



PAKISTAN NUCLEAR REGULATORY AUTHORITY

Off Shore Marker Piles

Construction of Marker Piles and Navigational Aids
at Karachi Nuclear Power Plant

TENDER DOCUMENTS

Volume-3
(Rev-B)

Specification

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at Karachi Nuclear Power Plant*

Volume - III

CONTENTS

SECTION 1 -	GENERAL
SECTION 2 –	MATERIALS AND WORKMANSHIP, GENERALLY
SECTION 3 -	SITE CLEARANCE AND DEMOLITION
SECTION 11 -	STRUCTURAL STEELWORK
SECTION 12 -	DRIVEN PILING
SECTION 15 -	FENDERS, BOLLARDS, QUAY FURNITURE
SECTION 19 -	NAVIGATION AIDS
SECTION 31 -	METALWORK
SECTION 35 -	PROTECTIVE COATINGS

CONTENTS

SECTION 1 - GENERAL

1.001	Location of the Works
1.002	General Description of the Works
1.003	Ground Investigations and Design Criteria
1.004	Temperature
1.005	Humidity
1.006	Rainfall
1.007	Winds
1.008	Waves
1.009	Tides
1.010	Currents
1.011	Existing Conditions
1.012	Setting-out Grid
1.013	Level Datum
1.014	Topographic Survey
1.015	Condition Survey
1.016	Hydrographic Survey
1.017	Movement Monitoring
1.018	Interference with Other Operations
1.019	Agreement of Engineer to Important Operations
1.020	Notice for Checking by Engineer
1.021	Loads on Existing Structures
1.022	Responsibility Unaffected by Examination by Engineer
1.023	Progress Meetings
1.024	Attendance upon Trades
1.025	Setting-out of Works
1.026	Existing Services
1.027	Existing Obstructions
1.028	Silting of Works during Construction
1.029	Project Signs
1.030	Fencing, Hoardings, Watching & Lighting
1.031	Traffic Safety & Control on Site
1.032	Approvals
1.033	Floating Equipment
1.034	Navigation
1.035	Reconfirmation of Marine Operations
1.036	Mooring, Buoys, Lights etc.
1.037	Night-time Markings and Lights
1.038	Removal of Wrecks and Sunken Equipment
1.039	Radio Link with Port Authority, Contractor's Radio Equipment
1.040	Security Passes
1.041	Visitors
1.042	Cleaning and Clearing of Roadways and Footpaths
1.043	Noise Control
1.044	Debris
1.045	Health and Safety, Generally

1.046	First Aid Facilities
1.047	Life Saving Apparatus
1.048	Diving
1.049	Use of Explosives
1.050	Quarries, Borrow Pits and Haul Roads
1.051	Office Accommodation
1.052	Furniture, Fittings, Other Equipment
1.053	Materials Testing Laboratory
1.054	Motor Vehicles
1.055	Boat
1.056	Survey Craft
1.057	Diving Pontoon
1.058	Provision of Equipment
1.059	Protective Clothing
1.060	Air Bottles
1.061	General
1.062	Setting-out and Survey Staff and Small Equipment
1.063	Materials Testing Staff and Transport
1.064	Vehicle Drivers
1.065	Boat Crew
1.066	Diving Assistance
1.067	Working Area(s) and Access
1.068	Contractor's Office, Stores, Workshops, etc.
1.069	Staff Quarters and Labour Camp
1.070	Services for Contractor's Use
1.071	Records
1.072	Progress Photographs
1.073	Progress Reports
1.074	Returns of Labour and Equipment
1.075	Submission of Information and Records
1.076	As-made Drawings
1.077	Nominated Subcontract Enquiries
1.078	Tender Drawings
1.079	Construction Drawings
1.080	Interpretation of Drawings
1.081	Contractor's Designs
1.082	Contractor's Working Drawings
1.083	Alternative Design Proposals
1.084	Standards and Codes of Practice
1.085	Marine Structures
1.086	Final Surface of any Work
1.087	Tidal and Underwater Work

SECTION 1 - GENERAL

Description of the Works

1.001 Location of the Works

The Works are located at Karachi Nuclear Power Plant on the Sindh coast of Pakistan about 5 kilometers west of Karachi. The location of the Permanent Works extends from in the vicinity of KNPP, covering an area up to 1100 m into the sea to a depth of over 9.0 m chart datum.

