

Gordon Mitchell
Consulting Engineers

**Gordon Mitchell Consulting Engineers
Greatdown, The Downs,
Mullingar,
Co. Westmeath.**

Ph: (044) 9358981

e-mail: info@gmce.ie

Specification

**Collooney National School,
Co. Sligo.**

SPECIFICATION FOR SITEWORKS

PREAMBLE

- 1 The Specification for Site Works is based on "The Specification for Road Works" published in 1978 by the Department of the Environment and modified or extended by any substitute, additional or cancelled Clauses or Sub-Clauses referred to below.
- 2 A substitute Clause or Sub-Clause as indicated by the prefix "S" is an amendment of a Clause or Sub-Clause in the Specification for Road works and supersedes the whole of that Clause or Sub-Clause.
- 3 An additional Clause or Sub-Clause as indicated by the prefix "A" supplements the Clause or Sub-Clauses of the Specification for Road Works and has a number subsequent to the last one of the appropriate series of those Clauses or Sub-Clauses relevant to the subject matter covered.
- 4 The sections to be adopted for this siteworks specification are:

Series	100	-	General
	200	-	Site Clearance
	500	-	Drainage (including pressure mains)
	600	-	Earthworks
	800	-	Sub-bases and Roadbases
	1700	-	Materials

SERIES 100

GENERAL CLAUSES

102 OPERATIVES FOR THE ENGINEER'S STAFF

- S102.1** The Contractor shall supply the Engineer, free of expense, with all poles; pegs; templates; labour and other things necessary for measuring up or checking the Works. The Contractor shall provide men equal to the tasks required and maintain continuity of staff.

112 NOISE CONTROL

- S112.1** The Contractor shall employ the best practical means to minimise noise produced by his operations, including plant maintenance, and shall comply with the recommendations in BS 5228: Part 1: 1997 (Noise and Vibration Control on Construction and Open Sites).
- A112.2** All vehicles and mechanical plant used on the Works shall comply with requirements of BS 5228: Part 1: 1997.
- A112.3** Sound levels shall be monitored by methods set out in Appendix E of BS 5228: Part 1: 1997.
- A112.4** Any plant such as generators and pumps that are required to work outside the hours of 08.00 - 19.00 shall be placed in an acoustic enclosure to the approval of the engineer. The resultant noise level of all such sources on site shall be at least 5dB (A) below the existing background noise level.
- A112.5** The Contractor shall organise his operations with regard to the positioning of plant and the location of haul routes, etc., so it minimises construction noise to adjacent properties.
- A112.6** Piling including temporary piling shall be carried out by recognised noise reduced systems. General guidance should be taken from BS 5228: 1992 (Noise control on construction and open sites - Part 4. Code of Practice for noise and vibration control applicable to piling operations).
- A112.7** The period referred to as 'night' in Clause 45 of the Conditions of Contract shall be from 19.00 hours to 08.00 hours.

A112.8 The Contractor shall ensure that at all properties outside the site boundaries, the sound levels arising from activities, do not exceed the following volumes:-

		Leq(1 hour) dB(A)	Peak dB(A)
(a)	Mon. - Fri. 08.00 - 19.00	75	85
(b)	Mon. - Fri. 19.00 - 22.00	60	65
(c)	Saturdays 08.00 - 16.30	70	80
(d)	Sundays & Bank Holidays 09.00 - 16.00	60	65

A112.9 At all other times, the sound level of 50 dB(A) L10 (18 hour) and a maximum noise level of 55 dB(A) must not be exceeded unless the existing ambient noise levels are higher.

A112.10 Compliance with sub-Clauses of this Clause does not confer immunity from relevant legal requirements.

A113 PROGRESS MEETINGS

A113.1 The Contractor, or a responsible official from his organization, shall attend progress meetings which will be held at the discretion of the Engineer. The Contractor shall inform such Sub-Contractors and Suppliers as are necessary that their attendance at progress meetings shall be required. All tendered prices shall allow for attendance on site by the Contractor or any of his Sub-Contractors.

A114 TRESPASS

A114.1 The Contractor shall take adequate precautions to prevent trespass on or interference with adjoining properties by employees or by Sub-Contractors' employees.

A115 CONTRACTORS PROGRAMME

- A115.1** Prior to the commencement of the works, the Contractor shall prepare and agree with the Engineer a detailed programme for the execution of the component activities of the works so as to achieve contract completion within the construction period.

He shall complete all the works in an orderly, expeditious and workmanlike manner in accordance with the drawings and the specification.

A116 REMOVAL OF RUBBISH

- A116.1** The Contractor is to remove all surplus materials as they accumulate during the execution of the work and to leave the whole of the lands, roads, streets, etc, underfaced at the completion and to the satisfaction of the Engineer.
- A116.2** The Contractor shall keep all roads adjoining the site clear of spoil arising from the site.
- A116.3** All public and private roads which are being used by the Contractor, Sub-Contractors or suppliers vehicles for the construction of the works shall be kept clean and free of dirt and mud arising from the works.
- A116.4** The Contractor shall take all reasonable measures, which shall include the provision and use of adequate water spraying equipment to minimise dust nuisance.

A117 SITE OFFICES

- A117.1** All site offices, stores etc required for execution of the works shall be located in the "extent of contract" area shown on drawing.

A118 HOURS OF WORKING

- A118.1** Works other than pumping from excavations, watching or emergency work necessitated for the safety of the works, shall not be executed outside normal working hours. Normal working hours are defined in this instance as from 08.00 to 19.00 hours, Monday to Friday and 08.00 to 16.30 hours on Saturday.
- A118.2** The Contractor shall seek the written permission of the Engineer to carry out shift work. Such permission should be sought by the Contractor at least 7 days before his proposed commencement date for shift work. The Contractor shall not commence shift work without the written permission of the Engineer, which permission may be withdrawn at any time.

The same proviso shall apply for night and Sunday work. In cases where overtime and shift work are approved, the carting of spoil and deliveries of materials to the works shall be prohibited outside normal working hours. Furthermore, the noise restrictions given in Clause 112 (Noise Control) shall apply at all times.

A119 PLANT AND MACHINERY

A119.1 The contractor shall submit, post Tender, a list of all the plant proposed for use for the satisfactory execution of the works.

A120 MATERIALS AND WORKMANSHIP

A120.1 The Contractor shall provide everything necessary for the proper execution of the works according to the true intent and meaning of the Specification and drawings, provided same is reasonably to be inferred therefrom including all diesel fuels, sleeve pipes, packing materials.

The Contractor shall keep a competent Foreman on the contract works at all times when work is being done in connection with the Contract. The Foreman shall be authorised to receive instructions on behalf of the Contractor.

Nothing in this Specification shall be construed to relieve the Contractor from making good and perfect in all details the construction nor shall the omission of any detail absolve him from his liability in this respect.

A121 SETTING OUT THE WORKS

A121.1 Before the commencement of the Works the Contractor will be supplied with the information necessary to establish the lines and levels of the Works. The Contractor shall establish reference pegs and temporary bench marks of approved design in, locations appropriate for setting out and checking the Works. All reference pegs shall be carefully preserved except where construction requires their removal, and before such removal the approval of the Engineer shall be obtained.

All levels will be to Ordnance Datum Malin Head unless noted otherwise and the Contractor shall set up a T.B.M. on site with the O.D. clearly marked on it.

The Contractor shall, as soon as practicable, supply the Engineer with records in approved form relating to all reference pegs and temporary bench marks and shall keep such records up to date by formal notice to the Engineer.

The Contractor shall protect all triangulation stations from damage during the course of the Works. If the Contractor displaces or otherwise damages an ordinance survey station the Contractor shall engage at his own expense the ordinance survey office, (or an alternative surveying contractor of equivalent expertise and acceptable to the Engineer) to reinstate the marker at its original location. Should the Contractor displace or otherwise damage the survey stations, the Contractor shall be liable for the cost of reinstatement of the triangulation station, and this sum shall be deducted from the final account payable to the Contractor.

A122 CONTRACTOR RESPONSIBLE FOR CARRYING OUT THE ENTIRE CONTRACT

A122.1 The Contractor shall be and shall continue to be, until the works are handed over to the Employer, solely and absolutely responsible for carrying out all the works as well as for all injury or damage to the said works, or any part thereof, or to any persons, any livestock, or property of any description whatever which may be caused by or result from the execution of the works, whether they have been carried out skilfully and carefully and strictly in conformity with the provisions of this Specification or not.

A122.2 The Contractor will be responsible for the adequacy, stability and safety of all site operations and methods of construction (except the permanent works design and specification) which shall be in accordance with relevant health and safety procedures and current legislation.

A123 OWNERSHIP OF MATERIALS

A123.1 Materials and things excavated, cut down or removed in the course of any operation arising out of this Contract whether on public or private property shall generally become the property of the Contractor. All such materials which are surplus to or unsuitable for use in the works shall be disposed of by the Contractor either off the site or if agreed by the Engineer, on the site in an approved manner.

A124 SOCIAL WELFARE REGULATIONS

A124.1 By law, Employers in the construction industry must register with the Department of Social Welfare all employees whose employment commences on or after the 1st January, 1989 or the engagement of sub-contractors whose employment commences on or after the 1st January, 1990.

A sub-contractor is also legally bound to notify the Department of Social Welfare of any person engaged to perform any service either with him or on his behalf whether under a contract or any arrangement made or to be made by him.

All notifications must be sent to the Department of Social Welfare within one month of the new employee, sub-contractor or other person being taken on.

Social Welfare (Notification by Employees of Commencement of Employment) Regulations, 1988:
(S.I. 296 of 1988).

Social Welfare (Commencement of Employment) Regulations 1989:
(S.I. 339 of 1989).

A125 INSURANCES

- A125.1** In relation to insurances, under no circumstances will unspecified inner limits or exclusions be allowed except those defined in the Contract.

A126 OFFENSIVE FUMES

- A126.1** All statutory regulations in relation to exhaust emissions from plant shall be adhered to. Any plant emitting offensive fumes will be stopped immediately. No claims will be entertained for aforementioned stoppages.

A127 INTERNATIONAL AND NATIONAL STANDARDS

- A127.1** Nothing stated in this Specification is to be construed as discriminating against products and materials manufactured in any of the Member States of the European Community. Where items to an Irish Standard Specification, a British Standard Specification, or any other standard specification of a Member State of the European Community are called for, this requirement shall be read as including items to a national standard of any Member State of the European Community which provides an equivalent guarantee of safety and suitability.

Where items certified by the National Standards Authority of Ireland as complying with an Irish Standard are called for, the provisions of Circular Letter BC 14/92 shall apply, i.e. the requirement shall be read as either certified by the National Standards Authority of Ireland as complying with the Irish Standard Specification and shall bear the Irish Standard Mark or shall be certified as complying with a national standard of another Member State of the European Community, which provides an equivalent guarantee of safety and suitability - certification by the National Standards Authority of Ireland.

A128 HISTORICAL FINDS

- A128.1** During excavation and site clearing, the foreman and workmen shall watch out for objects that may be of archaeological or historical interest. All such articles whether coins, pottery, fossils, tools, utensils, weapons, bones, urns, vases, stone lined graves or the like shall be considered the property of the Local Authority.
The position of any such object in the strata should be specifically noted on discovery and marked on the layout plan. On any find being made, an immediate message shall be sent to the Engineer to that effect and the find shall not be disturbed until written instructions are given as to its disposal.

A129 DEMOLITION

- A129.1** Before commencing any demolition works, the Contractor shall satisfy the Engineer with respect to:
- (a) The order and procedure for carrying out the Works.
 - (b) That this insurances are in order.
 - (c) That the personnel are experienced in this type of work.
 - (d) That the work shall comply with BS 6187 Code of Practice for Demolition.

A130 IONISING RADIATION

- A130** Nuclear gauges or other sources of ionising radiations shall be used only where permitted or required by the engineer.

The Contractor shall advise the Engineer of his designated >radiation protection adviser= and provide the Engineer with a copy of the Contractor=s > local rules =covering the use of nuclear gauges or other sources of ionising radiation; these expressions having the meaning given in the Ionising Radiations Regulations 1985.

SERIES 200
SITE CLEARANCE

201 CLEARING

- S201.3** Subject to the provisions of Clause 32 of the Conditions of Contract and excluding items specifically mentioned in the Bill of Quantities, all materials arising from site clearance that are surplus or unsuitable for use in works shall become the property of the Contractor and shall be disposed of by him either off the site to his tip or if agreed by the Engineer on the site in an approved manner. The Contractor shall advise the Engineer in writing as to the location of his tip prior to the removal of material from site.
- A201.5** All demolition shall be carried out by workmen skilled in such work and shall be in accordance with BS 6187 (1982).
- A201.6** Where the line of an existing fence, hedge or wall is cut by the site boundary the severance shall be made good unless otherwise described in the Contract; either by the continuation of the fence, hedge, or wall in a different direction or by its termination at the boundary and tied into the new boundary. In the case of a strained wire or chainlink fence a straining post shall be installed, unless otherwise directed and the fence restrained.

202 EXISTING TREE STUMPS AND ROOTS

- S202.1** Where shown on the Drawings or directed by the Engineer trees shall be uprooted or cut down as near to ground level as possible. All felled timber shall be removed from the site.
- S202.2** Stumps and tree roots shall be grubbed up and deposited off the site in dumps to be provided by the Contractor. Holes left by the stumps or roots shall within one week be filled with suitable material as in defined in Cl 601 of "The Specification for Road Works " and compacted in accordance with Cl. 609 of " The Specification for Road Works ".
- A202.3** Where it is necessary to cut branches from trees that are to be preserved, the lopped ends so exposed shall receive an application of an approved sealant.
- A202.4** Blasting for Site Clearance shall not be employed

SERIES 500
DRAINAGE (INCLUDING PRESSURE MAINS)

501 TYPE OF PIPELINE

A501.6 Pressure Pipes

Plastic pipes (UPVC, HDPE or MDPE) shall comply with BS3505 and BS 6572 as appropriate and if conveying potable water shall be coloured blue.

Ductile iron pipes, fittings and joints shall comply with the relevant provisions of BS EN 545 : 1995 and BS EN 598 : 1995.

A501.7 Pipes for Watermain shall comply with Clause 1734.

502 EXCAVATION FOR PIPELINES AND DRAINAGE STRUCTURES

A502.5 Trenches in rock for pipes up to 100mm normal bore shall be excavated to provide a minimum clearance of 100mm around the outside of pipe barrels and joints. For pipes with nominal bore exceeding 100mm, the minimum clearance shall be increased to 150mm, the minimum clearance shall be increased to 150mm for flexible pipelines and to 200mm for rigid pipelines.

A502.6 In excavating for pipe and culverts in or adjacent to existing stream beds, the contractor shall provide for all difficulties due to water flow and ground water ingress to the excavations, including all damming, pumping, etc. Culverts crossing the carriageway coincide with ditches or watercourses; the rate for constructing piped culverts shall include for all difficulties associated with these ditches including the continuation of flow in the stream.

503 BEDDING, LAYING & SURROUNDING OF PIPES

503.7 Each pipe shall be carefully examined on arrival, any defective pipes shall not be used and shall be segregated and marked in a conspicuous manner.

Drains shall be laid in straight lines and to even gradients as shown on the drawings. Care shall be exercised in setting out and determining the levels of the pipes and the contractor shall provide suitable instruments and set up and maintain all sight rails, boning rods and bench marks, etc., necessary for the purpose.

All drains shall be kept free from earth, debris, surplus jointing materials and other obstruction during laying and until the completion of the works when they shall be handed over in a clean condition.

Drain laying will generally proceed from the downstream end and pipes shall be laid with the sockets leaning uphill and shall rest on solid and even foundation for the full length of the barrel. Socket holes shall be formed in the foundations as short as practicable but sufficiently deep to allow the pipe jointer room to work right round the pipe.

- A503.8** Plastic pipes shall be wrapped with a layer of plastic sheeting, 125um thick before being surrounded by concrete.

504 JOINTING OF PIPES

A504.13 Joints in pressure pipes

Plastic pipes shall have mechanical, socket welded or fusion welded joints and be jointed in accordance with manufacturer's instructions.

Flange adaptors, where required for connection to metal pipes, shall be fusion welded unless otherwise directed by the Engineer.

Ductile iron pipes shall have flanged or push fit joints and be jointed in accordance with the manufacturers instructions.

507 MANHOLES, CATCHPITS, INSPECTION CHAMBERS AND DRAW PITS.

S507.4 In-Situ Concrete Manholes

In-situ Concrete Manholes, chambers and outfall works shall be constructed to the locations, levels, dimensions and construction details shown in the Contract Documents.

In-situ manhole walls shall be constructed of Grade 30/20 mass concrete, reinforced concrete or solid concrete blocks, fair faced internally, free from honeycombing, and of a high standard of surface finish. Manholes shall be constructed on a concrete Grade 30/20 foundation slab.

The walls shall be brought up vertically to receive a roofing slab formed of concrete Grade 30/20 reinforced in accordance with the Drawings and Specification for Structural Concrete.

In-Situ Manhole Channels, bends and junctions shall be formed from half-round pipe sections with close butt joints bedded on the base and pointed flush with 3:1 sand-cement mortar. All concrete work shall be carried out in accordance with Clauses in "Specification for Structure Concrete for Highway Works. All manholes shall be watertight on completion, to the satisfaction of the Engineer

S507.5 Where the depth to invert of chambers exceeds 900mm below the finished surface of the carriageway or the adjacent ground, step-iron steps complying with BS 1247 and shall be built in as specified in BS 5911 : Part 1. Steelwork used for ladders, handholds and other fittings shall comply with BS970 and be galvanised in compliance with BS 729 after fabrication.

A507.10 Foundation slabs for precast manholes shall be cast in concrete Grade 20/20 to the dimensions shown on the drawings. The top surface of the slab is to be grooved at the time of casting to receive the lowest precast segment. Certificates of compliance with BS 5911 including test results shall be submitted to the Engineer for his approval covering all deliveries of precast units.

Precast concrete manholes, catchpits and inspection chambers shall comply with the requirements of BS 5911: Part 1 except for any special requirements for cement described in the Contract.

The relevant absorption tests required by BS 5911: Part 1 shall be carried out on materials from 1 section in every 50 of those required under the Contract.

Precast units shall be free of all significant damage or defects on delivery, and shall be stored and handled so as to avoid subsequent damage and excessive strain.

Protective slings and timber protective pieces shall be used where necessary in all handling operations. Damaged and defective units shall be immediately removed from site when so directed by the Engineer.

All precast units shall be bedded onto the top surface of the base or on to the next lower unit in Class 1 mortar. The mortar shall be made to a moderately stiff consistency and placed over the full lower face of the joint. The unit shall be brought into place and lowered vertically on the mortar and gently tapped or vibrated so as to evenly compress the mortar over the full joint face and so as to eliminate voids in the mortar. After plumbing in position the units shall be kept undisturbed until the mortar has hardened. Both faces of the joint being formed shall be dampened before joint formation to promote adhesion. Precast units shall be aligned on placing so as to provide the proper locations for step irons and manhole access. Internal mortar shall be struck flush and finished with metal trowel finish.

508 Gullies and Pipe Junctions

A508.5 Gullies and Frames

- 1 Precast concrete gullies shall be un-reinforced and conform with BS 5911 Part 230 (1992).
- 2 Clayware gullies shall comply with the requirements for round street gullies of BS65.
- 3 Cast iron gullies shall be manufactured from either grey iron or ductile iron and shall conform with the requirements of BS EN 124 (1994).
- 4 Gullies made of polypropylene, polyethylene, UPVC or other approved plastic materials of a pattern approved by the Engineer shall be permitted when used as permanent formwork to an insitu concrete gully as described in Clause 508.
- 5 Cast iron and cast steel gully gratings, cast iron kerb type gully covers and cast iron frames shall comply with the requirements of BS EN 124(1994). Prefabricated steel or bolted steel gratings shall be as described in the Contract.

509 TESTING AND CLEANING

A509.8 Testing Water Mains

Pipelines shall be tested hydraulically in sections during the course of construction. Testing shall be applied to prove the structural soundness of the various units of pipelines including valves, fittings etc; the contractor is to provide all pumps, jacks, gauges, struts, etc, necessary for carrying out the test and the gauges shall be tested to the satisfaction of the engineer. The test pressures shall be 1.5 times the manufacturers stated maximum operating pressures for various classes of pipelines in the works. When testing the pipelines shall be charged with water and all air released. Care shall be taken during charging of the mains to provide free outlets for air and to prevent water hammer. Pipelines shall then be kept under a nominal pressure for a period of 24 hours to allow absorption. Thereafter for a period of 2 hours the amount of water pumped during the period of tests shall be measured and shall not exceed a rate of 0.1 litres per millimetre nominal internal diameter per kilometre length of main per 30m head for each 24 hour period. If the amount of make up water in a 2 hour test exceeds the specified quantity the contractor shall locate and repair the leaks and repeat the test.

A509.9 Swabbing and Scouring of Pipelines

The contractor shall thoroughly swab the pressure pipes with foam swabs as directed. Swabbing shall be continued until the wash water runs clear and the contractor shall ensure that no erosion or silting occurs when waste water is discharged.

A509.10 Sterilisation of Watermain

Mains shall be sterilised after testing, swabbing and scouring. Chlorine solution shall be applied at the charging point as the main is being filled and shall be continued until the main is full and at least 50 mg per litre of free chlorine has been made available.

Chlorine gas shall not be injected directly to the main from a cylinder otherwise than through an approved chlorinator and care shall be taken to ensure that there is no flow back into the preceding sections of main. Treated water shall be left for a period as directed but not exceeding 24 hours and all valves to the system shall be operated at least once during this period.

Chlorine residual tests shall then be taken at the end of the main furthest from the point of injection. The sterilisation process shall be repeated until the chlorine residual is not less than 10 mg per litre.

A514 BURIED SERVICES

A514.1 All pipes, ducts, cables, mains and other services exposed by the excavations shall be effectively supported and protected by timbers or other means.

Where existing sewers and drains are exposed during excavation every joint and every part of them requiring support shall be packed up solid from the bed with concrete packing in such a way as to prevent settlement.

A515 RESTORE SURFACES

A515.1 Surfaces interfered with either on public or private property, are to be restored to their original condition.

A516 SAFETY CHAINS

A516.1 Safety chains are to be provided for all outlet pipes 600mm nominal bore and above. Safety chains should be made of low carbon galvanised steel or stainless steel, 10mm nominal size, short link, smooth welded chain to BS 4942: Part 2.

A517 PIPES AND JOINTS ADJACENT TO STRUCTURES

- A517.1** A flexible joint will be provided as close as is feasible to the outside face of any structure into which the pipe is built, compatible with the satisfactory completion and subsequent movement of the joint.
- A517.2** The length of the next pipe (rocker pipe) away from the structure shall be in the range 0.5 - 0.75 m for pipes up to 450mm nominal bore and shall not exceed 1m for pipes up to 750mm nominal bore.

A518 CONSTRUCTION TOLERANCES FOR PIPELINES AND CHAMBERS

WORK CATEGORY	DIMENSION ALIGNMENT	OR	PERMISSIBLE DEVIATION
Pipeline Manholes and chambers	Line and level Vertically		20mm 1 in 300

A519 THRUST BLOCKS

- A519.1** Except where self anchoring joints are used, thrusts from bends and branches in pressure pipelines shall be resisted by C22.5 concrete thrust blocks cast in contact with undisturbed ground.

- A519** Any additional excavation required to accommodate thrust blocks shall be carried out after the bend or branch is in position and the thrust face shall be trimmed back to remove all loose or weathered material immediately prior to concreting.

Thrust blocks shall be allowed to develop adequate strength before any internal pressure is applied to the pipeline.

Rapid hardening cement shall not be used in concrete for thrust blocks to plastics pipe.

Plastics pipes shall be wrapped with a layer of plastic sheeting 125um thick before being surrounded by concrete.

A520 PRESSURE PIPELINE FITTINGS AND APPURTENANCES

A520.1 Sluice Valves

Sluice valves shall be cast iron all flanged sluice valves supplied by Glenfield and Kennedy or approved supplier in accordance with BS 5163 Class 1 and to the sizes shown on the drawings.

A520.2 Air Valves

Air valves on watermain shall be double acting air valves kinetic type, Glenfield and Kennedy Catalogue No. 127101273 with inlet diameter 80mm. Air valves shall be fitted complete with all flanged tee piece and flanged/plain ended adaptors.

A520.3 Water Meter

Water meter on service connection to factory units shall be to a pattern approved by the consulting engineer.

A520.4 Hydrants

Hydrants on high density polyethylene water main shall be screwed down type hydrant squat, clockwise to close (Glenfield Kennedy or similar approved type) with male round thread 65 mm diameter outlet. Hydrant to be fitted complete with tee piece, flanged and plain ended adaptors and flanged distance pieces where necessary.

A520.5 Surface Boxes

Each surface box shall be accurately set to conform to the surface of the adjoining ground. Sluice valve surface boxes shall not be less than 100mm deep. The base shall be flanged and the clear opening at the top shall not be less than 89 mm diameter. The cover shall be cast iron. Surface boxes of sluice valves to which extended spindles are fitted shall have a web or diaphragm in a base which shall not be less than 150 mm deep.

The base shall be flanged and the clear opening in each direction shall be not less than 25 mm greater than the overall dimension of the air valve. The cover shall be perforated to allow a free escape of air. Stopcock and metre surface boxes shall be not less than 100 mm deep. The base shall be flanged and the clear opening shall be not less than 600 mm x 300 mm

A520.6 Indicator Posts and Plates

All sluice valves, air valves, hydrants, shall have indicator plates carrying appropriate letters located as near as possible to each item, and in accordance with IS 162. The indicator plates shall be 200mm square in cast iron with the appropriate letters in relief. The plates shall be painted black with bitumastic paint and letters shall be in white.

The indicating letters shall be as follows:

Sluice valve	SV
Air Valve	AV
Hydrant	H
Scour Valve	ScV

The plates shall be erected on either suitable permanent features or structures or special precast concrete marker posts.

SERIES 600
EARTHWORKS

601 Definition, Classification and General Use of Earthwork Materials

S601.1 (ii) A Suitable Material@ shall comprise all that which is acceptable for use in the Works excluding material described in S601.1 (iii).

(iii) A Unsuitable Material@ shall mean other than suitable material. Unsuitable material may be incorporated in landscape areas or earth bunds. Unsuitable material shall include: -

- (a) material from swamps, marshes or bogs;
- (b) peat, logs, stumps and perishable material;
- (c) material susceptible to spontaneous combustion;
- (d) material in a frozen condition;
- (e) clay of liquid limit exceeding 80 and / or plasticity index exceeding 55;
- (f) materials having a moisture content greater than the maximum permitted for such materials in the Contract, unless otherwise permitted by the Engineer.
- (g) A Unsuitable material@ shall include silts defined for the purposes of this Contract as uniformly graded material having a uniformity coefficient of 10 or less and containing 80% or more in the particle size range 0.06 - 0.002 mm and having a moisture content greater than the optimum moisture content of the material. In excavating these materials the Contractor=s attention is drawn to the requirements of Clause 601.10. The optimum moisture content shall be determined in accordance with BS 1377: Part 4: 1990, (2.5kg rammer). The sieve analysis test shall be wet analysis in accordance with BS 1377: Part 2: 1990.

Material of Class (d) if otherwise suitable shall be classified as suitable when unfrozen.

