleaning is usually suitable for hot dip galvanizing. It does not damage the surface and has been found to be satisfactory, for example for the type of joints used in parapets.

At welded joints

18 Site welds may be difficult to free from detrimental contamination by dry blast cleaning to Sa2½ quality. After an external weld has been freed of slag and wire brushed, wet cleaning should be specified before dry blast cleaning.

Alternatively combined wet/dry blast cleaning can be used, as this method is effective in removing contamination. When any form of blast cleaning is impracticable for external welds in painted only steelwork, wet cleaning should be followed by water based zinc or ferrous conversion coating and a coat of Item 110. In most box girders, the water and debris from wet blast cleaning of internal surfaces would be difficult to clear up satisfactorily and hence removal of slag, wire brushing and wet cleaning followed by using cold phosphate based conversion coating and Item 110 should also be specified. Item 110 should be followed by the first undercoat of the system.

When a thermally sprayed metal coating is to be applied over a welded joint, blast cleaning will be necessary.

The removal or stepping back of coatings (e.g. hot dip galvanizing) from the prepared joint area should prevent damage to the protective system. The protective treatment of welds and weld areas in hot dip galvanized steelwork should be dealt with separately in Appendix 19/2.

Sealing at joints, plies and fasteners

19 If joints or steel plies have been exposed to water it should be ensured that they are free from moisture before gaps are sealed and the paint system applied.

20 There should be a check that paint penetrates the fine gaps sufficiently to provide an effective seal and that other gaps are painted in sufficient depth to maintain the seal in position.

NG 1907 Procedures for Treatment at Areas of Mechanical Damage or Other Surface Defects

1 Damaged coatings may require different treatment in the workshop than on site. Reference should be made to Clauses 1904, 1905 and related NG for requirements and guidance on workmanship standards for remedial treatment.

2 Damage in the workshop to unprepared surfaces should be treated before blast cleaning. However, minor areas of repair to blast cleaned surfaces which are to be painted need not be re-blast cleaned. Generally, most damage to coated surfaces is caused during transport and erection, often due to

inadequate handling or stacking. Abrading is an effective method for dressing minor damage in steel surfaces or in metal coatings or for smoothing more heavily damaged areas after grinding. Fissures in the surface caused by the removal of 'hackles' or inclusions may need to be ground out, and when a thermally sprayed metal coating is to be applied the area should be blast cleaned; however, it should be ensured that mechanical damage or grinding, even if smoothed out does not reduce the thickness of the steel below specified limits.

3 Abrading is also an effective means of preparing small areas of damage in hard dry paintwork.

4 Blast primers less than 30 microns dry film thickness need not be replaced. However, other primers, e.g. Epoxy (two-pack) Primers, which are usually applied at film thicknesses greater than 30 microns, are an essential part of the protective system and should be replaced.

5 After surface preparation of a thermally sprayed metal coated area by abrading or grinding, the whole of the affected area should be dry blast cleaned to ensure overall adhesion of the re-application of thermally sprayed metal coating. There will be no clear demarcation between exposed steel substrate and the thermally sprayed metal coating.

6 It is generally possible to restore thermally sprayed metal coatings in the workshop and replacement by paint should not be allowed.

7 When a thermally sprayed metal coating together with any sealer is being restored on site during repairs to a damaged area the minimum thickness of metal coating should be increased to 150 microns. This is to ensure the required durability from the application on site.

It should be ensured that adhesion checks in accordance with IS EN ISO 2063, Annex A, method A1 are made at a representative number of repaired areas.

8 It would be uneconomical as well as unreasonable to expect thermally sprayed metal coatings to be restored in every case of minor mechanical damage occurring on site, particularly on large components. However, the extent of repairs by painting should be strictly limited.

9 The incidence of damage is related to the type of component, care in storing and positioning for erection. For example, a length of parapet laid out on a roadway for an unnecessarily long period is likely to be damaged. Minimum damage commensurate with proper care in handling only should be accepted. The relaxation at site applies to hot dip galvanized only components (such as lighting columns and masts) as well as to hot dip galvanized components protected by a paint system. Marking of the surface or light bruising of hot dip galvanizing should not be considered as damage referred to in Clause 1907.

10 The bevelling back of edges of adjacent, and apparently unaffected paint coatings, or metal coatings, into sound coatings will not only improve appearance but may also show up unsuspected adhesion defects. Only dry methods of surface preparation should be used when removing damaged or faulty paint from the surface of thermally sprayed metal coatings (see NG sub-Clauses 1903.4-21). Hot dip galvanizing on the other hand is not porous, either wet or dry methods may be used to remove paint and prepare the surface before coating.

11 Item 155 contains a weak acid and should be wiped off immediately if it has been applied over paint. Affected paint should then be wet cleaned.

12 It should be ensured that the Contractor does not extend the specified overcoating times, otherwise local failure early in the life of the system is likely.

NG 1908 Procedures for Treatment of Local Failure in Protective Coatings

1 Local failure of coatings may also require different treatment in the workshop than on site. Remedial work is likely to be more extensive than in the case of repair to mechanical damage; this is because contamination or other cause of failure may affect a relatively wide area. Reference should be made to Clauses 1904, 1905 and related NG for requirements and guidance on workmanship standards for remedial treatment.

2 Achieving adequate standards of surface preparation, including freedom from harmful residues and detrimental contamination, is most important when remedying areas of local

failure in paint coats or thermally sprayed metal coating. Local failure, early in the life of the workshop coats or after completion of a system on site, is usually due to painting in adverse conditions or inadequate surface preparation initially e.g. ineffective removal of contamination including oil or grease prior to painting. Early failure of a thermally sprayed metal coating is often due to poor adhesion, the usual causes being delay in application, say overnight, excessive spraying distance or even steel at too low a temperature. The causes of local failure should be investigated as soon as possible so that the fault can be corrected. It should be ensured that all protective coatings are up to standard before steelwork leaves the workshop.

3 Although site blast cleaning to Sa2½ quality will be acceptable as far as visible residues are concerned, equivalent relaxation in the standard of chemical cleanliness is not permissible. Particular attention should be paid to checking the latter as contamination may have caused the local failure.

4 Local failure of hot dip galvanizing, e.g. detachment of the coating, may be indicative of extensive unsound hot dip galvanizing. In all cases the component should be regalvanized.

5 It should be ensured that the full extent of the failure has been cleared of unsound paint and checked that any abrading of paint coats has not damaged any underlying hot dip galvanizing by reducing its thickness unduly.

6 The cause of any failure should be ascertained and it should be ensured that the Contractor achieves the required standard of surface preparation, including the removal of contamination, before overcoating. The expertise to mount tests to verify that surfaces have been cleaned adequately should be available.

NG 1909 Metal Coatings

1 Adequate control of the pickling process is important otherwise the properties of higher grade steels can be affected. However, the requirements in Clause 1909 are precautionary and should prevent difficulties.

Passivation by chromating of hot dip galvanized surfaces should not be permitted if painting is intended, as this treatment, on CCTV masts, cantilever masts, steel lighting columns and bracket arms for instance, may prevent the action of Item 155.

2 Effective protection is unlikely in areas where the thickness of a thermally sprayed metal coating is less than 100 microns. The terms nominal or average are not used in the Specification. Although zinc metal spray is referred to in sub-Clause 1909.2, experience has shown that it is not suitable for overall application to highway structures such as bridges, gantries, CCTV masts, cantilever masts, steel lighting columns and bracket arms or parapets. Zinc metal spray will, however, have an application for other components, e.g. temporary structures in a mild environment.

It is now known that many failures of thermally sprayed metal coatings have been due to unsatisfactory surface preparation leading to poor adhesion. Application in two layers and poor application technique have also caused problems. Particular close inspection at all stages is essential. The standard of blast cleaning should be clean steel, Sa3 quality, medium profile using chilled cast iron grit or aluminium oxide grit.

3 Sherardized coatings offer temporary protection only, if fasteners cannot be free from detrimental contamination by dry methods, e.g. by dry cleaning or dry blast cleaning, they should be replaced.

4 The advice on sherardized coatings applies to zinc electroplated coatings.

5 The hot dip galvanizing of steelwork should only proceed when the procedure to be adopted by the Contractor will produce satisfactory workmanship complying with the Specification. In the case where acid pickling or fluxing is required prior to metal coating of higher grade high strength friction grip and tension control bolts or components of higher grade steels, e.g. steels with a tensile strength over 827 N/mm², possible defects caused by any hydrogen absorption or other adverse effects should be investigated.

NG 1910 Testing of Thermally Sprayed Metal Coatings

1 It is to be expected that contractors undertaking thermally sprayed metal coating have the necessary expertise, particularly in respect to understanding the importance of a clean sharp blast cleaning profile and of being

able to check adhesion with modern equipment. Nevertheless it should be ensured that all the requirements are being met, otherwise experience has shown that early and very expensive failures can occur. Adhesion tests should be made in accordance with recommendations of the manufacturer of the testing equipment, for example the pull-off force should be normal to the surface. Usual reasons for lack of adhesion are bad application techniques or blast cleaned surfaces which have been exposed, even for a short time, in a damp environment and have lost their initial bright finish. When the overall adhesion is suspect, all the thermally sprayed metal coating should be blast cleaned off the area in question as obviously any residual thermally sprayed metal coating may also be defective. In the excepted areas, adhesion cannot be checked by the test panel method; the only practical method being the grid test described in IS EN ISO 2063, Annex A, carried out as the work proceeds.

NG 1911 Paint and Similar Protective Coatings

1 Grease paints are protective coatings based on Calcium Soaps of Oxidized Petroleum Wax and are applied by brush or airless spray and are similar in appearance to ordinary paints but do not harden completely. When the solvent has evaporated grease paints are hard enough to walk on. Epoxy Pitch (two-pack) coatings and bitumens are also covered by Clause 1911 requirements.

2 Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet should be checked to ensure that the registered dates have been entered by the Contractor.

3 Tins should show all the specified markings and the required standard should be insisted on at the outset. Omission of the Item Number for example, can lead to delay in checking the specific gravity on site and the despatch of 'A' and 'B' samples.

4 In practice, a paint manufacturer issues Appendix 19/3, Form BE/P2 Paint Data Sheet, to the Contractor. The Data Sheets should be examined and any special stipulation as to application which may cause problems or delays during the Work should be noted and brought to the attention of the Contractor. If, for example, the weather is likely to be unfavourable the Contractor should be fully aware of any relevant restrictions on the application of the paints.

5 A source of supply should only be rejected after consultation with the Employers Representative.

Standard Terminology for the Description of Paints

6 Standard Terminology enables paints to be described in generic terms and without specifying trade names. It is used for the Registered Description in Paint System Sheets, in Data Sheets and in the Specification and should convey the following information in the order given:

(i) Name of Pigment: where a pigment provides inhibitive or structural properties it should be named, e.g. MIO, Zinc Phosphate. Where pigments provide colour, opacity or act as extenders etc. the pigments should not be named.

(ii) Type of Medium: except for acid type Blast Primers the type of medium should be stated, e.g., M/Phenolic, Phenolic (i.e. pure Phenolic), Silicone Alkyd, Polyurethane, Epoxy (two-pack). (See below for meaning of abbreviations.)

(iii) Use: i.e. Blast Primer, Primer, Undercoat or Finish. If two pack, add '(two-pack)'.

The first coat only of a new system is described as a Blast Primer or Primer, all subsequent intermediate coats are described as Undercoats, the last coat being the Finish. A Primer or Primer/Undercoat (i.e. a dual purpose paint) may be specified when it is desirable to obtain a relatively high film build in the first coat, usually for small areas on site.

(iv) Colour: a descriptive colour should always be stated as part of the Registered Description in Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet.

Convenient abbreviations have been introduced where these can be readily understood and used in Specifications, e.g.:

MIO Micaceous Iron Oxide

M/Phenolic	Modified Phenolic
MC Polyurethane	Moisture cured Polyurethane
HB	High build
NB	Normal build
LB	Low build
QD	Quick drying

Terminology Used in Painting Practice

7 For definitions of terms used in painting practice reference should be made to BS 2015 and IS EN ISO 4618. Specific meanings of the descriptions of workmanship standards for surface preparation of steel and coated steelwork are given in Clauses 1904 and 1905.

Protective Systems

8 The types of protective systems for steelwork (except CCTV masts, cantilever masts, steel lighting columns and bracket arms) are outlined in Table NG 19/1.

9 Using the information provided in parts 3 to 5 in Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet, the protective systems in Tables 19/2, 19/3 and 19/4 should be detailed by the Contractor in the remainder of Form BE/P1 (New Works) Paint System Sheet for bridge steelwork and parapets, gantries and other structures, bearings, CCTV masts, cantilever masts, steel lighting columns and bracket arms.

10 An Appendix 19/2 may be incorporated for situations where special preparation and/or protective systems may be required, or for other works requiring protection.