1.002 General Description of the Works

The Works to be delivered by the Contractor shall include but not to be limited to:

- The construction of marker piles towers and
- Navigational aids.

Existing Site Information

1.003 Ground Investigations and Design Criteria

Ground investigations in the vicinity of the proposed works were undertaken in 2012-2014. No guarantee is given of the adequacy of the information and the Contractor shall be responsible for making his own interpretation of the information provided.

1.004 Temperature

The temperature data complied as given below;

Month	Karachi					
	Mean Daily		Mean Monthly		Extreme Value	
	Max	Min	Max	Min	Max	Min
January	24.2	14.1	27.6	10.5	30.0	6.1
February	24.9	16.1	28.9	11.4	32.2	6.1
March	27.7	20.1	32.7	15.6	37.2	12.2
April	29.7	23.4	34.2	19.9	40.0	17.2
May	31.4	26.1	35.7	20.9	42.8	21.7
June	32.4	27.9	34.9	26.1	40.6	22.8
July	31.4	27.3	33.6	24.9	36.7	21.7
August	29.9	25.8	31.8	23.8	35.0	21.1
September	29.8	24.8	32.8	22.9	38.3	18.3
October	30.7	23.2	35.7	20.9	40.0	17.2
November	29.6	19.4	33.2	16.0	36.7	11.1
December	25.9	15.6	29.2	12.0	30.6	8.3

1.005 Humidity

Humidity ranges between 80-90% in the morning and 70-80% in the evenings in the months from April though to October.

1.006 Rainfall

From recorded observations in the region, the average annual rainfall is 200mm, occurring primarily during the south-west monsoon. The maximum rainfall recorded during a 24 hour period was 278mm in August 1953. The number of rainy days in a year ranges from 15-20.

1.007 Winds

Except in the winter months between November and March when the most common and strongest winds come from the north east, the predominant wind direction is from south west to west. From May to September the wind blows almost exclusively from that sector.

Wind Direction

Month	No of days with wind force				Percentage no of days of wind from									Mean wind speed k.p.h.
	8 or more	4-7	1-3	0	N	NE	E	SE	S	SW	W	NW	Calm	
January	0	2	28	1	28	33	10	2	2	4	8	12	1	10.0
February	0	3	23	2	25	26	9	2	1	17	14	17	1	10.9
March	0	3	27	1	12	6	2	0	2	17	39	20	0	13.2
April	0	4	26	0	4	2	1	0	1	30	50	10	0	15.6
May	0	15	16	0	1	1	0	1	3	38	51	5	0	18.7
June	0	19	11	0	1	1	1	1	2	44	47	3	0	20.5
July	0	21	10	0	1	0	0	0	2	41	50	6	0	20.6
August	0	18	13	0	0	0	0	0	1	39	55	4	0	19.2
September	0	7	23	0	2	1	0	0	1	32	58	6	0	16.1
October	0	2	28	1	15	11	3	0	2	18	34	18	0	10.6
November	0	2	26	2	33	26	7	2	3	6	9	15	0	8.5
December	0	2	29	0	33	39	7	1	2	5	5	9	0	9.5

The strongest winds occur between May and September. In June in Karachi, squalls are common in which winds of force 6 (approx. 25 knots) or more can occur. These squalls are usually accompanied by thunderstorms or dust storms, or both. Winds exceeding force 8 (40 knots) have been recorded for short periods in all seasons, generally in directions from west through north to east. However wind speeds seldom exceed 20 knots even during the south-west monsoon.

Wind Speed

Sector	Highest Monthly Average Wind Speed (Knots)
337.5° to 22.5°	11 to 16
22.5° to 67.5°	11 to 16
67.5° to 112.5°	01 to 10
112.5° to 157.5°	01 to 10
157.5° to 202.5°	01 to 10
202.5° to 247.5°	01 to 10
247.5° to 292.5°	17 to 21
292.5° to 337.5°	11 to 16

There is about one cyclonic storm per year in the Arabian Sea and these have occasionally crossed the coast close to Karachi. These cyclones can cause winds of at least force 10 (approx. 50 knots) from any direction, but winds of this strength would be unlikely to occur more often than once every 10 years. The highest wind speed that has been recorded in the Karachi area is 70 knots which occurred on 29th June, 1936.

1.008 Waves

The predicted significant wave height (Hs) for a return period of 1 year at the fairway buoy during the south-west monsoon are given below:-

Month	Hs (m)
April	2.2
May	2.3
June	3.9
July	3.9
August	3.1
September	2.7

Outside the period of the south-west monsoon and within the inner channel to the port the predicted wave climates are significantly less.