(iv) Rock shall mean the following;

- (a) Silurian: Green - grey, fresh, massive to slightly cleaved Siltstone, strong. In upper horizons becoming brown, highly weathered, slightly cleaved Siltstone, moderately strong to moderately weak, in places becoming Shale.
- (b) Carboniferous: Grey, fresh to slightly weathered crystalline Calcisiltite Limestone, strong interbedded with grey - brown, highly weathered, fissile, argillaceous Limestone to Shale, moderately weak to weak. Calcite veining noted. In upper horizons becoming brown, highly to completely weathered, fissile, argillaceous Limestone to Shale, moderately weak.
- (v) Argillaceous means a material containing clay minerals (for example argillaceous rocks include shales, claystones, siltstones and mudstones).

S601.9 All material surplus to requirements shall only be disposed by the Contractor in accordance with the Planning Regulations.

S601.11 Turf and all topsoil, not required for relaying, shall be removed from the area of cuttings and stockpiled for re-use (i.e. in the soiling of slopes of cuttings, embankments, berms, verges, central reserves and in the provision of beds for the cultivation of trees and shrubs). Clause 601.9 will apply if material is surplus to requirements.

Topsoil shall wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 1.5m. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

A601.13 For the purpose of the Contract the maximum permitted moisture content in accordance with Clause S601.1 (iii)(f) shall be as follows: -

- (a) For all soft materials (excluding gravels having less than 15% of fines passing the 63 micron sieve) the maximum permitted moisture content shall be the optimum moisture content x 1.1. The optimum moisture content shall be determined in accordance with Test No. 12 (2.5kg rammer) of BS 1377:1975.

The sieve analysis test shall be wet analysis in accordance with Test No. 7(a) of BS 1377:1975 (Vibrating Hammer Method). Sieve analysis shall be carried out as defined in (a) above.

A601.14 Prior to the commencement of any earthworks the Contractor shall prepare and agree with the Engineer a detailed programme for the phasing of the Works. In addition, the Contractor shall, three working days prior to the opening of any cut area, inform the Engineer of his intention to commence Excavation. The determination of the moisture content in accordance with Clauses 601.1(iii)(f) shall be made from samples taken prior to the commencement of the excavation and from that part of the sample passing the 20mm BS sieve. The method of drying to be used shall be by microwave oven or any other method approved by the Engineer. The results of these determinations shall be agreed by the Engineer and Contractor. In addition the Engineer shall determine the Classification of all earthworks materials prior to their use or disposal in accordance with the following categories;

- 1 Category 1: Granular Material shall be as described in this Clause.
 - (a) Type 1: Shall consist of non-argillaceous, well graded natural gravels or crushed rock with not less than 100% of the material passing a 25mm BS sieve, and at least 90% passing a 75mm BS sieve, at least 15% and not more than 60% shall pass the 5mm BS sieve, and not more than 10% shall pass the 75mm BS sieve. The material passing the 425 micron sieve when tested in accordance with Clause 5.4 of BS 1377: Part 2 :1990 shall have a plasticity index less than or equal to 8.
 - (b) Type II: Shall consist of non-argillaceous well-graded crushed rock with grading as for Type I except that not more than 5% shall pass the 75um BS sieve.
2. Category 2: Other suitable materials as defined in Clause 601.1(ii), including Rockfill, imported suitable material and materials excavated from areas of made ground, which are deemed by the Engineer to meet the requirements appropriate to suitable material.
3. Category 3: Unsuitable materials as defined in Clause 601.1(iii), and materials excavated from areas of made ground, which are deemed by the Engineer not to meet the requirements appropriate to suitable materials, together with Category 2 materials excess to the requirements of Category 2.

609 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL

S609.4 The Engineer will require that comparative field density tests be determined in accordance with BS 1377:Part 4 using the 2.5kg rammer method or the vibrating hammer method as appropriate for the each of the fills he intends to use which meet the requirements of the permitted Class or Classes (where within any Class of material the fill contains material having different maximum dry density and optimum moisture contents the Class shall be subdivided, by extending the identification system, in order to monitor the compacted density).

These tests will be carried out on a regular basis at the discretion of the Engineer. The costs of any delays caused by such tests will be deemed to be covered by the prices entered in the Bill of Quantities for Earthworks.

If the test results, when compared with the results of similar tests made on approved work containing material of the same classification, having similar characteristics and within the Specification requirements for moisture content compacted in accordance with Table 6/2, show the state of compaction to be inadequate, and this is held by the Engineer to be due to failure of the Contractor to comply with the requirements of the Contract the Contractor shall carry out such further work as the Engineer may decide is required to comply with the terms of the Contract.

If, however, the Contractor has fully complied with the requirements of the Contract and the Engineer decides that further compaction is required, he will issue a variation order to cover the additional compaction order.

The field dry density referred to in this Clause shall be measured in accordance with BS 1377:Part 9 except that nuclear methods shall only be used where permitted by the Engineer. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377:Part 9. Use of nuclear gauges shall comply with Clause A130.

Nuclear gauges or other sources of ionising radiations shall be used only where permitted or required by the engineer.

The Contractor shall advise the Engineer of his designated >radiation protection adviser= and provide the Engineer with a copy of the Contractor=s > local rules = covering the use of nuclear gauges or other sources of ionising radiation; these expressions having the meaning given in the Ionising Radiations Regulations 1985.

A618 INSPECTION OF FINISHED EXCAVATION

- A618.1** No work shall be begun on any blinding layer or formation until the Engineer or his representative has seen and approved the formation surface. The Contractor shall notify the Engineer when the excavation is ready for inspection.

A619 NORMAL EXCAVATION

- A619.1** Normal excavation shall mean excavation in all materials except solid rock. Boulders with a volume of 0.5cu m in trenches or 1.0cu m in mass excavation shall be regarded as normal excavation.

Old masonry culverts or drains and old masonry wall structure below the ground which can be removed by 0.5cu m backacter shall likewise be deemed to be normal excavation.

A620 PUMPING AND BALING

- A620.1** The Contractor shall provide and perform as part of the Contract all pumping, baling, removing of water than may be required in executing the various Works and in maintaining the Works free from water and no water shall be allowed to accumulate in any trench or part of the works at any time.

A621 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

- A621.1** The Contractor shall provide for the disposal of all surplus excavated material not required for use in or on the works. The surplus material shall be properly removed and in no circumstances will the Contractor be allowed to leave spoil heaps on site.

A622 PREPARATION OF SUB-GRADE

- A622.1** The formation shall be well cleaned, free from mud and slurry and properly shaped and compacted where necessary, to an even and uniform surface as shown on the drawings. All exposed formations shall be inspected by the Engineer and no sub-base materials shall be placed until the formation has been approved by the Engineer. Once the formation has been prepared, constructional traffic shall not be allowed to run thereon without the permission of the Engineer.

A623 GEOTEXTILES

A623.1 A suitable geotextile which conforms with the following

It will sustain a tensile load of not less than 5.0kN/m at break and have a minimum failure strain of 10% when determined in accordance with BS 6906: Part 1.

It will have a minimum puncture resistance of 1200 N when determined in accordance with BS 6906: Part 4;

It will have a minimum tear resistance of 200 N when determined in accordance with ASTM Standard D4533-85.

It will have a size distribution of pore openings such that the maximum O90 size when determined in accordance with BS6906: Part 2, is 100 microns.

It will allow water to flow through it, in either direction, normal to its principal plane at a rate of not less than 30 litres/m²/sec under a constant head of water of 100mm and a maximum breakthrough head of 50mm when determined in accordance with BS 6906: Part 3.

A623.2 Geotextiles shall be protected at all times against mechanical or chemical damage. Those susceptible to damage by light shall not be uncovered between manufacture and incorporation in the Permanent Works. Temporary exposure shall not exceed 5 hours.

A623.3 The geotextile shall be laid and where lapping is employed adjacent sheets or strips of geotextile shall be overlapped by at least 300mm.

A623.4 The layer of material on which the geotextile is to be placed shall not have protrusions or sharp projections which are likely to damage the geotextile during installation or in service. The method of installation shall ensure that the geotextile is in continuous contact with the surface on which it is to be placed and the geotextile shall not be stretched or bridged over hollows or humps. Operation of construction plant directly on the installed geotextile will not be permitted and its covering with fill material shall take place immediately after its laying.

A624 TESTING OF GEOTEXTILES

A624.1 The 'wide strip' tensile strength test shall be carried out as follows by a method approved by the Engineer.

- (a) The test pieces shall be 200mm wide and have a gauge length of 100mm.
- (b) A minimum of five test specimens shall be taken and tested in each of the two principal directions within the geotextile relating to its mode of manufacture, in order to determine the characteristic strength of the geotextile.
- (c) The rate of strain shall be 10% plus or minus 3% per minute.
- (d) The characteristic strength shall be taken as the value of the strength of the material below which not more than 5% of the test results may be expected to fall. This represents the strength at 1.64 standard deviations below the mean strength.

A624.2 The flow rate of water shall be determined as follows:-

- (a) Geotextiles shall be tested in an unloaded condition under a 100mm constant head of water.
- (b) Flow shall be in a single direction.
- (c) The area to be tested shall be circular and between 50mm and 100mm diameter.
- (d) Before testing the test piece shall be conditioned in clean water for one hour.
- (e) The water used in the test shall:
 - (i) be as free of air as possible and the apparatus shall be supplied from a still tank and not directly from a mains supply.
 - (ii) not be contaminated with detergents or other substances and there shall be no recycling of the water.
 - (iii) have a temperature not less than 10 degrees C nor in excess of 25 degrees C. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15 degrees C using published data on variation in viscosity of water with temperature.

- (f) The quantity of flow to be collected shall not be less than 2 litres or alternatively the flow shall be collected for a period of time in excess of 15 s.
- (g) The number of test pieces shall be a minimum of 4 and the number of flow runs per test piece shall be a minimum of 4.
- (h) The flow shall be quoted in litres/m⁵/s. The standard deviation of the flow results shall be stated together with the mean.

A625.3 The pore size distribution and determination of O90 shall be as follows:-

- (i) The pore size distribution shall be obtained by determining the percentages of each of a number of different designated sizes of glass spheres complying with BS 6088 (chosen so as to cover the range of pore sizes) which are retained on the geotextile when shaken through it employing the geotextile as a sieve.
- (ii) A cumulative frequency graph of percentage of spheres retained against designated size shall be plotted and the size corresponding to 90% retained is the required O90
- (iii) For each sieving at least 100g of the glass spheres shall be shaken for 10 min on a test piece of geotextile supported and clamped in place on a BS sieve of frame diameter 300mm and aperture size greater than 10mm.
- (iv) The sieve apparatus shall have a vibrational frequency of 50 Hz and a maximum vertical amplitude of 0.75mm.
- (v) 5 test pieces having dimensions exceeding the dimensions of the sieve shall be taken to provide a mean of O90 pore size.

SERIES 800
SUB-BASES AND ROADBASES

801 MATERIALS FOR SUB-BASES AND ROADBASES

- A801.5** Except where otherwise specified unbound material up to 210 mm compacted thickness shall be spread in one layer so that after compaction the total thickness is as specified. Unbound material of compacted thickness greater than 210 mm shall be laid in two or more layers and the minimum compacted thickness of any such layer shall be 100 mm. Where the layers of unbound material are of unequal thickness the lowest layer shall be the thickest layer.

802 CONSTRUCTION REQUIREMENTS FOR MATERIALS TO CLAUSES 803 TO 811 INCLUSIVE

- S802.7** At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted cement-bound material shall be cut back to a vertical face where the specified thickness of properly compacted cement-bound material has been obtained.
- S802.14** Vibrating rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls.
- (i) The requirements for vibrating rollers are based on the use of the lowest gear on a self-propelled machine with mechanical transmission and a speed of 1.5 - 2.5 km/h for a towed machine, or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased number of passes shall be provided in proportion to the increase in speed of travel.
 - (ii) Where the mechanical vibration is applied to two rolls in tandem, the minimum number of passes shall be half the number given in Table 8/1 for the appropriate mass per metre width of one vibrating roll. If one roll differs in mass per metre width from the other, the number of passes shall be calculated as for the roll with the smallest value. Alternatively, the machine may be treated as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value or, if appropriate, each roll may be assumed to be attached to a separate machine and the requirements of sub-clause 18 applied.
 - (iii) Vibrating type rollers operating without vibration will be classified as smooth-wheeled rollers.
 - (iv) Vibrating rollers shall be operated with their vibratory mechanism operating only at the frequency of vibration recommended by the manufacturers. All such rollers shall be equipped with or provided with a device that shall indicate the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.

- (v) Where compaction of material is required adjacent to structures vibration will be achieved by use of a Vibrating-plate compactor, complying with the requirements of Table 8/1 for number of passes for specific layer depths.

S802.17 Power rammers are machines that are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator. One pass of a power rammer shall be considered to have been made when the compacting shoe has made one strike on the area in question.

S802.18 Combinations of different types of plant or different categories of the same plant will be permitted; in which case the number of passes for each shall be such proportion of the appropriate number in Table 8/1 as will together produce the same total compactive effort as any one operated singly, in accordance with Table 8/1.

804 GRANULAR MATERIAL TYPE B

S804.2 The material passing the 425m BS. sieve when tested in accordance with BS. 1377 shall be non plastic. By "Non- Plastic" is meant that it is not possible to obtain a Plastic Limit in accordance with BS 1377.

S804.4 The material shall have a 10% fines value of 130 kN or more when tested in compliance with BS 812 except that samples shall be tested in a saturated and surface dried condition. Prior to testing the selected test portions shall be soaked in water at room temperature for 24 hours without previously having been oven dried.

A804.5 Where this material is crushed rock it shall be crushed from a non-argillaceous rock.

SERIES 1700

MATERIALS

1719 MANHOLES AND INSPECTION CHAMBERS

- S1719.1** Manholes shall be constructed of solid concrete blockwork to IS20, in-situ concrete or precast concrete units to BS 5911 Part 1.
- S1719.2** Manhole roofs shall consist of a reinforced concrete cover slab suitably reinforced to carry all the probable dead and live loads and shall be of minimum thickness 150mm. Alternatively a precast concrete slab complying with BS 5911 may be used.
- S1719.3** Manholes and chambers shall be substantially watertight with no identifiable flow of water penetrating the Permanent works.

1720 MANHOLE COVERS AND FRAMES

- S1720.1** Manholes covers, gully gratings and frames shall be manufactured from iron complying with BSEN 124 with a minimum 600mm diameter opening.

1724 PIPES FOR DRAINAGE AND DUCTS

S1724.2 Cast Iron, Grey Iron or Ductile Iron Pipes and Fittings

Pipes shall be provided with spigot and socket joints. They shall comply with the requirements of BS 437-Cast Iron pipes. Ductile Iron pipes for sewage shall comply with BS EN 598.

S1724.3 Clay Pipes

- (i) Clay pipes to be used for sewage shall be 'British Standard' pipes and pipes for surface water shall be either 'British Standard' or 'British Standard Surface Water' all manufactured to the requirements of BS EN 295. Other than for French drains, the pipes shall have Type 1 sockets and be supplied complete with the manufacturer's recommended flexible joint, or with Type 2 sockets for cement mortar joints or plain ended pipes supplied with sleeve couplings.
- (ii) Watertight flexible joints for clayware pipes except those for French drains shall comply with BS 65.

S1724.4 Clay pipes for French drains may be any one of the following generally to BS EN 295

- (i) Unperforated pipes not exceeding 1.5 m in length with Type 1 or Type 2 sockets:
- (ii) Perforated pipes of any length with Type 1 or Type 2 sockets:
- (iii) Perforated pipes of any length with plain or rebated ends and flexible sleeve couplings.

S1724.5 Concrete Pipes

S1724.5.1 Concrete Pipes for general drainage:

- (i) Pipes having an internal diameter less than or equal to 900 mm shall be:
 - (a) Concrete pipes to BS 5911:1992
- (ii) Pipes having an internal diameter greater than 900 mm shall comply with:
 - (a) Sub-clause 1.3.1(i) above except that the Contractor shall submit test certificates to the Engineer, furnished by the pipe manufacturer, confirming that the 28 day minimum works cube strength for concrete is not less than 50 N/sq.mm and that the pipes comply with the Requirements of this Clause and
 - (b) Submission, by the Contractor, of samples and test certificates of same except that the pipes shall bear the stamp of the registered certification trade mark of the National Standards Authority of Ireland or The British Standards Institution, and shall be clearly labelled for identification:
- (iii) Watertight Flexible Joints shall be so constructed as to tolerate a longitudinal movement of +/- 10mm without breaking the seal. They shall also tolerate deviations in any direction from a straight line not less than those given below:

Pipe Diameters (mm)	Movement Tolerances (degrees)
150 - 600	2
600 - 1200	1
over 1200	0.6

All ogee concrete surface water pipes, in surface water sewers and drains, shall be to BS 5911 Part 110.

Concrete sewer pipes with spigot and socket joints with flexible joints, where specified in the contract shall comply with BS 5911 Part 100.

S1724.6 Concrete pipes for use in French drains may be any one of the following:-

- (i) Porous concrete pipes to BS 5911 Part 110:
- (ii) Concrete pipes to BS 5911:Part 100:1992 with a maximum length of 1.5 m laid with open joints:
- (iii) Perforated concrete pipes complying with the strength and manufacturing requirements of BS 5911:Part 110:1992 of any length, with holes not greater than 10 mm nor less than 3 mm diameter. The total area of holes shall be not less than 1000 sq.mm per metre length of pipe:

S1724.7 The cement used in the manufacture of concrete pipes shall be one of those complying with Clause 1709 of the Concrete Specification except that supersulphated cement shall not be used. Sulphate resisting cement shall be used where described in the Contract.

S1724.13 Pipes of Plastic Materials

S1724.14 Pipes for French drains shall be perforated or slotted; if perforated, holes shall be not greater than 10 mm nor less than 3 mm diameter; if slotted, slots shall be no wider than 4 mm nor less than 0.6 mm, otherwise shall comply with the requirements of the specification for soil pipes, drains, sewers and fittings made with unplasticised polyvinyl chloride (uPVC) issued by the Department of the Environment. The total area of holes shall be not less than 1000 sq.mm per metre length of pipe. Plastic pipes for light duty sub-soil drains for use as specified in the Contract shall conform to BS 4962.

S1724.16 Ducts

Service ducts shall have a smooth internal bore without any sharp edges to the ends of the pipes. Service ducts shall be constructed of any of the following, laid, bedded and surrounded as described in the Contract:

- (i) Vitrified clay ducts with self-aligning flexible sleeve joints manufactured in accordance with the tolerances, permeability and strength requirements of BS 65. The internal ends of ducts shall be radiused to 3 mm minimum;
- (ii) Unplasticised polyvinylchloride (uPVC) pipes complying with Class B or C of BS 3506 or with BS 4660;

A1724.16 uPVC. CLASS B DUCTING

Material

The material from which the ducts are to be produced shall consist substantially of Polyvinyl Chloride, to which may be added only those additives which are needed to facilitate the manufacture of sound ducts of satisfactory surface finish and mechanical strength. Re-cycled material if used shall not exceed 33⅓% by weight the balance being virgin material. It shall be uniformly mixed.

Finish

The bores shall be smooth and free from grooves, cracks and sharp protrusions. Ducts shall not be kinked but a slight uniform curvature is permissible. Ends shall be square in the duct axis. The colour of the ducts should be black or dark grey and be uniform throughout.

Nominal Diameter (mm)	Minimum Wall Thickness (mm) Class B
100	3.4

Lengths

The ducts shall be 6m effective lengths not including the socket.

Joints

Each pipe shall have a socket at the end. The socket, which shall be an integral part of the pipe, shall have a minimum length of 75mm and shall be of push fit type, with the non-socket end suitable prepared for an even smooth joint.

Testing

Samples for test, as prescribed in the following clauses, shall be taken at random during manufacture. Laboratory tests results shall be recorded and made available to the Engineer. The ducts shall comply with the following test requirements.

Tensile Strength

The tensile strength of the P.V.C. shall not be less than 45MN/m² and the elongation at break shall not be less than 80%.

Impact test

The ducts shall be tested in accordance with BS 4660. The duct shall withstand an impact load of 2 kilos dropped from a height of 2 metres. The ducts shall be sufficiently strong to withstand normal transit and handling loads without breaking or cracking when temperatures are within the normal ambient external experienced in this country.

Reversion Tests

A test piece of duct 150mm in length shall be immersed in ethylene glycol at 150°C for 15 minutes and then allowed to cool. The length of the specimen shall not change by more than 5%

Deformation

When a 200mm sample length is placed between two flat parallel horizontal plates the duct diameter shall not deform more than 3mm when a load of 95N is applied. The test load shall be applied in increments of 20N every 15 seconds at an ambient temperature of 20°C.

Time Deformation

When two lengths of pipe 0.5m long are continuously subjected to a uniformly distributed crown load of 150/kg/m/pipe at 20°C the average % deformation under load of the internal vertical diameter after 48 hours shall not exceed 5.5%.

Marking

The ducts shall be suitably marked at intervals of a minimum 1m with a figure designating the nominal diameter in mm, the manufacturer's code letter or letters, and the last two figures of the year of manufacture. The marking shall be in characters of not less than 6mm and of contrasting

A1734 WATERMAIN

A1734.1 Watermains shall consist of:

- 1 Class C Hard Polyvinyl Chloride pipes.
All PVC pipes shall comply with IS 123 Class C and shall be jointed with type A non tension rubber ring type joints in accordance with manufacturer's instructions.

Handling and installation shall comply with the "Recommendations for handling and installation of uPVC pipes" issued by EOLAS.

Unplasticised PVC pipes for watermains shall also be certified by the National Standards Authority of Ireland (NSAI) and shall bear the appropriate mark of conformity. Proof of the Authority=s declaration of equivalence, together with a copy in English of all the documentation and related test data confirming compliance, shall be furnished for the Engineer=s approval.
- 2 Ductile iron pipes made in accordance with BSEN 545.
The Contractor shall provide manufacturer=s test certificates for each pipe consignment making up the total order. Sockets and joints shall be painted a suitable colour for identification purposes.
- 3 Fibre cement pipes to the requirements of IS EN S12
- 4 Polyethylene pipes, type 50, to the requirements of IS: 135.

A1734.2 SERVICES PIPES

Service pipes in consumer connections shall be one of the following types:-

- (a) Annealed Copper Pipes to the requirements of IS EN 1057.
- (b) Heavy Gauge Polythene Pipes, type 32, to the requirements of IS: 134.
- (c) High Density Polythene Pipes, type 50, shall comply with IS 135: 1975.

A1734.3 HARD POLYVINYL CHLORIDE PIPES

General

Watermains shall be hard PVC pipes, approved quality and manufactured to IS 123, SR 3 and the Department of Local Government Provisional Specification so as to satisfy its requirements fully. They shall be manufactured from Polyvinyl Chloride without plasticisers, fillers or adulterants and shall be smooth, free from grooves, scratches, dents or other defects and the ends cut off smoothly and square to the pipe axis. The cross section of the pipe material at any cut shall be free from blisters, hollows or bubbles. The standard lengths of the pipe shall be 6 m., exclusive of any sockets, with a positive tolerance only of 100 mm being allowed. Where test pieces have been cut from pipes, the shortened pipe, provided it has a usable length of not less than 4 m shall be accepted to a maximum of 5% of the order. The requirements for straightness, diameter and thickness, with permissible tolerance as set forth in the above mentioned Specification, shall be satisfied. All pipes will be expected to meet the conditions specified for internal water pressure, impact, swelling, shrinkage effect on water, light transmittance and marking. The selection of samples for test and the facilities for testing shall be in accordance with the requirements detailed in the above specification and actual testing shall satisfy the conditions laid down therein.

Handling of uPVC pipes

The handling and installation of the pipe shall be in accordance with the recommendations prepared by Eolas in collaboration with the Department of the Environment. These recommendations cater for the handling, storage, installation, testing and repair of unplasticised PVC watermains and service pipes and the Contractor will be expected to make himself thoroughly acquainted with them and to observe them in detail.

The recommendations stress that it is of great importance that care should be exercised in the handling of pipes to avoid damage to the wall surface.

Pipes should not be dragged along the ground and they should be loaded and unloaded by hand and the use of skids should be avoided. They should be laid down gently and should never be dropped on a hard surface. Specific conditions relating to storage of pipes, both long term and temporary, stacking, transport, loading, unloading and site inspection on delivery have been detailed in the recommendations referred to above and these must be satisfied by the Contractor.

The Contractor shall observe the precautions relating to pipe installations as set out in the recommendations already referred to above. When work is carried out during very hot weather, final connections to fixed joints shall be deferred until the majority of the pipeline has been covered with backfill. Where pipes are encased in concrete, either as protection or anchorage, a membrane such as felt or polythene film shall be placed between the concrete and the PVC pipe.

The formation of bends on the site will not be accepted and all bends required shall be obtained from the pipe supplier. Under special circumstances approved by the Engineer, hot bending on the site will be permitted for pipes up to and including 40 mm size provided the work is carried out by a trained operator using suitable bending springs and other equipment.

Jointing of uPVC pipes

Jointing of pipes shall be carried out with approved collar type joints consisting of a PVC coupler with internal rubber sealing rings. Pipe ends shall be suitably chamfered for insertion in the couplers and jointing shall be done in accordance with the manufacturer's instructions. In the jointing of pipes, special care must be taken to protect the spigot ends of pipe and the couplers from contact with grit or dirt and approved lubricants must be used on the grooves and rings of the couplers and on the pipe ends. Care is to be taken to ensure that the correct type collar is used for the class of pipe being installed.

Where spigot and socketed cemented joints are required such as for service pipes, they shall be carried out in accordance with the manufacturer's detailed instructions. Where metal saddles are used for service connections, they shall be examined carefully for the presence of burrs or sharp edges which might damage the pipe surfaces. All such burrs shall be carefully removed and the edges of the saddle in contact with the pipe shall be suitably rounded. Saddles shall not be over-tightened.

Specials

Specials, such as tee pieces for branch lines, scour out branches and air valves shall be standard type "Wavintee" or equal CI tee pieces. Sluice valves fitted on the line of main shall be standard double flanged type. The joints between the PVC pipes and the flanges of the valves and fittings shall be made by means of approved type of CI flanged and spigot adaptors with internal rubber sealing ring, PVC pipe ends shall be suitably chamfered for insertion in the adaptors and jointing shall be done in accordance with the manufacturer's instructions.

A one metre length of CI double flanged pipe shall be provided and fitted each side of the sluice valve. A block of Grade 15 concrete for the full width of the pipe trench and extending 75 mm under and over the barrel of each such double flanged, CI piece shall be placed centrally on the fittings for a length of 600 mm for anchorage against movement on a vertical arc.

Service Connections to uPVC pipes

Connections for services shall be made to the PVC mains by means of specially formed collar clamped on the main by means of a wedged shaped clamp. The position of the service connection shall be accurately marked on the main, the collar clamped over the main. The tap will be fixed in the collar by means of a pressure drilling apparatus.

Where tapping into the empty mains is permitted by the Engineer, the saddle shall first be clamped on the main and the position of the hole accurately marked. The saddle shall then be removed and the hole drilled in the pipe by means of a steel bit drill. The saddle shall then be replaced and the ferrule tap screwed on water seal between the pipe and the saddle shall be obtained by means of a rubber ring glued in place on the underside of the saddle.