Table NG 19/1: Summary of Protective Systems

Type	Main use	Accessibility	Description
I	Steelwork Except Bearings, CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms	Ready Access	High build, quick drying Epoxy (two-pack) system
II	Steelwork Except Bearings, CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms	Difficult Access	Aluminium Metal Spray plus high build, quick drying Epoxy (two-pack) system or High Build Glass Flake Epoxy System
III	Interior of Box Girders	Ready or Difficult Access	High build, quick drying Epoxy (two-pack) system
IV	Hot dip galvanized surfaces, e.g. Parapets	Ready or Difficult Access	Hot dip galvanizing plus zinc phosphate epoxy sealer and primer, with a polyurethane finish
V	Steel in Bridge Bearings (and metal coated fasteners)	Ready or Difficult Access	Aluminium Metal Spray plus Sealer, plus zinc phosphate epoxy sealer and primer, with a polyurethane finish

Protective systems for CCTV masts, cantilever masts, steel lighting columns and bracket arms are also given in NG 1911.12

Protective Systems for Steelwork Except Bearings, CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms

11 General

(i) The protective systems for bridge and other highway structures include systems which are satisfactory for sign gantries, footbridges, parapets and also for structures such as towers and buildings. Systems for structures which have to withstand especially aggressive conditions, salt hoppers for example, are not listed. Systems for traffic sign posts and plastic coated items are covered in Series 1200 and fencing in Series 2600.

(ii) Types I and II protective systems should not require major maintenance up to 20 years. Type II protective system incorporating a thermally sprayed metal coating should require maintenance of paint coats only at the time of the first and second planned maintenance subject to the thermally sprayed metal coating of all welded or bolted site joints and to the avoidance of mechanical damage during erection. Treatment of site joints during erection requires particular care, e.g. selection of a satisfactory abrasive, achieving the required standard of cleanliness, avoiding damage to adjacent thermally sprayed metal coating and ensuring that site thermally sprayed metal coating and sealing is completed immediately after blast cleaning; the required thickness of thermally sprayed metal coating being obtained in one continuous operation [see sub-Clause 1909.2 (iv)]. Site paint coats should be applied as soon as practicable over the sealed aluminium metal spray and in any case within the timescale given in sub-Clause 1914.27.

(iii) Item 159 is an Aluminium Epoxy Sealer for use when aluminium metal spray is to be overcoated with Epoxy paints.

(iv) Colours of finishing paints and finish equivalent, shall be agreed in writing with the National Roads Authority.

Semi-gloss Finishes

High gloss is usually stated as 75 or more gloss units (gu), on a 60^0 geometry head in accordance with IS EN ISO 2813. Semigloss (or sheen) is usually stated as 45gu (±10) on a 60^0 geometry head. When a low sheen finish is acceptable, or is specifically required such as for sign gantry steelwork, Item 169, low sheen polyurethane, should be used.

Protective Systems for Steel in Bridge Bearings

12 General

(i) The 'required durability' of Type V protective system which consists of aluminium metal spray plus a paint system, is no maintenance up to 12 years, minor maintenance from 12 years and major maintenance after 20 years. The protective coatings on bridge bearings are likely to require repair of mechanical damage sustained during erection.

(ii) MIO Epoxy paints have been selected for the protective system to provide quick drying and impact resistant coatings which can be applied by either brush or airless spray. The Contractor may opt to apply the last two MIO Epoxy coats on site at the same time as he is painting the site fasteners and remedying any erection damage. Medium or dark grey MIO Epoxy Finish is usually suitable for bearings for concrete bridges, and hence special finish coats will be required less frequently than in the case of steel bridges where the colour of the bearings may be required to match the finishing paint on the steelwork. Provision has been made for replacing the last MIO Epoxy coat with a Polyurethane finish coat in case a different colour is required, e.g. to match main steelwork system.

(iii) The use of MIO Epoxy (two-pack) paints is standard, and the fact that the Contractor applies the site coats and carries out any remedial work should make it unnecessary for the bearing manufacturer to visit the site. It should be ensured, however, that at each stage the bearing protective system is in good condition and that site coats are properly applied. See sub-Clause NG 1920.1.

Protective Systems for CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms

13 General

(i) The six protective systems should be studied. For motorways and other roads the protective system most appropriate to the environment, see (ii) and (iii) below, should be selected, and then Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet completed by the Contractor, bearing in mind that CCTV masts, cantilever masts, steel lighting columns and bracket arms of 3 mm section thickness or less are to be hot dip galvanized.

The 'required durability' of the exterior coatings, which consist of aluminium metal spray plus sealer, hot dip galvanizing only or one of these metal coatings plus a paint system, is no maintenance up to 8 years, minor maintenance after 8 years and major maintenance after 15 years.

(ii) The simplest protection should be either aluminium metal spray plus sealer or hot dip galvanizing only (see Type A1 and G1 protective systems). These systems should be suitable for masts and columns in an inland environment with ready access for maintenance. Masts and columns situated in an inland environment with difficult access or marine environment with ready or difficult access will require a metal coating plus paint coats. See Type A2a, A2b, G2a and G2b protective systems.

(iii) The choice of metal coating and paint system [i.e. Type A2a, A2b G2a or G2b] is left to the Contractor. Planted masts and columns protected with A2b or G2b protective systems should have an additional sacrificial steel thickness of a minimum 1.0 mm above that needed in the design, from the bottom of the mast or column to at least 250 mm above ground level.

(iv) The policy for the protection at column bases is as follows:

(a) Masts and columns, which have been aluminium metal sprayed externally, require internal protection for the ground section and door area. Blast cleaning, to Sa2½ quality, medium profile, followed by application of Pitch Epoxy (two-pack) paints, extending from the bottom to 300 mm above the door opening, has been specified for internal protection of these masts and columns.

(b) External surfaces of the ground section of all rooted masts and columns are protected by Pitch Epoxy (two-pack).

(c) External surfaces of flange mounted masts and columns do not require special treatment at the base unless the flange is below ground level or built over, e.g. covered by a plinth. In this case Pitch Epoxy (two-pack) should be specified.

Appendices 19/1 and 19/2

14 The environment, accessibility, required durability of the systems and finish colour for the Works, should be written into Form BE/P1 (New Works) Paint System Sheet (parts 3, 4 and 5): see Clause 1918 and NG 1918. The factors to be taken into account in determining the descriptions are described below.

(i) Environment

Location of structures

Two locations are considered; 'Inland' and 'Marine'.

Structures out of reach of sea salt spray are considered as being 'Inland'. Structures which can be affected by sea salt spray are considered as being 'Marine'.

(ii) Accessibility

For maintenance painting purposes, new structures are described as having either Ready Access or Difficult Access.

The description Ready Access would apply to structures where future restrictions on working time due to road or rail traffic are likely to be minimal and where future access on site is unlikely to be a problem.

The description Difficult Access would apply, for example, to a bridge or sign gantry over a motorway or to a bridge

over a railway where painting is likely to be restricted to one section at a time or halted completely at certain periods when traffic is heavy.

It would also apply on two counts to a high bridge, say, without painting gantries and built over difficult terrain or a river where movement on the ground would be difficult and because extensive scaffolding would be required.

(iii) Required Durability

For the protective systems (except for CCTV masts, cantilever masts, steel lighting columns and bracket arms), the periods 'No maintenance up to 12 years,' 'Minor maintenance from 12 years' and 'Major maintenance after 20 years' will be sufficiently accurate for both access situations and the environments described in this sub-Clause. However, when access is especially difficult, e.g. when dismantling of cover plates is necessary, a special system may be required. In such a case the usual periods for 'No maintenance' and 'Minor maintenance' would not be applicable (N/A); 'Major maintenance' being given as, say, 20 years, or even 25 years.

(iv) Colour

When a BS colour is specified in Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet, the BS 4800 reference should follow the descriptive colour, e.g. green-yellow 12 B 21.

Additionally any special finishes should be stated, e.g. low sheen

The choice of system will depend finally on the following:

(a) Type of structure, especially in the case of a bridge;

(b) Expected service life of structure based on its use;

(c) Environment (for CCTV masts, cantilever masts, steel lighting columns and bracket arms only);

(d)Accessibility.

NG 1912 Testing of Paints

Testing Authority

1 Paint testing shall be undertaken by the appointed independent testing authority and an independent testing laboratory which shall both be CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8, or an equivalent testing authority and/or testing laboratory in any member state of the European Community as agreed with the National Roads Authority.

Provision of Samples

2 Quality assurance of paint as delivered, that is verification of the composition data and application characteristics given in paint manufacturers' registered formulations can only be carried out on paint samples taken from previously unopened tins; these are known as 'A' Samples.

Before the Contractor despatches the 'A' Samples to the address given in sub-Clause NG 1912.6 for testing in accordance with Clause 1912, the checks referred to in sub-Clause NG 1912.4 below should be carried out but on paint taken from other tins of the same batch.

'B' Samples, on the other hand, should be taken from paint in use to ensure that it is as supplied. See sub-Clause 1912.9 and sub-Clause NG 1912.10.

'A' Samples

3 Although 'A' samples are not required in the case of certain bridge and other highway structures described in sub-Clause 1912.4, 'B' samples should still be taken as these make an effective contribution to quality control.

4 Special deliveries of single tins of paint arranged by the Contractor, to the site or to the testing authority, are not acceptable as 'A' samples. Samples should be selected from fully representative batches at the workshop or on site. As a minimum, the condition of the paint in the tins should be examined and, after mixing, the specific gravity should be checked; matching of finish colours to BS 4800 should also be checked. Paint found to be faulty, especially in the case of appreciably incorrect specific gravity should be rejected

at the workshop or on site. It should be ensured that the cause of any unsatisfactory application during the procedure trial is remedied before the start of the main painting.

5 After submission of the first 'A' samples of each type of paint, further 'A' samples should be submitted for testing as painting proceeds depending on the weight of structural steel in the Works.

The Contractor may deliver paint to the workshop or site in containers up to 25 litres providing that the tops are of the completely removable clip-on type and that the contents are thoroughly stirred using a mechanical mixer when taking samples and prior to use. 'A' samples should be correctly labelled before despatching for testing.

6 Details of each set of samples despatched should be listed in Appendix 19/4, Form BE/P3 Paint Sample Despatch List.

A copy of each form should be forwarded immediately to the National Roads Authority, the Employers Representative and a further copy to CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8, which is the testing authority unless agreed otherwise with the National Roads Authority.

Single copies of completed Form BE/P1 (New Works) Paint System Sheet should be sent to the addresses as above, at the same time that Form BE/P3 Paint Sample Despatch List is forwarded for the first 'A' samples or first 'B' samples (if 'A' samples are not required).

Not Used [Results of tests will be notified by the Employers Representative. The Employers Representative will report all results of the testing to the Specialist Required for the Design, as stated on Form BE/P3, who will then notify the Contractor of the results.

Non-receipt of paint samples for testing, for which a Form BE/P3 has been received, will be notified by the Employers Representative.]

7 It should be noted that at the height of the painting season, testing and assessment of the first 'A' samples may take 2 to 3 weeks from receipt of paint samples at the testing authority with a completed BE/P3 form. Unless therefore special arrangements can be made with the testing authority for priority in testing samples, the Contractor cannot be expected to start painting under 3 weeks from the time of awarding the Contract.

Once the Contract has been awarded, the Contractor should order paint early enough to enable the first 'A' samples to arrive at the testing laboratory at least 3 weeks before painting is due to start, or sooner if possible, so that the results of the analysis can be assessed in time. Also, throughout the work, the remaining paint should be ordered sufficiently in advance to allow time for testing subsequent 'A' samples.

About 2 weeks is required for testing 'B' samples.

8 Painting may be permitted to be started before the results of testing 'A' samples have been received only if postponing the painting would mean an unacceptable delay in the work; however, such permission should not relieve the Contractor of his obligations under the Contract. When a first 'A' sample is rejected, an 'A' sample of the replacement batch of paint should be submitted for testing as soon as possible. If painting is allowed to proceed with a replacement batch or a subsequent batch still under test, such permission should not relieve the Contractor of his obligations under the Contract.

'B' Samples

9 Control or 'B' samples are to be taken, in the case of single component paint, from a painter's kettle or from the airless spray gun nozzle, in order to ensure that paint actually being applied will be tested. Samples should be taken as spot checks, with a minimum of one batch in three being sampled. 'B' samples of mixed two-pack materials can only be tested on site and before any reaction has taken place. In addition, for two-pack materials, separate samples are to be taken of the components and dispatched to laboratory for analysis.

Provision of 500 ml Tins, Packing and Transport of 'A' and 'B' Samples

10 It should be ensured that there are an adequate number of tins, lids and lid clips at the start of the work to enable samples to be taken.

11 Unless tin lids are clipped down securely, and the tins properly packed, the contents may be spilled. Even if only one tin leaks, the

spilled contents may obliterate markings on other tins, testing thus being delayed until new samples are checked and delivered.

12 The selected 'A' or 'B' samples should be labelled correctly as described in Appendix 19/4 and despatched promptly throughout the Contract. Not only should the Contractor despatch samples promptly, but his transport arrangements should be such that the samples reach the testing laboratory without delay, particularly in the case of the first 'A' or 'B' samples.

NG 1913 Storage Requirements and Keeping Periods for Paint

1 It should be ensured that a suitable store has been provided and that paint is unloaded directly into it. The store temperature should be controlled within the limits specified. Extremes of temperature, freezing conditions in particular, can affect the properties of the paint. The paint store should be as near as practicable to the painting areas. If the paint store is at a considerable distance from the work area, paint is unlikely to be returned to the store at the end of the working day, or several tins may well be kept out on site to be ready for use and thus may be damaged by extremes of temperature; also if the inspector has to waste time in journeying to and from the paint store to check deliveries and select samples, his supervision of the work will be less effective.

2 The date of manufacture in particular should be marked on the tins, see sub-Clause 1911.3. If the date of manufacture is not indicated the paint should always be rejected.