1.009 Tides

Tidal level referred to Datum of Soundings

Abbreviation	Name	Level to Port Datum (m)
HAT	Highest Astronomical Tide	+3.40
MHHW	Mean Higher High Water	+2.81
MLHW	Mean Lower High Water	+2.20
MSL	Mean Sea Level	+1.67
MHLW	Mean Higher Low Water	+1.15
MLLW	Mean Lower Low Water	+0.54
LAT	Lowest Astronomical Tide	-0.37

Source: Pakistan Tide Tables

Actual water levels have been recorded for many years at the tide gauge at Manora. Extreme values, taken at Karachi Port are as follows;

June 1902	Highest tidal water level during cyclonic storm	+4.4 m
23 rd May 1959	Highest high water springs near solstices	+3.7 m
25 th December 1953	Lowest low water springs near solstices	-0.7 m

A tide gauge and bench mark has been established at Karachi Nuclear Power Plant. There are other Survey of Pakistan bench marks within the boundary of Kanupp. The Bench mark "BP-1-KN-12" is located at the boat yard. The value is;

Latitude: 24 50 43.93796 N
Longitude: 66 47 02.54126 E
Height : 11.6965 m above mean sea level.

1.010 Currents

The velocity of the current during the northeast monsoon is insignificant both in the coastal area, as well as in the open sea, and only seldom exceeds 0.51m/s (about 1 knot). Compared with this, the current velocity during the southwest monsoon attains forces of up to 1m/s (2 knots), though only outside the limited Pakistan coastal area.

1.011 Existing Conditions

The Contractor shall be deemed to have fully inspected the existing site before submitting his Tender in order to satisfy himself with regard to the extent and nature of the works and shall further be deemed to have included in his rates and prices for accommodating same.

Surveys

1.012 Setting-out Grid

The Contractor shall at the commencement of the Works establish additional fixed survey stations which will be used for setting out the Works. The survey stations shall be constructed in suitable positions and in such a manner that they are not disturbed during the construction of the Works.

1.013 Level Datum

The level datum for the Works shall be Chart Datum. The Engineer will indicate to the Contractor a bench mark located at the Boat House and their levels relative to chart Datum. The Contractor shall establish bench marks for the construction of the Works.

1.014 Topographic Survey

Before commencing the Works the Contractor shall carry out a topographic survey of the specific areas of the Site, in which the position and level of all existing features shall be accurately measured.

1.015 Condition Survey

Before commencing the Works the Contractor shall undertake jointly with the Engineer a condition survey of the existing structures and installations which are affected by the Works, and shall prepare a report which shall constitute an agreed written and photographic record of the condition of these structures and installations.

The agreed record shall be signed by the Contractor and the Engineer and a copy given to the Engineer.

1.016 Hydrographic Survey

Before commencing marine construction Works in any area, the Contractor shall

undertake a hydrographic survey jointly with the Engineer. The survey shall cover the area occupied by the Works and extend for a distance of 10m beyond the area occupied by the Works. The survey shall be plotted to a scale of 1:500. The drawing(s) shall be signed by the Contractor and the Engineer. A copy of the survey drawing(s) shall be given to the Engineer together with a reproducible negative.

1.017 Movement Monitoring

The Contractor shall monitor the movement of structures during construction and commissioning by measurements taken at survey points to be established by the Contractor at locations agreed with the Engineer.

Conduct of the Works

1.018 Interference with Other Operations

The Works shall be conducted throughout the period of construction so as not to interfere with third party traffic or the use of the port facilities in the vicinity of the Site.

The Contractor shall programme the Works so as to cause minimum interference and disruption to other parties with approved access to Contractor's working areas, or rights of way on the Site or in its approaches, and shall make due allowance for the work of other contractors working on or near the Site.

The Contractor shall programme the Works so as to ensure that the temporary or permanent removal, obstruction, obscuring, relocation or modification of existing navigation aids does not compromise the safety of the existing channel for navigation.