A1734.3 IRON PIPES

General

Iron pipes shall be either ductile iron cast or spun, complying with BSEN 545. They shall be of best metal, tough and close grained and such that when broken shall not be white or mottled. There shall be no admixture of cinder iron or other inferior metal. The pipes shall be perfectly straight and truly cylindrical in the barrel, free from all imperfections of casting. They shall be perfectly smooth inside and no lumps or rough places shall be left in any part.

All pipes are to be protected by bitumen. and coated thoroughly to fill the surface. Internally they shall be lined with concrete. Each consignment of pipes is to be accompanied by a certificate from the manufacturer giving the results of the transverse tensile and hydraulic test and certificate that the pipes and special casting have been manufactured in accordance with the BS for ductile iron.

All specials are to be provided by the Contractor and in his prices set out in the priced Bill of Quantities carried forward to tender, he shall provide for every bend, tee, valve, flange, piece, reducer, puddle collar, bellmouth, rose, spindle, valve key, hydrant, surface box foundation and other necessary fittings shown on drawings and/or referred to in specification or reasonably necessary for the proper completion of the work.

All precautions necessary in the handling, storage or laying of pipes shall be strictly observed by the Contractor.

Concrete Lining

Concrete lined cast iron pipes shall be in accordance with BS EN 545, with a concrete lining spun on the pipe.

For pipes up to and including 250 mm in diameter, the thickness of the lining shall be at least 5 mm thick. From 300 to 600 mm inclusive, the lining shall be at least 6 mm thick. Greater than 600 mm, the lining shall be 9.5 mm thick. In no case shall thickness of the lining exceed the given figure by more than 3 mm.

Testing for Soundness

Before placing the pipe in the trench, each length shall be brushed out inside and then suspended at the centre of its length and struck with a hammer at both ends to find out whether it is sound. If the pipe is found to be defective it shall be discarded and removed from the vicinity of the Works. This test in no way relieves the Contractor from his responsibility for replacing any defective pipes discovered during subsequent testing.

Jointing of Iron pipes

All iron pipes shall be flexibly jointed, unless detailed otherwise. Joints shall be spigot and socket type and shall be completed in accordance with manufacturer's instructions and BS. The joint type to be used in each specified task will be referred to in the Bill of Quantities. Jointing rings shall comply with BS 2494.

Lead joints may, in certain circumstances, be required by the Engineer and shall be constructed as follows:

Each pipe shall be carefully inserted in the socket of the pipe previously laid and two strands of rope yarn shall be forced into the joint. When the yarn is well packed home with caulking tools, a space of not less than 50 mm shall be available for lead.

Molten lead shall be poured into this space in one operation and when cooled, shall be properly caulked and dressed. The weight of lead in any pipe joint shall be in accordance with the following table:

Pipe Dia mm.	Weight Lead Kg.
75	1.5
100	2.0
150	3.0
200	4.0
225	5.0

SPECIFICATION

FOR STRUCTURAL CONCRETE

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IS EN 206-1	2002	Concrete Part 1: Specification, Performance, Production and Conformity (consisting of IS EN 206-1:2000 and The Irish National Annex).
IS EN 12350 Parts 1-7	2000	Testing Fresh Concrete
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BS 12:	1991	Specification for Portland Cement
BS 146:	1991	Specification for Portland BFC
BS 882: Part 2	1992	Specification for Aggregate from Natural Sources for Concrete
BS 1047:	1983	Specification for Air-cooled BF Slag Aggregate for Construction Use
BS 1370:	1979	Specification for Low Heat Portland Cement
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BS 4449:	1988	Specification for Carbon Steel Bars for the Reinforcement of Concrete
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BS 6588:	1991	Specification for Portland Pulverised Fact Ash Cement
BS 8110: Part 1	1997	Structural Use of Concrete Code of Practice for Design and Construction
BS 8110: Part 2	1985	Code of Practice for Special Circumstances
PD 6534	1993	Guide to the use in the UK of DD ENV 206: 1992. Concrete. Performance, Production Placing and Compliance Criteria.

1 CONCRETE - CLASSIFICATION OF MIXES

1.1 General

Unless otherwise described in the Contract, designed concrete, either ordinary structural concrete or special structural concrete, shall be utilized. The concrete compressive strength classes for the Contract are given on the drawings.

1.2 Ordinary Structural Concrete

Ordinary structural concrete shall contain only materials specified in Clause 02.

1.3 Special Structural Concrete

Special structural concrete is concrete containing an admixture or material other than those specified in Clause 2 below.

1.4 Designed Concrete

Concrete for which the required properties and additional characteristics are specified to the producer who is responsible for providing a concrete conforming to the required properties and additional characteristics. The contractor shall, unless otherwise specified, select the concrete consistence class depending on the methods of placing, compaction and finishing involved in a particular project.

2 CONCRETE - ORDINARY STRUCTURAL - CONSTITUENT MATERIALS

2.1 Cement

Cement shall comply with one of the following sub-Clauses (i) to (iii) below:-

- (i) IS 1 (Normal and Rapid Hardening Portland Cement) as amended, in accordance with the Irish Standard Mark Licensing Scheme of Eolas. Manufacturers or suppliers Certificates of Compliance with the Standard shall be provided when requested by the Engineer.
- (ii) BS 12 Specification for Portland Cement
- (iii) BS 4027 Specification for Sulphate-resisting Portland Cement

Cement should be stored in moisture proof conditions. Care should be taken that cement is used rotationally and that no cement is stored too long.

The use of high alumina cement or concrete is prohibited.

2.2 Aggregate

Unless otherwise specified or agreed by the Engineer, aggregates shall comply with one of the following Standards, as appropriate:

- (i) IS 5 Aggregates for Concrete
- (ii) BS 882: Part 2 Specification for Aggregates from Natural Sources for Concrete
- (iii) BS 3797:1990 Specification for Lightweight Aggregates for Masonry Units and Structural Concrete.

The use of sea dredged aggregates is prohibited.

The shell content of the aggregate included as calcium carbonate as determined by the method in IS 5: Part 3.3 shall not exceed the following amounts:

Nominal Size (mm)	%
40	2
20	5
10	15
Fine	30

The flakiness index (when determined by the method described in IS 5: Part 3.2) of the coarse aggregate shall not exceed 35% for 10 mm aggregate nor 30% for 20 mm aggregate. For concrete compressive strength class C32/40 or higher the ten per cent fines value of the coarse aggregate determined in accordance with IS 5: Part 3.9 shall be not less than 100 kN and for other grades not less than 50 kN.

Chloride levels shall be determined daily in accordance with IS 5: Part 3.8 or as otherwise agreed by the Engineer.

2.3 Water

If water for the Works is not available from a Public Utility Undertaking supply the Engineers approval shall be obtained regarding the source of supply and manner of its use. When required by the Engineer the Contractor shall arrange for tests of the water to be carried out in accordance with BS 3148: 1980 - Methods of Test for Water for Making Concrete. Water from the sea or tidal rivers shall not be used.

3 CONCRETE - SPECIAL STRUCTURAL - CONSTITUENT MATERIALS

3.1 Cement

Cement shall comply with Clause 2.1 or subject to the approval to the Engineer, with one of the following:-

- (i) BS 1370 Specification for Low Heat Portland Cement
- (ii) BS 12 Specification for Portland Cement

3.2 Aggregate

Aggregate shall comply with the requirement of Clause 2.2. Unless otherwise described in Contract or agreed by the Engineer lightweight aggregate shall comply with the requirements of BS 3797 (Lightweight Aggregates for Concrete).

3.3 Water

Water shall comply with Clause 2.3 above.

3.4 Admixtures

3.4.1 General

No admixtures should be used without written approval of the Engineer. The quantity and method of using admixtures shall be in accordance with the manufacturer's recommendations and in all cases shall be subject to approval by the Engineer.

Unless otherwise specified or approved by the Engineer, an admixture shall comply with one of the following:-

- BS 1014 (Pigments for Portland Cement and Portland Cement Products)
- BS 5075 (Concrete Admixtures except chloride-based admixtures)

In all cases the Contractor shall provide the following information for the Engineer's approval:-

- (a) the quantity to be used, in kilograms per kilogram of cement and in kilograms per cubic meter of concrete;
- (b) the detrimental effects caused by adding greater or lesser quantity in kilograms per cubic meter of concrete;
- (c) the chemical name(s) of the main active ingredient(s);
- (d) whether or not the admixture leads to the entrainment of air;

If required by the Engineer, the Contractor shall demonstrate the action of an admixture by means of trial mixes.

3.4.2 Calcium Chloride

The use of calcium chloride in any form is prohibited.

4 CONCRETE - GENERAL REQUIREMENTS

4.1 Concrete Compressive Strength Class

For each specified compressive strength class of concrete, the minimum characteristic cylinder or cube strength in N/mm^2 shall be as given in Table 4.1.

Designed concrete shall be used for the compressive strength classes listed hereunder. The grade of concrete shall be defined by its compressive strength class.

TABLE 4.1 Compressive Strength Classes of Concrete

Compressive Strength Class	Minimum Characteristic Cylinder Strength N/mm^2	Minimum Characteristic Cube Strength N/mm^2
C8/10	8	10
C12/15	12	15
C16/20	16	20
C20/25	20	25
C25/30	25	30
C28/35	28	35
C30/37	30	37
C32/40	32	40
C35/45	35	45
C40/50	40	50
C45/55	45	55
C50/60	50	60
C55/67	55	67
C60/75	60	75
C70/85	70	85
C80/95	80	95
C90/105	90	105
C100/115	100	115

The characteristic strength shall be the 28 day strength for all concrete.

The maximum aggregate size shall be 20mm. The Engineer shall be notified of any proposal to depart from this.

4.2 Minimum Cement Content, Maximum Water / Cement Ratio and Cover Requirements

For designed concrete mixes minimum cement content and maximum free water / cement ratio shall meet the requirements of Table F1 (IRL) of IS EN 206-1: 2002, taking account of the relevant exposure conditions as defined in Table 1 of IS EN 206-1:2002. Minimum cover shall comply with the requirements of Appendix C Table 4.3 of IS EN 206-1:2002, represented by Table 4.2 of this Specification.

Table 4.2 – Minimum Concrete Compressive Strength Classes (IS EN 206-1:2002)

Exposure Condition	Internal Dry	Foundations or Internal Wet	External
Concrete Compressive Strength Class	C25/30	C28/35	C30/37
Nominal Cover to all Reinforcement (+- 5mm)	20mm	40mm	40mm
Minimum Cement Content	280kg/m ³	300kg/m ³	320kg/m ³
Maximum Free Water / Cement Ratio	0.65	0.60	0.55
Maximum Aggregate Size	20mm	20mm	20mm

Note: Other Special Requirements for: Precast Concrete, Prestressed Concrete, Aggressive Soil, Water Retaining Structures, Concrete Fill to Hollow Blockwork (See Relevant Specifications).

4.3 Maximum Cement Content

The cement content shall not exceed 450 kg/m³ unless otherwise described in the Contract or agreed by the Engineer.

4.4 Chloride Content

The total chloride content of a concrete mix arising from the aggregate and any other source shall not exceed the appropriate limit given in Table 4.3 when determined in accordance with BS 812.

4.5 Maximum Sulphate Content

The total water-soluble sulphate content of the mix, expressed as SO₃, shall not exceed 4%. The Sulphate shall be calculated as the total from the various constituents of the mix.

4.6 Control of Alkali-silica Reaction

- 4.6.1 Either Clause 4.6.2 or Clause 4.6.3 shall be complied with. The Contractor shall indicate to the Engineer which of the procedures he proposes to adopt.
- 4.6.2 For protection of the structure by controlling the reactive silica content of the aggregates, the following shall be complied with:

TABLE 4.3 Maximum Total Chloride

Maximum total chloride content expressed as % of chloride ion by weight of cement.

Type or Use of Concrete

Prestressed concrete, heat-cured concrete containing embedded metal	0.1
Concrete made with cement complying with BS 4027	0.2
Concrete containing embedded metal and made with cement complying with IS 1, BS 12, BS 1370,	0.3

Note: % chloride ion x 1.648 = % equivalent sodium chloride
% chloride ion x 1.566 = % equivalent anhydrous calcium chloride.

- 4.6.2.1 Representative samples of the aggregates to be used shall be subjected to petrographic examination by a competent petrographer approved by the Engineer. The definition of rock types shall be as per IS 5: Part 3.14: Description and classification of aggregates.

Where the geological formation of the source material is complex, data from borings may be required to prove the nature of the parent strata.

The petrographer shall produce a report and shall quantify the presence if any of each of the potentially reactive constituents listed in Table 4.3. The report shall state the geological age of any chert discovered. Where the petrographer is evaluating a parent rock or gravel the report shall indicate the percentage of such constituents likely to remain in the aggregates after they have been processed to IS 5.

The Contractor shall then provide the Engineer with a report showing the percentage of the potentially reactive constituents which will occur in the proposed concrete mix as a result of blending the coarse and fine aggregates.

If the content of potentially reactive materials or rock is above the limits given in the second column in Table 4.4, the aggregates may be acceptable at the Engineer's absolute discretion following further assessment as per Clause 4.6.2.2.

TABLE 4.4

Aggregate Types	Acceptable Maximum Content
Potentially reactive mineral or rock	Zero
Opaline silica Crystobalite Tridymite	Zero
Microcrystalline and cryptocrystalline quartz, chalcedony	5%
Volcanic glass	5%
Highly strained* quartz	30% or less

* If the average undulatory extinction angle obtained from at least 20 separate quartz grains (measured in thin sections under a petrological microscope) is more than 25 degrees, the quartz shall be classified as highly strained.

4.6.2.2 Where the limits of potentially reactive material given in Table 4.4 are exceeded the aggregates may still be acceptable at the Engineer's sole discretion. To determine acceptability or otherwise of the aggregates the Engineer will require testing in accordance with ASTM C-289-87 and ASTM C-227-87 or as may be otherwise instructed.

4.6.3 For protection of the structure by controlling the alkali content of the cement or concrete, the following clauses shall be complied with:

4.6.3.1.1 The calculated alkali content of the concrete mix shall not exceed 4.0 kg per cubic meter of concrete. If the assessment of the aggregate indicates that the only potentially reactive mineral or rock discovered is microcrystalline or cryptocrystalline quartz or chalcedony derived from chert which is of carboniferous age or older, the limit may be increased to 4.5 kg per cubic meter.

or

4.6.3.1.2 The alkali content of the Portland cement shall not exceed 0.6%.

4.6.3.2.1 The alkali content of the Portland cement shall be taken as the certified average soluble alkali content of the cement plus 1.64 times the standard deviation. The certified

average acid soluble alkali content shall be the average of the last 25 determinations of alkali content carried out on consecutive daily samples immediately prior to submission. The Contractor shall submit to the Engineer the test certificates furnished by the cement manufacturer. The alkali content of the Portland cement shall be determined in accordance with the method recommended in BS 4550: Part 2 or by the use of an x-ray fluorescence technique calibrated against that Standard

- 4.6.3.2.2 The equivalent sodium oxide content of the coarse and fine aggregate shall be calculated from the quantity of chloride ion present, which shall be measured by the method in IS 5: Part 3.8: Method of test for chloride salts.
- 4.6.3.2.3 For the purposes of 4.6.3.1.1 the calculated alkali content of the concrete mix shall be determined by **summing:**
- (a) The certified average acid soluble content of the cement plus 1.64 times the standard deviation.
 - (b) 0.76 times the chloride ion content of the aggregate taken as the percentage by weight (ignore if less than 0.01%).
 - (c) The Na_2O contribution of any admixtures.

5 MIX REQUIREMENTS FOR DESIGNED CONCRETE

5.1 Suitability of Proposed Mix Proportions

The Contractor shall submit for the Engineer's approval, prior to the supply of any designed concrete, the following information:-

- (i) the nature and source of each material;
- (ii) either:
 - (a) appropriate existing data as evidence of satisfactory previous performance for strength, consistence and water/cement ratio.

or

- (b) full details of tests on trial mixes carried out in accordance with Clause 5.2 below.

- (iii) the quantities of each material per cubic meter of fully compacted concrete.

Any change in the source of material or in mix proportions shall be subject to the Engineer's prior approval (except changes in cement content of not more than 20 kg/m³ of which the Engineer shall be notified).

5.2 Trial Mixes

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved material typical of those he proposes to use in the works, for all grades, to the Engineer's satisfaction before commencement of concreting.

The contractor shall ascertain the consistence class of the trial mixes.

Sampling and testing procedures shall comply with BS EN 12350:2000.

The concreting plant and means of transport employed to make the trial mixes and to transport them representative distance shall be similar to the corresponding plant and transport to be used in the Works. A clean dry mixer shall be used and the first batch discarded. Test cubes shall be taken from trial mixes as follows: For each mix a set of six cubes shall be made from each of three consecutive batches. Three from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the engineer.

The tests shall be carried out in a laboratory approved by the Engineer.

The average strength of the nine cubes tested at 28 days shall exceed the specified characteristic strength by 20% or $6/\text{Nmm}^2$ whichever is the greater.

If trial mixes are required to demonstrate that the maximum free water/cement ratio is not exceeded two batches should be made in the laboratory with cement and surface dry aggregates known from past records of the suppliers of the material to be typical. Proposed mix proportions should not be accepted unless both batches have the correct cement content and a free water/cement ratio below the maximum specified value at the proposed degree of consistence.

For this purpose existing laboratory test reports may be accepted instead of trial mixes only if the Engineer is satisfied that the materials to be used in the structural concrete are likely to be similar to those used in the tests.

5.3 Additional Trial Mixes

During production the Contractor shall carry out trial mixes and tests, if required by the Engineer before substantial changes are made in the materials or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with Clause 6.4.

6 CONCRETE - PRODUCTION

6.1 Cement

Cement used in concrete, concrete products and other cement based products shall be certified as complying with IS 1: 1963 as amended, in accordance with the Irish Standard Mark Licensing Scheme of Eolas. Manufacturers' or suppliers' certificates of compliance with the Standard shall be provided when requested by the Engineer.

Different cements shall be stored in separate silos. Alternatively, these materials may be stored in bags in dry weatherproof sheds with raised floors and each consignment shall be kept separate and distinct. Any cement that has become injuriously affected by damp or other causes shall be removed from site immediately. The use of cements of the same type from different sources will not normally be permitted.

Records shall be kept by the contractor (and verified by resident supervisory staff) of the cement used in each pour. Care shall be taken that cement is used rotationally and that no cement is stored too long.

Where permission to use cement from a source other than that used in the original trial mixes is granted, the procedure given in 5.2 shall be repeated.

6.2 Aggregate

Aggregates shall consist of natural pit sand and washed gravel or approved crushed stone. All aggregates shall be hard, uniform and clean. Aggregates shall conform to BS 1047, BS882, and BS 3797: Part 2. Single sized coarse aggregates and fine aggregates shall be used for concrete grades above 15N, unless otherwise agreed by the Engineer, and stored in separate hoppers, or different stacks which shall be separated from each other. Relative proportions of coarse aggregates to be used shall be determined on the basis of the trial mixes.

All aggregates shall be kept free from contact with deleterious matter with adequate provision for drainage, and shall be stored and handled so as to avoid segregation.

The overall grading of the aggregates shall be such as to produce concrete of the specified quality that will work readily into position without segregation or excessive bleeding. The overall grading shall be controlled throughout the work so that it conforms closely to that assumed in the selection of the mix proportions. Each delivery shall be inspected and, if required by the Engineer, tested in accordance with BS 812. The Contractor shall provide copies of the results of routine control tests carried out by the aggregate producer.

For ordinary unreinforced structural concrete of compressive strength classes C8/10, C12/15, C16/20, C20/25 and C25/30 the mix proportions should be selected from a designed concrete mix to be determined by the contractor or his agent, and submitted to the engineer for his approval.

The compressive strength class of concrete to be used in a particular situation shall be as indicated on the relevant drawings but in any case shall not be less than the appropriate compressive strength class chosen from Table F1 (IRL) of IS EN 206-1:2002 taking account of the relevant exposure conditions as defined in Table 1 of IS EN 206-1:2002.

The maximum nominal aggregate size shall be 20 mm. The Engineer shall be notified of any proposal to depart from this.

6.3 Batching and Mixing

Concrete shall be produced in accordance with the procedures of IS EN 206-1:2002, Section 9.

The quantities of cement, fine aggregate and the various sizes of coarse aggregate shall be measured by weight unless otherwise agreed by the Engineer.

Separate weighing machines shall be used for cementitious materials and aggregates unless otherwise agreed by the Engineer. Alternatively, cementitious materials may be measured by using a whole number of bags in each mix. The quantity of water adjusted for the free moisture content of the aggregate shall be measured. Any admixture to be added shall be measured and, if solid, shall be measured by weight. Different types of cement shall not be mixed.

The batch weight of aggregate shall be adjusted to allow for the free moisture content of the aggregate being used.

All measuring equipment shall be maintained in a clean and serviceable condition, its accuracy shall be checked over the range in use when set up at each site, and maintained thereafter. The accuracy of equipment shall fall within the following limits:-

Measurement of cementitious material	$\pm 3\%$ of the quantity of cement in each batch
Measurement of water	$\pm 3\%$ of the quantity of water in each batch
Measurement of aggregate	$\pm 3\%$ of the total quantity of aggregate in each batch
Measurement of admixture	$\pm 5\%$ of the quantity of admixture in each batch

The mixer shall comply with BS 1305. The measuring devices in the mixer must be properly calibrated and should be checked periodically. Care should be taken to ensure that all components are thoroughly mixed and in particular any admixtures are uniformly distributed throughout the batch.

The mixing time shall be not less than that recommended by the manufacturer and should be determined on site to give a workable mix consistent with the cement content, required consistence and required strength subject to tests.

Mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the Engineer, the first batch of concrete through the mixer shall then contain only two-thirds of the normal quantity of coarse aggregate. Mixing plants shall be thoroughly cleaned before changing from one type of cement to another.

The capacity of the mechanical mixer shall be the minimum size consistent with bag batching in the various grades.

Suitable containers and weighing equipment shall be made available for weight testing. Tests shall be done at the Engineer's discretion. Concrete may be rejected if weight tests are not consistent with the mix and aggregate being used.

Slump tests will be carried out. A 300 mm x 200 mm x 100 mm cone shall be available at all times on site.

Mixing shall conform with the best modern techniques consistent with producing a uniform dense thoroughly mixed concrete. Water shall be measured and added in an approved manner.

Hand mixing shall be allowed only on the approval of the engineer and in no case where significant structural members are being cast.

If allowed, hand mixing shall be on water-proofed timber or on a concrete platform.

Materials shall be thoroughly mixed and water added in an approved manner.

6.4 Control of Strength of Designed Concrete

Adjustments to mix proportions shall be made subject to the Engineer's approval, in order to minimise the variability of strength and to maintain the characteristic mean strength.

6.5 Ready-mixed Concrete

Ready-mixed concrete shall comply with this series and the following special requirements. The concrete shall be carried to site in purpose-made agitators, operating continuously, once mixing is complete. The concrete shall be compacted and in its final position within 2 hours of the introduction of cement to the aggregate, unless a longer time is agreed by the Engineer. The time of such introduction shall be recorded on the delivery note together with the weight of the constituents of each mix

When truck-mixed concrete is used, water shall be added under supervision either at the Site or at the central batching plant as agreed by the Engineer, but in no circumstances shall water be added in transit. Unless otherwise agreed by the Engineer, truck mixer units and their mixing and discharge performance shall comply with PD 6534.

7 CONCRETE - COMPLIANCE

7.1 General

All sampling and testing of constituent materials shall be carried out in accordance with the appropriate Irish or British Standard. In particular, sampling and testing of fresh and of hardened concrete shall comply with BS EN 12350:2000 and IS EN 12390:2000 respectively, unless this is at variance with this Specification, in particular cement content, consistence class and free water/cement ratio shall comply with IS EN 206-1:2002.

7.2 Strength

7.2.1 General

The compliance scheme for strength shall be in accordance with IS EN 206-1: 2002, Section 8. Compliance with the specified characteristic strength shall be based on tests made on cubes at an age of 28 days unless there is evidence, satisfactory to the Engineer, that a particular testing regime is capable of predicting the strength at 28 days of concrete tested at an earlier age. Unless otherwise directed by the Engineer, the rate of sampling shall be as given in Table 7.1 but not less than one set of cubes shall be taken on each day that concrete of that compressive strength class is used.

Table: 7.1

Element of Structure	Testing Rate
Columns	One set of 3 No cubes/batch
Beams, Slabs, Foundations, Walls	One set of 3 No cubes/per 20 m ³ or part thereof

7.2.2 Testing

One set of cubes shall be made from a sample taken from a randomly selected batch of concrete. Samples shall be taken at the point of discharge from the delivery vehicle.

Compliance with the characteristic strength shall be assumed if the conditions given in both (a) and (b) are met.

- (a) the average strength determined from any group of four consecutive test results exceeds the specified characteristic strength by 3 N/mm^2 for concrete of compressive strength class C16/20 and above.
 2 N/mm^2 for concrete of compressive strength class C8/10 and C12/15.
- (b) the strength determined from any test result is not less than the specified characteristic strength minus
 3 N/mm^2 for concrete of compressive strength class C16/20 and above
 2 N/mm^2 for concretes of compressive strength class C8/10 and C12/15.

If only one cube result fails to meet the second requirement (b), then that result shall be considered to represent only the particular batch of concrete from which that was taken.

If the average strength of any group of four consecutive test cubes fails to meet the first requirement (a), then all the concrete in all the batches represented by all such cubes shall be deemed not to comply with the strength requirements. For the purposes of this clause the batches of concrete represented by a group of four consecutive test cubes shall include the batches from which samples were taken to make the first and the last cubes in the group of four, together with all the intervening batches.

Cube result data should be sent to the engineer at regular intervals during the contract. The location with grid references, levels and the area represented by each set of cubes should be stated on the data sheets.

Special testing shall be used if required in the Contract.

If the average strength of the test specimens taken to represent a given batch of concrete fails to meet the appropriate requirement, the whole of that batch of concrete represented by those specimens shall be deemed not to comply with the strength requirements of the Specification. Compliance with this requirement in respect of a given batch of concrete shall not be adduced as evidence of compliance in respect of any other batch.

When a test specimen representing a particular batch of concrete does not comply with the specification. Some non-destructive tests may be carried out on this batch at the Engineers discretion and at the Contractors expense to check its compliance with the strength requirements of the specification. The concrete batch shall be accepted if the non-destructive test results are satisfactory. Otherwise the concrete in question shall be rejected and replaced at the Contractors expense.

At the Engineer's discretion the Target Mean Strength may be adjusted in the course of a job in the light of the variability of cube results as they accumulate. Specifically if the standard deviation of 28 day results exceeds 7.5 Newtons per sq mm, the Target Mean Strength will be adjusted upwards and shall exceed the Characteristic Strength by 1.64 times the standard deviation.

7.3 Concrete Consistence

The consistence of the fresh concrete shall be such that the concrete is suitable for the conditions of handling and placing as described in Clause 9.3 so that after compaction as described in Clause 9.3 it surrounds all reinforcement, and completely fills the formwork. Consistence class shall be determined for each batch or at such times as directed by the Engineer using tests in accordance with IS EN 12350-2:2000. The consistence shall be within the limits of the required value given in Clause 4.2.1 of IS EN 206-1:2002.