3 The requirement that paint in use should be returned to store and kept in sealed containers is necessary for both brushing and airless spray grades. Paints with fast evaporating solvents will be adversely affected if the containers are left open in hot weather.

4 Only the types of paint referred to in sub-Clause 1913.4 should be considered for extended keeping times. The performance of other paints can be permanently affected if their keeping times are exceeded. The paint manufacturer's checks will include the following:

Property	Likely fault
Condition in tin	Settlement, skinning, separation
Viscosity	Tendency to body
Drying time	Absorption of dryers
Fineness of grind	Pigment agglomeration, resin 'seeding'
Colour	Flocculation, agglomeration of colour pigments

Lastly, the paint manufacturer will verify that the specific gravity of paint about to be returned after any necessary reconstitution is correct.

5 Paints which have exceeded the keeping period before delivery, or during storage before or after testing under Clause 1912, should not be used. These paints should not be tested or retested until the requirements of sub-Clauses 1913.4 and 5 have been complied with. Remains of moisture cured type coatings in opened tins, should be discarded at the end of the work shift.

NG 1914 Application of Paint

1 In exceptional circumstances, additional solvent may be required when painting is carried out at extremes of temperature or to correct a minor deviation from the normal viscosity.

2 It should not only be checked that surface preparation has been carried out in accordance with the Specification but also that the standard has been maintained up to the time of application.

3 Paints and other protective coatings in the Manual of Paints for Structural Steelwork (NRA Addendum to BD 35) are generally applied either by brush or airless spray or by both. However, for paints with lower viscosity, e.g. Aluminium epoxy sealer, good use can be made of air assisted spray equipment to avoid over application, flooding and overspray of paint. The use of rollers scaffolding has been found to be unsatisfactory and should not be permitted.

4 Work should not proceed outside the limits specified in Clause 1914. Records should be kept, as these will be required should any premature failure occur.

Difficulties may arise on site in deciding when a surface is dry enough to paint. Most types of paints besides MC systems, are intolerant of moisture at the time of application and during the curing period. Generally, the rule should be, if moisture is present or may be expected to be present at the time of application or during the curing period, then painting should not go ahead. IS EN ISO 8502-4 provides guidance on the estimation of the probability of condensation prior to paint application and IS EN ISO 8502-8 describes the field method for the refractometric determination of moisture on a steel surface.

5 In winter or when weather conditions are unfavourable, it should be ensured that workshop, in which structural steelwork is to be painted, are properly enclosed.

6 A check on the amount of paint used after allowing for waste is a useful verification of film thickness.

7 A record of wet film thickness checks should be kept. This is particularly important in the case of site painting; non-destructive checks of total mdft are unlikely to be conclusive although they are useful as a guide. If there is any doubt about the mdft of the workshop or complete system it is possible to cut out 10 mm x 10 mm samples and have these checked. The usual practice, however, is to make an angle cut using cutting tool edge angle as IS EN ISO 2808 into the system and to check the thickness of each coat with a small viewing microscope fitted with a graticule. A proprietary instrument of this type is available. Equipment necessary to carry out these checks should be kept on site.

8 Defects are, as often as not, due to inadequate surface preparation rather than application of faulty paints. Compliance with the Specification, especially the requirement for satisfactory adhesion, should be checked from the time work starts and not left until the steelwork is about to be despatched from the workshop or until the Contractor has dismantled his scaffolding and is about to leave the site. Remedying faults in a difficult access situation, such as over a motorway, is usually time consuming and expensive.

Stripe Coats

9 Paint has a tendency to pull away from corners and even if the specified minimum total dft can be attained by careful application, it is unlikely to be maintained and stripe coating is always necessary. Protective system Types I, II and III (see sub-Clause NG 1911.7) require only one stripe coat in Item 112 paint to be applied over Item 111 in the Works, other protective systems, except for CCTV masts, cantilever masts and steel lighting columns and bracket arms are to include two stripe coats. The first stripe coat is applied at the workshop to reinforce the workshop system and the second on site to reinforce the site coats. When the whole system is applied at the works or on site, e.g. at connections, two stripe coats will still be required. It should be ensured that the first stripe coat on fasteners treated with Item 155 is brush applied carefully, any final traces of grease should be removed beforehand using a solvent, and not by wet cleaning down. On small square bars a single extra undercoat, applied in the workshop or on site, replaces both the stripe coats. For stripe coat details for CCTV masts, cantilever masts, steel lighting columns and bracket arms see sub-Clause NG 1921.3.

Except for the above, application of stripe coats by airless spray is acceptable, and in most cases gives better and more uniform results. However, in areas where space is restricted or when the system itself is brush applied, the Contractor will usually opt for brush application of stripe coats. 'Brushing out' of stripe coats should be avoided otherwise little paint will remain on the corners.

Exposure Times for Prepared Steel Surfaces and for Metal Coatings.

Exposure Times and Treatment of Item155 and Overcoating Times for Paints

10 The times quoted in sub-Clauses 1914.15 to 27 are basic requirements when painting is carried out in average conditions in the workshop or on site. However, longer or shorter exposure times may be permissible depending on conditions. For example, in an environment where the relative humidity is low, clean steel which has been dry blast cleaned in the workshop or on site, can be left for longer than 4 hours provided that there will be no adverse effect.

Exposure times on site for sealed thermally sprayed metal coatings may also be extended in good conditions. Components will be considered as not having been exposed, as described in sub-Clause 1914.20, if they are fully protected during the short time which may be required for transport from workshop to workshop.

Transport should not be allowed during unfavourable weather, e.g. heavy rain, and should be restricted to a mile or so at the most.

11 Because of the variations in the surface condition of hot dip galvanizing and the lack of uniformity following the application and drying of Item 155, with the exception of assembled fasteners treated with Item 155, it has been found expedient to wash all surfaces treated with Item 155 before painting.

12 In a mild environment the time after delivery to site for the application of Item 155 may be increased to allow painting to suit weather conditions or the work programme. In all cases the requirements of sub-Clause 1902.6 for removing dust and debris should not be overlooked.

NG 1915 Procedure Trials

1 The procedure trials are to ensure that the Contractor has the necessary knowledge and expertise, and that with the supervision, labour and equipment proposed to be used, the Contractor is capable of carrying out the Work in accordance with the Specification.

2 The National Roads Authority attach considerable importance to procedure trials and permission to omit them shall only be given in exceptional circumstances.

3 If changes in any paint formulation appear to be necessary, the Contractor should arrange for the paint manufacturer to make the necessary adjustments and forward the revised formulation to the National Roads Authority, Employers Representative and the Coatings Section, Materials Technology Department, CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8 and verify that the revised formulation is acceptable before agreeing to its application.

4 The requirement for further trials may be relaxed providing the Contractor can furnish evidence to demonstrate that replacement labour has the necessary skill and experience and that new equipment is suitable.

NG 1916 Storage and Transport of Steel and Fabricated Steelwork

1 It should be ensured that steel earmarked for the Works and held in stock for any length of time is adequately protected, e.g. stored under cover. However, if it is decided provisionally to accept rusted and possibly pitted steel as structurally satisfactory, checks should be made on the depth of corrosion defects and freedom from contamination, after blast cleaning. Dry blast cleaning may have to be repeated or air/water/ abrasive blast cleaning employed in order to achieve the required standard of cleanliness.

2 Although relatively fast drying paints which keep down handling times for steelwork painted in the workshops have been listed in the protective systems in Clause NG 1911, overlapping of coats and cold weather may result in areas where the workshop system takes longer to dry, thus delaying the handling and loading.

3 If at any time the Contractor has not complied with the requirements of sub-Clause 1916.3, the badly stored steelwork should be re-stacked immediately.

It is important, for example, that water is not allowed to pond inside box girders awaiting erection because restoring the specified standard of surface preparation by blast cleaning inside box girders after erection will be difficult to achieve.

4 If light steelwork is stored in the erection area it will be liable to damage during the handling of heavier components or from site traffic; it should therefore be stored out of the way until required.

5 Bridge parapets especially, CCTV masts, cantilever masts, steel lighting columns and bracket arms, tend to be laid out in position along the roadside for considerable periods where they are liable to site traffic damage and contamination. Therefore the requirements of sub-Clause 1916.5 should be complied with.

6 Damage to protective coatings can be avoided or kept to a minimum by careful slinging, stacking and general handling of steelwork. If preventable and excessive damage has been caused the Contractor should restore the coatings before undertaking further

work. Such damage to protective coatings on CCTV masts, cantilever masts, steel lighting columns and bracket arms, for example, should be restored before erection.

NG 1917 Surfaces in Contact with Concrete

1 Steel surfaces in contact with concrete will usually be adequately protected from corrosion and therefore overall protective paint or other coatings are not normally required.

In areas where a steel/concrete bond is not required the adjacent primer and first undercoat, or the primer only if applied at an mdft of 40 microns, may be specified for the contact area to reduce rust staining before and during the erection stage. Uncoated aluminium metal spray is particularly reactive to wet concrete and, even when sealed, should not extend into the concrete/ steelwork contact area when not protected by paint. Item 110 applied at 25 microns mdft should cover the peaks of the aluminium metal spray and provide a barrier coat between the thermally sprayed metal coating and concrete contact surfaces.

2 In areas such as the underside of hot dip galvanized base plates or in concrete/hot dip galvanised steel contact areas in composite construction, it is generally accepted that hot dip galvanizing does not react harmfully with concrete, and as selective hot dip galvanizing is impractical, the concrete may come into contact with hot dip galvanized surfaces. The 25 mm return for paint coats is still required.

Concrete or grout spatter or runs should, however, be cleaned off, see sub-Clause 1902.9. In higher risk areas, particularly in the presence of high humidity, the use of a protective membrane or sheathing should be considered.

NG 1918 Form BE/P1 (New Works) Paint System Sheet (Appendix 19/1) Form BE/P2 Paint Data Sheet (Appendix 19/3)

1 Normally, a copy or copies of Appendix 19/1, Form BE/P1 (New Works) Paint System Sheet, will be provided in the tender documentation, of which parts 1 to 5 will have been completed. It should be ensured that in part 1 of Appendix 19/1 the National Grid reference has been included.

Grid references are not required for parapets only.

2 As soon as the Contract has been awarded, the Contractor is required to prepare a copy or copies of Form BE/P1 (New Works) Paint System Sheet of which he will have completed parts 6 to 10 for each of the required systems. At the same time, the Contractor is required to provide relevant copies of Appendix 19/3, Form BE/P2 Paint Data Sheet, containing data which is required for checking paints before and after application. Full application instructions are also to be provided. The information provided in Appendix 19/3 is the responsibility of the Contractor.

Approved copies of Form BE/P1 (New Works) Paint System Sheet should be forwarded to the Employers Representative, prior to any paint sampling.

Approved copies of Form BE/P1 (New Works) Paint System Sheet should be forwarded to the testing laboratory, together with the first Appendix 19/4, Form BE/P3 Paint Sample Despatch List. See Clause NG 1912 for details of checks on samples and despatch requirements, also the instructions to the inspector in Appendix 19/4.

NG 1919 Access and Lighting

1 For surface preparation and coating application to be carried out satisfactorily, it is important that the working area and access should permit, wherever possible, unrestricted access to the workface by the operators. For example, if the blast cleaning nozzle or the airless spray gun cannot be held at the correct angle or be moved freely, then good uniform work will be difficult to attain. Care should be taken to provide access to ensure optimum distance of the spray gun, as well as adequate ventilation. It is equally important that the supervisory staff and inspectors should feel secure when carrying out checks.

2 If lighting is inadequate, workmanship will also be adversely affected and thorough inspection difficult; it should therefore be ensured that natural lighting is supplemented by temporary lighting as necessary to maintain an intensity of

illumination at the workface of at least the specified 500 lux during work and inspection. Spot lighting of small areas is not acceptable and hence the requirement that the lighting should cover at least 1.0 m².

NG 1920 Additional Requirements for the Protection of Steel in Bridge Bearings

Applicable Clauses

1 The testing of 'A' samples will seldom apply but 'B' samples should be taken and checked immediately in the workshop for compliance. Also, as the procedure trials are unlikely to be necessary, it should be checked that the correct abrasive is being used and that the standard of blast cleaning and application of thermally sprayed metal coating comply with the Specification.

It should be ensured that the requirements of Clause 1918 regarding the provision of Form BE/P1 (New Works) Paint System Sheet and Form BE/P2 Paint Data Sheet are met.

Supply of Coatings

2 In order to minimise costs the bearing manufacturer may stock two-pack epoxy coatings supplied by a single manufacturer of his choice.

It should be checked that Item 155 and other coatings are supplied by the paint manufacturer listed in the approved Form BE/P1 (New Works) Paint System Sheet.

NG 1921 Additional Requirements for the Protection of CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms

Applicable Clauses

1 The testing of 'A' samples is not required for CCTV masts, cantilever masts, steel lighting columns and bracket arms but 'B' samples should be taken and checked immediately for compliance. Also, as the procedure trials are unlikely to be necessary, it should be checked that the correct abrasive is being used and that the standard of blast cleaning and application of thermally sprayed metal coating comply with the Specification. A separate Form BE/P1 (New Works) Paint System Sheet should be provided for each different system on each area of the masts and columns in accordance with Clause 1918. For example, in the case of a Type A2 protective system for planted masts and columns, the Contractor will need to complete three Form BE/P1 (New Works) Paint System Sheets, one for the treatment of external upper surfaces, one for the treatment of external ground surfaces and one for the treatment of internal surfaces.