The Contractor shall:

- (a) Construct temporary diversions where Works activities interfere with the existing foot or road traffic. Diversions shall be to the approval of the Engineer and concerned authorities, and shall have a capacity not less than that of the routes which they replace. They shall be constructed in advance of likely interference and shall be maintained
- (b) Make available for operational use or for construction by others, parts of the Works which are not completed. Such use shall not relieve the Contractor of any duties or obligations under the Contract, including responsibilities for the safety of the Works and the public. The Employer will reimburse the Contractor for any proven additional costs incurred as a direct consequence of complying with this requirement

The Contractor shall so far as is reasonably practical undertake the Works in such a manner that his operations and plant, including floating plant, are undertaken without encroaching on the existing facilities.

1.019 Agreement of Engineer to Important Operations

Notwithstanding the submission by the Contractor and agreement by the Engineer of any Programme, no important operation shall be carried out without the written consent of the Engineer.

1.020 Notice for Checking by Engineer

The Contractor shall give the Engineer sufficient notice in advance of the time of any proposed operation (not less than 24 hours) to enable the Engineer to make such necessary arrangements for checking and supervision. The Contractor shall only request inspections when works have been completed and the Contractor is satisfied that those works are satisfactory and ready for inspection.

1.021 Loads on Existing Structures

The Contractor shall be responsible for assessing the existing strength of the existing structures and their capacity to carry the loads imposed by Contractor's Equipment. Any damage to these structures due to the use of the Contractor's Equipment shall be rectified by the Contractor.

1.022 Responsibility Unaffected by Examination by Engineer

The examination by the Engineer of any part of the Works or of any document or sample submitted by the Contractor shall not relieve the Contractor of any responsibilities or liabilities.

1.023 Progress Meetings

Progress meetings will be convened by the Engineer at both weekly and monthly intervals and at other times as appropriate. The purpose of the meetings will be to review the progress of the Works, to discuss the Contractor's programme and to cover such other matters under the Contract as may be specified or notified by either the Engineer or the Contractor. Such meetings shall be attended by an authorised senior representative of the Contractor.

The agenda and minutes of each meeting will be prepared by the Engineer with a copy to the Contractor. The Contractor shall record agreement of the minutes, either by signing them or by minuted oral agreement at the following meeting.

1.024 Attendance upon Trades

Each trade shall provide for, and make good as necessary, for all other trades so that each section of the work is carried out in its correct sequence and completed in accordance with the Specification.

1.025 Setting-out of Works

The Contractor shall give the Engineer reasonable notice of any intention to set out or take levels for any part of the Works so that arrangements may be made, if required, for monitoring the work. The accuracy of setting out and levelling shall be within the tolerances specified in the Specification, or as agreed with the Engineer.

1.026 Existing Services

The Contractor shall be responsible for locating existing services within the Works and for protecting them during the progress of the Works.

Where appropriate, the Contractor shall open up the ground in advance of the main work, by hand digging if necessary, to locate precisely the position and details of the services which are likely to affect its operations.

The Contractor shall be responsible for arranging any necessary temporary diversions, supports and protection from interruptions of services. The Contractor shall carry out these temporary works as directed and to the satisfaction of the appropriate authority and the Engineer.

All diversions shall be reinstated, and all temporary works removed on completion, to the satisfaction of the appropriate authority and the Engineer.

1.027 Existing Obstructions

The Contractor shall note that the Works are in an area where other marine structures may have been constructed and that remnant of these and other obstructions may be present, in or on the seabed. The Contractor shall satisfy himself as to the nature and extent of any obstructions and shall be responsible for taking any necessary measures to deal with any obstructions which may affect the Works. Such measures shall include the provision of buoys and lights and all things necessary for the safety while the obstruction remains. The Contractor shall remove any such obstruction at the earliest possible time [all at his own expense].

1.028 Silting of Works during Construction

The Contractor shall ascertain the propensity of the site for inundation by silt or debris of any sort during construction, whether from the Contractor's activities, the activities by others or as a result of natural conditions. The Contractor will be responsible for removing silt and debris from the Works to meet the requirements of this Specification and the Engineer, and to enable the completed Works to fulfill their required function(s).

1.029 Project Signs

The Contractor may provide a sign or signs on site stating the project and the names of Contractor, Employer and Engineer. The sign(s) is subject to approval by the Engineer and Employer.

1.030 Fencing, Hoardings, Watching & Lighting

The Contractor shall provide and maintain continuous fencing or hoardings around the areas of work, storage, offices, etc., and all necessary watching and lighting. The Contractor shall be required to have at least one watchman at each main area of work at all times when work is not in progress.

For work at night the Contractor shall arrange adequate lighting at each area of operation with adequate standby in case of failure. The Contractor shall satisfy

the relevant authorities that such lighting will not constitute a hazard to traffic by land, sea or air in the areas adjacent to the Site.