7.4 Air Content of Fresh Concrete

When the Contract requires air entrainment the average air content of the fresh concrete shall be:

7% for natural aggregates for 10 mm nominal size

6% for natural aggregates for 14 mm nominal size

5% for natural aggregates for 20 mm nominal size

4% for natural aggregates for 40 mm nominal size

The percentage air content determined from individual samples taken at the point of placing the concrete and representative of any given batch of concrete shall be within $\pm 1.5\%$ of the specified value. The average percentage air content from any four consecutive determinations from separate batches shall be within $\pm 1.0\%$ of the specified value.

The air content shall be checked as described in BS EN 12350-7:2000 Part 106 as follows:

- (a) for each batch;
- (b) at such times as directed by the Engineer;

8 CONCRETE - SURFACE FINISH

8.1 Trial Panels

When required in the Contract and before commencing concreting the Contractor shall prepare a trial panel of size and surface finish acceptable to the Engineer. The panel shall be filled with the proposed concrete mix compacted by the method to be used in the work. As soon as practicable after compaction, the forms shall be removed to enable the Engineer to check the surface finish and compaction achieved.

8.2 Control of Color

Each constituent material shall be obtained from a single consistent source. The aggregates shall be free of any impurities that may cause staining. The mix proportions and the grading, particularly of the fine aggregate, shall be maintained constant. The same type of plywood or timber shall be used in formwork throughout similar exposed areas.

8.3 Release Agents

Release agents for formwork shall be to the approval of the Engineer. Where a concrete surface is to be permanently exposed, only one agent shall be used throughout the entire area. Release agents shall be applied evenly and shall not be permitted to come into contact with reinforcement, pre-stressing tendons and anchorages.

Where the concrete is to receive an applied finish the release agent shall be compatible.

8.4 Surface Finishes for Concrete

8.4.1 Formed Surfaces-Classes of Finish Formwork as described in Clause 9.2 shall be capable of producing the following finishes as required in the Contract:-

Class F1: No extra requirement.

Class F2: The irregularities in the finish shall be no greater than those obtained from the use of wrought thickened square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discolouration shall be made good to the satisfaction of the Engineer.

Class F3: The resulting finish shall be smooth and of uniform texture and appearance. All surfaces should be true with clean arrises. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the finish to the satisfaction of the Engineer. Internal ties and embedded metal formwork supports will not be allowed.

The formwork shall be adequately strong and shall be braced or tied about and below the relevant sections in order to avoid the filling of holes, etc.

Class F4: The requirements for Class F4 are as for Class F3 except that internal ties and/or embedded metal formwork supports will be permitted. The ties shall be positioned only in rebates or in other positions as described in the Contract or as agreed by the Engineer.

Class F5: The resulting finish shall be smooth and of uniform texture. Any blemishes and imperfections, such as discolouration and fins, shall be made good to the satisfaction of the Engineer. Provision for the embedment of metal parts in the Permanent works on a regular spacing, shall be allowed.

Class F6: Bush Hammered Finish.

Class F7: Exposed Aggregate Finish.

Class F8: Board Marked Finish.

Permanently exposed concrete surfaces to Classes F2 to F8 finish shall be protected from rust marks and stains of all kinds.

Unless otherwise described in the Contract, all formwork joints for exposed surfaces of concrete to Class F2 to F8 finish shall form a regular pattern agreed by the Engineer with horizontal and vertical lines continuous throughout each structure and all construction joints shall coincide with these horizontal or vertical lines.

Table 8.1 Schedule of Formed Surface Concrete Finishes

Type	BOQ Reference	Location
F1	Type A	Underground and not visible in finished structure
F2	Type C (unexposed)	Overground excluding fairfaced work
F3	Type C (fairface)	Fairfaced Work
F4		
F5		
F6		
F7		
F8		

See Bill of Quantities/Contract Documents for full details.

8.4.2 Unformed Surfaces-Classes of Finish

Class U1: The concrete shall be uniformly leveled and screeded to produce a plain surface. No further work shall be applied to the surface unless it is used as a first stage for a Class U2 or Class U3 finish.

Class U2: After the concrete has hardened sufficiently, the Class U1 finish shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

Class U3: When the moisture has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, a Class U1 finish shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

Class U4: This finish is for bridge decks that are to receive approved waterproofing systems. The concrete shall be uniformly leveled and screeded to produce a plain surface. When the concrete has sufficiently hardened to prevent laitance being worked to the surface it shall be floated to produce a uniform surface free from screed marks and exposed aggregate. Finally the surface shall be textured by brushing or otherwise to the waterproofing manufacturer's requirements as agreed by the Engineer. The accuracy of the finished surface shall be such that it does not deviate from the required profile by more than 10 mm over a 3 m gauge length or have any abrupt irregularities more than 3 mm.

Class U5: This finish is for foot bridge surfaces that are to receive either separate or combined systems, or coatings of waterproofing and surfacing materials. The concrete shall be uniformly leveled and screeded to produce a plain finish. When the concrete has sufficiently hardened to prevent laitance being worked to the surface it shall be floated to produce a surface free from screed marks and exposed aggregate. Finally the surface shall be textured to the waterproofing and surfacing manufacturer's requirements as agreed by the Engineer. The accuracy of the finished surface shall be such that it does not deviate from the required profile more than 5 mm over a 3 m gauge length or have any abrupt irregularities.

Class U6: Bush-Hammered Finish.

Class U7: Exposed Aggregate Finish.

Table 8.2 Schedule of Unformed Surface Concrete Finishes

Type	Location
U1	Substructure, slabs with screeds.
U2	Floor slabs with/without beams with hard tiling, paving.
U3	Exposed slabs, stairs treads, carpet/pvc finish, slabs under access floors.
U4	
U5	
U6	
U7	

See Bill of Quantities/Contract Documents for full details.

9 CONCRETE - CONSTRUCTION GENERAL

9.1 Construction Joints and Pour Sizes

The position of construction joints shall be as described in the Contract and/or agreed with the Engineer before the concrete is placed. When concrete is placed in vertical members, walls, columns and the like, the lifts of concrete shall finish level or, in sloping members, at right angles to the axis of the members, and the joint lines shall match features of the finished work, if possible, or be formed by grout checks. All day joints in beams and slabs other than those indicated on the drawings shall be at the points of contra flexure. Kickers if required shall be constructed integrally with the lift of concrete below. They shall be at least 100 mm high and they shall be provided in all locations shown on the drawings and at all locations where in the Engineer's opinion the specified quality of concrete or finish requires their use.

Concreting shall be carried out continuously up to construction joints. When the concrete is self supporting but still sufficiently green the formwork shall be removed, as necessary, to expose the construction joint, subject to Clause 9.5. The concrete surface shall be sprayed with a fine spray of water or scabbled with a stiff brush, just sufficiently to remove the outer mortar skin and expose the larger aggregate without disturbing it. Alternatively, where this preparation proves impracticable the hardened surface skin and laitance shall be removed by sand blasting or a needle gun. Hardened surfaces shall not be hacked. Formwork retarding agents shall not be used unless authorised by the Engineer. Immediately before fresh concrete is placed against the joint, the joint shall be cleaned, dampened and coated with a neat cement/water slurry, the surface shall be free of standing water. Joints made on facing surfaces shall be treated with special care to avoid any leakage of grout. All horizontal joints shall have a suitable rebate detail and should be treated as above and grouted with a 30 mm thickness of 1:1 sand/cement grout directly ahead of concreting. Care shall be taken that the concrete is well worked into the grout to leave a dense uniform finish on the soffit of the beam.

Pour sizes, except as agreed otherwise with the engineer shall be as shown in the table below.

Maximum Areas and Dimensions of Concrete Pours for Different Types of Construction

Construction	Maximum Area (m ²)	Maximum Dimension (m)
Water-resisting walls	25	5
Water-resisting slabs	100	10
Slabs with major restraint at both sides	100	13
Slabs with major restraint at one end only	250	20
Slabs with little restraint in any direction	500	30
Walls	40	10

9.2 Formwork

9.2.1 Design and Construction:

The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and for the appropriate method of placing and compacting. The formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage. Where necessary, the formwork shall be so arranged that the soffit form, properly supported on props only, can be retained in position for such period as may be required by maturing conditions as described in Clause 9.4(ii). If the component is to be prestressed whilst still resting on the soffit form, provision shall be made to allow for elastic deformation and any variation in weight distribution.

Shuttering shall be constructed from purpose made mild steel units, from quality planned seasoned timber or from other approved materials lined or treated consistent with the categories of finishes schedule. Where it is intended to re-use formwork it shall be thoroughly cleaned and made good to the satisfaction of the Engineer.

The formwork to vertical sides of walls and beams shall be supported by means of suitable external braces, internal metal fasteners or bolts. The use of internal timber spacers or wire ties will not be permitted. In addition for fairfaced work, the formwork shall be so fixed, braced and tied that neither bolts, wires nor patented fasteners shall be used through the concrete section. The formwork shall be adequately strong and shall be braced above and below the relevant section in order to avoid the filling of holes, etc. All formwork shall be provided with temporary opes to facilitate removal of debris. The inner surface of all formwork shall be treated with an approved mould oil or retarding compound as appropriate.

Internal metal ties which require to be withdrawn through hardened concrete shall not be used where either face is permanently exposed. Where internal ties are left in they shall be provided with a mortar cover approved by the Engineer of a least 40 mm or the nominal cover to the reinforcement whichever is the greater. Where internal ties are removed the resulting hole should be suitably filled to the cover requirements above.

9.2.2 Cleaning and Treatment of Forms:

The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent, where applicable as described in Clause 8.3. Immediately before concreting, all forms shall be thoroughly cleaned out. Temporary opes should be provided in all formwork to facilitate removal of debris.

9.2.3 Projecting Reinforcement, Fixing Devices:

Where holes are needed in forms to accommodate projecting reinforcement or fixing devices, care shall be taken to prevent loss of grout when concreting or damage when striking forms.

9.2.4 Control:

The design, detailing, construction and use of Temporary Works is the sole responsibility of the Contractor, he shall take into account the recommendations of BS 5975 Code of Practice for Falsework as well as "Formwork" - a joint report of the Concrete Society and the Institution of Structural Engineers 1986. All design and detailing of temporary works shall be carried out under the control of a competent Temporary Works Designer and construction and use shall be under the direct control of a competent Falsework Coordinator.

All vertical props shall be fitted with adjustable screws or hardwood folding wedges for adjusting or striking. The Contractor shall submit details of his proposals for the design, detailing, construction and use of all temporary works to the Engineer well in advance of commencement of Temporary Works.

9.2.5 Void Formers:

Void Formers shall be made of either Standard duty (SD) expanded polystyrene to BS 3837, of cardboard or of other suitable material approved by the Engineer. They shall be of adequate strength to resist deformation as a result of loads resulting from movement of personnel, or concreting operations.

The maximum moisture absorption of polystyrene shall be 4% by volume and the external faces of cardboard void formers shall be sealed to prevent moisture absorption from the wet concrete. Details of proposed void formers and of the proposed method of location and anchorage shall be submitted to the Engineer well in advance for ordering.

9.2.6 Openings

Holes, chases and other openings required for the passage of pipes, conduits, etc, shall be provided by inserting suitable sleeves, cores and sinkings in the shuttering before placing the concrete. Subcontractors shall be required by the general contractor to furnish full information in regard to the position and size of such openings and chases and the position of bolts, slips and other fastenings to the engineer for approval. The cutting of chases, holes or other openings in the finished work shall not be permitted without the approval of the engineer. Such holes and chases shall be made only in approved locations and shall be cut with approved tools.

9.3 Transporting, Placing and Compacting

Concrete shall be so transported in accordance with the procedures of IS EN 206-1:2002 and placed that contamination, segregation or loss of the constituent materials does not occur. The manufacturer is required to give a written declaration of conformity to IS EN 206-1:2002 with each delivery.

The engineer shall be given adequate notice of the timing of each concrete pour.

Concrete shall not be placed in any part of the works until the Engineer's approval has been given. If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Engineer. Concreting shall then proceed continuously over the area between construction joints.

Concrete, when deposited, shall have a temperature of not less than 5°C and not more than 30°C. Fresh concrete shall not be placed against in-situ concrete that has been in position for more than 30 minutes unless a construction joint is formed as described in Clause 9.1 above. The depth of lift and the extent of pour to be concreted in any one pour shall be subject to approval by the engineer.

Concrete shall not be dropped into place from a height exceeding 2 meters unless prior approval has been given by the Engineer. When trunking or chutes are used they shall be kept clean.

Concrete shall not be pumped or discharge through items containing aluminum alloys. Concrete shall not be placed in flowing water. Underwater concrete shall be placed in position by tremies or by pipeline.

Concreting operations shall not be permitted to displace reinforcement, tendon ducts, tendon anchorages, void formers or formwork, or to damage the faces of formwork. Competent steel fixers and formwork carpenters shall be in constant attendance during concreting operations.

Concrete shall be thoroughly compacted by vibration, with the exception of screeds, unless otherwise agreed by the Engineer during the operation of placing and thoroughly worked around the reinforcement, tendons or duct formers around embedded fixtures and into corners of the formwork to form a solid mass free from voids. When vibrators are used to compact the concrete, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation of the ingredients.

All necessary compaction shall be completed within 30 minutes of discharge from the mixer or agitator.

Particular care shall be taken when concreting members of substantial thickness to avoid layering of concrete, and the whole thickness shall be placed in one pass. In deck slabs where void formers are used, adequate means to prevent flotation shall be employed and care taken to ensure adequate compaction of the concrete placed beneath the void formers.

A sufficient number of vibrators in serviceable condition shall be on site to ensure that spare equipment is always available in the event of breakdowns.

Vibration shall not be applied by way of the reinforcement. Where vibrators of the immersion type are used, contact with reinforcement and all inserts shall be avoided as far as is practicable. Vibration should be fitted with rubber tips. Worn tips should be replaced. Concrete shall not be subjected to disturbance between 4 hours and 24 hours after compaction except with the agreement of the Engineer.

Whenever vibration has to be applied externally, the design of formwork and the position of vibrators shall ensure efficient compaction and the avoidance of surface blemishes.

There shall be no excess water on the top surface on completion of compaction.

9.4 Tolerance

The finished structure and all its parts including arrises, soffits and other surfaces shall be constructed to the lines, levels and location shown on the drawings subject to the following tolerances unless otherwise specified.

- (i) Horizontal Deviation from intended position ± 25 mm
- (ii) Deviation from intended level ± 6 mm
Maximum slope in floor 1 : 350 measured over 700 mm in any direction.
- (iii) Deviation from vertical or near-vertical plane 2 mm per m with a maximum out of plumbness of 25 mm for heights in excess of 12.5 m
- (iv) Length, cross-section, straightness, squareness, twist and flatness deviations specified in Clause 6.2.8.3 BS 8110:1997: Part 1, plus/minus 50%

For warehouse floors refer to Table 7.1 and Table 7.2 of TR34 Concrete Industrial Ground Floors - A Guide to Their Design and Construction for Tolerance Limits.

The applicable limits for various properties of flatness for superflat, category 1 or category 2.

Floors as specified are given in Table 7.1 and Table 7.2 of TR 34.

See Bill of Quantities/Contract Documents for full details of locations of required flatness of warehouse floors.

All beams shall be cambered at the rate of 5 mm / 3 m length of span and proportionally if required by the engineer.

9.5 Striking of Formwork

The Engineer shall be informed in advance when the Contractor intends to strike any formwork

9.5.1 General

Formwork shall be removed in a manner not to cause undue abrasion, impact or damage the concrete, and at times to suit the requirements for its curing and to prevent restraint that may arise from elastic shortening, shrinkage or creep.

9.5.2 Striking Period

Where the concrete compressive strength is confirmed by tests on concrete cubes stored under conditions approved by the Engineer that simulate the field conditions, formwork supporting concrete in bending may be struck when the cube strength is 10 N/mm^2 or three times the stress to which it will be subjected, whichever is the greater.

For ordinary structural concrete made with ordinary Portland cement only, in the absence of control cubes the period before striking shall be in accordance with the minimum periods given in Table 9.5, unless otherwise directed by the Engineer.

TABLE 9.2 MINIMUM PERIOD BETWEEN STRIKING FORMWORK

Type of Formwork	Minimum period before striking		
	16°C	7°C	t°C (any temperature between 0°C and 25°C)
Surface Temperature of concrete			
Vertical formwork to columns walls and large beams	12 hours	18 hours	300 hours / (t + 10)
Soffit formwork to slabs	4 days	6 days	100 days / (t + 10)
Props to slabs	10 days	15 days	250 days / (t + 10)
Soffit formwork to beams	9 days	14 days	230 days / (t + 10)
Props to beams	14 days	21 days	360 days / (t + 10)

9.6 Curing of Concrete

9.6.1 Curing Methods

When placed the concrete shall not be jarred, walked on or otherwise disturbed during setting.

Immediately after compaction and thereafter for the curing time, except where elevated temperature curing is used, concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes, frost, and from drying out. The method of curing shall prevent loss of moisture from the concrete. The curing time shall be the number of days given in Table 9.6 unless the average surface temperature of the concrete during the required number of days falls below 10°C, in which case the period of curing shall be extended until the maturity of the concrete reaches the value given in the table.

Details of all curing liquids, compounds, membranes and methods to be used, and subsequent removal where necessary shall be subject to the approval of the engineer. Where the Contractor proposes to use a curing liquid, compound or membrane on surfaces on which a waterproofing system is to be laid then it shall be compatible with the system and he shall demonstrate by comparative tests on site that adhesion of the primer to the concrete surface is not reduced.

9.6.2 Accelerated Curing

Elevated temperature curing as described below may be used only with normal Portland cement, rapid hardening Portland cement or sulphate resisting Portland cement:-

- 9.6.2.1 The formwork may be generally heated to no more than 20°C prior to the placing of concrete.
- 9.6.2.2 Once placing is complete the concrete shall be left for 4 hours without additional heating. The concrete temperature can then be raised at a maximum rate of 10°C per half hour.
- 9.6.2.3 The concrete temperature shall at no time exceed 70°C.
- 9.6.2.4 The rate of subsequent cooling shall not exceed the rate of heating.

- 9.6.2.5 Cubes shall be cured under identical conditions to those which the concrete is subjected to and in a manner to be approved by the Engineer.

The use of accelerated curing methods for concrete containing other types of cement or any admixture shall be subject to the Engineer's approval.

TABLE 9.3: NORMAL CURING PERIODS

Minimum periods of protection for different weather conditions

Conditions under which concrete is maturing	Number of days (where the average surface temperature of the concrete exceeds 10°C during the whole period)			Equivalent maturity (degree hours) calculated as the age of the concrete in hours multiplied by the number of degrees Celsius by which the average surface temperature of the concrete exceeds 10°C			
	Other*	SRPC	NPC or RHPC	Other*	SRPC	NPC or RHPC	
1 Hot weather or drying winds	7	4	3	3500	2000	1500	
2 Conditions not covered in 1	4	3	2	2000	1500	1000	

Note: Other* includes all permitted cements except NPC, RHPC and SRPC.

Key: NPC Normal Portland cement
RHPC Rapid-hardening Portland cement
SRPC Sulphate-resisting Portland cement

9.7 COLD WEATHER WORK

Concrete shall not be placed while the air temperature is below 2°C measured on a rising thermometer or below 4°C measured on a falling thermometer unless the following requirements are met.

- 9.7.1 The aggregates and water used in the mix shall be free from snow, ice and frost.
- 9.7.2 The surface temperature of the concrete at the time of placing shall be at least 5°C and shall not exceed 30°C.
- 9.7.3 The surface temperature of the concrete shall be maintained at not less than 5°C until the concrete reaches a strength of 5 N/mm² as determined by tests on cubes that were cured under identical conditions to the structural concrete, in a manner approved by the Engineer.
- 9.7.4 Before placing concrete, the formwork, reinforcement, pre-stressing steel and any surface with which the fresh concrete will be in contact shall be free from snow, ice and frost.
- 9.7.5 Cement shall not be allowed to come into contact with water at temperature greater than 60°C.

9.8 Hot Weather Work

During hot weather the contractor shall ensure that the constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position.

Cement shall not be allowed to come into contact with water at a temperature greater than 60 °C.

9.9 Water-Resisting Construction

In general construction shall be in accordance with BS 8110 where a concrete structure is required to retain water eg. underground basement / water tanks.

The contractor shall ensure the following is carried out:

1. Provide waterbars strictly in accordance with manufacturer's requirements to all construction / day joints, where practical.
2. All service entry points are to be located above any possible maximum flood level.
3. Where a service has to be brought through a water retaining structure at a level below the maximum water level service pipe to be cast into wall with puddle flange welded to pipe.
4. Any ducts that enter wall below water level should be puddle flanged and turned up to ensure open end of duct is above flood level.
5. Unless otherwise noted on drawings proprietary system "Cementaid Everdure Caltite" or SIKA Waterproofing Concrete Additive applied strictly in accordance with manufacturer's specification. Cement content of concrete to be increased as requested by specialist supplier.

In water-resisting construction, waterstops shall be used in all construction joints and movement joints in accordance with the manufacturer's written instructions. The contractor shall obtain the agreement of the engineer for the methods to be used to maintain the waterstops in their correct locations and to prevent damage while the concrete is being placed and during and after removal of the formwork.

The contractor shall submit to the engineer for agreement drawings indicating the positions of joints and details of waterstops to be used. Details shall include schedules of all junction pieces, which shall be purpose made, and isometric layouts of waterstops.

Where waterstops within the concrete section are proposed, the contractor shall submit to the engineer for agreement details of the methods to be used to ensure full compaction of the concrete around the waterstop.

9.10 Defective Work

Any concrete damaged during setting, from any cause whatsoever shall be cut out and replaced by the contractor at his own expense.

All work damaged by frost or inclement weather shall be removed and reinstated at the Contractor's expense, entirely to the satisfaction of the Engineer.

9.11 Precast Concrete (Site Works)

Precast concrete grade shall be as stated in the contract documents.

Prices should include for timber moulds lined with 3 mm thick oil-tempered hardboard and for casting in suitable lengths.

All exposed faces to be finished at least 6 mm thick in cement and sand (1:3) homogeneous with unit. Holes shall be filled and the surfaces pumiced. Arrises shall be protected. Joints shall be 3mm maximum thickness and flush pointed where exposed.

9.12 Safety

Provision shall be made for any fixings, cheats, holes and handrails required for the safe erection and maintenance of the structure. Any such provisions impacting on appearance or structural properties shall be noted on shop drawings and agreed in advance of manufacture with the engineer.

10 REINFORCEMENT - MATERIAL

Reinforcement Supply and Testing

- 10.1** Unless otherwise agreed with the Engineer, all reinforcement suppliers shall hold a valid Certificate of Approval for manufacture and/or fabrication issued by the UK Certification Authority for Reinforcement Steel (CARES).

The CARES Certificate of Approval Number shall be stated on all documentation.

- 10.2** If reinforcing steel is cut and bent by a supplier other than a CARES – approved supplier, the fabricator shall operate a quality management system to ISO 9002, which shall be approved as part of the contractor's quality management system.

10.3 Hot Rolled Bars

Hot rolled steel bars shall comply with BS 4449 except that no bar shall contain a flash weld.

10.4 Cold Worked Bars

Cold worked steel bars shall comply with BS 4449 except that no bar shall contain a flash weld.

10.5 Hard Drawn Steel Wire

Hard drawn mild steel wire shall comply with BS 4482.

10.6 Steel Fabric

Steel fabric reinforcement shall comply with BS 4483 and shall be delivered to the site in flat mats.

10.7 Bond Strength

The classification of deformed bars as type (1) or (2) for bond strength shall be in accordance with BS 8666.

The contractor shall deliver free of charge samples of reinforcement for testing as directed or otherwise manufacturer's certificates. Any reinforcement not complying with the specification shall be removed from the site. In the measurement of weight, the nett lengths as shown on the drawings and schedules shall be taken in conjunction with the nett weight per meter based on the nominal diameter or size of reinforcement. Reinforcement shall be deemed to weigh 7850 kg/m^3 . Reinforcement shall be cut and bent to the Engineer's schedules and in accordance with BS 8666.

11 REINFORCEMENT - BAR SCHEDULE

11.1 Dimensions; Cutting and Bending

The requirements of BS 8666 shall be complied with. The bar schedules are based on the dimensions of the concrete and the minimal cover to the reinforcement described in the Contract. The reinforcement shall be cut and bent within the tolerances given in BS 8666 but this shall not relieve the Contractor of his responsibility for the correct fit of the reinforcement and the achievement of the required cover as described in Clause 12

Bending at temperatures below 5°C or in excess of 40°C may only be carried out with the Engineer's approval and under his supervision. Any reinforcement bar that has already been bent shall not be rebent at the location of the original bend without the Engineer's permission. Any reinforcement on the schedule should not be recut without the engineer's permission.

12 REINFORCEMENT - FIXING

12.1 Reinforcement

Reinforcement shall be secured against displacement. Unless specified otherwise, the actual concrete cover shall be not less than the required nominal cover, minus 5mm.

The cover to a bar in an outer layer of reinforcement shall not exceed the nominal cover described in the Contract by more than 4% of the overall dimension of the member, measured in the same direction, or by more than 20 mm, whichever is the lesser. Bars in inner layers shall be located as described in the Contract; they shall be in close contact with the bars of the outer layer, unless otherwise indicated.

Cover blocks shall be of comparable strength, durability and appearance to the surrounding concrete. They shall match the mix proportions of the adjacent material so far as is practicable. They shall ensure that the reinforcement is correctly positioned and shall be as small as possible consistent with their purpose, of a shape acceptable to the Engineer and designed so that they will not overturn or be displaced when the concrete is placed.

Wire cast in the block for the purpose of tying it to the reinforcement shall be as described below. Stainless steel tying wire shall be used in cover blocks to exposed surfaces.

Other types of cover blocks may be used only with the approval of the Engineer. Pieces of wood, metal, tile or porous material shall not be used as cover blocks.

Projecting ends of ties or clips shall not encroach into the concrete cover. Knots in tying wire shall be located on the side remote from the surface of the concrete. Tying wires shall be either:

- (i) 1.6 mm diameter soft annealed iron wire for unexposed surfaces
or
- (ii) 1.2 mm diameter stainless steel wire for exposed surfaces, bridge decks and when required in the Contract.

Mesh and fabric reinforcement shall be supported at intervals of not more than 1m centers each way. Concreting shall not commence until the formwork and reinforcement has been approved by the Engineer.

A properly calibrated cover meter should be kept on site during the contract and should be checked periodically. The minimum cover to the free reinforcement in all concrete elements should be found and records with grid reference etc. should be kept and sent to the Engineer on request.

For slabs, checks should be carried out adjacent to support points and at midspan. A check should cover an area of not greater than 10 m². For walls, checks should cover an area not greater than 10 m².

13 REINFORCEMENT - SURFACE CONDITION

13.1 Surface Condition

Immediately before concrete is placed around it, reinforcement shall be clean, free from mud, oil, paint, retarder, release agent, loose rust, loose mill scale, snow, ice, grease or any other substance that can be shown to affect adversely the steel or concrete chemically, or to reduce the bond.

14 REINFORCEMENT - LAPS AND JOINTS

14.1 Laps and Joints

Laps and joints including sleeving, threading and other mechanical connections shall be made only as described in the Contract or as agreed by the Engineer.

15 REINFORCEMENT - WELDING

15.1 General

Welded reinforcement shall not be incorporated in the permanent work without the written approval of the Engineer. The Contractor shall demonstrate to the satisfaction of the engineer that at each location the fatigue life, durability and other properties of the member are not adversely affected by the proposal.