Surface Preparation

2 Because CCTV masts, cantilever masts, steel lighting columns and bracket arms are made of relatively thin steel the level of rusting of steel offered for the work should be limited as described in Clause 1921. Pitting inside masts and columns, particularly those which have not been hot dip galvanized, will shorten the useful life of the mast or column.

Stripe Coats

3 CCTV masts, cantilever masts, steel lighting columns and bracket arms are manufactured on a production line, and to reduce the time required for painting only one stripe coat has been specified. When the last two coats are site coats, the stripe coat may also be applied on site.

NG 1970 Maintenance Provision - Introduction

1 The 1970-1984 Clauses cater for surface preparation and protective coating requirements for maintenance painting of steelwork for protection against corrosion.

The Clauses are applicable to steel sections and fabricated steelwork in bridges, parapets, gantries and other highway structures, including bearings, CCTV masts, cantilever masts, steel lighting columns and bracket arms, (but excluding traffic sign posts), which are to be protected with the protective systems described in Clause 1976. Clause 1984 is concerned similarly with steel CCTV masts, cantilever masts, steel lighting columns, (but excluding traffic sign posts), and bracket arms.

2 The detailed requirements for surface preparation, the coatings and their application are specified by means of appropriate Series NG 1900 Appendices. The format is flexible and can cater for a single component contract, e.g. from a length of parapet, up to the involved requirements of a bridge strengthening and widening scheme.

3 The information on environment, accessibility, type and condition of existing protective system and expected durability will give the Contractor guidance on the constraints and extent of the work to be carried out. The 'Required Durability' is a means of alerting the paint manufacturer as to the performance expected from the protective system offered.

Substitute and Additional Clauses

4 Clauses 1970 to 1984, should be scrutinised to ensure that all aspects of the Contract can be covered satisfactorily. When, exceptionally, Substitute or Additional Clauses are required, the alterations should be made after agreement with the National Roads Authority.

Consultations on Health Hazards and Environmental Restrictions

5 Health hazards associated with pollution of the atmospheric environment have to be taken into account during surface preparation and the application of protective coatings. Unless necessary precautions are taken and any limitations on the Contractor's method of working (Appendix 1/23) are observed, people may be adversely affected, also the site ground area and waterways may become contaminated to an unacceptable extent. The precautions to be taken during the application of protective coatings are usually stated by the suppliers, e.g. ventilation to remove strong solvent vapour. In the case of blast cleaning with nonmetallic abrasives, particularly if large surface areas are involved, plans should be discussed with the Relevant Authorities and other interested parties and clearance obtained for the proposals. The debris produced by combined wet and dry blast cleaning (see sub-Clauses 1972.18 and 19) can usually be contained satisfactorily. However, in some cases it may be necessary to use dry blast cleaning only, e.g. to clean up a thermally sprayed metal coating based system. This method is usually acceptable for a structure in an unpopulated area, even over a road.

For a structure near or over a river, it may be necessary to prevent any debris from falling into the water or even on the ground nearby. In other areas, for example near a dust sensitive industrial process, the spreading of any dust in the atmosphere near the plant would be unacceptable.

Also, although operators can usually be protected from the effects of spray application, it may be necessary in some cases to protect the immediate environment from overspray); it may even be expedient to specify brush application only.

If as a result of investigation it is clear that side sheeting or close boarded scaffolding is required to reduce or prevent dust and debris being released into the atmosphere or from falling into a river, say, this should be stated in Appendix 19/8.

The Contractor should ensure that all his operations fully comply with the relevant statutory instruments and guidance published by the Health and Safety Authority, including (Control of Major Accident Hazards Involving Dangerous Substances) Regulation 2006 (S.I. No. 74 of 2006) and (Dangerous Substances and Preparations) (Marketing and Use) (Amendment) Regulations 2006 (S.I. No. 364 of 2006. The Control of Lead at Work Regulations 2002, published by the UK HSE should also be referred to as a guidance document.

6 Dry blast cleaning on its own breaks up an existing protective system into small particles and these, together with the spent abrasive, form a dense dust cloud which may also contain toxic material, e.g. debris from lead paints. Dust from dry abrading may sometimes be toxic e.g. dust from fungus spores inside box girders, but the volume of dust is much smaller. Operatives and supervisors who work in these

conditions should be suitably protected. Although protection during wet abrasive blast cleaning is also necessary, the wetted particles are more easily contained in the Work area.

7 When the existing paint system on the structure is found to contain lead the use of closed circuit ultra high pressure water blasting (which combines water blasting, filtration and vacuum) should be considered.

8 Highly volatile solvents can cause illness very quickly during paint application. Less volatile but strong smelling solvents may not be so injurious but can be temporarily almost as disabling. Some pigments and media are also toxic. Appropriate protection and control measures, in accordance with the paint manufacturer's health and safety data sheets, should therefore be taken by personnel likely to be affected by either handling or the close proximity of paints. Adequate ventilation is necessary particularly in enclosed spaces such as inside box girders.

9 Where the maintenance painting is to be undertaken over a road open to traffic, the need for traffic management and other measures to protect road users should be implemented.

NG 1971 Maintenance Provision - Surface Preparation – General Requirements

1 In most cases the use of a cleaning agent followed by rinsing is considered to be more effective than the use of a solvent. If traces of oil or grease remain after the first attempt, further cleaning may be necessary. However, if wetting of the surface is not permissible, use of a solvent may be necessary.

2 It should be ensured that, throughout the duration of the Work, clean water is used for wet cleaning and rinsing. Generally, potable water will be satisfactory, but there should be a check that the water (or the cleaning agent) does not leave harmful residues on the surface. Warm water may be used where appropriate.

3 There should also be a check that the cleaning agents offered do clean satisfactorily and do not themselves leave harmful residues on the surface after final rinsing. Abrasives should be checked for freedom from impurities, which could contaminate the surface to be cleaned.

4 It should be ensured that the necessary information and equipment for the optical and chemical checking of surfaces for freedom from corrosion products and contamination are available (see Clause NG 1973).

The appearance of surfaces prepared to clean steel or sound metal coating can be checked satisfactorily for residues of rust and other corrosion products or impacted dirt with a 10x illuminated magnifying glass. Although a magnifying glass can also be used on dry surfaces for an initial check for soluble salts, a final check has to be made using reagents, especially after wet blast cleaning or cleaning down.

In cases of heavy contamination, more intensive or repeated surface preparation may be necessary. The Contractor will be expected to have sufficient expertise to recognise such areas when the extent of the work is ascertained.

5 Dry methods or closed circuit wet methods of surface preparation should be specified for the inside of box girders otherwise excessive water will accumulate on the bottom surfaces especially between stiffeners. Appropriate ventilation should be provided as surfaces may remain wet for some time and delay painting. The internal surfaces of hollow sections which are to be coated should be free from dust and debris as far as practicable.

6 Although the initial surface preparation may have been satisfactory, and all dust and debris removed, further dust may well collect on the cleaned surface. In harsh environments further pollutants may also be deposited. It is essential, therefore, to check surfaces immediately before painting.

7 As part of good practice feathering of existing paint should take place, exposing weak edges.

8 Unless otherwise specified fasteners should be prepared and painted to the same standard as adjacent main surfaces, if special treatment of fasteners is required, this should be specified in Appendix 19/7.

9 One or two typical joints should be included in the procedure trials to verify the efficiency of techniques for freeing joints of water or for preventing its ingress. If a wet joint is suspected, dry compressed air should be used to free the joint of water, after the surface preparation at the joint has been completed. If painting is undertaken in winter months, then

it may be necessary to apply heat to dry out joints. During dry warm weather, the problem will be less severe although it should be ensured that water penetrating the joint as a result of surface preparation, is removed.

The use of sealants which set hard should be avoided unless they are known to adhere well and not to shrink.

NG 1972 Maintenance Provision - Surface Preparation- Materials and Methods

Abrading

1 Abrading and blast cleaning are the two basic methods for removal of unsound coatings. Scraping and wire brushing alone will not achieve an adequate standard of cleanliness and are therefore considered as no more than an aid in removing thick rust scale, encrusted dirt and paint from areas which should then be abraded. Other methods such as flame cleaning may be specified by the introduction of additional clauses. IS EN ISO 8504-3 describes methods for hand-tool and power-tool cleaning of steel substrates before application of paints and related products. It applies both to new steelwork and to steel surfaces that have been coated previously and that show areas of breakdown requiring maintenance painting. It also describes the equipment to be used and the procedure to be followed.

2 Wet abrading by hand is often preferred for surface preparation of hot dip galvanized only or hot dip galvanized and painted parapets.

Wet abrading may also be used for cleaning down finishes over sound paint where any underlying thermal metal spray coating is protected by an adequate thickness of paint. However, if the coats are unsound, water should not be used.

3 Power wire brushing, whether or not preceded by chipping or scraping, is unlikely to achieve a satisfactory standard of cleanliness and is therefore considered as no more than an aid prior to abrading.

4 Abrading will be used mainly to repair mechanical damage and during restoration of local failure in the paint system. Water should not be allowed to come into contact with exposed thermally sprayed metal coatings which are porous, nor if possible with bright steel. However, wet abrading can be usefully employed where hot dip galvanizing is present.

5 Only power tools which rotate at the relatively high speeds necessary for abrading or power wire brushing should be used. The use of hard grinding wheels or discs is not permitted for abrading as their edges can easily cut into the surface.

6 Electric drill speeds are relatively slow, the use of hand-held drills as a power source for wire brushing often results in a polished appearance due to the formation of a patina of pollutants and corrosion products.

7 Sub-Clause 1972.5 caters for the protection of exposed areas of cleaned steel substrate or thermally sprayed metal coatings before they can be adversely affected by wetting or debris from adjacent surface preparation.

Dry or Wet Cleaning

8 It should be ensured that the selected cleaning agent is used at the recommended concentration.

9 Dry cleaning is usually satisfactory for internal surfaces as these are less likely to have become contaminated. Nevertheless these surfaces should be checked before painting and further cleaning carried out if necessary. If this is unsatisfactory, advice should be sought from the National Roads Authority.

10 Metallic grit particles embedded in the existing paint or steel surface should be dislodged during cleaning down, otherwise they should be dislodged by scraping as described in sub-Clause 1972.10.

Dry Blast Cleaning using Dry Air/Abrasive System

11 The abrasive offered by the Contractor for blast cleaning should be checked for impurities as these may contaminate the surfaces to be cleaned (methods for checking for impurities are given in IS EN ISO 8502). If the type, grade and particle shape offered are appreciably different from those of the abrasive used during the procedure trials then the results that were achieved at that time are unlikely to be repeated during the Work.

12 If particles of abrasive are allowed to fall onto a freshly painted surface they are likely to become embedded in the wet paint. Embedded abrasive in fresh paint should be removed, and if necessary, the affected coat restored. If dried films only have been affected, wet cleaning may

prove effective in removing such surface dust, however, careful checks should be made.

13 Copper slag can be used to blast clean steel surfaces, also to remove unsound paint; however, if surfaces have become heavily contaminated, dry blast cleaning may not be adequate and wet blast cleaning may be necessary. Modern and efficient blast cleaning equipment, which will recirculate metallic abrasive, is available. The requirements for fasteners are covered in sub-Clause 1971.9.

Sand (or other substance) containing free silica may not be used as an abrasive for blast cleaning.

Wet Blast Cleaning using Low Pressure Air/Water/ Abrasive System

14 The main advantages of wet blast cleaning are that it keeps dust down and that it is the best method of removing heavy contamination and soluble steel corrosion product. It should not be used to clean up thermally sprayed metal coatings because they are porous. Wet blast cleaning will not produce a profile on the surface and should not be used as the only method for surface preparation of steel. It should only be used on bolted connections if dry blast cleaning is impractical, otherwise water will penetrate into the joint. It is, however, satisfactory for welded joints which are to be painted, also for cleaning up or removing paint over a steel substrate.

15 Unless blast cleaned and adjacent surfaces are cleared of abrasive and debris within a short period, re-contamination is likely.

Wet Blast Cleaning using High Pressure Water/ Abrasive System or Ultra High Pressure Water System

16 The efficiency of the equipment selected by the Contractor should be checked during the procedure trials. Wet blast cleaning will not produce a surface profile and should not be used as the only method of surface preparation of steel.

17 No flash rusting should occur after ultra high pressure water system cleaning.

Combined Wet/Dry Blast Cleaning

18 When wet blast cleaning is used to prepare steel surfaces, flash rusting may occur if painting is delayed. The required standard of cleanliness should be restored by light dry blast cleaning and paint should be applied while the surfaces are still clean.

19 As already mentioned, one of the main advantages of wet blast cleaning is its effectiveness in removing contamination; however, if this is not achieved using wet blast cleaning any subsequent light dry blast cleaning, although it may restore a clean appearance, is unlikely to remove contamination remaining on the surface or in the blast cleaned profile. For very heavy contamination ultra high pressure water/abrasive system cleaning should be considered, as in this method heat is generated by the impact energy of the water on the steel, which will assist in contamination removal.