1.031 Traffic Safety & Control on Site

The Contractor shall provide, erect and maintain such traffic signs, lights, barriers and other measures as may be necessitated on site by the execution of the Works. The measures shall be to the approval of the Engineer and of the relevant authorities.

Marine Operations

1.032 Approvals

The Contractor shall make all arrangements and obtain all necessary approvals for any temporary marine traffic arrangements and control.

At least 14 days before marine works commence, the following shall be submitted to the Engineer:

- a) Evidence that the KANUPP have been notified of the Works.
- b) Licenses, permits etc. to undertake the Works and any related conditions of restrictions.
- c) Approval of temporary traffic control arrangements.

1.033 Floating Equipment

The Contractor shall comply with the regulations and shall obey the orders of relevant authority(ies) in respect of navigation or mooring of floating Equipment and boats in the adjacent waterway/harbour and in the vicinity of the Site, and shall conduct operations in such a manner that they do not interfere with the use of the waterways, anchorages or wharves jetties, causeways, dolphins etc.

Only classified vessels, fully registered and recently surveyed, shall be used on the Works. All craft and floating Equipment shall be manned at all times with adequate crew to be able to effectively deal with normal emergencies.

1.034 Navigation

The Contractor shall conform to any bye-laws and regulations concerning navigation and shall obey the orders of any authorised officer in reference thereto. The Contractor is to submit full details of any operations that may cause any interference to shipping to the Engineer for comment at least 7 days before the event and is to make such modifications as the Engineer may require in order to keep interference to the minimum. Normal movement of craft within the harbour shall be notified to the authorised authorities. All craft shall be fitted with VHF radios.

1.035 Reconfirmation of Marine Operations

Any marine operations to be carried out by the Contractor which involve the suspension of ship movement and which have been agreed with the relevant

authorities are to be reconfirmed with both the Engineer and those authorities seven days before the agreed date.

When the Contractor does not carry out any operation reconfirmed with the Engineer and the relevant authorities, requiring the authorities to suspend shipping movement for the duration of the operation, then the Contractor shall reschedule the operation to the convenience of the authorities.

Any delays arising from rescheduling the operations to the authorities' convenience shall be deemed to be the Contractor's responsibility except where it can be shown that cancellation of the reconfirmed operation was due to circumstances outside the Contractor's control.

1.036 Mooring, Buoys, Lights etc.

The Contractor shall provide such buoys, moorings and fastenings as may be required for securing the Contractor's floating Equipment and craft and also such buoys, warning lights, signs and signals (if any) arising as a consequence of undertaking the Works as the appropriate authorities may direct or as the Engineer may deem necessary to meet the requirements of the authorities.

All moorings shall be agreed by the relevant authorities, and all anchors must be marked by lit buoys.

1.037 Night-time Markings and Lights

The Contractor shall during the execution of the Works provide and maintain every night from sunset to sunrise such light or lights on or near the Works as the appropriate authorities or the Engineer may require.

1.038 Removal of Wrecks and Sunken Equipment

The Contractor shall immediately remove all Equipment and materials and wrecks which have sunk in connection with the execution of the Works from any cause whatsoever. Until the wrecks or sunken Equipment or materials have been removed the Contractor shall set all such buoys and display at night such lights and do all such things for the safety of navigation as may be required by the Engineer or the relevant authorities. In the event of the Contractor failing to carry out these obligations the Employer may arrange buoying and lighting and remove the same, and the Contractor shall refund to the Employer all costs incurred in connection therewith.

1.039 Radio Link with Port Authority, Contractor's Radio Equipment

The Contractor shall maintain a radio-telephone link with the authority. The radio shall be manned at all times during working hours and all radio messages shall be logged.

Radio frequencies used by the Contractor, including those relating to on-board communication equipment, shall be to the approval of any duly constituted authority having jurisdiction. The Contractor shall be responsible for obtaining the necessary licenses and permits.

1.040 Security Passes

The Contractor shall, where necessary, arrange for all employees and subcontractors to have valid security passes and identification cards required for access the site.

1.041 Visitors

The Contractor shall not allow any unauthorized visitors on the Site. Authorised visitors shall sign a Contractor's visitor's book. The Contractor shall provide safety helmets and any other appropriate protective clothing for such visitors.