15.2 Flash Buttwelding

Flash butt welding shall only be carried out with the combination of flashing, heating, upsetting and annealing to the Engineer's approval and subject to satisfactory performance of trial joints. Only those machines that automatically control this cycle of operations shall be used.

15.3 Manual Metal-Arc Welding

Metal-arc welding shall be carried out in accordance with and the recommendations of the reinforcement manufacturers, subject to the approval of the Engineer and the satisfactory performance of trial joints.

15.4 Other Methods

Other methods of welding may be used subject to the approval of the Engineer and to their satisfactory performance of trial joints.

15.5 Strength of Structural Welded Joints

The strength of all structural welded joints shall be assessed following tests on trial joints to demonstrate that they achieve the strength of the parent bar.

SPECIFICATION

FOR PRECAST PRESTRESSED HOLLOWCORE CONCRETE UNITS

1.0 DESIGN

1.1 DESIGN CRITERIA

1.1.1 Units shall be designed and manufactured by specialist precast subcontractor in accordance with:

- | | | |
|------------------------|---|----------------------------|
| BS 8110: Part 1: 1997 | - | Structural use of Concrete |
| BS 8110: Part 2: 1985: | - | Special Circumstances |

Design calculations shall be forwarded to the Engineer.

1.1.2 Loading

Units shall be designed for all dead loads and live loading in accordance with BS 6399: Part 1: 1996.

The greater live loads in any category shall be assumed to apply unless otherwise stated.

Where loads (including block or stud partitions) are not specifically called up on engineers drawings precast supplier to ascertain from architects drawings or client details of proposed loading on units.

1.1.3 Concrete Pouring

Pouring, placing, shuttering, curing, etc of concrete precast units shall comply with Michael Punch & Partners Specification for Concrete.

1.1.4 Durability

Concrete cover to reinforcement and prestressing tendons shall be as given in Table 1.

TABLE I

**NOMINAL COVER TO ALL STEEL (INCLUDING LINKS)
TO MEET DURABILITY REQUIREMENTS**

**Conditions of
Exposure**

BS 8110: Part 1: 1997 - Table 3.3

Nominal Cover

mm	mm	mm	mm	mm	
Mild	25	20	20	20	20
Moderate	-	35	30	25	20
Severe	-	-	40	30	25
Very Severe	-	-	50	40	30
Most Severe	-	-	-	-	50
Max. free water/cement ratio	0.65	0.6	0.55	0.5	0.45
Min. Cement content kg/m ³	275	300	325	350	400
Lowest grade of Concrete	C30	C35	C40	C45	C50

1.1.5 Fire Resistance

Minimum fire rating requirements shall be those of the Proposed Building Regulations. The precast supplier shall ascertain from the Architect his requirements for fire resistance. Where available, the requirements of The Fire Officers conditions shall be met.

1.1.6 Sound Resistance

Units shall be designed by specialist precast subcontractor in accordance with BS5821, and Part E of the Building Regulations to architects requirements.

1.1.7 Finish

Formed surfaces of concrete shall be free from honeycombing and lipping. Provide a uniform tamped finish to all top surfaces unless otherwise specified. Provide a fair-faced finish to soffits of floor units unless otherwise specified similar in quality to an approved sample.

1.2 DESIGN METHOD

1.2.1 Handling Stresses

Precast units shall be designed to resist, without damage, all stresses induced by handling, storage, transport and erection. When stacking, units shall be supported at the ends.

1.2.2 Compatibility

The design of connections in precast construction must ensure compatibility.

1.2.3 Anchorage at Supports

Where reinforcement is being used to provide the structural integrity of beam or slab ends on corbels or nibs, it shall be carefully overlapped and anchored as shown on the drawings.

1.2.4 Joints for Movement

The number of spacing of joints which allow for movements due to shrinkage, thermal effects and possible differential settlement of foundations shall be as shown in the drawings.

1.2.5 Stability Ties

Ties shall be provided as shown in the drawings and shall be effectively continuous.

1.2.6 Bearings for Precast Members

Units shall be laid on true and level bearings. Minimum bearing shall be 100mm.

1.2.7 Bedding for Precast Members

Units shall be laid on 1:3 mortar bed.

1.2.8 Structural Connections between Precast Units

Connections should be designed to maintain the standard of protection against weather, fire and corrosion required for the remainder of the structure.

1.2.9 Reinforcement Grouted into Aperture

An adequate capacity to restrain pull-out shall be provided on the inside of the pocket or recess.

1.2.10 In situ concrete and jointing mortar shall not be stressed for at least 10 days after placing. Periods during which the air shade temperature remains below 3°C shall not be taken into account.

1.2.11 Design compressive stress at the extreme fibre at transfer shall not exceed 0.5 times concrete strength at transfer.

1.2.12 Jacks for Prestressing

- a All jacks used for prestressing shall be capable of stressing all the strands in any one tendon simultaneously.
- b A suitable method of testing the accuracy of the load measuring equipment is by calibration against a special proving ring fitted with an accurate and sensitive dial gauge. The load-measuring device shall be calibrated to an accuracy within ∇ 2%.

1.2.13 Strands shall not be stressed while the shade temperature is below 0°C

1.2.14 Strands and anchorage components shall be assembled in accordance with the manufacturers written instructions.

- 1.2.15** Prestressing jacks shall be operated coaxially with the strands.
- 1.2.16** The position of nominal zero stress shall be established and then the stress increased in the strands at a uniform rate. The permissible deviation between actual and calculated extensions for the full strand load shall be ∇ 6%.
- 1.2.17** The strand loads extensions and amount of draw-in at each anchorage shall be recorded accurately and copies of records submitted to the engineer if requested.
- 1.2.18** Where the cover to the strands is not adequate to achieve the required fire resistance, the contractor shall make provision to bring the fire resistance up to the required rating. The contractor shall include in his quotation for any renderings required in this context. Details of finish shall be subject to the architect's approval.

2.0 MATERIALS

2.0.1 Concrete Grade

The engineer shall be informed of the source of each material to be used and subsequently whenever a change is made. No admixture shall be used without written approval of the engineer. Admixtures containing chloride or nitrate shall not be used.

2.1 PRESTRESSING TENDONS

- 2.1.1** Prestressing tendons shall be stress relieved seven wire strand to BS 5896: 1980, designation BS 5896/3, relax class 2 in accordance with Table 6 BS 5896: 1980.

or

Cold drawn wire to be BS 5896: 1980, designation BS 5896/2, relax class 2 in accordance with Table 4 BS 5896.

- 2.1.2** The reinforcement shall be of the size and number as shown on the shop drawings and so positioned to maintain the specified cover.

2.1.3 All cutting to length and trimming of ends should be by either:

- a high speed abrasive cutting wheel, friction saw or any other method approved by the Engineer at not less than 1 diameter from the anchor.
- b Oxy-acetylene cutting flame, using excess oxygen to ensure a cutting rather than a melting action at not less than 75mm from the anchor. Care should be taken to ensure that neither the flame nor splashes come into contact with either the anchorage or other tendons.

2.1.4 All reinforcement for prestressing shall be free of loose rust, pitting, mechanical damage and kinking. All strands or parts thereof which are to be bonded shall be free from oil, grease and other bond-breaking materials at the time when bond is established.

2.2 CEMENT

2.2.1 Cement used shall be Normal Portland Cement and shall be certified as complying with IS 1:1963 as amended, in accordance with the Irish Standard Licensing Scheme. Manufacturer's or supplier's certificates of compliance with the standard shall be provided when requested by the engineer.

2.2.2 Cement must be stored dry in completely moisture proof conditions. Invoices and delivery dockets shall be available on request.

2.2.3 Records shall be kept by the manufacturer of the cement used in each pour. Care shall be taken that cement is used rotationally and that no cement is stored too long.

2.3 AGGREGATES

2.3.1 Aggregates shall consist of natural pit sand and washed gravel or approved crushed stone. All aggregates shall be hard, uniform and clean. Aggregates shall conform to I.S. 5: 1990.

2.3.2 Maximum size of aggregates shall be 20mm for precast, prestressed hollowcore concrete floor units and 10mm for structural screed where applicable.

2.4 WATER

Water shall be clean and free from impurities harmful to the concrete.

2.5 CONCRETE GRADE

The concrete grade to be used shall be at the manufacturer's discretion but shall not be less than that corresponding to the durability requirements of Table 1.

2.6 STRUCTURAL SCREED (if applicable)

2.6.1 The concrete grade of the structural screed shall be the same as that used in the precast prestressed hollowcore floor units.

The structural screed shall not be cast while the air shade temperature is below 2°C on a rising thermometer or below 5°C on a falling thermometer. The number and spacing of reinforcing bars in the structural screed shall be as shown on the drawings.

2.6.2 The precast, prestressed hollowcore floor units shall be so propped as to prevent loss of the precamber during setting of the structural screed. Propping shall not be removed for at least 6 days after the screed being poured. However a longer period may apply depending on curing conditions. The engineer should be consulted in any case.

2.6.3 The interface between the structural screed and precast, prestressed hollowcore units shall be so constructed as to provide for horizontal shear transfer.

2.6.4 Reinforcing mesh for structural screed shall conform to BS 4483.

3.0 MATERIALS TESTING

3.1 TESTING OF STRANDS

3.1.1 At the engineers discretion 2 samples of prestressing tendon shall be provided for testing.

3.2 TESTING OF CONCRETE

3.2.1 Testing plan and rates of sampling of concrete shall conform with the relevant clauses BS 5328 and BS 1881. All relevant cube test results shall be forwarded to the engineer. In particular cube tests shall be taken regularly to identify the concrete strength at transfer.

3.3 TESTING OF AGGREGATES

3.3.1 The supplier shall forward all information concerning aggregate sources. At least two samples of each aggregate type per month of production shall be provided for testing at the Engineer's discretion.

3.4 TESTING OF WATER

3.4.1 Where the quality of supply is doubtful the water shall be tested in accordance with BS 3148.

4.0 WORKMANSHIP

4.1 TOLERANCES

- 4.1.1** Allowance in length for construction inaccuracies for supported members up to 15m span may be taken as the greater of:
- a 15mm, or 3mm per metre distance between the faces of steel or precast concrete supports.
 - b 20mm, or 4mm per metre distance between the faces of masonry supports.
 - c 25mm, or 5mm per metre distance between the faces of in situ concrete supports.
- 4.1.2** Units shall be cut to nominal length taking account of the above workmanship tolerances, the manufacturer's tolerances and the site dimensions. Care shall be taken to ensure minimum bearing of 100mm.
- 4.1.3** The location of prestressing tendons shall be within 5mm of the positions shown on the shop drawings.
- 4.1.4** The permissible deviation for the location and orientation of anchorages shall be ∇ 3mm from those shown on the shop drawings.
- 4.1.5** Precamber on units shall be such that "lipping" at joints between adjacent units shall not exceed 8mm. The total camber shall not exceed 25mm.
- 4.1.6** Thickness of precast unit required is shown on floor layouts. Precast supplier to notify engineer if thickness of units will vary from that indicated on drawings.
- 4.2** Cutting prestressed units to the required length and shape shall be only by high speed cutting wheel or by saw. No breaking shall be allowed on site.
- 4.2.1** 12mm diameter holes shall be drilled in the soffit at each hollowcore to allow drainage at 400mm from each end. These holes shall be made by the main contractor at the Engineers discretion.

4.3 SITE JOINTING

Joints shall be filled with 10mm max aggregate concrete and well compacted. Any excess mortar shall be removed. Alternatively a 1:1 sand: cement grout shall be used.

4.4 SERVICES HOLES

4.4.1 Holes or notches with any dimension greater than the lesser of 100mm or (K-2C)mm shall not be formed on site where K is the core spacing (centre to centre) and C is the nominal cover as defined in Table 1.

4.4.2 Holes or notches with any dimension greater than 100mm shall be as shown on the mechanical services builders work drawings or engineers drawings and shall be formed using a core drill or concrete saw. The design of the units shall take account of such holes. All holes to be clearly dimensioned on shopdrawing.

4.5 SPLAY CUTS

Splay cuts shall only be formed with a concrete saw.

5.0 SHOP DRAWINGS

Shop Drawings to take account and refer to stability ties and structural steel in screed (if any) as detailed on engineers drawings and in accordance with IS 325 and BS 8110.

5.1 Two copies of manufacturers shop drawings shall be forwarded in good time to the engineer for checking. Details of prestressing shall be clearly indicated.

6.0 HEALTH & SAFETY REGULATIONS

Design, supply and erection of units shall be in accordance with relevant health and Safety procedures and current legislation.

MASONRY SPECIFICATION

SECTION 1

MATERIALS AND PROPERTIES

1.1 **CONCRETE BLOCKS**

All blocks shall comply with the requirements of IS 20: Part I: 1987.

1.1.1 **Standard Blocks**

The concrete blocks shall be Type A (5) solid (440 x 215 x 100 mm 20kg 5N/mm²) and conform to IS 20: Part I: 1987 unless noted otherwise on the drawings.

Methods of measuring dimensions and determining strength and drying shrinkage shall be in accordance with IS : 20 1987.

Where blocks of strength other than 5N/mm² are used on site they shall be stacked separately and clearly distinguished by colour.

1.2 **MORTARS**

1.2.1 ***Materials for Mortar***

1.2.1.1 **Cement**

The cement used in the mortar shall be in accordance with IS EN 197-1:2001.

1.2.1.2 **Lime**

Lime used in mortars shall be non-hydraulic (calcium) limes or semi-hydraulic (calcium) and magnesium limes to conform to the requirements of IS EN 459-1:2001 and BS 6463 Parts 101 to 103.

Alternatively lime shall be hydrated or magnesium hydrated and conform with IS 8: 1973.

1.2.1.3 **Sand**

The sand shall be free from deleterious substances and shall comply with the requirement for quality and grading of sand for mortar given in IS 5: 1990.

1.2.1.4 **Water**

Water shall be free from impurities harmful to the mortar. Where the quality of supply is doubtful the water shall be tested in accordance with IS EN 1008:2002. The contractor shall ensure that water is not wasted during construction operations.

1.2.1.5 **Admixtures**

Admixtures may be used subject to the engineer's approval in writing. This includes plasticisers and anti-freeze agents. These must be non-toxic and should not include or produce volatile organic compounds. Only plasticisers complying with BS 4887: Part 1: 1986 will be considered. Calcium-chloride based agents may never be used. Admixtures should where possible come from local, renewable, sustainably acquired resources that minimize pollution during all stages.

1.2.2 ***Preparation of Mortars***

1.2.2.1 **Recommended mortars**

A type (iii) mortar as described in Table 15 of BS 5628 Part 3 : 2001 shall, unless otherwise noted on drawings, be used. For example for a cement: sand mortar with plasticiser proportions by volume of dry materials shall be 1:5 to 6.

1.2.2.2 **Equivalent mortar mixes**

Alternative mortar mixes may only be used subject to the engineer's approval in writing.

1.2.2.3 **Batching of mortars**

The materials for the mortar shall be measured accurately to conform with the specified mix proportions either by weigh batching or by the use of gauge boxes. Where pre-batched mortar is stored in silos on site, the supplier shall provide sufficient details including cube test reports to satisfy the Engineer as to the mix design. Two sets of two cubes are to be taken from each silo load on site.

1.2.2.4 **Mixing of mortar**

The mortar shall be mixed by machine. Mortar shall be used within two hours of the mixing of the cement and water and any mortar not then used shall be discarded and not retempered. Ready-mix mortar with retarders is not permitted and may only be used in exceptional circumstances and only with the written permission of the engineer.

1.3 **CONCRETE FOR CORE FILLING**

1.3.1 ***Materials***

1.3.1.1 **Cement**

The cement used in the concrete shall be in accordance with IS EN 197-1 : 2001.

1.3.1.2 **Fine and Coarse Aggregates**

The coarse aggregate shall have a nominal size of 10 mm and shall comply with the requirements of IS 5: 1990. Fine aggregate shall be in accordance with IS 5.

1.3.1.3 **Water**

Water shall be free from impurities harmful to the concrete. Where the quality of supply is doubtful the water shall be tested in accordance with IS EN 1008 : 2002.

1.3.1.4 **Admixtures**

Use of admixtures and the procedure for their use shall be subject to the engineer's approval in writing.

1.3.2 ***Preparation of Concrete***

1.3.2.1 **Recommended mix**

Concrete core filling shall be 35N 10 having:

A slump of 125 mm

Minimum cement content = 300 kg/m³

Maximum free water/cement ratio = 0.6

Details of proposed mix shall be forwarded to the engineer for approval in good time, and shall meet the requirements of IS EN 206-1 : 2002 and BS 8500-1 : 2002.

1.3.2.2 **Alternative mix**

Alternative concrete mixes may only be used subject to the engineer's approval in writing.

1.4 **REINFORCEMENT, WALL AND BONDING TIES.**

1.4.1 ***Reinforcement***

Reinforcement used shall comply with the requirements of BS 4449 : 1997 and BS 5628: Part 2 : 2000.

1.4.2 ***Bed Joint Reinforcement.***

Bed joint reinforcement shall comply with the requirements of BS 4449:1997 as appropriate. Reinforcement in the outer leaves of external cavity walls or external walls generally shall be of stainless steel, Grade 304 unless agreed otherwise with the engineer. Reinforcement for the inner leaf shall also be stainless steel or galvanised unless agreed otherwise with the engineer. Cover to reinforcement shall be appropriate to the exposure conditions but under no circumstance can it be less than 20 mm.

1.4.3 ***Bonding Ties***

Metal straps for bonding where shown on drawings shall be stainless steel Grade 304 on external walls or galvanised mild steel on internal walls for the dimensions as specified on drawing.

1.4.4 ***Wall Ties***

Wall ties shall be double triangle grade 304 stainless steel wire ties of 3.75 mm diameter ("e.g. Aerotie") are acceptable for 100 mm cavities. Lugs shall be provided for fixing of insulation. Ties proposed for wider cavities shall also comply with and be tested in accordance with the requirements of IS 268. All ties shall incorporate drips. Where ties are provided in particularly corrosive environments such as coastal areas, they shall be Austenitic Stainless Steel Grade 316 (18/10/12). Alternative tie types and proprietary systems are acceptable subject to their satisfying the requirements of IS 268 and their satisfying the requirements of the Health & Safety Project Supervisor (construction stage).

1.5 **HANDLING AND STORAGE OF MATERIALS**

1.5.1 ***Cement***

Cement shall be stored in a manner to ensure that it is not affected by damp and shall be used in the order of delivery. Delivery dates must be clearly visible.

1.5.2 ***Sand***

Sands shall be stored separately according to type where they will not be contaminated.

1.5.3 ***Metals***

Reinforcement, ties and restraint systems shall be protected from becoming contaminated, and reinforcement shall be free from loose mill scale and rust. Contact between dissimilar metals that may result in bi-metallic corrosion is not permitted and must be eliminated by incorporating a separating membrane.

1.5.4 ***Blocks***

Facing blocks shall be carefully unloaded so as to avoid damage to the units. All blocks shall be stacked on prepared level hardstanding areas to ensure that the stack is stable and blocks used for fairfaced work shall be protected to prevent the exposed faces from becoming stained or marked. All stacks shall be protected from rain, frost, wetting from ground moisture and soiling. Different block types shall be stacked separately and be carefully labelled.

1.5.5 ***Suppliers***

Proposed suppliers of blocks, and readymixed mortar shall be notified and agreed with the engineer before the works commence and in sufficient time to enable samples to be seen and tested.

Any proposed change in suppliers shall be notified to the Engineer who may direct additional materials testing to be done.

1.6 **TESTING**

1.6.1 ***General***

Independent testing of blocks shall be carried out in accordance with IS 20: 1995.
At least 2 sets of block samples shall be tested during the course of construction.
The maximum interval between sampling shall be 3 months.

The engineer shall be notified to supervise sampling.

1.6.2 ***Mortar***

Independent testing of mortar shall be in accordance with BS 4551: 1998. This applies to all types of mortar (site batched, readymixed, pre-batched, etc.) Trial mixes are to be tested and results submitted to the Engineer, prior to the commencement of masonry work on site.

SECTION 2

WORKMANSHIP

2.1 **GENERAL**

2.1.1 ***Dimensions***

All blockwork shall be set out and built to the respective dimensions, thickness and heights shown upon the drawings.

2.1.2 ***Uniformity***

All perpend, quoins, joints, etc., shall be kept strictly true and square, other angles shall be plumbed and the whole properly bonded or tied together and the bed joints levelled as the work proceeds.

2.1.3 ***Bond***

The blockwork shall be built to the bond indicated on the drawings. Where no bond is indicated, the units shall be laid in stretcher bond. Where possible the coursing shall be arranged to allow a full block to be positioned directly beneath a lintel bearing.

For 215 mm solid, a double course stretcher bond in accordance with normal practice is acceptable, unless otherwise noted on drawings.

Where 215 mm solid walls are constructed with two 100 mm blocks on edge with 15mm mortar filling, ties are to be provided at 450 mm centres both horizontally and vertically. Alternatively BRC Bricktie (CF Range) or approved equivalent in stainless steel at 450 c/c vertically can be used.

Where the outer leaf of cavity walls is to be constructed from stack bonded masonry, additional cavity wall ties in the form of BRC Wallforce or approved equivalent shall be provided at 450 c/c vertically. Only stainless steel reinforcement, ties and supports are to be used and dpc trays etc and other details should be upgraded to allow for the extra water penetration through the outer leaf.

2.1.4 ***Cutting***

Blocks used for facing shall be cut with a masonry saw. Where it is necessary to cut the blocks wet they shall be allowed to dry before being built into the wall. Blocks used for profiled piers where applicable (see drawings) shall also be sawcut.

2.1.5 ***Chases***

The positions and size of the chasings shall be as indicated on the drawings and shall be carried out neatly using a chasing tool. Chasing in any 4 inch blockwork and load bearing walls generally shall be only with the engineer's approval. Chasing generally shall not exceed one third of the wall thickness. Horizontal chasing in blockwork of any thickness may not be carried out without the Engineer's written approval. Allow all masonry to set for a minimum of 14 days before chasing.

2.1.6 ***Weather***

Contractors shall provide a max/min thermometer on site and keep a daily record of temperature.

No block laying shall be carried out when the temperature is at or below 3°C unless precautions are taken to ensure a minimum temperature of 4°C in the work when laid and thereafter to maintain the temperature above freezing point until the mortar has hardened by the use of insulated coverings. The use of wet blocks or bricks or the placing of mortar on frozen surfaces is not permitted. Should any block wall be damaged by frost it shall be pulled down and made good at the contractor's expense. Walls shall, where necessary, be adequately braced during construction to prevent damage by winds or other causes. This bracing during construction is solely the contractor's responsibility. Scaffolding platform planks shall be turned on edge at night to prevent damage to mortar beds from rain drop spatters.

2.1.7 ***Laying***

Each block shall be laid and adjusted to its final position while the mortar is still plastic.

Overhand work is not permitted without written approval from the Engineer. Raise walls uniformly with no portion more than 1200 mm above another at any time, raking back between levels. Do not carry up any one leaf more than 1.5 m in one day unless otherwise instructed.

2.1.8 ***Maximum Tolerances***

Plumbness: ∇ 10mm per metre
 ∇ 10mm max.

Line: ∇ 10mm per metre
 ∇ 10mm max

Level: ∇ 5mm per metre
 ∇ 10mm max

Note: these figures are a guide only. The approved sample shall comprise the acceptable standard.

A 2m x 2m sample of each block type shall be built for the engineer and architect's approval. The make-up of the panel may be mixed to reflect the work on the project at the engineers/architects direction.

2.2 **MORTAR JOINTS**

2.2.1 ***Bedding***

All blocks shall be laid on a full mortar bed. Vertical joints shall be filled. All joints are to be nominally 10mm thick.

2.2.2 ***Joint Types***

2.2.2.1 **Facing work**

Joint profiles to be tooled as shown in drawings. The tooling of joints shall be carried out to the specified profiles while the mortar is thumb-print hard.

2.2.2.2 **Standard work**

Joints shall be raked for plastering.

2.2.3 ***Excess mortar***

Any mortar which extrudes from the joint of fairfaced units shall be cut away and on no account is mortar to be smeared onto the face of the block. Cavities are to be kept clear of mortar droppings by the use of a timber lath which is placed in the cavity and removed, cleaned and repositioned at regular intervals. Mortar droppings shall be removed from all wall ties and from cavity trays and stepped flashings.

2.2.4 ***Reinforced Walls***

The cores shall be kept clear and clean of mortar droppings and any extruding mortar shall be removed while soft.

2.2.5 ***Junction With Other Materials***

Where masonry abuts main structural members such as RC walls or columns or structural steel stanchions, it shall be tied to these members at 450 c/c vertically using proprietary fixings such as abbi-slots, L-ties or halfen channels which can be cast-in or fixed as advised by the manufacturer and shall use the corresponding wall tie only. If ties are bolted in position, 6 mm anchors/bolts should be used, of the same material as the tie. Under no circumstance will shot-fixing of ties be accepted.

2.3 **CONTROL JOINTS**

Control joints shall be constructed as indicated on the drawings. Expansion joints shall be cleaned out to ensure that mortar does not bridge the joint. Where joints are not shown on drawings they should be provided at 6 m c/c in blockwork and 12 m c/c in brickwork. Wall ties shall be placed at 450 c/c across control joints on internal leaves to ensure adequate tying of the structure. They shall be debonded as necessary to ensure that the movement paths are maintained.

2.4 **DOUBLE LEAF (CAVITY) WALLS**

2.4.1 ***Wall ties***

The walls shall be built with cavities of the width shown on the drawings and tied together with ties embedded in the mortar at least 50 mm. Unless otherwise detailed the ties shall be staggered in alternate courses and spaced in accordance with the following table. (Applicable horizontal spacing of ties in 100 mm cavity = 750 mm.)

Where insulation is to be provided, the ties shall be fitted with lugs.

Least leaf thickness (mm)	Cavity Width (mm)	Horizontally (mm)	Vertically (mm)
75	50 - 75	450	450
90 or more	50 - 75	900	450
90 or more	75 – 100	750	450
90 or more greater than	100 - 150	450	450

The spacing may be varied locally provided that the number of ties per unit area is maintained and the spacing does not exceed 900 mm in any direction.

Additional ties shall be provided in every course within 225 mm of openings and on each side of control joints as indicated in the relevant masonry standards. Ties shall be falling to the external leaf.

2.4.2 ***Cavities***

The cavity and ties shall be kept clear and clean of mortar droppings or other materials during construction and any extruding mortar shall be struck off flush. No cavity shall be sealed off until inspected and approved by the engineer.

2.4.3 ***Weepholes (cavity walls, for Brickwork and Fairface Blockwork Only)***

Weepholes 10 mm wide by 75 mm high, spaced at centres not exceeding 900 mm and extending through the vertical mortar joints of the outer leaf, shall be provided at ground level and at positions where the cavity is bridged (eg over lintels, stepped damp proof courses etc.) or at locations indicated on the drawings.

2.4.4 ***Vent holes***

Vent holes shall be of the dimensions as for weepholes and shall be positioned at locations indicated on the drawings.

2.5 **PARTITIONS**

Partitions shall not be built on suspended slabs until after the props have been removed. Where partitions are non-loadbearing but require fire resistance the gap between the top of the wall and the slab soffit above should be fire-stopped to Architect's Detail. 100 mm non-loadbearing block partitions shall generally be restrained laterally at the top by angles or ties fixed to the slab soffit with M6 expansion anchors above.