Other Requirements

20 If water from cleaning down, and debris from abrading, spreads onto blast cleaned and freshly painted surfaces, the paint is likely to be damaged or contaminated. On the other hand, when dry blast cleaning is carried out last, the dry dust and debris can be removed without difficulty from the surfaces of cleaned down existing coatings. This also applies to wet blast cleaning debris which, in any case, has to be washed off within 1 hour. Areas of metal spray coating which have been prepared to bright metal should be protected before they become wetted for any reason, e.g. rain, condensation as well as by washing down water. This problem does not arise with hot dip galvanising which is not porous. Local areas of steel substrate or metal coatings which have been prepared and then painted to protect them from adjacent washing down, as required by sub-Clauses 1972.5 to 7, 1972.20 to 22 and 1972.25 should also be rinsed using clean water at the same time as the adjacent areas are finally rinsed down.

21 The removal of deposits from the workpiece and adjacent surfaces after wet blast cleaning is important otherwise serious recontamination of the surface may occur. A scatter of abrasive particles and minor spot or flash rusting can be removed by the subsequent dry blast cleaning.

22 Sub-Clauses 1972.20 to 22 are important sub-Clauses as they inform the Contractor of the sequence of operations necessary to keep contamination of adjacent surfaces to a minimum when different methods of surface preparation are used.

Grinding After Surface Preparation

23 Grinding has to be carried out carefully without damaging the surface and only skilled

operators should be allowed to carry out this work. It should be ensured that checks for defects are undertaken as surface preparation proceeds and that these are remedied by the Contractor.

NG 1973 Maintenance Provision - Surface Preparation – Workmanship Standards

1 The standards of surface preparation which can be achieved on site are covered by sub-Clause 1973.1. The appropriate description should be used in Appendix 19/6 for the particular Contract for cross reference by the Contractor, this will enable him to ascertain the degree of cleanliness required.

2 Only the terms for the description of the standards of surface preparation listed in these clauses should be used in writing out Appendix 19/6 requirements. Failed paint and paint over rust scale and loose mill scale, also failed metal coatings of any type, are described as 'unsound' as they have to be removed (see sub-Clause 1973.2). The term 'metal coating' is used to describe zinc thermal metal spray, aluminium thermal metal spray and hot dipped galvanized coatings. It should be verified during the procedure trials that the Contractor is capable of detecting and removing unsound coatings and that the standard is maintained throughout the Work.

3 Prolonged surface preparation may be required to ensure that any remaining traces of contamination or corroded metal coating will not be detrimental to the existing or subsequent coatings.

4 Aluminium metal spray which has been properly applied in the first place is difficult to remove completely and therefore traces of firmly adhering aluminium may be allowed to remain in the profile. Fortunately aluminium is generally less affected by corrosion than zinc and the surface can usually be cleaned up satisfactorily. Complete removal, except for traces of clean aluminium, is only necessary when the coating has been badly applied, e.g. when there is evidence of dry spray or lack of adhesion, in which case the coating tends to disintegrate and can be blast cleaned off without difficulty. These faults should be looked for during the pre-specification survey and checked during the feasibility trials where these are carried out.

5 The various terms used to describe coatings e.g. unsound paint, and the extent of surface preparation and cleanliness e.g. clean steel, are defined. For practical purposes it will be seen that there are basically two requirements for surface preparation, firstly the workmanship or physical requirements (see sub-Clauses 1973.2 (i) to (vi)) and the requirements for chemical cleanliness (see sub-Clause 1973.1 (i) to (vii)). Also refer to IS EN ISO 8504-1 to -3.

6 There are, broadly speaking, three types of surfaces to be checked for satisfactory surface preparation, viz. a steel substrate, a metallic coating and paint coating. Some of the contaminants and most corrosive agents will affect each type of surface differently; also any resulting corrosion products will be different. The method of surface preparation has a bearing both on the appearance and on chemical cleanliness. Wet blast cleaning and wet cleaning down will remove most contamination more effectively than dry blast cleaning or dry brushing down. The appearance of a rusted and pitted surface after dry blast cleaning may be satisfactory, but where steelwork has been exposed in a harsh environment, considerable quantities of harmful soluble salts such as sulphates and chlorides will remain in the surface profile and in any pits. It is also the case that it will be more difficult to free paint coats which have a rough surface, such as micaceous iron oxide, of contamination than it would be for a gloss finish. Pitted surfaces should be washed down and dried to remove contaminants.

7 Where feasibility trials have been undertaken, these will have enabled the surveyor's recommendations for specifying surface preparation to be verified; also by the time the trials have been completed, the methods of checking for cleanliness optically and chemically should have been established satisfactorily and thus be ready for use when the contract procedure trials take place. Unfortunately, at present there are no known published standards for tests or acknowledged safe limits for contamination, but refer to IS EN ISO 8502.

8 The most practical methods at the moment for detecting chemical contamination involve swabbing and noting the effect on indicator papers or liquid reagents. Some indicator papers are described as being 'semi-quantitative'; however, as commercial kits have not yet been designed specifically for the detection of contamination found on painted or steel surfaces of exposed structures such as bridges, final assessment is often done after analysing the swabbing water in a laboratory, when a judgement based on experience is made as to whether any remaining residues are likely

to be detrimental. Even so, the amount of contamination removed by a given swabbing technique will vary considerably according to the roughness of the surfaces, particularly if pitted. The various liquid reagents which require safe handling conditions on site show the presence only of contamination in the swabbing water by changing colour and do not indicate the quantity of contamination. When effective surface preparation methods are used, residues can usually be shown to have been reduced to trace levels. The inspection firms should have the necessary equipment for checking for contamination at site and in the laboratory and could provide a demonstration from one of their surveyors or inspectors during the survey or feasibility trials, or during the procedure trials at the start of the Contract. Contractors are aware of the problems of contaminants and will usually accept reasonable requirements. The requirements for each Contract, however, have to be considered separately.

NG 1974 Maintenance Provision - Metal Coatings

1 Effective protection is unlikely in areas where the thickness of a thermally sprayed metal coating is less than 100 microns. Although zinc metal spray is referred to in sub-Clause 1974.2, the use of aluminium metal spray is preferred.

Zinc metal spray will, however, have an application for other components e.g. temporary structures in a mild environment.

It is known that many failures of thermally sprayed metal coatings have been due to unsatisfactory surface preparation leading to poor adhesion. Application in two layers and poor application technique have also caused problems. Particular close inspection at all stages is essential. The standard of blast cleaning should be clean steel, medium profile using chilled cast iron grit, steel or aluminium oxide grit.

NG 1975 Maintenance Provision - Testing of Metal Spray Coatings

1 It is to be expected that Contractors undertaking thermally sprayed metal coating have the necessary expertise, particularly in respect to understanding the importance of a clean sharp blast cleaning profile and of being able to check adhesion with modern equipment. Nevertheless, it should be ensured that all the requirements are being met, otherwise experience has shown that early and very expensive failures can occur. Adhesion tests should be made in accordance with recommendations of the manufacturer of the testing equipment, for example the pull-off force should be normal to the surface. Usual reasons for lack of adhesion are bad application techniques or blast cleaned surfaces which have been exposed, even for a short time, in a damp environment and have lost their initial bright finish. When the overall adhesion is suspect, all the thermally sprayed metal coating should be blast cleaned off the area in question as obviously any residual thermally sprayed metal coating may also be defective. In the excepted areas, adhesion cannot be checked by the test panel method; the only practical method being the grid test described in IS EN 22063 Annex A, carried out as the Work proceeds.

NG 1976 Maintenance Provision - Paint and Similar Protective Coatings

1 Grease paints are protective coatings based on Calcium Soaps of Oxidized Petroleum Wax and are applied by brush or airless spray and are similar in appearance to ordinary paints but do not harden completely. When the solvent has evaporated grease paints are hard enough to walk on.

2 Appendix 19/6, Form BE/P1 (Maintenance) Paint System Sheet should be checked to ensure that the registered dates have been entered by the Contractor.

3 Tins should show all the specified markings and the required standard should be insisted on at the outset. Omission of the Item Number for example, can lead to delay in checking the specific gravity on site and the despatch of 'A' and 'B' samples.

4 In practice, a paint manufacturer issues Appendix 19/3, Form BE/P2 Paint Data Sheet, to the Contractor. The Data Sheets should be examined and any special stipulation as to application which may cause problems or delays during the Work should be noted and brought to the attention of the Contractor. If, for example, the weather is likely to be unfavourable the Contractor should be fully aware of any relevant restrictions on the application of the paints.

5 A source of supply should only be rejected after consultation with the Employers Representative.

Standard Terminology for the Description of Paint

6 Standard Terminology enables paints to be described in generic terms and without specifying trade names. It is used for the Registered Description in Paint System Sheets, in Data Sheets and in the Specification and should convey the following information in the order given:

(i) Name of Pigment: where a pigment provides inhibitive or structural properties it should be named, e.g. MIO, Zinc Phosphate. Where pigments provide colour, opacity or act as extenders etc. the pigments should not be named.

(ii) Type of Medium: the type of medium should be stated, e.g., M/Phenolic, Phenolic (i.e. pure Phenolic), Silicone Alkyd, Polyurethane, Epoxy (two-pack). (See below for meaning of abbreviations.)

(iii) Use: i.e. Blast Primer, Primer, Undercoat or Finish. If two-pack, add '(two-pack)'.

The first coat only of a new system is described as a Blast Primer or Primer, all subsequent intermediate coats are described as Undercoats, the last coat being the Finish. A Primer or Primer/Undercoat (i.e. a dual purpose paint) may be specified when it is desirable to obtain a relatively high film build in the first coat, usually for small areas on site.

(iv) Colour: a descriptive colour should always be stated as part of the Registered Description in Appendix 19/6, Form BE/P1 (Maintenance) Paint System Sheet.

Convenient abbreviations have been introduced where these can be readily understood and used in Specifications, e.g.:

MIO	Micaceous Iron Oxide
M/Phenolic	Modified Phenolic
MC Polyurethane	Moisture cured Polyurethane
HB	High build
NB	Normal build
LB	Low build
QD	Quick drying

Terminology Used in Painting Practice

7 For definitions of terms used in painting practice reference should be made to BS 2015 and IS EN ISO 4618. Specific meanings of the descriptions of workmanship standards for surface preparation of steel and coated steelwork are given in Clause 1973.

NG 1977 Maintenance Provision - Surface Preparation and Protective Systems

Protective Systems

1 The types of protective systems for steelwork are outlined below:

The following systems are suitable for all environments and all access situations. All protective systems types, except for Type V (M) grease paints, should not require major maintenance up to 20 years.

2 Using the information provided in parts 3 to 9 in Appendix 19/6, Form BE/P1 (Maintenance) Paint System Sheet, the protective systems in Table 19/7 should be detailed by the Contractor in the remainder of Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet for bridge steelwork and parapets, gantries and other structures, bearings, CCTV masts, cantilever masts, steel lighting columns and bracket arms.

TABLE NG 19/2 - Summary of Protective Systems

Type	Description	Application on to	Comment
I (M)	High Build Epoxy (two-pack)/Polyurethane (two-pack) finish systems	External steelwork where the existing protective system is removed by blast cleaning over the whole of the surface area down to clean steel or sound aluminium or zinc metal spray coating	Suitable for application when steel and ambient temperatures are at or expected to be above the minimum specified in sub-Clause 1981.6.i during the curing period
II (M)	Moisture cured Polyurethanes (two-pack) systems	(small areas may be abraded).	Suitable for application at night-time when temperatures are low and when some surface moisture (but not running water) may be present on the steelwork surface due to the high relative humidity (RH) levels, however adequate levels of ventilation should be ensured.
III (M)	Epoxy/ Polyurethanes finish systems	Hot dip galvanizing treated with Item 155 or other adhesion promoter	MIO epoxy undercoat (Item 112) or slow curing single coat MIO epoxy (Item 121) which provides excellent adhesion properties for the treatment of galvanized surfaces which have been prepared using an adhesion promoter.
III (M) Alternative	Extended Cure Epoxy/ Polyurethanes finish systems	Hot dip galvanizing	Slow curing single coat MIO epoxy (Item 121) which provides very good adhesion properties for the treatment of galvanized surfaces.
IV (M)	MC/Epoxy/Polyurethane systems	External steelwork where the existing protective system is removed by blast cleaning over the whole of the surface area down to clean or Sa2 or St3 steel.	Not to be used when steel and/or ambient temperatures at the time of application or during the curing period are at or below 0°C.
V (M)	Grease paint systems	Where the remaining service life of the structure is less than 20 years or where the extent and intensity of surface preparation required to provide a surface suitable for applying a conventional paint system is technically unattainable or too costly to achieve.	Grease paints should not be used where there is pedestrian access, e.g. parapets on overbridges.

3 An Appendix 19/7 may be incorporated for situations where special preparation and/or protective systems may be required, or for other works requiring protection.

4 General

(i) The protective systems for bridge and other highway structures include systems which are satisfactory for sign gantries, footbridges, parapets and also for structures such as towers and buildings. Systems for structures which have to withstand especially aggressive conditions, salt hoppers for example, are not listed. Systems for traffic sign posts and plastic coated items are covered in Series 1200 and in Series 2600.

(ii) Colours of finishing paints and finish equivalent shall be agreed in writing with the National Roads Authority.

Semi-gloss Finishes

High gloss is usually stated as 75 or more gloss units (gu), on a 60° geometry head in accordance with IS EN ISO 2813. Semi-gloss (or sheen) is usually stated as 45gu (±10) on a 60° geometry head. When a semi-gloss finish is acceptable, or is specifically required such as for sign gantry steelwork, Item 169, low sheen polyurethane, should be used.