1.042 Cleaning and Clearing of Roadways and Footpaths

The Contractor shall ensure that existing roadways and footpaths within the vicinity of the Site used by vehicles or Equipment of the Contractor, the Contractor's suppliers or subcontractors, are kept clean and clear of all materials, dirt, soil or debris.

1.043 Noise Control

The Contractor shall follow the general recommendations of BS 5228 to minimize noise and vibration.

1.044 Debris

The Contractor shall not discharge any oil or noxious materials within the Site or into drains, ditches, watercourses or the sea adjoining the Site. The Contractor shall remove from the Site and the adjacent areas any debris arising out of the construction of the Works.

1.045 Health and Safety, Generally

The Contractor shall comply with the health and safety requirements of the Specification and with the health and safety recommendations for building and civil engineering work published by the International Labour Organisation.

1.046 First Aid Facilities

The Contractor shall provide and maintain at each main area of Works, including floating plant, first aid medical facilities for the use of the Contractor's personnel and also those of the Employer and the Engineer.

1.047 Life Saving Apparatus

The Contractor shall provide and maintain at each active marine area of the Works a minimum of three lifebelts, with buoyant lifelines at least 30m long, in easily accessible positions, together with a boat suitable for rescue work fully equipped and ready for immediate use.

1.048 Diving

All diving operations shall be carried out in accordance with accepted international standards of safety eg. "Diving Operations at Work Regulations 1981" (SI 1981 No. 399) issued under the Health and Safety at Work Act of the United Kingdom.

Prior to the start of any proposed diving operations the Contractor shall submit to the Engineer a copy of the diving rules intended for use generally, and also to any hazards peculiar to specific aspects of the Works and to shipping. The Contractor shall also submit to the Engineer a general method statement for diving operations.

The Contractor's diving team shall have, as a minimum requirement, a competent diving supervisor, two qualified divers and a linesman in attendance at all times when underwater works requiring diving are being carried out.

The diving equipment used by the Contractor shall conform to international diving standards.

1.049 Use of Explosives

The storage, handling, transport and use of all explosives for use in connection with the Works shall be the responsibility of the Contractor, and shall be in accordance with the requirements of "Blasting", relevant authorities, the Employer, and with the applicable recommendations in BS5607.

Before using explosives the Contractor shall submit to the Engineer written details of proposed warning and safety precautions for the protection of all persons, works, property and shipping from injury or damage.

Blasting will not normally be permitted within 20 meters of any completed Permanent Works under water or 10 meters on land, and shall be carried out only during the hours of daylight.

1.050 Quarries, Borrow Pits and Haul Roads

The Contractor shall find, prove, establish, operate, maintain and close down on completion of the Works, any quarries or borrow pits provided as a source of construction materials.

The Contractor shall be responsible for ensuring that the materials obtained meet the Specification and are available in sufficient quantities to enable the programme to be met.

Facilities for Engineer's Site Staff

1.051 Office Accommodation

The Contractor shall provide onsite for the *sole* use of the Engineer the following temporary buildings to serve as office accommodation:

1 No air conditioned office, including washrooms, of minimum plan area 40m². See Appendix 1.1.

The design, construction, location and layout of building(s) and surroundings shall be agreed with the Engineer.

The Contractor shall not more than 7 days after the Award of the Contract submit full details to the Engineer, including floor plans, elevations; construction principles and materials, before commencing the erection.

The Contractor shall be responsible for raising the ground (if necessary), grading and drainage in the vicinity of the building(s), with suitable access and walkways. The Contractor shall construct a covered hard-standing to accommodate 2 vehicles adjacent to the office, and an access road to the parking area. The access road shall be high enough in order not to be inundated during heavy rain. Outside lighting shall be installed around the buildings and the parking area, and appropriate signs shall be erected to indicate the purpose of the facilities.

All facilities shall conform to the best standards for the required types. The facilities in shall represent the minimum requirements. The Contractor shall provide all additional incidentals necessary, so that the facilities will be completely adequate and satisfactory in every respect for their intended use. Painting both the exterior and the interior shall be as agreed with the Engineer.

Buildings shall be complete with all services including potable water, electricity and sewerage. Site cabins shall have electricity, chemical toilets and stored water. Each room shall have at least 3 N°. 13 amp sockets. All power shall be 220V, 50Hz, except where otherwise agreed by the Engineer. All rooms shall be adequately illuminated by fluorescent lighting.