2.6 **REINFORCEMENT**

2.6.1 ***Reinforcement***

The reinforcement shall be of the size and number as shown on the drawings and shall be positioned accurately and secured against displacement so as to maintain the specified cover as shown on the drawings.

2.6.2 ***Bed Joint Reinforcement***

Bed joint reinforcement shall have an effective cover of not less than 20 mm and shall be continuous except at control joints, or where otherwise indicated. Bed joint reinforcement is to be positioned as shown on the drawings.

2.7 **CORE FILLING**

Core shall be filled in lifts not exceeding 675 mm. The concrete or mortar filling shall be well tamped or vibrated around reinforcement to ensure that it is fully compacted. The procedure for core filling shall be approved by the Engineer.

2.8 **LINTELS**

2.8.1 All lintels shall have a minimum sound bearing of 200 mm or greater if indicated on drawings or recommended by manufacturers.

2.8.2 In situ concrete lintels shall be of concrete grade appropriate to the exposure condition as indicated on drawings. Cover to reinforcement shall likewise be appropriate. Details generally shall be as shown on drawings.

- 2.8.3 Prestressed concrete lintels shall not be used in opes exceeding 1500 mm unless calculations are submitted to and approved by the engineer. Concrete grade and cover to reinforcement shall be as detailed in BS 8110. Propping arrangements shall be strictly in accordance with manufacturer's recommendations. Lintels shall be laid **rough side up** and soffits shall be plastered using expanded metal as necessary. Lintels shall be not be drilled or notched. The contractor shall forward span/load tables from the proposed supplier. The suppliers shall be responsible for ensuring the correct type and stress level of reinforcement in accordance with BS 8110.
- 2.8.4 Where U-block lintels are used the concrete used for filling shall be vibrated and shall be the same as that specified in Clause 1.3.2.1 of this specification for core filling. The arrangement of reinforcement shall be as shown on the drawings. In the absence of any details been shown, approval for a particular detail must be sought from the Engineer prior to filling of the U-block. Under no circumstances should a U-block lintel be unreinforced. Fair-faced U-blocks shall be made from the same batch as the standard blocks and should be indistinguishable from them in terms of colour, texture and finish. Care must be taken to ensure the soffit joints match all others.
- 2.8.5 Steel lintels shall be used where indicated on drawings. All steel lintels shall be hot dip galvanised. Ends shall be touched up on site using bitumistic paint.
- Lintels on external leafs shall be stainless steel Grade 304 unless otherwise agreed. In particularly corrosive environments such as coastal areas and estuaries, lintels on external leaves shall be Grade 316 stainless steel.

2.9 **MASONRY SUPPORT ANGLES**

- 2.9.1 Relieving angles shall be provided at a maximum of 9m centres vertically or every third storey (whichever is less). They shall fully comply with the requirements of Clause 29.2 of IS 325 : Part 1 and shall be constructed from grade 304 Austenitic stainless steel. In particularly corrosive environments, relieving angles shall be grade 316 stainless steel.
- 2.9.2 Relieving angles and angles supporting outer leafs over openings shall be designed in accordance with the relevant Irish and British Code of Practice. The support system must take account of the possibility for bi-metallic corrosion in damp environments.
- 2.9.3 Proprietary systems such as the Ancon MDC System should be used in preference to continuous angle support systems such as the Ancon CFA System. In locations where there is a large variation in the line of the structural frame the Ancon MDK System should be used. Other equivalent proprietary systems or bespoke systems can be used with the approval of the Engineer after suitable sample calculations have been submitted and approved. All systems must be designed, specified and installed in complete compliance with the manufacturer's requirements.

2.9.4 Where uniformity of joint thickness is required such as finished block/brick on the external leaf, the angle shall be held back a minimum of 30mm to allow for mastic pointing and the masonry in direct contact with the angle shall be notched to accommodate the angle thickness.

SECTION 3

RELATED WORK

3.1 **SEALING**

Joints around door and window frames, control joints, abutting joints at external columns and other joints where sealing is indicated or required shall be brush painted with primer and filled with sealant of a colour specified by the architect, the whole of which shall be carried out in accordance with the manufacturer's recommendations.

3.2 **FLASHING**

Wall flashings shall be built into or secured to the blockwork in accordance with the details shown on the drawings. Care shall be taken to ensure that the flashing has adequate laps.

3.3 **DAMP-PROOFING**

3.3.1 ***Damp- proof courses***

Horizontal damp-proof courses shall be provided at positions shown on the drawings and be positioned so as to fully cover the leaf thickness. All horizontal damp-proof courses shall be laid on an even bed of fresh mortar and eventually covered by mortar so as to maintain regular coursing and joint thickness and while exposed shall be protected from damage while the building is proceeding. Stepped damp-proof courses at openings shall extend beyond the end of lintel by at least 100 mm. All horizontal damp-proof courses shall protrude 10mm from the external face of the wall and be turned downwards. Vertical damp-proof courses shall be of adequate width and be fixed so as to separate the inner and outer leaves of the wall. The material for damp-proof courses shall comply with BS 743 or BS 6515. Damp proof courses shall be adequately protected during the works.

3.3.2 ***Tanking***

Tanking and waterproofing of basement walls or retaining walls shall be carried out to the details as shown on the drawings and all materials are to be used in accordance with the manufacturer's recommendations.

3.4 **BACKFILLING**

Backfilling shall not be placed against concrete masonry walls within 5 days of completion of the construction. Vehicles shall not be operated closer to the wall than a distance equal to the height of the wall except where the engineer gives explicit approval in writing.

3.5 **PAINTING**

Concrete blockwork shall be painted in accordance with the painting schedule and paint shall be applied in accordance with the manufacturer's recommendations. Painting shall not commence until the surface of the walls has been allowed to dry out and has been cleaned down to remove all dust, dirt and mortar dabs. Where efflorescent occurs, it shall be removed with a cloth or stiff brush, prior to painting. Where unplastered masonry is to be painted, the block type shall have a finer texture than standard blocks to ensure that adequate coverage of paint is achieved.

3.6 **RENDERING**

Newly applied rendering, including stipple and spatter-dash coats, shall be kept damp for the first three days. A second coat shall not be applied until the previous layer has hardened for seven days. The surface of rendering shall be as specified on the engineers drawings. The block surface and subsequent rendering coats may be damped sufficiently to ensure suction but in no case shall free water be left on the surface. Rendering shall not be applied to frost-bound walls or during frosty conditions. Any rendering shall be discontinuous at control joints. Plaster stops shall be provided as appropriate.

3.7 **PLASTERING**

Before plastering all dirt, dust and efflorescence shall be removed. The walls shall be treated and plastered in accordance with the manufacturer's recommendations. Any plastering shall be discontinuous at control joints. Plaster stops shall be provided as appropriate.

3.8 **WALL TILING**

Before tiling all walls shall be allowed to dry to the level recommended by the tiling manufacturer. Movement joints shall be provided at control joints and any other locations recommended by the tiling manufacturer.

STEELWORK PAINT SPECIFICATION

CORROSIVITY CATEGORY VERY LOW (C1 in accordance with ISO 12944 – Part 2)

NOT FOR EXTERIOR USE.

INTERIOR: HEATED BUILDINGS WITH CLEAN ATMOSPHERES, E.G. OFFICES, SHOPS, SCHOOLS, HOSTELS.

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Code of Practice

Definitions and general considerations shall be in accordance with ISO 12944 Parts 1:18 as modified or extended by any substitute or additional clauses in this specification.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp arises and burrs ground smooth. The surface shall be treated by solvent cleaning, steam cleaning or high pressure

water hosing followed by clean water rinsing, to remove deposits of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.8 Blasting Cleaning

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast cleaning shall be either G.40 steel grit S.230 steel short, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 Inspection

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.19 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.20 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.21 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.22 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

2.0 Paint System for Corrosivity Category C1 – Very Low Corrosivity

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

2.1 Paint System for Steelwork NOT Requiring a Decorative Finish

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 1 pack alkyd primer to nominal dry film thickness 100 microns.

Preferred Systems:

1. Interplate 180 NEA/NEA071 and (Interprime 466 CPA576 or Interprime 106)
2. Hempel Shopprimer 1528 and Hempel Industrial Primer 13624
3. Jotun Muki Zinc 3000 and Jotun Conseal Primer

2.2 Paint System for Steelwork Requiring a Decorative Finish

A decorative coating shall be incorporated if required. See Architect's drawings and specifications.

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 1 pack alkyd primer to nominal dry film thickness 100 microns

Finish Coat – 1 pack alkyd gloss enamel to nominal dry film thickness 40 microns (RAL or BS number to be provided).

Preferred Systems:

1. (Interplate 180 NEA/NEA071 or Interprime 106) and Interprime 466 CPA576 and Interlac 665 CZ Series
2. Hempel's Shopprimer 1528 and Hempel Industrial Primer 13624 and Hempalin Gloss Enamel 52140
3. Jotun Muki Zinc 3000 and Jotun Conseal Primer and (Jotun Conseal TC or Pilot 2)

2.3 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK PAINT SPECIFICATION

CORROSIVITY CATEGORY LOW (C2 in accordance with ISO 12944 – Part 2)

Exterior: Atmospheres with low level of pollution. Mostly rural areas.

Interior: Unheated buildings where condensation may occur, e.g. depots, sports halls.

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Code of Practice

Definitions and general considerations shall be in accordance with ISO 12944 Parts 1:18 as modified or extended by any substitute or additional clauses in this specification.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp arises and burrs ground smooth. The surface shall be treated by solvent cleaning, steam cleaning or high pressure

water hosing followed by clean water rinsing, to remove deposits of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.9 **Blasting Cleaning**

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast cleaning shall be either G.40 steel grit S.230 steel shot, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of

detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 **Inspection**

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.20 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.23 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.24 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.25 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

3.0 Paint System for Corrosivity Category C2 – Low Corrosivity

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

3.1 Paint System for Steelwork NOT Requiring a Decorative Finish

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry film thickness 80 microns

Second Primer Coat – 2 pack epoxy / micaceous iron oxide coating to nominal dry film thickness 80 microns

Preferred Systems:

4. Intercure 200 and Intercure 420
5. Hempadur 47200 and Hempadur 45880 Epoxy MIO (45880-1243)
6. Jotun Penguard Stayer or Penguard HB

3.2 Paint System for Steelwork Requiring a Decorative Finish

A decorative coating shall be incorporated if required. See Architect's drawings and specifications.

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry film thickness 75 microns

Finish Coat – 2 pack epoxy to nominal dry film thickness 85 microns (RAL or BS number to be provided)

Preferred Systems:

4. Intercure 200 and Intergard 540
5. Hempadur 47200 Epoxy ZP MIO and Hempadur 4588 Epoxy Finish
6. (Jotun Penguard or Penguard HB) and Jotun Penguard HB

3.3 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK PAINT SPECIFICATION

CORROSIVITY CATEGORY MEDIUM (C3 in accordance with ISO 12944 – Part 2)

EXTERIOR: URBAN AND INDUSTRIAL ATMOSPHERES, MODERATE SULPHUR DIOXIDE POLLUTION. COASTAL AREAS WITH LOW SALINITY.

INTERIOR: PRODUCTION ROOMS WITH HIGH HUMIDITY AND SOME AIR POLLUTION, E.G. FOOD PROCESSING PLANTS, LAUNDRIES, BREWERIES, DAIRIES.

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Code of Practice

Definitions and general considerations shall be in accordance with ISO 12944 Parts 1:18 as modified or extended by any substitute or additional clauses in this specification.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp arises and burrs ground smooth. The surface shall be treated by solvent cleaning, steam cleaning or high pressure

water hosing followed by clean water rinsing, to remove deposits of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.10 Blasting Cleaning

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast-cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast-cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast-cleaning shall be either G.40 steel grit S.230 steel shot, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 **Inspection**

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.21 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.26 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.27 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.28 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

4.0 Paint System for Corrosivity Category C3 – Medium Corrosivity

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

4.1 Paint System for Steelwork NOT Requiring a Decorative Finish

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry thickness 80 microns

Second Primer Coat – 2 pack epoxy / micaceous iron oxide to nominal dry film thickness 160 microns

Preferred Systems:

7. Interplate 180 NEA / NEA071 and Intercure 200 EPA214 / EPA240 and Intercure 420 EBA403 / EBA420
8. Hempel's Shopprimer 1528 and Hempadur 4720 Epoxy ZP MIO and Hempadur 4588 HS
9. Jotun Muki Zinc 3000 and (Jotun Penguard Stayer or Penguard HB) and Penguard HB @ 150 dft

4.2 Paint System for Steelwork Requiring a Decorative Finish

A decorative coating shall be incorporated if required. See Architect's drawings and specifications.

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry film thickness 70 microns

Second Primer Coat – 2 pack epoxy / micaceous iron oxide to nominal dry film thickness 120 microns

Finish Coat – 2 pack acrylic polyurethane to nominal dry film thickness 50 microns RAL or BS number to be provided

Preferred Systems:

7. Interplate 180 NEA / NEA071 and Intercure 200 EPA214 / EPA240 and Intercure 420 EBA403 / EBA420 and Interthane 990 PH Series / PHA046
8. Hempel's Shopprimer 1528 and Hempadur 47200 and Hempadur 45880 HS and Hemptthane 5521 Polyurethane Finish
9. Jotun Muki Zinc 3000 and (Jotun Penguard Stayer or Penguard HB) and (Jotun Penguard Stayer or Penguard HB) and Jotun Hardtop

4.3 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK PAINT SPECIFICATION

CORROSIVITY CATEGORY HIGH (C4 in accordance with ISO 12944 – Part 2)

EXTERIOR: INDUSTRIAL AREAS AND COASTAL AREAS WITH MODERATE SALINITY.

INTERIOR: CHEMICAL PLANTS, SWIMMING POOLS, COASTAL SHIP AND BOAT YARDS.

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Code of Practice

Definitions and general considerations shall be in accordance with ISO 12944 Parts 1:18 as modified or extended by any substitute or additional clauses in this specification.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides and burrs ground smooth. The surface shall be treated by solvent cleaning, steam cleaning or high pressure water hosing followed by clean water rinsing, to remove deposits

of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.11 Blasting Cleaning

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast-cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast-cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast-cleaning shall be either G.40 steel grit S.230 steel short, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 Inspection

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.22 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.29 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.30 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.31 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

5.0 Paint System for Corrosivity Category C4 – High Corrosivity

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

5.1 Paint System for Steelwork NOT Requiring a Decorative Finish

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry thickness 80 microns

Second Primer Coat – 2 coats of 2 pack epoxy / micaceous iron oxide coating to nominal dry film thickness 200 microns

Preferred Systems:

10. Interplate 180 NEA / NEA071 and Intercure 200 EPA214 / EPA240 and Intercure 420 EBA403 / EBA420
11. Hempel's Shopprimer 1528 and Hempadur 47200 and Hempadur 45880 HS
12. Jotun Muki Zinc 3000 and (Jotun Penguard Stayer or Penguard HB)

5.2 Paint System for Steelwork Requiring a Decorative Finish

A decorative coating shall be incorporated if required. See Architect's drawings and specifications.

Site Holding Primer (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide primer to nominal dry film thickness 150 microns

Second Primer Coat – 2 coats of 2 pack epoxy / micaceous iron oxide coating to nominal dry film thickness 80 microns

Finish Coat – 2 pack acrylic polyurethane to nominal dry film thickness 50 microns (RAL or BS number to be provided)

Preferred Systems:

10. Interplate 180 NEA / NEA071 and Intercure 200 EPA214 / EPA 240 and Intercure 420 EBA403 / EBA420 and Interthane 990 PH Series / PHA046

11. Hempel's Shopprimer 1528 and Hempadur 47200 and Hempadur 45880 HS and Hemplathane 5521 Polyurethane
12. Jotun Muki Zinc 3000 and (Jotun Penguard Stayer or Penguard HB) and (Jotun Penguard Stayer or Penguard HB) and Jotun Hardtop

5.3 Paint System where Abrasive Blasting Not Possible (Galvanised) Steelwork

Where indicated on the drawings, steelwork and its associated steel fixings shall receive the following coating system from supplier approved by the Engineer:

Pre-treatment

Thorough degreasing to remove all grease, dirt and any other contamination. Before the application of the Intercure 420 MIO a thin coat of interprime etch solution GDA160 should be applied in accordance with the manufacturer's instructions. It is extremely important that the dry film thickness of the etch primer is not applied in excess of the manufacturer's requirements.

Under Coat

After a minimum of 4 hours drying apply 1 full coat of 2-pack High Build Epoxy containing Micaceous Iron Oxide, each coat to a Nominal Dry Film Thickness 75 microns with a minimum requirement of 60 microns of airless spray.

Finish Spray

After a minimum of 16 hours drying apply 1 full coat of 2-pack, Isocyanate Free, High Performance Polyurethane Type, Acrylic Finish to a Nominal Dry Film Thickness 50 microns with a minimum requirement of 40 microns by airless spray.

Compliance

The following specification is deemed to comply with the above general specification if carried out strictly in accordance with the manufacturer's instructions:

- a. International Protective Coatings:
Intercure 420 EBA403/EBA420
Interfine 629 HS HY Series/HYA340
Applied to the thicknesses specified above.

5.4 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the

project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK PAINT SPECIFICATION

**CORROSIVITY CATEGORY VERY HIGH (Industrial or Marine)
(C5 in accordance with ISO 12944 – Part 2)**

INDUSTRIAL EXTERNAL: INDUSTRIAL AREAS WITH HIGH HUMIDITY AND AGGRESSIVE ATMOSPHERE.

INDUSTRIAL INTERNAL: BUILDINGS OR AREAS WITH ALMOST PERMANENT CONDENSATION AND WITH HIGH POLLUTION.

MARINE EXTERNAL: INDUSTRIAL AREAS WITH HIGH HUMIDITY AND AGGRESSIVE ATMOSPHERE.

MARINE INTERNAL: BUILDINGS OR AREAS WITH ALMOST PERMANENT CONDENSATION AND WITH HIGH POLLUTION.

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Code of Practice

Definitions and general considerations shall be in accordance with ISO 12944 Parts 1:18 as modified or extended by any substitute or additional clauses in this specification.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp arises and burrs ground smooth. The surface shall be treated by solvent cleaning, steam cleaning or high pressure water hosing followed by clean water rinsing, to remove

deposits of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.12 Blasting Cleaning

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast-cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast-cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast-cleaning shall be either G.40 steel grit S.230 steel short, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 Inspection

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to

grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.23 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.32 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.33 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.34 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

6.0 Paint System for Corrosivity Category C5 – Very High (Industrial & Marine)

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

6.1 Paint System for Steelwork NOT Requiring a Decorative Finish

Primer Coat – 2 pack epoxy zinc rich primer to nominal dry film thickness 80 microns

Second Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide high build coating to nominal dry film thickness 200 microns

Preferred Systems:

13. Interzinc 52 and Intercure 200 HS
14. Hempadur Zinc 1736 and Hempadur 4588 HS
15. Jotun Barrier 77 and 1 x Penguard Stayer @ 80, 1 x Penguard HB @ 80

6.2 Paint System for Steelwork Requiring a Decorative Finish

A decorative coating shall be incorporated if required. See Architect's drawings and specifications.

Primer Coat – 2 pack epoxy zinc rich primer to nominal dry film thickness 80 microns

Second Primer Coat – 2 pack epoxy zinc phosphate / micaceous iron oxide high build coating to nominal dry film thickness 170 microns

Finish Coat – 2 pack acrylic polyurethane to nominal dry film thickness 50 microns (RAL or BS number to be provided)

Preferred Systems:

13. Interzinc 52 Intercure 200 HS and Interthane 990 PH Series / PHA046
14. Hempadur Zinc 1736 and Hempadur 45880 HS and Hempathane 5521 Polyurethane
15. Jotun Barrier 77 1 x Penguard Stayer @ 80, 1 x Penguard HB @ 80 and Jotun Hardtop

6.3 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK PAINT SPECIFICATION

CORROSIVITY CATEGORY Im2 (Im2 in accordance with ISO 12944 – Part 2)

**EXTERIOR: SEA OR BRACKISH WATER.
NOT FOR INTERIOR USE.**

See Architect's drawings and specifications for decorative finish requirement.

If required, decorative finish to be in accordance with this specification.

1.0 Definitions

Definitions and general considerations shall be in accordance with ISO 12944 Part 1:18 as modified or extended by any substitute or additional clauses.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer (except where permitted under Item 3.21 of this specification) and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

When cleaning or painting operations are being carried out on the site, the Contractor shall protect surrounding areas and adjacent structures to the approval of the Engineer, in order to avoid any damage, spotting, over-spray, or contamination produced by cleaning or painting operations.

Protection against adjacent blasting shall be of a substantial nature and shall be approved for each area before blasting commences.

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp
arises and burrs ground smooth. The surface shall be treated by solvent cleaning, steam

cleaning or high pressure water hosing followed by clean water rinsing, to remove deposits of oil or grease immediately prior to blasting. The operation of any surface cleaning method shall not be allowed to contaminate wet paint films.

Blast-cleaning of steel surfaces shall be carried out with adequate lighting and the equipment to be used shall be capable of producing the standards of cleaning as specified herein. No dry blast-cleaning shall be carried out during periods when the temperature of the steel is below the dew point.

Surfaces that are no longer accessible after assembly must be painted beforehand in accordance with this standard.

1.13 Blasting Cleaning

Quality grade Sa2.5 to ISO 8501-1:1988 is the minimum quality requirement. It is advisable to refer to ISO standards 8502, 8503 and 8504 prior to blast-cleaning. After blasting, all dust and spent blast media must be removed by vacuum or brush before any coating is applied and no member shall go forward for priming or coating until cleaned surfaces have been passed by the Engineer. Where a longer period than three hours has elapsed since cleaning, it shall be re-blasted immediately prior to painting. Under no circumstances must a primer coat be applied over blast-cleaned surface on which rust bloom has started to appear.

Company and equipment item nameplates and stamped identification codes must remain legible.

The abrasive used in blast-cleaning shall be either G.40 steel grit S.230 steel short, 16 grit aluminium oxide or their equivalents, to produce an average grater depth on the blasted surface of not more than 50 -75 microns. Abrasive shall be free from contamination. The minimum acceptable profile is 35 microns. The surface profile must correspond to Rugotest No. 3, N10a, Keane – Tator Comparator 3 mils segment. Please note that steel shot alone will not give a good angular profile and should be used in combination with steel grit for best results.

Non-metallic abrasives may only be used with the approval of the Engineer and shall be of the silica-free type. Expendable abrasive shall be used for all blast-cleaning for on-site work. The re-use of abrasive will be permitted on the site.

Surface laminations and other imperfections raised by the cleaning process shall be repaired at this stage. All surface defects revealed by blast-cleaning shall be referred to the Engineer before any dressing is undertaken.

Where dressing has been necessary, these areas shall be re-blasted to remove all rust and to provide an adequate paint key to the approval of the Engineer.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2°C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (e.g. air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (e.g. relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (e.g. shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washing with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 Inspection

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information. Testing shall be carried out in accordance with ISO 12944 Part 6 unless noted otherwise.

The following are the applicable tests and documents: -

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer / contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.24 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.35 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.36 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.37 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

7.0 Paint System for Corrosivity Category Im2

Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive a coating system in accordance with ISO 12944 1998: Part 5 Table A.2, High expected durability for expected time to first maintenance in excess of 15 years unless agreed otherwise with the Engineer. The paint supplier must be approved by the Engineer prior to application. The proposed coating system must be confirmed by the paint supplier prior to application, to be in accordance with the above requirement. Details of a preferred paint system are given below.

7.1 Paint System Steelwork

Site Holding (if required) – 2 pack epoxy primer to nominal dry film thickness 25 microns

Primer Coat – 2 pack modified epoxy coating to nominal dry film thickness 350 microns

Preferred Systems:

16. Interplate 180 NEA / NEA071 and Interzone 954 EAA Series / EAA954
17. Hempel's Shopprimer 1528 and Hempadur Multi-strength 45540
18. Jotun Muki Zinc 3000 and Jotun Marathon

RAL or BS number to be provided if decorative finish required. See Architect's drawings and specifications.

7.2 Notes

The dry film thicknesses shown above are based on a paint system by the manufacturers noted below. Tenderers should confirm that appropriate dry film thicknesses are provided to give the specified level of protection.

The products referred to above are produced by International Coatings Ltd, Hempel Paints Ltd and Jotun Paints Ltd. If products from other manufacturers are proposed for use on the project, detailed information on the proposed products should be submitted to the Engineers at tender stage for approval.

All coatings to be applied strictly in accordance with manufacturer's recommendations and all relevant technical and health and safety data sheets.

Reference to a standard implies the most recent version.

STEELWORK COATING SPECIFICATION C7 PROTECTIVE COATING – GALVANISING

1.0 Required British Standards

Operations shall comply with the provisions of BS EN ISO 1461 “Hot Dip Galvanized Coating on Fabricated Iron and Steel – Specifications and Test Methods” and also those of BS EN ISO 12944 "Paints and Varnishes – Corrosion Protection of Steel Structures by Protective Paint Systems" except where modified by this specification.

The above notwithstanding, the galvanising coat thickness adopted shall not be less than 2 oz per sq ft (611 g per sq metre) or 85 micro metres in thickness (mean thickness).

Note: References to British Standards always implies the most recent version.

2.0 Preparation of Steelwork After Fabrication

For steelwork to be given a protective treatment, all welding slag, spatter, flux, residues, oxides, fumes, snags and strikes shall be removed and all sharp arises and burrs ground smooth.

Remove dirt, loose mill scale and heavy rust by mechanical scraping. Thoroughly clean surface with detergent or steam. Rinse with warm water.

Remove residual oil and grease by swabbing contaminated areas only with emulsion cleaner. Thoroughly clean treated areas with detergent or steam and rinse with clean cold water. Ensure adjacent surfaces of component and other cleaned components are not contaminated by cleaning and degreasing operations.

Dry surfaces with oil-free air blast.

Pickle or blast clean and flash pickle steel to suit zinc coating thickness required.

It shall be the responsibility of the fabricator to ensure that the galvanising system used shall be sufficient to achieve the design performance specification.

- 3.0** Particular care shall be taken to use bolts, washers and other ancillaries which are suitably protected to the required standard (galvanised or sheradised).

4.0 Repair of Polished Galvanising

Clean, degrease, wash down and dry damaged "polished" and adjacent areas.

It shall be the responsibility of the fabricator to provide a suitable zinc rich paint to touch up all damaged or unprotected areas to give protection equal to that on undamaged surfaces, overlapping adjacent areas by 20 mm.

5.0 Repair of Bare Areas

- a Clean bare steel or steel-zinc alloy using needle gun and/or rotary wire brush.
- b Clean, degrease, wash down and dry, thinned and adjacent sound galvanised surfaces.
- c Immediately apply zinc-rich paint to bared steel or steel-zinc alloy and thinned galvanising, overlapping sound galvanised surfaces by 20 mm, to give protection equal to that on undamaged surfaces.

6.0 Testing

Measure zinc thickness with magnetic or electromagnetic meter. Re-galvanise if thickness is deficient.