Appendices 19/6 and 19/7

5 The environment, accessibility, required durability of the systems, finish colour, the proposed sequence of operations and extent of surface preparation and painting required for the Works, should be written into Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet (parts 3 to 9): see Clauses 1982 and NG 1982. The factors to be taken into account in determining the descriptions are described below.

(i) Environment

Location of structures

Two locations are considered; 'Inland' and 'Marine'.

Structures out of reach of sea salt spray are considered as being 'Inland'. Structures which can be affected by sea salt spray are considered as being 'Marine'.

(ii) Accessibility

For maintenance painting purposes, structures are described as having either Ready Access or Difficult Access.

The description Ready Access would apply to structures where restrictions on working time due to road or rail traffic are likely to be minimal and where access on site is unlikely to be a problem.

The description Difficult Access would apply, for example, to a bridge or sign gantry over a motorway or to a bridge over a railway where painting is likely to be restricted to one section at a time or halted completely at certain periods when traffic is heavy.

It would also apply on two counts to a high bridge, say, without painting gantries and built over difficult terrain or a river where movement on the ground would be difficult and because extensive scaffolding would be required.

(iii) Required Durability

For the protective systems (except for CCTV masts, cantilever masts, steel lighting columns and bracket arms), the periods 'No maintenance up to 15 years,' 'Minor maintenance from 15 years' and 'Major maintenance after 20 years' will be sufficiently accurate for both access situations and the environments described in this Clause. However when access is especially difficult, e.g. when dismantling of cover plates is necessary, a special system may be required. In such a case the usual periods for 'No maintenance' and 'Minor maintenance' would not be applicable (N/A); 'Major maintenance' being given as, say, 20 years, or even 25 years.

For the protective systems for CCTV masts, cantilever masts, steel lighting columns and bracket arms, the 'required durability' of the exterior coatings, which consist of aluminium metal spray plus sealer, hot dip galvanizing only or one of these metal

coatings plus a paint system, is no maintenance up to 8 years, minor maintenance after 8 years and major maintenance after 15 years.

(iv) Description of Existing Protective System(s)

The existing protective system(s) should be described briefly, the various coats, including metal coatings, being named as accurately as possible. On older bridges, where there may be as many as 20 coats, a group description should be given together with an estimate of the average total thickness. A description of coats of lead based paints and other materials which may become health hazards during surface preparation should be included.

(v) Sequence of Operations

In most cases it will be adequate for the sequence of operations to be as proposed by the Contractor. However, when the Work has to be carried out in a special sequence, detailed requirements should be given in Appendix 19/7.

(vi) Surface Preparation

It is important that the principle of specifying 'Method' and 'Standard' using the appropriate references to Clause 1972 and 1973 should be followed carefully, also each part of the structure and the surfaces to be painted on each part should be described accurately.

If parapets are included in the maintenance painting contract for a bridge, and a different paint system is required, then the system for the parapets should be listed separately and a separate Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet provided. For parapets and similar items, where there may be many small areas requiring different methods of surface preparation and painting, the method of billing may be by length, all variations being allowed for in the price.

The various parts of the structure should be referred to as Area A, B, C etc, and a standard method of surface preparation and paint system should be specified and billed separately for each part, minor variations in the amount of work being ignored. However if there is a large area where different surface preparation and protective coatings, e.g. where different intensities of abrading are required the related cleaning down and painting therefore have to be specified and billed in detail, as is necessary.

In the case of work by Contract, the paint coat summary is intended to make clear to tenderers the system required for each of the prepared surfaces, and assists in the pricing of like for like.

(vii) Calculating Paint Quantities and Costs

(a) The minimum dry film thickness (mdft) of a coat of paint is the specification requirement from which the amount of paint to be ordered and cost of paint are calculated.

(b) The quantity of paint required for painting a known area to a specific minimum dry film thickness is a function of a number of criteria:

- The volume solids of the paint.
- The degree of roughness for the surface to which the paint is to be applied. The roughness is mainly created by the blast cleaning process, and in particular by the particle size of the abrasive used in the operation. The coarser the abrasive, the greater the 'peak to valley' height produced, and the larger is the quantity of paint required to fill the profile before measurable dry film thicknesses over the peaks is achieved.
- The amount of over-application and uneven application of paint, overspray wastage, and wastage due to losses in containers, equipment, and spillage etc.
- The shape, configuration and complexity of the structure to be painted.

(c) The volume solids of a paint is the ratio of solid components remaining after evaporation of solvent, expressed as a percentage of the volume of the wet film.

Calculation of the theoretical quantity of paint required to cover a known area on a smooth plane surface is based upon the following relationship:

1 litre of paint at 100% volume solids will cover an area of 1 square metre to a thickness of lmm (1000 microns).

The theoretical spreading rate for a particular product is calculated from the volume solids of that product using the following equation:

Theoretical spreading rate (metres2/litre)

$$= \frac{\text{Volume solids} \times 10}{\text{Required dft (microns)}}$$

The volume solids should be determined using IS ISO 3233.

Other methods of determining and expressing volume solids are sometimes quoted by paint suppliers. Some of these alternatives lead to a higher value of volume solids and hence a more optimistic theoretical spreading rate, which may not be achieved in practice.

(d) Factors indicated in (vii)(b)(2nd and 3rd bullets points above) affect the actual spreading rate, which is derived from the theoretical rate. Extra paint must be allowed for, to take these factors into account. The most significant of these factors is normally the peak to valley height of the blast profile (vii)(b)(2nd bullets point above). For a blast profile of 60 microns it is necessary to apply an extra quantity of paint equivalent to a dft of approximately half the peak to valley height i.e. an extra 30 microns of dft before measurable thickness occurs. In a specified 50 microns primer coat, this would result in an increase of 30/50 or 60% over the theoretical quantity required over a smooth surface. A blast profile with a peak to valley height of 100 microns would result in 100% increase over the theoretical quantity for the same primer coat. The effect of blast profile on subsequent undercoats and final coats will be much less significant.

The skill of the applicator and the awareness of the Inspector checking the Work play an important part in determining the extent of losses from over-application. By exercising careful control of paint fluid pressure and by the constant use of wet film thickness gauges to monitor paint application, excessive wastage can be avoided.

The responsibilities of the Contractor with respect to the application of paint are clearly stated in sub-Clause 1981.8.

Estimated percentages of extra paint to allow for factors 2(iii) and 2(iv) will vary significantly. At best they can be as low as 20%, but can also be as high as 60%, for complex geometric structures such as lattice girders.

(e) Calculation of Paint Costs

Comparisons of price between different brands of paint, which may have different volume solids content should be based upon the following steps:

Step 1 Determine the theoretical spreading rate for the required dry film thickness, as follows:

Theoretical spreading rate (m2/litre)

$$= \frac{\text{Volume solids} \times 10}{\text{Required dft (microns)}}$$

Step 2 Divide the price per litre by the theoretical spreading rate to arrive at a cost/square metre

Cost per square metre

$$= \frac{\text{Price/litre}}{}$$

Theoretical spreading rate

Step 3 Theoretical overall cost = (Cost per square metre) x (total area)

Step 4 Practical overall cost = (Theoretical overall cost) x (factors considered in paragraph (vii)(d) above)

(viii) Paint system(s) and application instructions

Although the methods of surface preparation of the main steelwork are specified separately, each maintenance paint system should be specified as one continuous operation in the order in which the Contractor will be expected to carry out the Work. For example, the 1st coat to be applied may be a patch primer for application to local areas abraded to bright steel, the next coat, i.e. the 2nd coat, may be a blast primer to be applied over areas of clean steel, the 3rd coat may be an undercoat applied over the 1st and 2nd coat, the 4th coat may be an undercoat applied over the 2nd coat. Painting instructions on the amount of overlap and method of application should also be given as appropriate in Appendix 19/7 if different from standard.

Excepting for small areas of overlapping, e.g. inside corners and where application is particularly difficult, the local dry film thickness for any primer should not exceed the specified mdft by more than 30% and for other paints by more than 75%. This is particularly important if the specified mdft is on the upper limit of the range given in the Manual.

Experience has shown that any special instructions should be listed separately under 'Special application instructions' in Appendix 19/7.

The application of a coat should only be specified over areas which have a clear demarcation. For example, once an overall undercoat has been applied, it is not practical to specify that the next coat should only be applied over areas previously blast cleaned.

For specification purposes, a patch is an area in an existing system, which is abraded or blast cleaned down to sound paint (viz not to a steel substrate or metal coating) and which, prior to applying overall coats, is required to be patch painted in order to provide the extra dft necessary for protection. Areas prepared down to a steel surface or to a metal coating will require a full paint system and are not termed patches - even if the areas are small. Paint for patching is called off separately and not with the paints for the system, one or two of the undercoats being specified for this purpose. Generally patches will be less than, say, 0.5 m2. Only very exceptionally will the finished appearance be of sufficient importance to warrant applying extra patch painting over and above the thickness necessary to provide protection, that is to match the thickness of the old surrounding paint in order to provide a virtually even surface. Where patch painting has been carried out, the total dft of the old coats plus patch coats and overall new coats should not be less than 250 microns and, with the exception of parapets having ready access, not less than 350 microns in harsh environments for steelwork not having a metal coating. The total dft of old coats plus patch coats and overall new coats on parapets not having a metal coating, but with ready access, should not be less than 250 microns.

(ix) **Dry film thickness**

Paint coats which are applied at too great a thickness may have to be left to harden considerably longer than the recommended overcoating time otherwise solvent may be trapped causing blistering of the next coat(s). Also, overthick application may give rise to crazing or cracking or other surface defects, especially if exposed to heat before the coating has hardened.

(x) **Special application instructions**

If special methods are required for applying paint, say, at bearings or expansion joints, or due to environmental conditions, then these should be specified in Appendix 19/7.

(xi) **Paint products**

Requirements for the quality assurance scheme and certification of

paints are given in BD 35 'Quality Assurance Scheme for Paints and Similar Protective Coatings' (DMRB 2.4.1). All paints to be used in the Works should have a current IAB, BBA HAPAS Road and Bridges Certificate or equivalent.

(xii) **Colour**

When a BS colour is specified in Appendix 19/6, Form BE/P1 (Maintenance) Paint System Sheet, the BS 4800 reference should follow the descriptive colour, e.g. green-yellow 12 B 21.

Additionally any special finishes should be stated, e.g. low sheen.

6 The choice of system will depend finally on the type of structure, especially in the case of a bridge and the expected service life of structure based on its use.

NG 1978 Maintenance Provision - Testing of Paints

Provision of Samples

1 Paint testing shall be undertaken by the appointed independent testing authority and an independent testing laboratory which shall both be CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8, or an equivalent testing authority and/or testing laboratory in any member state of the European Community as agreed with the National Roads Authority.

Provision of Samples

2 Quality assurance of paint as delivered, that is verification of the composition data and application characteristics given in paint manufacturers' registered formulations, can only be carried out on paint samples taken from previously unopened tins; these are known as 'A' samples.

Before the Contractor despatches the 'A' Samples to the address given in sub-Clause NG 1978.6 or 1978.7 for testing in accordance with Clause 1978, the checks referred to in sub-Clause NG 1978.4 below should be carried out but on paint taken from other tins of the same batch.

'B' samples on the other hand, should be taken from paint in use to ensure that it is as supplied. See sub- Clause 1978.9 and sub-Clause NG 1978.10.

'A' Samples

3 Although 'A' samples are not required in the case of certain bridge and other highway structures described in sub- Clause 1978.5, 'B' samples should still be taken as these make an effective contribution to quality control.

4 Special deliveries of single tins of paint arranged by the Contractor, to the site or to the testing authority, are not acceptable as 'A' samples. Samples should be selected from fully representative batches. As a minimum, the condition of the paint in the tins should be examined and, after mixing, the specific gravity should be checked; matching of finish colours to BS 4800 should also be checked. Paint found to be faulty, especially in the case of appreciably incorrect specific gravity should be rejected on site. The Supervisor is required to check the specific gravity of paints before despatching 5 litre 'A' samples and 500 ml 'B' samples to the testing authority for testing. When the specific gravity of paint samples is appreciably incorrect, then the paints should be rejected in the Works or at site, testing of samples by the testing authority being unnecessary. Painting inspectors will, in most cases, have the experience to know when to reject a paint which has an appreciably high or low specific gravity. For example, the Inspector will know that a ± 3 % difference on the specific gravity of, say, an MIO phenolic paint is not as critical as a ± 3% difference on, say, a Silicone Alkyd Finish.

The following specific gravity tolerances are a useful guide for the Supervisor in deciding whether or not samples should be despatched to the testing authority for testing:

Paints with a specific gravity up to 1.4: + or - 3%

Paints with a specific gravity greater than 1.4: + or -4%

The method of test to be used for determination of specific gravity is in accordance with IS EN ISO 2811-1. It should be ensured that the cause of any unsatisfactory application during the procedure trial is remedied before the start of the main painting.

5 After submission of the first 'A' samples of each type of paint, further 'A' samples should be submitted for testing as painting proceeds depending on the quantity of paint to be used in the Contract.

The Contractor may deliver paints to the site in containers up to 25 litres providing that the tops are of the completely removable clip-on type and that the contents are thoroughly stirred using a mechanical mixer when taking samples and prior to use. 'A' samples should be correctly labelled before despatching for testing.