Facsimile, internet and PABX telephone services shall be provided in the main office by the Contractor. These shall be in the name of the Contractor who shall pay all user charges, including installation, maintenance and removal. Each office shall be equipped with a telephone connected to the PABX.

Offices and meeting rooms shall be air conditioned. The air conditioning may be either individual units or a central ducted system and shall be adequate to maintain a temperature of not more than 24°C (dry bulb) at a relative humidity of 50% during the hottest season of the year. The noise level of the air conditioning while working should be sufficiently low to allow normal voice level discussions to take place.

At least one room shall be capable of providing at all times environmental conditions suitable for the operation of specified electronic office equipment.

Buildings shall be weatherproof, fire protected, heat-insulated and secure. Windows shall give adequate light and ventilation and be protected with metal mosquito-proof gauze and have security bars and Venetian, or other approved, sun blinds. Ceiling height above the floor level shall be at least 2.75m. All internal partition walls shall be sound insulated. Floors shall be PVC tile covered. In toilets and other washing areas the floors shall have drains to assist cleaning.

All doors shall be fitted with locks, with two keys provided for each lock. Two master keys shall be provided, appropriate to all locks.

Office accommodation shall be provided complete within 14 days of the Commencement Date and shall be equipped and maintained by the Contractor to the satisfaction of the Engineer until 1 month after the effective date of the Taking-Over Certificate for the Works or such earlier time as instructed by the Engineer, whereupon the buildings and furniture shall be removed from the Site.

The Contractor shall provide all labour, materials and equipment for maintaining and cleaning offices, furniture and fittings. The Contractor shall replace and/or restore, as directed, any facilities or parts thereof that become damaged, worn out, lost or stolen. The Contractor shall provide an adequate stock of all expendable items and shall ensure proper and continuing functioning of all components and parts of the facilities.

A full/part time cleaner(s) shall be provided. Containers shall be provided for waste disposal in each office and these shall be emptied and disposed of daily.

Furnishing and fittings shall be to the approval of the Engineer.

1.052 Furniture, Fittings, Other Equipment

The Contractor shall provide for the sole use of the Engineer, the following office furniture, fittings and other equipment.

See Appendix 1.2

1.053 Materials Testing Laboratory

The Contractor shall provide a laboratory for the use of both the Contractor and the Engineer, for the testing of materials on Site in accordance with the Specification, including such additional tests as may be required. It shall be operated by staff provided by the Contractor working under the direction of the Engineer.

The laboratory shall be in a self-contained temporary building at a location agreed with the Engineer. It shall have a plan area sufficient to accommodate all the equipment, materials, functions and test programmes laid down in the Specification and any further testing required by the Contractor to ensure the quality of the Works.

The laboratory shall include, for the exclusive use of the Engineer, an enclosed, air conditioned office of at least 6m² area with soundproof partition walls and an internal lockable door. The office shall be equipped with a telephone and electrical sockets with furnishings and fittings similar to those for the Engineer's office.

The laboratory building shall be to the standards specified for Engineer's offices and to the approval of the Engineer.

The Contractor shall equip the laboratory with sufficient new equipment of the best quality to carry out the laboratory tests as required in the Specification. The tests to be covered and the relevant standards to which they are to be performed are: This list is indicative only. The Contractor shall refer to the Specification for the full scope of tests required.

The laboratory, furnishings and test equipment shall be provided within 28 days of the Commencement Date and shall be maintained by the Contractor to the satisfaction of the Engineer until 1 month after the effective date of the Taking-Over Certificate for the Works or such earlier time as instructed by the Engineer, whereupon the laboratory shall be removed from the Site. The test equipment shall remain the property of the Contractor and shall revert to the Contractor upon the authorised removal of the laboratory, or at such prior time as instructed by the Engineer.

The Contractor shall provide all labour, materials and equipment for the maintenance and cleanliness of the laboratory. Containers shall be provided for waste disposal and these shall be emptied daily.

The Contractor shall be responsible for ensuring that all test equipment is correctly calibrated before it is used for testing, and shall provide evidence of this if required by the Engineer. The Contractor shall in addition arrange periodic calibration checks in accordance with the manufacturer's recommendations, or as stated in the relevant standard or directed by the Engineer.

The laboratory shall incorporate space and facilities for storing and curing of concrete test cubes and other test samples in accordance with the Specification.

The laboratory shall be provided with an adequate number of work benches.

1.054 Motor Vehicles

The Contractor shall provide, within 7 days of the Commencement Date, or at such later time as approved by the Engineer, the following new vehicle for exclusive use by the Engineer.