**STEELWORK PAINT SPECIFICATION
GALVANISED STEELWORK
REQUIRING A DECORATIVE FINISH**

1.0 DEFINITIONS

For the purposes of this specification, the following definitions shall apply:-

Two-pack paint - A paint supplied as two separate ingredients to be thoroughly mixed in exact proportions before use.

Dew Point - The temperature of the atmosphere at which the relative humidity rises to 100 per cent.

Dry Film thickness - The thickness of the solid portion remaining of the surface after curing and / or evaporation of any volatile matter.

Sweep Blast - Light cleaning by blast cleaning sufficient to thoroughly roughen the surface of the existing coatings, but not sufficient to remove a complete layer of the existing coating.

1.1 Materials

All paints, primers, epoxide, thinners, curing agents and other approved protection materials, hereafter referred to as paints, and cleaning solvents for any protective coating system in this specification shall be the products of the same manufacturer and shall be certified by that manufacturer to provide a compatible paint system. All paints shall be applied in accordance with the manufacturer's recommendations.

Where fabrication of steelwork involves welding, partial treatment of the steelwork prior to fabrication may only be undertaken where the primer has a welding certificate for the dry film thickness stated below.

1.2 Thinning

All paints shall be used as supplied by the manufacturers without thinning or adulteration except where specially allowed under this specification, when the thinner specified by the manufacturer shall be used.

1.3 Data Sheets

The Contractor shall submit to the Engineer copies of the data sheets for all paint materials he proposes to use, together with any identifying codes.

1.4 Paint Containers

The name of the manufacturer, date of manufacture, colour of paint, batch number, together with information regarding special storage conditions, if any, shall be clearly shown on each container. All paint shall be supplied in sealed containers of the open drum type and of not more than 25 litres capacity.

1.5 Storage of Paint

All paint shall be kept under cover in conditions as recommended by the manufacturer and in accordance with the appropriate fire regulations. The arrangement for storing paint shall ensure that each batch can be issued for use in order of delivery. Paint shall not be used after the expiry date shown on the container.

1.6 Preparation of Paint for Use

Paint shall be prepared adjacent to the location where the painting work is to be carried out. Paints shall be thoroughly prepared by carefully extracting any skins and mechanically mixing to ensure that no sediment is left at the bottom of the can.

Only thinners of quality and quantity specified by the paint manufacturers shall be used.

1.7 Surface Preparation

Surface preparation and painting operations shall comply with the recommendations of ISO 12944 Part 4 except where modified by this specification.

Through de-greasing to remove all grease, dirt and any other contamination, followed by one coat of etch solution.

1.8 Coating Application Methods

All paint application shall be strictly in accordance with the manufacturer=s recommendations, especially safety and hygiene instructions. Applications of paint by airless spray equipment shall be in accordance with the manufacturer=s recommendation, unless otherwise approved or directed by the Engineer.

The paint manufacturer=s written instructions regarding spraying-tip sizes, pack ratios, proportions of thinners (if any) mixing instructions, shelf-and-pot-life, cleaning solvents, and Health and Safety recommendations shall be observed. The relevant clauses of this section as well as the appropriate data sheets of all products to be used shall be continually available at the place of use.

1.9 Conditions

Coating shall not be carried out when a) the ambient temperature is below 2° C, b) the surfaces are wet, c) humidity in the vicinity is such that condensation could readily occur on the surfaces either immediately before or during the coatings, (eg air or metal temperatures within 3°C of dewpoint and air temperature below 5°C or d) when high humidity could have a detrimental effect on the coating (eg relative humidity above 85 per cent).

If heating and / or ventilation is employed to secure suitable conditions to allow coating work to proceed, then care shall be taken that treatment or a local surface area does not cause adverse conditions in adjacent surfaces and that such measures are maintained until such time when their removal would not have a detrimental effect on the applied coating.

1.10 Cleanliness of Surface

Neither initial coating nor any subsequent applications shall be made unless the surface to be treated is clean, dry and dust-free. If dust has settled on the surface it shall be removed by vacuum cleaner or brush.

1.11 Coating

For each application, all weld runs, angles and edges shall be stripe coated first. Minimum over coating period for the primer should be observed prior to over coating with the next coat over the whole area.

At bolted connections, clearance at holes shall be maintained, and runs through holes avoided. Temporary bolts shall be fitted in any threaded fittings and removed before the coating has set. Unless otherwise directed all metal fittings and attachments capable of easy and safe removal shall be removed. They shall be cleaned and refixed after the finish coat is dry and hard. Where they cannot be removed, they shall be protected before surface preparations are begun.

At all junctions of base metal with existing coatings the coating shall be feathered out over 100mm to provide a smooth graduated profile before any new coatings are applied.

Any coat to a member shall be applied over the whole surface in one operation unless application over partial area is approved by paint manufacturers and the Engineer.

In the event of any foreign materials (eg shot or grit) being found embedded in the paint film, the effected areas shall be re-blasted and the complete painting system re-applied. All paint shall be applied in such a manner as to ensure a continuous covering film, free from issues, tears, runs, sags etc.

The painting processes shall be so separated from blast-cleaning that no dust, detritus or grit falls on the fresh paintwork or insufficiently hardened coats. Site weld area, including the coated surface damaged by heat, shall be prepared to BS 7079: Part A1 St3. All weld flux and spatter shall be removed.

Other painted areas next to the weld areas shall be suitably protected when the above operations are carried out.

1.12 Film Thickness

The protective paint systems shall be applied in continuous films to give the total dry thickness over the steel required by the specification.

Wet thickness gauges shall be used continually by the applicator to ensure that the dry thickness requirements will be met.

The dry thickness measurement is carried out with a digital coating thickness gauge, accuracy $\pm 3\%$. It is recommended that the wet coat is continually checked with a thickness gauge, as per manufacturer's product data sheets.

Where new paint is to be applied over existing sound paint, the thickness of the existing paint shall be measured after it has been cleaned and prepared for over-coating and immediately before any new paint is applied.

If the total dry film thickness is less than specified, additional coats of finish paint shall be applied until a dry film thickness of not less than specified is obtained. An additional finishing coat shall be applied at places (such as exposed edges or plates) where corrosive conditions will be exceptionally severe and over protruding or irregular feature (such as bolt heads and welds). Dry film thickness will be determined and reported in accordance with BS 3900 Part C5.

1.13 Multiple Coats

Oil, grease and other similar contamination of paint films shall be removed by brushing and washed with an approved solvent: these areas shall be scrubbed with a two per cent solution of detergent and then thoroughly rinsed with clean hot water.

Painted surfaces on which there is evidence of atmospheric contamination or salt deposition shall be washed down by brushing with soft nylon brushes and clean water and thoroughly dried before further coats of paint are applied.

The intervals between coats shall normally be as recommended by the manufacturer and agreed by the Engineer, taking into account the conditions of application. No further coat shall be applied until the previous coat has dried and cured to the correct degree.

All paints shall be applied to give a finish of uniform colour and texture acceptable to the Engineer. The applied coatings shall be inspected to verify that the coatings are free of runs, sags, blisters, pinholes, dry spray, mud-cracking, and other defects that affect the performance, or quality of the protective coating system. The Engineer may direct the brushing out of any runs or sags or the removal of paint and repainting of the surface.

1.14 Handling

If Works applied coat is final coat of system, then every effort should be taken to minimise handling damage and dirt contamination.

Where practical, handling should be by use of lifting lugs rather than by wrap-round chain. Items should be spaced using wooden batons, corners protected where appropriate, and steelwork handled at every stage in a way which minimises damage to the coating.

Every effort should be made to minimise dirt contamination of coated steelwork. In particular, storage on site prior to erection should be such as to minimise ponding and walk-over. Measures such as sheeting-in loads should be considered where practical.

1.15 Repair of Damaged Areas

Any coated surfaces damaged at any stage of the work (including bolt heads etc.) must be thoroughly cleaned to remove contamination to BS 7079:A1 St2 minimum, without polishing the steel surface. Coating edges should be firm and feathered. All surrounding areas should be cleaned as necessary to present a sound surface for local over painting.

Site application by brush/roller should be carefully carried out to provide as neat an appearance as possible. The full specified dry film thickness of the system should be reinstated at the damage points, which over bare steel will require a minimum of three site applied coats. All touch-up areas should appear in a solid colour. Procedures and materials used in the repair process must be approved by the paint manufacturers and the Engineer prior to use.

1.16 Final Cleaning

The Engineer shall require all coated surfaces to be washed down and cleaned to his satisfaction before he makes his final inspection of the Site treatments.

1.17 Inspection

The Engineer reserves the right to inspect the work in progress. The contractor is obliged to grant the representative of the ordering party access to the workshops and to provide any necessary information.

The following are the applicable tests and documents:-

1. The cured primer must no longer be soluble in its original solvents, nor sensitive to softening by heat.
2. ASTM D 3359-92A, Standard Test Methods for Measuring Adhesion by Tape Test. Result- 4B is the minimum acceptable result.
3. ASTM D 4138-88, Standard Test Method for Measurement of Dry Film Thickness of Protective Coatings by Destructive Means. Result- as visually seen.
4. ASTM D 4541-85, Standard Test Method for Pull Off Strength of Coatings using Portable Adhesion Testers. Result- as per paint manufacturer's criteria.
5. NACE RPO287, Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces using Replica Tape. Result- as per this specification.
6. ASTM D 4414, Practice for measurement of Wet Film Thickness of Organic Coatings by Notch Gauges. Result- as per product data sheet.
7. SSPC PA 2, Measurement of Dry Paint Thickness with Magnetic Gauges. Result- as per this specification.
8. NACE RPO188, Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings. Result- No holidays must be present.
9. ASTM E 377, Standard Test Method for Measuring Humidity with a Psychrometer. Result- as per this specification.
10. ASTM D 4285, Test Method for Indicating Oil or Water in Compressed air. Result- None present.

1.18 Quality Control

The manufacturer/contractor shall ensure that sufficient quality control systems are in place to carry out this specification. This should include a visit and an evaluation of a subcontractor's ability to carry out this specification.

1.19 Guarantee

The contractor guarantees that the work is carried out in a skilful manner, and that there is good adhesion to the base material. The contractor is obliged to rectify proven defects at his own cost. If he is not able to rectify the defects within a two week period, the ordering party is entitled to have the repair work carried out by a third party at the cost of the contractor.

1.38 Multiple Products

Where products from more than one coating manufacturer (including hot dip galvanising) are intended for use by the Contractor on a particular structural element, as for instance in (but not limited to) the case of architectural coating overlying a corrosion protection coating system, the Contractor shall forward to the Engineer for comment prior to adopting a coating system, written confirmation from the manufacturers of all coating products intended for use in the complete coating system, confirming the compatibility of their product (or products) with the product (or products) provided by the other manufacturer (or manufacturers) within the complete proposed coating system.

1.39 Health and Safety

All works are to be carried out in accordance with the requirements of the Health and Safety at Work Act, 1989, in accordance with the paint manufacturer's recommendations and in accordance with good practice.

1.40 Painter Requirements

All painters working for the main contractor or subcontractor must have all union cards and be covered for public liability insurance.

2.0 PAINT SYSTEM FOR GALVANISED STEELWORK REQUIRING A DECORATIVE FINISH

2.1 Unless noted otherwise on the drawings, steelwork and its associated steel fixings shall receive the following coating system from supplier approved by the Engineer:

Etch Solution

Undercoat

2-pack high build epoxy with micaceous iron oxide to Nominal Dry Film Thickness 75 microns.

Finish Coat

2-pack polyurethane finish to Nominal Dry Film Thickness 50 microns in selected colour (RAL or BS number required).

2.1.2 Compliance

The following specification is deemed to comply with the above general specification if carried out strictly in accordance with manufacturer's instructions:

a. International Protective Coatings:

1 x Interprime etch solution GDA160

1 x Intercure 420 EBA403/EBA420

1 x Interthane 799 PQ SERIES/PQA015

applied to the thicknesses specified above.

2.1.3 Notes

- Coating to be applied in accordance with relevant technical, health and safety data sheets.
- Reference to a British Standard implies the most recent version.

SPECIFICATION

PRECAST CONCRETE ROOF BEAMS AND PURLINS

1.0 DESIGN

1.1 DESIGN CRITERIA

- 1.1.1** Units shall be designed and manufactured by specialist precast subcontractor in accordance with:

BS 8110: Part 1: 1997	-	Structural use of Concrete
BS 8110: Part 2: 1985:	-	Special Circumstances

Design calculations shall be forwarded to the Engineer.

1.1.2 Loading

Precast elements shall be designed for all dead loads including self weight, roof and ceiling finishes and services in accordance with their unit weights, and live loading in accordance with BS 6399: Part 1: 1996.

Where loads are not specifically called up on engineer's drawings, precast supplier is to ascertain from architects drawings or client details of proposed loadings.

1.1.3 Concrete Pouring

Pouring, placing, shuttering, curing, etc. of precast units shall comply with Michael Punch & Partners specification for concrete.

1.1.4 Durability

Concrete cover to reinforcement shall be as given in Table I.

TABLE I
NOMINAL COVER TO ALL STEEL (INCLUDING LINKS)
TO MEET DURABILITY REQUIREMENTS

**Conditions of
Exposure Nominal Cover**
BS 8110: Part 1: 1997 - Table 3.3

	mm	mm	mm	mm	mm
Mild	25	20	20	20	20
Moderate	-	35	30	25	20
Severe	-	-	40	30	25
Very Severe	-	-	50	40	30
Most Severe	-	-	-	-	50
Max. free water/cement ratio	0.65	0.6	0.55	0.5	0.45
Min. Cement content kg/m ³	275	300	325	350	400
Lowest grade of Concrete	C30	C35	C40	C45	C50

1.1.4 Fire Resistance

The minimum requirements shall be those of the Proposed Building Regulations, or otherwise those of Table 4.4: BS 8110: Part 2: 1985.

The precast supplier shall ascertain from the Architect his requirements for fire resistance. Where available, the requirements of the Fire Officers conditions shall be met.

1.1.5 Sound Resistance

Units shall be designed by specialist precast subcontractor in accordance with BS5821, and Part E of the Building Regulations to architects requirements.

1.1.6 Finish

Formed surfaces of concrete shall be free from honeycombing and lipping. Provide a fair-faced finish to soffits and sides of concrete beams and purlins.

1.1.7 Drawings

The following drawings shall be provided.

- (a) Reinforcement detailing.
- (b) Bearing details, cover to reinforcement.
- (c) Propping details where applicable.

1.2 DESIGN METHOD

1.2.1 Handling Stresses

Precast elements shall be designed to resist, without damage, all stresses induced by handling, storage, transport and erection.

1.2.2 Compatibility

The design of connections in precast construction must ensure compatibility.

1.2.3 Bearings for Precast Elements

Elements shall be laid on true and level bearings.

Minimum bearing shall be 100mm.

1.2.4 Structural Connections Between Precast Units

Connections should be designed to maintain the standard of protection against weather, fire and corrosion required for the remainder of the structure.

1.2.5 Cover

Where the cover to the reinforcement is not adequate to achieve the required fire resistance, the contractor shall make provision to bring the fire resistance up to the required rating. The contractor shall include in his quotation for any renderings required in this context. Details of finish shall be subject to the architect's approval.

2.0 MATERIALS

2.0.1 The engineer shall be informed of the source of each material to be used and subsequently whenever a change is made. No admixtures shall be used without written approval of the engineer. Admixtures containing chloride or nitrate shall not be used.

2.1 REINFORCEMENT

2.1.1 Reinforcement shall conform to the requirements of the following standards:

Rolled mild steel bars	BS 4449
Cold worked bars (high yield)	BS 98 / 710443 DC
Fabrics	BS 4483

2.1.2 The reinforcement shall be of the size and number as shown on the shop drawings and so positioned to maintain the specified cover and shall be located within 5mm of the positions shown on the drawings.

2.1.3 All reinforcement shall be free of loose rust, pitting, mechanical damage and kinking. All reinforcement to be bonded shall be free from oil, grease and other bond-breaking materials.

2.2 PRESTRESSING TENDONS

- 2.2.1** Prestressing tendons shall be stress relieved seven wire strand to BS 5896: 1980, designation BS 5896/3, relax class 2 in accordance with Table 6 BS 5896: 1980.

or

Cold drawn wire to be BS 5896: 1980, designation BS 5896/2, relax class 2 in accordance with Table 4 BS 5896.

2.3 CEMENT

- 2.3.1** Cement used shall be Normal Portland Cement and shall be certified as complying with IS 1: 1963 as amended, in accordance with the Irish Standard Licensing Scheme of the IIRS. Manufacturers' or suppliers' certificates of compliance with the standard shall be provided when requested by the engineer.
- 2.3.2** Cement must be stored dry in completely moisture proof conditions. Invoices and delivery dockets shall be available on request.
- 2.3.3** Records shall be kept by the manufacturer of the cement used in each pour. Care shall be taken that cement is used rotationally and that no cement is stored too long.

2.4 AGGREGATES

- 2.4.1** Aggregates shall consist of natural pit sand and washed gravel or approved crushed stone. All aggregates shall be hard, uniform and clean. Aggregates shall conform to I.S.5: 1990.
- 2.4.2** Maximum size of aggregates shall be 20mm for precast concrete beams and purlins.

2.5 WATER

Water shall be clean and free from impurities harmful to the concrete.

2.6 CONCRETE GRADE

The concrete grade to be used shall be at the manufacturer's discretion but shall not be less than that corresponding to the relevant exposure condition of Table 1 of this specification.

3.0 MATERIALS TESTING

3.1 TESTING OF STRANDS

At the engineer's discretion, 2 samples of prestressing tendons shall be provided for testing.

3.2 TESTING OF CONCRETE

- 3.2.1** Testing plan and rates of sampling of concrete shall conform with the relevant clauses of BS 5328 and BS 1881. All relevant cube test results shall be forwarded to the engineer. In particular cube tests shall be taken regularly to identify the concrete strength at transfer.

3.3 TESTING OF AGGREGATE

- 3.3.1** The supplier shall forward all information concerning aggregate sources. At least two aggregate samples per month of production shall be provided for testing at the Engineer's discretion.

3.4 TESTING OF WATER

- 3.4.1** Where the quality of supply is doubtful the water shall be tested in accordance with BS 3148.

4.0 WORKMANSHIP

4.1 TOLERANCES

4.1.1 Allowance for construction inaccuracies may be taken as the greater of:

- (a) 15mm, or 3mm per metre distance between the faces of steel or precast concrete supports.
- (b) 20mm, or 4mm per metre distance between the faces of masonry supports.
- (c) 25mm, or 5mm per metre distance between the faces of insitu concrete supports.

4.1.2 Precast elements shall be cut to nominal length taking account of the above workmanship tolerances, the manufacturer's tolerances and the site dimensions. Care shall be taken to ensure minimum bearing of 100mm.

5.0 HEALTH & SAFETY REGULATIONS

Design, supply and erection of units shall be in accordance with relevant health and safety procedures and current legislation.

SPECIFICATION

FOR STRUCTURAL STEELWORK

PROJECT SPECIFICATION

1.1 NATIONAL STRUCTURAL STEELWORK SPECIFICATION

The specification for structural steelwork has incorporated the National Structural Steelwork Specification for Building Construction, published by the British Constructional Steelwork Association Ltd, in association with The Steel Construction Institute.

1.2 PROPOSED WORKS

- (i) Brief description of the structure.
- (ii) Intended purpose of the structure
- (iii) Details of site within which the works will be constructed.

1.3 DESIGN AND DRAWING

- (i) Design concept statement
- (ii) Design drawings
- (iii) Design standards for connection design
- (iv) Forces, moments and their combination to be transmitted by each connection which is to be designed and detailed by the Steelwork Contractor.
- (v) Particular fabrication details and types of connection.
- (vi) Details of cutouts, holes or fittings required for use by others.
- (vii) Camber.

1.4 WORKMANSHIP

- (i) Any special welding procedures which have to be approved prior to work commencing.
- (ii) Any special requirements regarding fabrication or erection attachments (see clause 3.4.4 and 5.4.5).
- (iii) Any production test plates which are required (see clause 5.4.7).
- (iv) Areas of steelwork where the scope of weld inspection is to be greater than the minimum specified (see clause 5.5.5).
- (v) Any special requirements regarding weld acceptance criteria (see clause 5.5.6).

1.5 ERECTION

- (i) Site plan
- (ii) Any limitations or dimensions or weights of components to be delivered to site.
- (iii) Any design features which would affect the construction sequence, or which may create an unusual hazard during construction.
- (iv) Special requirements for temporary bracing and/or propping; the stage when it is no longer necessary, or whether it is to be left in position after completion of the steelwork (see clause 8.4.1)
- (v) Define the responsibilities at the interface between the steelwork and other trades.
- (vi) Coordination with project supervisor for construction stage.

1.6 PROTECTIVE TREATMENT

- (i) Refer to paint specification or other protective treatment specifications such as galvanizing.

1.7 ADDITIONAL INSPECTIONS AND TESTS

- (i) Inspections or tests to be carried out or witnessed by the engineer or inspection authority.
- (ii) The period of advance notice for these additional requirements.

1.8 PROGRAMME

- (i) The dates by which the site is expected to be ready for erection of structural steelwork.
- (ii) Integration of Steelwork Contractors programme with Main Contractors requirements.
- (iii) Co-ordination with Main Contractor and Project Supervision for the Construction Stage in relation to Health and Safety requirements.

1.9 GENERAL CONDITIONS AND CONTRACT PARTICULARS

- (i) Main Contract
- (ii) Sub-contract
- (iii) Main Contract parties and Consultants
- (iv) Appendix to Main Contract
- (v) General Attendance
- (vi) Special Attendance
- (vii) Order of Work
- (viii) Other Particulars
- (ix) Endorsements
- (x) Acceptance
- (xi) Form of Tender

MATERIALS

2.1 MATERIAL QUALITIES

Materials shall **be in ROLLED SECTIONS, STRUCTURAL HOLLOW SECTIONS, PLATES and BARS** and shall comply with the appropriate standard shown in Table A of the National Structural Steelwork Specification for Building Construction.

2.2 MATERIAL TESTING

All steel shall have been specifically tested in accordance with the appropriate material quality standard shown in Table A of The National Structural Steelwork Specification for Building Construction, published by The British Constructional Steelwork Association Limited.

2.3 TEST CERTIFICATES

The Steelwork Contractor shall obtain the manufacturers test certificate.

2.4 DIMENSIONS AND TOLERANCES

Dimensions and Tolerances shall comply with the appropriate standard shown in Table A of The National Structural Steelwork Specification for Building Construction, published by The British Constructional Steelwork Association Limited.

2.5 SURFACE CONDITION

- (i) Steel surfaces when used shall not be more heavily pitted or rusted than Grade C of BS 7079 Part A1.
- (ii) Surface defects in hot rolled sections, plates and wide flats revealed during surface preparation which are not in accordance with the requirements of BS EN 10163 shall be rectified accordingly.
- (iii) Surface defects in hot rolled hollow sections revealed during surface preparation which are not in accordance with the requirements of BS EN 10210-1 shall be rectified accordingly.

2.6 SUBSTITUTION OF MATERIAL OR FORM

Material quality or section form of components may, with the agreement of the Engineer be substituted where it can be demonstrated that the structural properties are not less suitable than the designed component.

2.7 WELDING CONSUMABLES

2.7.1 Standards

Consumables for use in metal arc welding shall comply with BS 639, BS 2901, Part 1, BS 4165 or BS 7084 as appropriate.

2.7.2 Storage

Consumables to be stored in the Steelwork Contractor's works and on the Site, shall be kept in a controlled atmosphere, in accordance with BS 5135. Any drying or baking of consumables before issue shall be carried out in accordance with the manufacturer's recommendations.

2.8 STRUCTURAL FASTENERS

2.8.1 Ordinary Bolt Assemblies

Shop and site bolts and nuts shall be to the following grades:

- (i) Grade 4.6 in accordance with BS 4190, or
- (ii) Grade 8.8 or 10.9 in accordance with BS 3692,

but with dimensions, tolerance and threaded length to BS 4190.

Note: see clause 6.1.1 for bolt/nut combinations.

2.8.2 High Strength Friction Grip (HSFG) Bolt Assemblies

HSFG bolt assemblies shall be in accordance with BS 4395.

Note: see clause 6.3.1 for bolt/nut combinations

2.8.3 Foundation Bolts

Holding down bolts shall be in accordance with BS 7419.

2.8.4 Cup and Countersunk Bolts

Cup and countersunk bolts shall be in accordance with BS 4933.

2.8.5 Washers

Metal washers shall be made in accordance with BS 4320 Section 2.

Unless otherwise specified, black steel washers to Form E shall be used. (see clause 3.4.8 for washers for holding down bolts).

2.8.6 Lock Nuts

Lock nuts shall be in accordance with BS 4929: Part 1.

2.8.7 Fastener Coatings

Where specific coatings are required, they shall be provided by the fastener manufacturer.

2.9 SHEAR STUDS

Proprietary studs used in composite construction shall be the headed type with the following properties after being formed:

- (i) Minimum yield strength - 350 N/mm^2
- (ii) Minimum ultimate tensile strength - 450 N/mm^2
- (iii) Elongation of 15% on a gauge length of $5.65 \sqrt{A}$, where A is the area of the test specimen.

2.10 PROPRIETARY ITEMS

All proprietary items shall be used in accordance with the manufacturer's recommendations and instructions.

DRAWINGS

3.1 GENERAL

3.1.1 British Standards

All design, fabrication and erection drawings shall be made in accordance with BS 1192 Parts 1 and 2.

Where welding symbols are used, they shall conform to BS 499 Part 2.

3.1.2 Revisions

Revised drawings shall have a suffix letter added to the number and a description in the notes stating the changes that have been made and the date.

The drawing office system shall ensure that the revised drawings are issued and the earlier copies withdrawn or clearly marked "superseded".

3.2 GENERAL ARRANGEMENT DRAWINGS

3.2.1 Marking System

Every component which is to be individually assembled or erected shall be allocated an erection mark.

Members which are identical in all respects may have the same erection mark.

3.2.2 General Arrangement Drawings (Marking Plans)

Drawings shall be prepared by the Steelwork Contractor showing plans and elevations at a scale such that the erection marks for all members can be shown on them. Preferred scales are 1:100 or larger.

The drawings shall show the grid locations as indicated on the design drawings, main dimensions, member levels and centre lines. Details at an enlarged scale should also be made if these are necessary to show the assembly of members.

3.3 FOUNDATION PLAN DRAWINGS

Foundation Plan Drawings shall show the base location, position and orientation of columns, the marks of all columns, any other members in direct contact with the foundations, their base location and level, and the datum level. (See clause 1.3,1 (xi)).

The drawings shall show complete details of fixing steel or bolts to the foundations, method of adjustment and packing space.

3.4 FABRICATION DRAWINGS

3.4.1 Fabrication Shop Drawings

Fabrication Drawings shall show all necessary details and dimensions to enable fabrication of components to proceed.

3.4.2 Drawing Register

A drawing register shall be made and used for the control and issue of drawings. It shall incorporate a system so that erection marks of the components can be readily identified with each drawing.

3.4.3 Microfilming

If drawings are to be microfilmed for record purposes, they shall be prepared in accordance with BS 5536.

3.4.4 Attachments to Facilitate Erection

The Fabrication Drawings shall show details of holes and fittings necessary to comply with the safety requirements and to provide for lifting and erection of components.