6 Details of each set of samples despatched should be listed in Appendix 19/4, Form BE/P3 Paint Sample Despatch List.

A copy of each form should be forwarded immediately to the National Roads Authority, the Employers Representative and a further copy to CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8, which is the testing authority unless agreed otherwise with the National Roads Authority.

Single copies of completed Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be sent to the addresses as above, at the same time that Appendix 19/4 Form BE/P3 Paint Sample Despatch List is forwarded for the first 'A' samples or first 'B' samples (if 'A' samples are not required).

[Not used] Results of tests will be notified by the Employers Representative. The Employers Representative will report all results of the testing to the Specialist Required for the Design, as stated on Appendix 19/4 Form BE/P3, who will then notify the Contractor of the results.

Non-receipt of paint samples for testing, for which an Appendix 19/4 Form BE/P3 has been received, will be notified by the Employers Representative.

7 It should be noted that at the height of the painting season, testing and assessment of the first 'A' samples may take 2 to 3 weeks. Unless special arrangements can be made with the testing authority for priority testing of samples, the Contractor cannot be expected to start painting under 3 weeks from the time of awarding the Contract.

Once the Contract has been awarded, the Contractor should order paint early enough to enable the first 'A' samples to arrive at the testing authority at least 3 weeks before painting is due to start, or sooner if possible, so that the results of the analysis can be assessed in time. Also, throughout the Work, the remaining paint should be ordered sufficiently in advance to allow time for testing subsequent 'A' samples.

About 2 weeks are required for testing 'B' samples.

8 Painting may be permitted to be started before the results of testing 'A' samples have been received only if postponing the painting would mean an unacceptable delay in the Work; however, such permission should not relieve the Contractor of his obligations under the Contract. When a first 'A' sample is rejected, an 'A' sample of the replacement batch of paint should be submitted for testing as soon as possible. If painting is allowed to proceed with a replacement batch or a subsequent batch still under test, such permission should not relieve the Contractor of his obligations under the Contract.

'B' Samples

9 Control or 'B' samples for single component paints are to be taken from the painter's kettle or from the airless spray gun nozzle, in order to ensure that paint actually being applied will be tested. Samples should be taken as spot checks, with a minimum of, say, one batch in three being sampled. 'B' samples of mixed two-pack materials can only be tested on site and before any reaction has taken place. In addition, for two-pack material, separate samples are to be taken of the components and dispatched to laboratory for analysis.

Provision of 500 ml Tins, Packaging and Transport of 'A' and 'B' Samples

10 It should be ensured that there are an adequate number of tins, lids and lid clips at the start of the Work to enable samples to be taken.

11 Unless tin lids are clipped down securely, and the tins properly packed, the contents may be spilled. Even if only one tin leaks, the spilled contents may obliterate markings on other tins, thus delaying testing until new samples are checked and delivered.

12 The selected 'A' or 'B' samples should be labelled correctly as described in Appendix 19/4 and despatched promptly throughout the Contract. Not only should the Contractor despatch samples promptly, but his transport arrangements should be such that the samples reach the testing laboratory without delay, particularly in the case of the first 'A' or 'B' samples.

NG 1979 Maintenance Provision - Storage Requirements and Keeping Periods for Paints

1 The Contractor should ensure that suitable storage has been provided and that paint is unloaded directly into it. The store temperature should be controlled within the limits specified. Extremes of temperature, freezing conditions in particular, can affect the properties of the paint. The paint store should be as near as practicable to the painting areas. If the paint store is at a considerable distance from the Work area, paint is unlikely to be returned to the store at the end of the working day, or several tins may well be kept out on site to be ready for use and thus may be damaged by extremes of temperature; also if the inspector has to waste time in journeying to and from the paint store to check deliveries and select samples, his supervision of the Work will be less effective.

2 The date of manufacture in particular should be marked on the tins (see sub-Clause 1976.3). If the date of manufacture is not indicated, the paint should always be rejected.

3 The requirement that paint in use should be returned to store and keep in sealed containers should be enforced for both brushing and airless spray grades. Paint with fast evaporating solvents will be adversely affected if the containers are left open in hot weather.

4 Only the types of paint referred to in sub-Clause 1979.4 should be considered for extended keeping times. The performance of other paints can be permanently affected if their keeping times are exceeded. The paint manufacturer's checks will include the following:

Property	Likely fault
Condition in tin	Settlement, skinning, separation
Viscosity	Tendency to body
Drying time	Absorption of dryers
Fineness of grind	Pigment agglomeration, resin 'seeding'
Colour	Flocculation, agglomeration of colour pigments

Lastly, the paint manufacturer will verify that the specific gravity of the paint about to be returned to site after any necessary reconstitution is correct.

5 Paints which have exceeded the keeping period before delivery, or during storage before or after testing under Clause 1978, should not be used. These paints should not be tested or re-tested until the requirements of sub-Clauses 1979.4 and 5 have been complied with. Remains of moisture cured type coatings in opened tins, should be discarded at the end of the Work shift.

NG 1980 Maintenance Provision - Procedure Trials

1 Procedure trials are to ensure that the Contractor has the necessary knowledge and expertise and that, with the supervision, labour and equipment he proposes to use, the Contractor is capable of carrying out the Work in accordance with the Specification.

2 The National Roads Authority attach considerable importance to procedure trials and permission to omit them shall only be given in exceptional circumstances or in the case of very minor works.

3 If changes in any paint formulation appear to be necessary, the Contractor should arrange for the paint manufacturer to make the necessary adjustments and forward the revised formulation to the National Roads Authority, Employers Representative and a further copy to CREST (Centre for Research in Engineering Surface Technology), FOCAS Institute, DIT Kevin St, Dublin 8, which is the testing authority unless agreed otherwise with the National Roads Authority, and verify that the revised formulation is acceptable before agreeing to its application.

4 The requirement for further trials may be relaxed providing the Contractor can furnish evidence to demonstrate that replacement labour has the necessary skill and experience and that new equipment is suitable.

NG 1981 Maintenance Provision - Application of Paint

1 The level of supervision of the application of paint will depend on the type and importance of the project, the degree of difficulty of the Work and local conditions, and on the type of coating and its intended service life. Supervision should be undertaken by suitably qualified and experienced people. The Contractor should be responsible for carrying out this supervision, but additional supervision by the Employers Representative is advisable, even for corrosion protection work in the workshop. Guidance on the selection of Painting Inspection firms and their duties is given in the NRA Addendum to BD 87 'Maintenance Painting of Steelwork'.

2 In exceptional circumstances additional solvent may be required when painting is carried out at extremes of temperature or to correct a minor deviation from the normal viscosity.

3 It should not only be checked that surface preparation has been carried out in accordance with the Specification but also that the standard has been maintained up to the time of application.

4 Paints and other protective coatings in the Manual of Paints for Structural Steelwork (NRA Addendum to BD 35) are generally applied either by brush or airless spray or by both. However, for paints with low viscosities e.g. aluminium epoxy sealer, good use can be made of air assisted spray equipment to avoid over application, flooding and overspray of paint.

The use of rollers has been found to be unsatisfactory and should not be permitted.

5 Work should not proceed outside the limits specified in Clause 1981. Records should be kept, as these will be required should any premature failure occur.

Difficulties may arise on site in deciding when a surface is dry enough to paint. Most types of paints, besides MC systems, are intolerant of moisture at the time of application and during the curing period. Generally, the rule should be, if moisture is present or may be expected to be present at the time of application or during the curing period, then painting should not go ahead. IS EN ISO 8502-4 provides guidance on the estimation of the probability of condensation prior to paint application and IS EN ISO 8502-8 describes the field method for the refractometric determination of moisture on a steel surface.

6 A check on the amount of paint used after allowing for waste is a useful verification of film thickness.

7 A record of wet film thickness checks should be kept. Non-destructive checks of total mdft are unlikely to be conclusive although they are useful as a guide. If there is any doubt about the mdft of the complete system, it is possible to cut out 10mm x 10mm samples and have these checked. The usual practice however is to make an angle cut using cutting tool edge angle as IS EN ISO 2808 into the system and to check the thickness of each coat with a small viewing microscope fitted with a graticule. A proprietary instrument of this type is available. Equipment necessary to carry out these checks should be kept on site. Destructive tests on paint coats should be kept to a minimum and only used to confirm dry film thicknesses in cases of dispute.

8 Defects are, as often as not, due to inadequate surface preparation rather than application of faulty paints. Compliance with the Specification, especially the requirement for satisfactory adhesion, should be checked from the time work starts and not left until the Contractor has dismantled his scaffolding and is about to leave the site. Remedying faults in a difficult access situation, such as over a motorway, is usually time consuming and expensive.

Stripe Coats

9 During film formation or drying paint has a tendency to pull away from corners, and even if the specified minimum total dft can be attained by careful application it is unlikely to be maintained and stripe coating is always necessary. Stripe coat(s) should be specified in all areas taken down to a steel or metal coated surface and in all areas taken down to sound paint. It should be ensured that the first stripe coat on fasteners treated with Item 155 is brush applied carefully, any final

traces of grease should be removed beforehand using a solvent, and not by wet cleaning. On small square bars a single extra undercoat replaces the stripe coat(s). For stripe coat details for CCTV masts, cantilever masts, steel lighting columns and bracket arms see sub-Clause 1984.1.

Except for the above, application of stripe coats by airless spray is acceptable, and in most cases gives better and more uniform results. However, in areas where space is restricted or when the system itself is brush applied, the Contractor will usually opt for brush application of stripe coats. 'Brushing out' of stripe coats should be avoided otherwise little paint will remain on the corners.

Exposure Times for Prepared Steel Surfaces and for Metal Coatings

Exposure Times and Treatment of Item 155 and Overcoating Times for Paints

10 The times quotes in sub-Clauses 1981.23 to 30 are basic requirements when painting is carried out in average conditions. However, longer or shorter exposure times may be permissible depending on conditions. For example, in an environment where the relative humidity is low, clean steel which has been dry blast cleaned, can be left for longer than 4 hours provided that there will be no adverse effect. Exposure times for sealed thermally sprayed metal coatings may also be extended in good conditions.

NG 1982 Maintenance Provision - Form BE/P1 (Maintenance) Paint System Sheet (Appendix 19/6) Form BE/P2 Paint Data Sheet (Appendix 19/3)

1 Normally, a copy or copies of Appendix 19/6, Form BE/P1 (Maintenance) Paint System Sheet, will be provided in the tender documentation, of which parts 1 to 9 will have been completed. It should be ensured that in part 1 of Appendix 19/6 the National Grid reference has been included.

Grid references are not required for parapets only, or for CCTV masts, cantilever masts, steel lighting columns and bracket arms (other than high masts).

2 As soon as the Contract has been awarded, the Contractor is required to prepare a copy or copies of Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet of which he will have completed parts 10 to 14 for each of the required systems. At the same time, the Contractor is required to provide relevant copies of Appendix 19/3, Form BE/P2 Paint Data Sheet, containing data which is required for checking paints before and after application. Full application instructions are also to be provided. The information provided in Appendix 19/3 is the responsibility of the Contractor.

Approved copies of Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be forwarded to the Overseeing Organisation, prior to any paint sampling.

Approved copies of Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be forwarded to the testing laboratory, together with the first Appendix 19/4, Form BE/P3 Paint Sample Despatch List. See Clause NG 1978 for details of checks on samples and despatch requirements, also the instructions to the inspector in Appendix 19/4.

NG 1983 Maintenance Provision - Access, Containment and Lighting

1 For surface preparation and coating application to be carried out satisfactorily, it is important that the working area and access should permit, wherever possible, unrestricted access to the workface by the operators. For example, if the blast cleaning nozzle or the airless spray gun cannot be at the correct angle or be moved freely, then good uniform work will be difficult to attain. Care should be taken to provide access to ensure optimum distance of the spray gun, as well as adequate ventilation. It is equally important that the supervisory staff and inspectors should feel secure when carrying out checks.

2 If lighting is inadequate, workmanship will also be adversely affected and thorough inspection difficult; the Contractor should therefore ensure that the natural lighting is supplemented by temporary lighting as necessary to maintain an intensity of illumination at the workface of at least the specified 500 lux during working and inspection. Spot lighting of small areas is not acceptable and hence the requirement that the lighting should cover at least 1.0m^2.

NG 1984 Maintenance Provision - Additional Requirements for the Protection of CCTV Masts, Cantilever Masts, Steel Lighting Columns and Bracket Arms

Applicable Clauses

1 The testing of 'A' samples is not required for CCTV masts, cantilever masts, steel lighting columns and bracket arms but 'B' samples should be taken and checked immediately for compliance. Also, as the procedure trials are unlikely to be necessary, it should be checked that the correct abrasive is being used and that the standard of blast cleaning complies with the Specification. A separate Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be provided for each different system on each area of the masts and columns in accordance with Clause 1982.