Unless specifically agreed otherwise, such holes and fittings may remain on the permanent structure. Account shall be taken of Clause 5.4.5 when detailing the welding of temporary attachments.

3.4.5 Welding

- (i) Any requirements for edge preparations for welds shall be indicated on the Fabrication Drawings.
- (ii) Welding inspection requirements which differ from those specified in clause 5.5.5 shall be indicated on the drawings.

3.4.6 Packings, Clearances and Camber

When preparing Fabrication Drawings, the Steelwork Contractor shall make provision for:

- (i) Packings which may be necessary to ensure proper fit-up of joints (see clauses 6.2.1 and 6.4.1);
- (ii) The need for clearances between the fabricated components so that the permitted deviations in fabrication and erection are not exceeded. (see Sections 7 and 9);
- (iii) The Engineer's requirements for pre-set or cambers (see clause 1.3.1).

3.4.7 Hole Sizes

- (i) For ordinary bolts and HSFG bolts:

not exceeding 24 mm diameter - 2 mm greater than the bolt diameter
greater than 24 mm diameter - 3 mm greater than the bolt diameter
- (ii) For holding down bolts:

6 mm greater than the bolt diameter, but with sufficient clearance to ensure that a bolt, whose adjustment may cause it to be out of perpendicular, can be accommodated through the base plate (see clause 9.4.3).
- (iii) For fitted bolts:

in accordance with clause 6.1.8.

3.4.8 Holding Down Bolt Covers

Holding down bolt details shall include provision of loose cover plates or washers with holes 3 mm greater than the holding down bolts.

3.4.9 Connections to allow Movement

Where the connection is designed to allow movement, the bolt assembly used shall remain secure without impeding the movement.

3.4.10 Machining Note

Any machining requirements shall be clearly noted on the Fabrication Drawings.

3.4.11 Drilling Note

The Fabrication Drawings shall indicate those locations where holes shall be drilled in accordance with the situations noted below (see also clause 4.6.3):

- (i) In non-slip connections for HSFG bolts;
- (ii) At locations where plastic hinges are assumed in the design analysis;
- (iii) In elements of rigid connections where yield lines are assumed;
- (iv) Where repetition of loading makes fatigue critical to the member design;
- (v) Where the design code of practice does not permit punched holes.

3.4.12 HSFG Faying Surfaces

When considering the coefficient of friction to use in the design of high strength friction grip bolted connections, the following values are to be used:

- (i) Unless the Engineer advises otherwise, untreated surfaces which are in accordance with BS 4604 may be considered as having a slip factor of 0.45; masking shall be used to keep the surfaces free of protective treatments.
- (ii) Surfaces which have been machined, or given any type of treatment, shall have the slip factor determined by tests carried out in accordance with BS4604 Part 1.

3.5 ERECTION DRAWINGS

3.5.1 Erection Method Statement

When necessary to amplify the information given in his erection method statement, the Steelwork Contractor shall prepare Erection Drawings.

3.5.2 Temporary Steelwork

Details and arrangements of temporary steelwork necessary for erection purposes shall be shown on the Erection Drawings.

3.6 DRAWING ACCEPTANCE

3.6.1 Acceptance by the Engineer

Drawings made by the Steelwork Contractor shall be submitted to the Engineer for acceptance in the period designated by the Engineer.

3.6.2 Meaning of Acceptance

Acceptance by the Engineer of drawings prepared by the Steelwork Contractor means that the Steelwork Contractor has correctly interpreted the design requirements and that the Engineer accepts the Connection Design.

Acceptance does not relieve the Steelwork Contractor of the responsibility for accuracy of his calculations, detail dimensions on the drawings, nor the general fit-up of parts to be assembled on site.

3.6.3 Acceptance Classification

The following designations may be used by the Engineer when accepting drawings:

Classification	Meaning
1 “Accepted” or “Reviewed” or “No Comment” or “Approved”	Drawing is accepted and may be released for construction
2 “Accepted subject to comments” comments, but need not be re-submitted for acceptance	Drawing must be amended in line with the
3 “Not Accepted”	Drawing must be amended in the way indicated and re-submitted for acceptance

3.7 “AS ERECTED” DRAWINGS

On completion of the contract, the Steelwork Contractor shall provide the Main Contractor with one set of paper prints of “As Erected” drawings comprising:

General Arrangement Drawings

Fabrication Drawings

Drawings made after fabrication showing revisions

The fabrication drawing register

WORKMANSHIP - GENERAL

4.1 IDENTIFICATION

4.1.1 Traceability of Steel

All steel to be used in the works shall have a test certificate (see Clause 2.3).

4.1.2 Material Grade Identification

The material grades of all steel shall be identifiable except for design grades 43A and 43B, and in the case of structural hollow sections, 43C.

4.1.3 Marking Steelwork

- (i) Individual pieces shall be capable of positive identification at all stages of fabrication.
- (ii) Completed components shall be marked with a durable and distinguishing erection mark in such a way as not to damage the material. Hard stamping may be used, except where otherwise specified by the engineer.

Where areas of steelwork are indicated on the drawings as being unmarked, they shall be left free of all markings and hard stamping.

4.2 HANDLING

Steelwork shall be bundled, packed, handled and transported in a safe manner so that permanent distortion does not occur and surface damage is minimised.

4.3 CUTTING AND SHAPING

4.3.1 Cutting Operations

Cutting and shaping of steel may be carried out by shearing, cropping, sawing, nibbling, laser cutting or machine flame cutting, except that where machine flame cutting is impractical, hand flame cutting may be used.

4.3.2 Flame-cut Edges

Flame-cut edges which are free from significant irregularities shall be accepted without further treatment except for the removal of dross, otherwise cut edges shall be dressed to remove irregularities.

4.3.3 Columns

- (i) Columns with ends not in direct bearing or intended to be erected on packs or shims, shall be fabricated to the accuracy given in clause 7.2.2.
- (ii) Columns intended to be in direct bearing shall be fabricated to the accuracy given in clause 7.2.3.
- (iii) Column sections which are one metre and over in width or depth and are intended to be in direct bearing, shall be specially prepared at the butting ends so that the erection tolerances in clauses 9.5.4 and 9.5.5 can be achieved.

4.4 MACHINING

4.4.1 Thickness of Machined Parts

The thickness of elements shown on the drawings as requiring machining shall mean the minimum thickness after the machining operations.

4.5 DRESSING

4.5.1 Removal of Burrs

Cut edges shall be dressed to remove dross, burrs, and irregularities. Holes shall be dressed as required to remove burrs and protruding edges.

4.5.2 Dressing of Edges

Sharp edges shall be dressed, but a 90° rolled, cut, sheared or machined edge is acceptable without further treatment.

4.6 HOLING

4.6.1 Matching

All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted without undue force through the assembled members in a direction at right angles to the faces in contact. Drifts may be used but holes shall not be distorted.

4.6.2 Drilling Through More Than One Thickness

Drilling shall be permitted through more than one thickness where the separate parts are tightly clamped together before drilling. The parts shall be separated after drilling and any burrs removed.

4.6.3 Punching Full Size

Full size punching of holes shall be permitted when:

- (i) The tolerance on distortion of the punched hole does not exceed that shown in clause 7.3.3;
- (ii) The holes are free of burrs which would prevent solid seating of the parts when tightened;
- (iii) The thickness of the material is not greater than the hole diameter;
- (iv) The maximum thickness for all steel grades used from the standards listed in Table A of The National Structural Steelwork Specification for Building Construction, published by The British Constructional Steelwork Association Limited.

12 mm for sub-grade A

16 mm for sub-grade B

20 mm for sub-grade C or higher sub-grade;
- (v) In spliced connections when the holes in mating surfaces are punched in the same direction.

4.6.4 Punching and Reaming

Punching is permitted without the conditions in clause 4.6.3, provided that the holes are punched at least 2 mm less in diameter than the required size and the hole is reamed to the full diameter after assembly.

4.6.5 Slotted Holes

Slotted holes shall be made by one of the following methods:

- (i) Punched in one operation
- (ii) Formed by drilling two holes and completed by cutting
- (iii) Machine operated flame cutting.

4.7 ASSEMBLY

All components shall be assembled within tolerances specified in Section 7 and in a manner such that they are not bent, twisted or otherwise damaged.

Drifting of holes to align the components shall be permitted, but must not cause damage or distortion to the final assembly (see clause 6.2.2).

4.8 CURVING AND STRAIGHTENING

Curving or straightening components during fabrication, shall be performed by one of the following methods:

- (i) Mechanical means, taking care to minimise indentations, or change of cross-section;
- (ii) The local application of heat, ensuring that the temperature of the metal is carefully controlled, and does not exceed 650°C;
- (iii) The induction bending process where the procedure used includes careful temperature control;
- (iv) After curving or straightening, welds within the area of curving or straightening shall be visually inspected. Welds which are to be subject to non destructive examination shall have these tests carried out after curving or straightening.

4.9 INSPECTION

Sufficient components shall be checked for dimensional accuracy and conformity to drawing, to prove that the manufacturing process is working satisfactorily.

4.10 STORAGE

4.10.1 Stacking

Fabricated components which are stored prior to being transported or erected shall be stacked clear of the ground, and arranged if possible so that water cannot accumulate. They shall be kept clean and supported in such a manner as to avoid permanent distortion and damage to protective coatings.

4.10.2 Visible Markings

Individual components shall be stacked and marked in such a way as to ensure that they can be identified.

WORKMANSHIP - WELDING

5.1 GENERAL

Welding shall be a metal arc process in accordance with BS 5135 and BS 4570, as appropriate, together with other clauses contained in this section, unless otherwise specifically permitted by the Engineer.

Welding consumables used shall be chosen to ensure that the mechanical properties of the weld metal are not less than those required for the parent metal.

Joints shall be prepared in accordance with BS 5135. Precautions shall be taken to ensure cleanliness of the connection prior to welding.

5.2 WELDER QUALIFICATION

5.2.1 Testing

Welders shall be tested to meet the requirements of BS EN 287 Part 1 but, in the case of welders engaged on fillet welding only, BS 4872 Part 1 is an acceptable alternative.

As an alternative, when permitted by the Employer, welders may be tested to meet the requirements of the American Society of Mechanical Engineers, ASME IX, or the American Welding Society, AWS D1.1.

5.2.2 Certification

Welder testing shall be witnessed and certificates endorsed by an independent Inspection Authority.

The certification shall remain valid providing it complies with the conditions for re-approval of certification specified in BS EN 287 Part 1.

5.3 WELDING PROCEDURES

5.3.1 Preparation of Procedures

Approved written welding procedures shall be available in accordance with BS 5135, and tested in accordance with BS EN 288 Part 3 by the Steelwork Contractor.

5.3.2 Approval of Procedures and Procedure Tests

Procedures and tests shall be approved by an independent Inspection Authority.

5.3.3 Availability of Welding Procedure Sheets

Welding Procedure sheets shall be made available to the welder prior to the commencement of the work and shall be available to the Engineer and Inspection Authority on request.

5.4 ASSEMBLY

5.4.1 Fit-up

Joints shall be fitted up to the dimensional accuracy required by the welding procedure, depending on the process to be used, to ensure that the quality in Table 2 is achieved.

5.4.2 Jigs

Fabrications assembled in jigs may be completely welded in the jig, or may be removed from the jig after tack welding.

5.4.3 Tack Welds

- (i) Tack welds shall be made using the same procedures as for the root runs of main welds. The length of the tack shall be the lesser of 4 times the thickness of the thicker part or 50 mm, unless demonstrated by a weld procedure qualification.
- (ii) Tack welds which are not defective may be incorporated into main welds provided that the welder is qualified as in clause 5.2. However, where joints are welded using an automatic or mechanised process, the suitability of the tack weld used for incorporation into automatic processes shall be demonstrated in the weld procedure qualification.
- (iii) Where tack welds are made in circumstances other than those identified above, they must be removed.

5.4.4 Distortion Control

The sequence of welding a joint or a sequence of joints shall be such that distortion is minimised (see Section 7).

5.4.5 Fabrication or Erection Attachments

Welding of attachments required for fabrication or erection purposes shall be made in accordance with the requirements for a permanent weld.

When removal is necessary, they shall be flame cut or gouged at a point not less than 3 mm from the surface of the parent material. The residual material shall be ground flush and the affected area visually inspected. When thicknesses are greater than 20 mm it shall also be checked by magnetic particle inspection. Acceptance criteria are as set out in Table 2 of the National Structural Steelwork Specification for Building Construction, published by the British Constructional Steelwork Association Ltd, in association with The Steel Construction Institute. Attachments shall not be removed by hammering.

5.4.6 Extension Pieces

Where the profile of a weld is maintained to the free end of a run by the use of extension pieces they shall be of material of a similar composition, but not necessarily the same grade, as the component. They shall be arranged so as to provide continuity of preparation and shall be removed after completion of the weld and the surface ground smooth.

5.4.7 Production Test Plates

Where production test plates are required for testing purposes (see clause 1.4 (iii)), they shall be clamped in line with the joint. The grade of material and rolling direction shall match the parent plate, but need not be cut from the same plates or cast.

5.5 NON-DESTRUCTIVE TESTING OF WELDS

5.5.1 Record of Testing

The test results shall be recorded and be available for inspection by the Engineer.

5.5.2 Visual Inspection of Welds

- (i) Visual inspection shall be made in accordance with guidance given in BS 5289 over the full length of the weld and before NDT inspection is performed - see Tables 1 and 2 of the National Structural Steelwork Specification for Building Construction published by The British Constructional Steelwork Association Limited.

Any welds which will be rendered inaccessible by subsequent work shall be examined in accordance with Tables 1 and 2 of the National Structural Steelwork Specification for Building Construction published by The British Constructional Steelwork Association Limited, prior to loss of access.

- (ii) A suitably qualified person for visual inspection of welds may be a welding inspector or a welder who can provide evidence of having been trained and assessed for competence in visual inspection of the relevant types of welds.

5.5.3 Surface Flaw Detection

- (i) Where a closer examination of a weld surface is required in accordance with Table 1 of the National Structural Steelwork Specification for Building Construction published by The British Constructional Steelwork Association Limited, magnetic particle inspection (MPI) shall be used in accordance with the recommendations given in BS 6072.

If magnetic particle inspection equipment is not available, dye penetrant inspection (MPI) may be used in accordance with the recommendations given in BS 6443.

Final surface flaw detection of a welded joint shall be carried out not less than 16 hours from the time of completion of the weld to be inspected, or not less than 40 hours in the case of welds to Design Grade 55 material.

Note: Where a welding procedure requires an inspection after initial weld runs before further welding is performed, such inspections may be carried out when the weld metal has cooled to ambient temperature.

- (ii) A suitably qualified person for surface flaw detection of welds may be a welding inspector or a welder who holds a current certificate of competence in surface flaw detection of the relevant types of work, from a nationally recognised authority.

5.5.4 Ultrasonic Examination

- (i) Where ultrasonic examination is required in accordance with Tables 1 and 2 of the National Structural Steelwork Specification for Building Construction published by The British Constructional Steelwork Association Limited it shall be made in accordance with BS 3923 Part 1, Level 2B. Examination shall be carried out not less than 16 hours from the time of completion of the weld to be inspected, or not less than 40 hours in the case of butt welds thicker than 40 mm or any welds to Design Grade 55 material.
- (ii) Operators carrying out final ultrasonic examination of the weld shall hold a current certificate of competence from a nationally recognised authority.

5.5.5 Scope of Inspection

The scope of inspection shall be in accordance with Table 1 of the National Structural Steelwork Specification for Building Construction published by The British Constructional Steelwork Association Limited

5.5.6 Acceptance Criteria and Corrective Action

Acceptance criteria, corrective action and re-testing shall be in accordance with Table 2 of the National Structural Steelwork Specification for Building Construction, published by the British Constructional Steelwork Association Ltd, in association with The Steel Construction Institute for components subject to static loading.

Note The acceptance criteria shown in Table 2 are not intended to apply to bridges, offshore structures, or other dynamically loaded structures.

5.6 SHEAR STUD WELDING

5.6.1 Method

Shear studs shall be welded in accordance with the manufacturer's recommendations for materials, procedures and equipment.

5.6.2 Trial Welding

- (i) When specified by the Engineer and before production welding of studs commences, procedure trials shall be carried out the trials shall be made on samples of material and studs representative of those to be used in the work. The samples of materials and studs shall be agreed with the Engineer.
- (ii) Where primers are to be applied to the work prior to the welding of studs they shall be applied to the sample material before the procedure trials are made.

5.6.3 Tests and Inspection

- (i) All studs are to be visually inspected. They shall show a full 360⁰ collar.
- (ii) At locations agreed with the Engineer a minimum of 5% of studs which have satisfied the visual inspection shall have a bend test. The bend test shall be made by striking the head of the stud with a 6 kg hammer until it is displaced laterally a distance of about one quarter of the height of the stud.

The stud weld shall not show any signs of cracking or lack of fusion.

- (iii) Studs subjected to the bend test shall not be straightened.

5.6.4 Defective Studs

Studs with defective welding shall be removed in the manner described in clause 5.4.5, and replaced and re-tested as in clause 5.6.3.

WORKMANSHIP - BOLTING

6.1 ORDINARY BOLTED ASSEMBLIES

6.1.1 Bolt/Nut Combinations

The combinations of bolts and nuts shall be not less than the following:

- 4.6 Bolts with grade 4 nuts (BS 4190)
- 8.8 Bolts with grade 8 nuts (BS 3692)
- 10.9 Bolts with grade 12 nuts (BS 3692)

Any bolt assemblies which seize when being tightened shall be replaced.

6.1.2 Differing Bolt Grades

Different bolt grades of the same diameter shall not be used in the same structure, except when agreed otherwise by the Engineer.

6.1.3 Bolt Length

The bolt length shall be chosen such that, after tightening, at least one thread plus the thread run-out will be clear between the nut and the unthreaded shank of the bolt and at least one clear thread shall show above the nut.

6.1.4 Washers

- (i) When the members being connected have a finished surface protective treatment which may be damaged by the nut or bolt head being rotated, a washer shall be placed under the rotating part.
- (ii) A suitable plate, or heavy duty, washer shall be used under the head and nut when bolts are used to assemble components with oversize or slotted holes.

6.1.5 Taper Washers

When the bolt head or nut is in contact with a surface which is inclined at more than 3° from a plane at right angles to the bolt axis, a taper washer shall be placed to achieve satisfactory bearing.

6.1.6 Galvanized Nuts

Nuts shall be checked after being galvanized for free running on the bolt and re-tapped if necessary to ensure a satisfactory tightening performance.

6.1.7 Bolt Tightening

Bolts may be assembled using power tools or shall be fully tightened by hand using appropriate spanners in accordance with BS 2583.

6.1.8 Fitted Bolts

Precision bolts to BS 3692 may be used as fitted bolts when holes are drilled or reamed after assembly so that the clearance in the hole is not more than 0.3 mm.

6.2 FIT-UP WHEN USING ORDINARY BOLTS

6.2.1 Fit-up

Connected parts shall be firmly drawn together. If there is a remaining gap which may affect the integrity of the joint, it shall be taken apart and a pack inserted.

6.2.2 Reaming

Where parts cannot be brought together by drifting without distorting the steelwork, rectification may be made by reaming, provided the design of the connection will allow the use of larger diameter holes and bolts.

6.3 HIGH STRENGTH FRICTION GRIP ASSEMBLIES

6.3.1 Bolt/Nut/Washer Combinations

BS 4395 Parts 1 or 2, as appropriate.

6.3.2 Tightening

The use of friction grip bolts shall comply with BS 4604. Part 1 or 2.

Tightening which complies with BS 4604 Part 1, may be by the torque control method, part-turn method, or with load indicating devices used in accordance with the manufacturer's recommendations.

6.3.4 Calibration of Torque Equipment

Torque spanners and other devices shall have a calibration check at least once per shift, and shall be re-calibrated where necessary in accordance with BS 4604.

6.3.5 Discarded Bolt Assemblies

If, after complete tightening, a bolt or nut has to be slackened off, the whole bolt assembly is to be scrapped.

6.4 FIT-UP WHEN USING HSFG BOLTS

6.4.1 Fit-up

Connected parts shall be firmly drawn together with all bolts partially tightened. The joint shall then be examined and if there is any remaining gap which may affect the integrity of the joint, it shall be taken apart and a pack inserted before recommencing the tightening procedure.

6.4.2 Reaming

- (i) Where parts cannot be brought together by drifting without distorting the steelwork, rectification can be made by reaming, provided that the design of the connection will allow the use of larger diameter bolts.
- (ii) Calculations shall be made to demonstrate that the connection remains adequate for the forces in the connection.

WORKMANSHIP - ACCURACY OF FABRICATION

7.0 ACCURACY OF FABRICATION

- 7.1.1** Accuracy of fabrication shall comply with the requirements of the National Structural Steelwork Specification for Building Construction, published by the British Constructional Steelwork Association Ltd, in association with The Steel Construction Institute.

WORKMANSHIP - ERECTION

8.1 GENERAL

8.1.1 Erection Method Statement

The Steelwork Contractor shall prepare a written method statement taking account of the information provided by the Engineer on design, erection and programme described in clauses 1.3, 1.5 and 1.6 respectively. The Steelwork Contractor shall submit the method statement to the Engineer for acceptance at least two weeks before erection commences.

The method statement shall comply with current health and safety requirements.

Erection shall not commence before the method statement has been accepted by the Engineer and the Project Supervisor for the Construction Stage.

8.1.2 Meaning of Acceptance

Acceptance by the Engineer of the Erection Statement means that the Engineer's design concept for safe erection has not been invalidated.

8.1.3 Provision of Setting-Out Lines by the Main Contractor

The Main Contractor shall provide and maintain until the steelwork is accepted, setting-out lines and datum levels within, or immediately adjacent to, the Works.

8.1.4 Handling and Storage

Components shall be handled and stored in such a manner as to minimise the risk of surface abrasion and damage. Fasteners and small fittings shall be stored under cover in dry conditions.

8.1.5 Damaged Steelwork

Any steelwork damaged during off-loading, transportation, storage or erection shall be restored to conform to the standards of manufacture as given in this Specification.

8.1.6 Column Baseplates and Slabs

- (i) Steel packings shall be supplied to allow the structure to be properly lined and levelled and of sufficient size to avoid local crushing of the concrete.
- (ii) Base packings shall be placed so that they do not prevent subsequent grouting to completely fill all spaces directly under the base plates.
- (iii) Base packs may be left permanently in place.

8.1.7 Grouting

- (i) Grouting shall not be carried out under column base plates until a sufficient portion of the structure has been aligned, levelled, plumbed and adequately braced.
- (ii) Immediately before grouting, the space under column base plates shall be clean and free of all extraneous matter.

8.2 SITE CONDITIONS

8.2.1 Main Contractor

Main Contractor shall:

- (i) Maintain the working surfaces of the Site free from standing water and remove water from foundations;
- (ii) Provide a firm, properly graded, working area and storage area; also maintain adequate access roads, into and through the site, for the safe delivery of plant and materials on normal road vehicles;
- (iii) Inform the Steelwork Contractor of the position of any underground services which may be considered liable to damage by the Steelwork Contractor's plant;
- (iv) Be responsible for removing overhead obstructions.

8.2.2 Steelwork Contractor's Responsibility

The Steelwork Contractor shall:

- (i) Ensure that the load spread under cranes and lifting plant is commensurate with the strength of firm standing provided by the Employer.

8.3 SAFETY

8.3.1 Responsibilities - All Parties

The initial planning, design, site management and procedures adopted for safe erection of the structure shall be in accordance with:

- (i) The recommendations given in BS 5531
- (ii) The requirements of current health and safety legislation
- (iii) The risk analysis
- (iv) The safety plan

8.3.2 Steelwork Contractor's Responsibility

The Steelwork Contractor shall:

- (i) Ensure that his operations comply with the Main Contractors rules for operating on site;
- (ii) Provide, install and maintain such safe systems of work to discharge properly his obligations in respect of current health and safety legislation.
- (iii) Comply with the requirements of the Project Supervisor for the Construction Stage.

8.4 STABILITY

8.4.1 Temporary Restraints until Permanent Features are Built

- (i) The Engineer shall advise the Steelwork Contractor of positions on the structure where temporary bracing or restraints are necessary until walls, floors or other non-steel structures are built. He shall also provide details of the forces and moments in these elements.
- (ii) The Steelwork Contractor shall design and provide the temporary bracing or restraints.

8.4.2 Other Temporary Restraints used by Steelwork Contractor

If the Steelwork Contractor uses temporary restraints during erection which do not substitute for permanent features, they may be removed after the structure has been lined, levelled and plumbed provided that sufficient steelwork and/or permanent bracing has been erected to ensure the stability of the structure under the worst expected conditions of dead, imposed and wind loading.

8.5 ERECTION LOADS

- (i) The Steelwork Contractor shall ensure that no part of the structure is permanently distorted by stacking of materials or temporary erection loads during the erection process
- (ii) The Main Contractor shall ensure that no other Contractor shall place loads on the partly erected structure without the permission of the Steelwork Contractor.

8.6 LINING AND LEVELLING

8.6.1 Alignment of Part of the Structure

Each part of the structure shall be aligned as soon as practicable after it has been erected. Permanent connections shall not be made between members until sufficient of the structure has been aligned, levelled, plumbed and temporarily connected to ensure that members will not be displaced during subsequent erection or alignment of the remainder of the structure.

8.6.2 Temperature Effects

Due account shall be taken of the effects of temperature on the structure and on tapes and instruments when measurements are made for setting out, during erection, and for subsequent dimensional checks. The reference temperature shall be 20°C.

8.7 SITE WELDING

Site welding shall be carried out in accordance with Section 5.

Welding shall not be permitted during inclement weather, unless adequate protective measures are taken.

8.8 SITE BOLTING

Bolting shall be carried out in accordance with Section 6.

8.9 CERTIFICATION OF COMPLETION

When the steelwork, or portion of the steelwork, has been completed, the Steelwork Contractor shall present a certificate for the Main Contractor and the Steelwork Contractor to sign.

The completion of the certificate means the following:

- (i) The Steelwork Contractor's signature signifies that an inspection has been made to ensure that all connections are completed and that the steelwork is erected in accordance with this Specification and contract requirements.
- (ii) The Main Contractor's signature signifies acceptance that the structure, or part of the structure, has been built in accordance with this specification and the contract requirements.

WORKMANSHIP - ACCURACY OF ERECTED STEELWORK

9.1 FOUNDATIONS

The Steelwork Contractor shall inspect the prepared foundations and holding down bolts for position and level not less than seven days before erection of steelwork starts. He shall then inform the Engineer if he finds any discrepancies which are outside the deviations specified in clause 9.4 of the National Structural Steelwork Specification for Building Construction requesting that remedial work be carried out before erection commences.

9.2 STEELWORK

Permitted maximum deviations in erected steelwork shall be as specified in clause 9.5 of the National Structural Steelwork Specification for Building Construction taking account of the following:

- (i) All measurements be taken in calm weather, and due note is to be taken of temperature effects on the structure (see clause 8.6.2).
- (ii) The deviations shown for I sections apply also to box and tubular sections.
- (iii) Where deviations are shown relative to nominal centrelines of the section, the permitted deviation on cross-section and straightness, given in Section 7, may be added.

9.3 INFORMATION FOR OTHER CONTRACTORS

The Steelwork Contractor shall advise Contractors engaged in operations following steel erection of the deviations acceptable in this document in fabrication and erection, so that they can provide the necessary clearances and adjustments.