NG Sample Appendices

NG SAMPLE APPENDIX 19/1 (SPECIFICATION FOR ROAD WORKS) SHEET NO. FORM BE/P1 (NEW WORKS) PAINT SYSTEM SHEET

1. CONTRACT TITLE: STRUCTURE. NO.: GRID REF.:				
2. DATE OF ISSUE OF DOCUMENTS TO TENDERERS:				
3. ENVIRONMENT AND ACCESSIBILITY				
4. REQUIRED DURABILITY OF SYSTEM: NO MAINTENANCE: ..... YEARS MINOR MAINTENANCE: ..... YEARS MAJOR MAINTENANCE: ..... YEARS	COLOUR OF FINISH:			
6. PAINT SYSTEM TO BE APPLIED OVER: AREA REF: ..... AREA DESCRIPTION: ..... PROTECTIVE SYSTEM TYPE: (i.e. I, II etc):				
7. DETAILS	1st Coat	2nd Coat	3rd Coat	4th Coat
Registered Description Item No. and Colour IAB/BBA HAPAS Roads and Bridges Certificate Reference Brand Name and Manufacturer's Ref. No. Manufacturer's Data Sheet No. Where applied How applied Min dry film thickness (mdft) Max local dft (See Cl. 1914.7) Estimated total volume of paint likely to be used. (litres) 'A' type testing required ? (YES/NO) (See Cl 1912.4) 'B' type testing required? (YES/NO) (See Cl 1912.11)				
8. STRIPE COAT DESCRIPTION (Including Item No. and colour) Workshop:	9. PAINT MANUFACTURER'S OFFICIAL STAMP:			
10. Mdft (μm) NOTE. The minimum total dry film thickness of the paint system, neglecting primers and sealers under 30 microns, shall be 15% greater (to the nearest 25 microns) than the sum of the mdfts of the individual paint coats.	11. APPROVED BY:			

[Note to compiler:

(i) The above is Appendix 19/1 Form BE/P1 (New Works) Paint System Sheet; a separate form should be provided for each structure, including CCTV masts, cantilever masts, steel lighting columns and bracket arms if appropriate, with items 1 to 5 completed. Sheets should be numbered for easy identification.]

NG SAMPLE APPENDIX 19/2: (NEW WORKS) REQUIREMENTS FOR OTHER WORK

[Notes to compiler:

1 Appendix 19/2 shall be incorporated for situations where special preparation and/or protective systems may be required, or for other works requiring protection. Form BE/P1 (New Works) Paint System Sheet should be provided with items 1 to 5 completed for structures described in this Appendix. The Contractor will then complete the Form using information provided in this Appendix.

2 When a white or pale tint Moisture Cured Polyurethane Finish or Polyurethane Finish (two-pack) is to be specified, an additional coat of Item 164 or 168 may be required to ensure complete obliteration of the MIO Epoxy Undercoat. Additional coats should be specified in this Appendix.]

3 Specific requirements relating to expansion joints.

NG SAMPLE APPENDIX 19/3 (SPECIFICATION FOR ROAD WORKS) FORM BE/P2 PAINT DATA SHEET

IAB/BBA HAPAS Road and Bridges Certificate Reference and Date:

Manufacturer :

Item No. :

Registered Description :

Brand Name and Reference No. :

Consistency and Method of Application :

Weight per 5 Litres (kg) :

Specific gravity : Colour:

For two-pack paints :

Base: Activator : Mixed components:

Volume Solids % :

For two pack paints volume solids % for mixed paint :

VOC content g/l (mixed) :

Manufacturer's Minimum Dry Film Thickness Range

Recommended lower mdft :

Recommended upper mdft :

Full Application Instructions :

Mix ratio :

Flash Point :

		5°C	10°C	20°C	30°C
Drying Times (hours)	Surface Dry				
	Hard Dry				
Overcoating Times (hours)	Minimum				
	Maximum				
Pot Life (hours)					

Cleaning Solvent State effects on Drying Times of Temperatures below 20°C :

Manufacturer's Application Restrictions, e.g. for Temperatures or Humidity :

Manufacturer's General Recommendations :

NG SAMPLE APPENDIX 19/4 (SPECIFICATION FOR ROAD WORKS) FORM BE/P3 PAINT SAMPLE DESPATCH LIST: SHEET 1

Contract Title.....

Structure Name .....Structure No. .....

Client Name ..... *(National Roads Authority, Local Authority or other company)*

Supervising

Firm (Employers Representative).....

Supervising Firm's Representative (Employers Representative) Name:..... Tel No.....

Address: .....Fax No.....

Painting Inspection Firm: .....

Samples Despatched From:.....(Note 1) Date Despatched .....

Inspector's Name: .....Tel No.....

Inspector's Signature.....

SAMPLES: (Numbered A1, A2 etc. or B1, B2 etc.) (Note 2)					
Sample No.	**Item No.**	**Manufacturer's Reference No.**	**Batch No.**	**Colour BS 4800 reference (Note 3)**	**Sp.G. (Notes 4 & 5)**

Paint Manufacturer.....

NG SAMPLE APPENDIX 19/4 (SPECIFICATION FOR ROAD WORKS) FORM BE/P3 PAINT SAMPLE DESPATCH LIST: SHEET 2

INSPECTOR to complete Form BE/P3 and to forward single copies to each of the following within 24 hours of despatch of samples by the Contractor to CREST:

1	National Roads Authority St Martin's House Waterloo Road Ballsbridge Dublin 4	2	CREST FOCAS Institute DIT – Kevin St Dublin 8	3	Employers Representative

INSPECTOR to forward Form(s) BE/P1 Paint System Sheet(s) with the first Form BE/P3 to all addresses unless otherwise agreed with the National Roads Authority.

INSPECTOR to select 'A' samples and to ensure that manufacturer's labels on tins comply with the Specification.

INSPECTOR to take and mark each 'B' sample tin with Item No., manufacturer's name and brand reference No., batch No. sample No. and colour (NOTE 2).

CONTRACTOR to CLIP DOWN LIDS of all tins and to pack, address and despatch samples. In addition to address, CONTRACTOR to label each case (or tin sent loose): 'NRA (State structure name) and DATE (date of despatch as noted above)'.

Notes

1 State whether from workshop or site (give name and address).

2 Batch samples comprising unopened tins to be marked A1, A2, etc. Control samples in 0.5 litre tins to be marked B1, B2, etc. Samples No. to run consecutively, i.e. A1 and B1 onwards.

3 Colour reference to BS 4800 to be given, as stated on Form BE/P1 (New Works) Paint System Sheet, e.g. 18 B 25.

4 For 'A' samples specific gravity (Sp.G.) to be measured by Inspector from separate tins of the same batch. For 'B' samples Sp.G. to be measured by Inspector when taking samples. Samples will be rejected unless Sp.G. is filled in above by Inspector.

5 If Sp.G. differs appreciably from data sheet do not despatch 'A' or 'B' samples.

6 Use of this Form, issue of samples to be agreed with the Employer, if the Employer is not National Roads Authority.

NG SAMPLE APPENDIX 19/5: (NEW WORKS) GENERAL REQUIREMENTS

[Note to compiler: This should include:]

1 Measures to contain people, plant, materials, dust and debris *[1901.3].*

[Cross-reference should be made in Appendix 1/23].

2 Requirements for

(i) wet blast cleaning and water pressure value if different from the requirements of sub-Clause 1903.12 and 13;

(ii) other preparation of surfaces if different from the requirements of sub-Clause 1903.20.

3 Requirements for surface preparation and material for 'restored' coatings if different from the requirements of sub-Clauses 1905.3 (i) and (ii).

4 Requirements for treatment to threaded fasteners if different from the requirements of sub-Clause 1906.2.

5 Requirements for thermally sprayed metal coating at joints if different from the requirements of sub-Clauses 1906.7 and 1906.8.

6 Requirements for stepping back workshop paint coats if required at non-friction bolted joints *[1906.16].*

7 Requirements for:

(i) thermally sprayed metal coating if different from the requirements of sub-Clause 1909.2;

(ii) sherardized coatings if different from the requirements of sub-Clause 1909.3;

(iii) electroplated coatings if different from the requirements of sub-Clause 1909.4.

8 Requirements for hot dip galvanized coatings if different from the requirements of sub-Clause 1909.1.

9 Requirements for procurement of paints if different from the requirements of sub-Clause 1911.5.

10 Requirements for the nominal 'ground' or 'plinth level' if different from the requirements of sub-Clause 1911.8.

11 Requirements for stripe coats if different from the requirements of sub-Clause 1914.13

12 Requirements at concrete/steelwork contact areas if different from the requirements of sub-Clause 1917.3.

13 Requirements for the protection of steel in bridge bearings if different from the requirements of Clause 1920.

14 Requirements for the protection of CCTV masts, cantilever masts, steel lighting columns and bracket arms if different from the requirements of Clause 1921.

NG SAMPLE APPENDIX 19/6 (SPECIFICATION FOR HIGHWAY WORKS) FORM BE/P1 (MAINTENANCE) PAINT SYSTEM SHEET 1

1. CONTRACT TITLE: STRUCTURE NO.: GRID REF.:								
2. DATE OF ISSUE OF DOCUMENTS TO TENDERERS:								
3. ENVIRONMENT AND ACCESSIBILITY:								
4. EXISTING PROTECTIVE SYSTEM(S): Metal coatings: Paint coatings: Average total thickness (microns):								
5. REQUIRED DURABILITY OF SYSTEM: NO MAINTENANCE: …. YEARS MINOR MAINTENANCE: …. YEARS MAJOR MAINTENANCE: …. YEARS			6. COLOUR OF FINISH:					
7. BILLED AREA						8. PROTECTIVE SYSTEM TYPE: (i.e. I (M), II (M), III (M), etc):		
REF: AREA DESCRIPTION:	SURFACE PREPARATION METHOD							
9. PAINT COAT SUMMARY	CONDITION OF SURFACES OF EXISTING SYSTEM AFTER SURFACE PREPARATION							
	Condition: Area Ref.		Condition: Area Ref.		Condition: Area Ref.		Condition: Area Ref.	
COAT & ITEM NO.	mdft	B or	mdft	B or	mdft	B or	mdft	B or
1st Coat: Item ….								
2nd Coat: Item ….								
3rd Coat: Item ….								
4th Coat: Item ….								
MIN TOTAL DFT TO BE OBTAINED								

NG SAMPLE APPENDIX 19/6 (SPECIFICATION FOR HIGHWAY WORKS) FORM BE/P1 (MAINTENANCE) PAINT SYSTEM SHEET 2

10. Details	1st Coat	2nd Coat	3rd Coat	4th Coat
Registered Description				
Item No. and Colour				
IAB/BBA HAPAS Roads and Bridges Certificate Reference				
Brand Name and Manufacturer's Ref. No.				
Manufacturer's Data Sheet No.				
Min dry film thickness (mdft) (µm)				
Max local dft (See sub-Clause 1981.8) (µm)				
Estimated total volume of paint likely to be used (litres)				
'A' type testing required ? (YES/NO) (See sub-Clause 1978.4)				
'B' type testing required? (YES/NO) (See sub-Clause 1978.12)				
11. STRIPE COAT(S) DESCRIPTION (Including Item No. and colour)				
12. PATCH COAT(S) DESCRIPTION (Including Item No. and colour)				
13. ADDITIONAL INFORMATION (By Paint Manufacturer)				
14. PAINT MANUFACTURER'S OFFICIAL STAMP:				
15. Mdft (µm)				16. APPROVED BY:
NOTE. The minimum total dry film thickness (mdft) of the paint system, neglecting primers and sealers under 30 microns, shall be 15% greater (to the nearest 25 microns) than the sum of the mdfts of the individual paint coats.				DATE

[Notes to compiler:

(i) Separate forms should be provided for each structure, including CCTV masts, cantilever masts, steel lighting columns and bracket arms if appropriate, with parts 1 to 9 completed. Sheets should be numbered for easy identification.

(ii) A description of coats of lead based paints and other materials which may become health hazards during surface preparation should be included in the description of Existing Protective System(s).

(iii) If more than four types of surface condition are specified, a continuation Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be provided in the tender document.]

NG SAMPLE APPENDIX 19/7: (MAINTENANCE) REQUIREMENTS FOR OTHER WORK

[Notes to compiler:

1. An Appendix 19/7 may be incorporated for situations where special preparation and/or protective systems may be required, or for other works requiring protection. Appendix 19/6 Form BE/P1 (Maintenance) Paint System Sheet should be provided with parts 1 to 9 completed for structures described in this Appendix. The Contractor will then complete the Form using information provided in this Appendix.

2. When a white or pale tint Moisture Cured Polyurethane Finish or Polyurethane Finish (two-pack) is to be specified, an additional coat of item 164 or 168 may be required to ensure complete obliteration of the MIO Epoxy Undercoat. Additional coats should be specified in this Appendix.]

3 Specific requirements relating to expansion joints.

NG SAMPLE APPENDIX 19/8: (MAINTENANCE) GENERAL REQUIREMENTS

[Note to compiler: This should include:

1 Measures to contain, people, plant, materials, dust and debris [1970.3].

[Cross-reference should be made in Appendix 1/23].

2 Whether fasteners should be prepared and painted to the same standard as adjacent main surfaces [1971.9].

3 Requirements for

(i) abrasive if different from the requirements of sub-Clause 1972.11;

(ii) wet blast cleaning and water pressure value if different from the requirements of sub-Clauses 1972.15 and 16.

4 Requirements for:

(i) requirements for hot dip galvanized coatings if different from the requirements of sub-Clause 1974.1;

(ii) thermally sprayed metal coating if different from the requirements of sub-Clause 1974.2;

5 Requirements for procurement of paints if different from the requirements of sub-Clauses 1976.5.

6 Requirements for stripe coats if different from the requirements of sub-Clause 1981.15.

7 Whether overcoating times are different from sub-Clause 1981.32.

8 Requirements for the protection of CCTV masts, cantilever masts, steel lighting columns and bracket arms if different from the requirements of Clause 1984.]