1 N° four wheel drive air conditioned high clearance type vehicle with a petrol engine of not less than 1600cc.

The vehicles shall be registered in the Contractor's name and shall remain the property of the Contractor for the duration of the Contract, or until such earlier time as ordered by the Engineer.

During the Contract the vehicles shall remain within the custody of the Engineer and they shall be insured, fuelled, repaired, serviced and maintained by the Contractor. If any vehicle is unserviceable for whatever reason, or is stolen, the Contractor may be required to replace it with a similar vehicle for the whole period of un-serviceability or loss. The Contractor shall be responsible for providing all spare parts to keep the vehicles in full safe working order.

Vehicles provided by the Contractor may be used by the Engineer in connection with other works for the Employer.

The Contractor shall obtain all permits to allow the vehicles to enter and leave the port or other restricted areas for the purpose of the Works.

1.055 Boat

The Contractor shall provide for the exclusive use of the Engineer during hours when the Contractor is working, a launch of at least 8m length powered by an inboard engine. It shall be of robust construction and suitable for use in open sea conditions. It shall be licensed (where appropriate), and maintained in good seaworthy condition. It shall have a maximum speed of at least 5 knots but with good slow speed characteristics. The forward part of the boat should have an enclosed area with a chart table and lockable compartment. The aft of the craft shall be open with a canvas awning and be provided with seats along the gunwales for at least [six] passengers, excluding crew.

10.56 Survey Craft

The Contractor shall provide a craft suitable for carrying out hydrographic surveys which shall be made available to the Engineer as required, but will not be for the Engineer's exclusive use. The survey craft shall be equipped with a maintained echo sounder and supply of paper as specified in Section 5.

1.057 Diving Pontoon

The Contractor shall provide a suitable diving pontoon for the use of the Engineer.

The pontoon shall be suitably sized to carry an enclosed weatherproof and insulated office cabin for the diving inspector of minimum area 6 m² and a deck area of at least 10mm for accommodating diving equipment and operations. .

The diving pontoon shall be seaworthy, sufficiently stable to be fully useable by divers at all times when marine works are being undertaken, and adequate for the security and safety of equipment and personnel.

The Contractor shall provide the pontoon with means of access agreed with the Engineer. The open deck space shall be covered with a canvas awning to an extent agreed with the Engineer.

The Contractor shall submit to the Engineer full details of the diving pontoon for approval in sufficient time to mobilize before diving works commence.

Equipment for use by the Engineer

1.058 Provision of Equipment

The Contractor shall provide survey and/or diving equipment to the approval of and for the sole use of the Engineer. The equipment to be provided is:-

- (a) survey equipment to be approved by the Engineer.
- (b) diving equipment to be approved by the Engineer.

The equipment shall be provided on Site within 7 days of the Commencement Date or at such other time as agreed by the Engineer. It shall remain the property of the Contractor and shall revert to the Contractor upon the authorised removal of the Engineer's Office, or at such other prior time as instructed by the Engineer.

The Contractor shall be responsible for maintaining the equipment in full working order and shall repair or replace at the Contractor's expense any equipment which is damaged or defective for any reason.

1.059 Protective Clothing

The Contractor shall make available for the use of the Engineer sufficient quantities of protective helmets, harnesses, ear muffs, goggles and lifejackets.

1.060 Air Bottles

The Contractor shall be responsible for filling as required the air bottles provided for diving use by the Engineer, using approved equipment. The Contractor shall have sufficient reserve bottles to ensure that two charged bottles are always available.

Attendance upon Engineer

1.061 General

The Contractor shall provide such assistance and supply such labour, materials and equipment as may be required by the Engineer to enable the Engineer to carry out site duties under the Contract. The cost of staff is deemed to be included in the item rates.

1.062 Setting-out and Survey Staff and Small Equipment

The Contractor shall provide the services of competent chainmen, staff men and labourers and shall supply materials and small tools such as pegs, poles, lines, spirit levels and other items required by the Engineer for checking the setting out of the Works or carrying out surveys.

1.063 Materials Testing Staff and Transport

The Contractor shall provide suitably experienced, qualified laboratory technicians and assistants to carry out, under the direction of the Engineer, the

testing of materials. The Contractor shall also provide transport, as required, for sampling and testing.

1.064 Vehicle Drivers

The Contractor shall provide, as required by the Engineer, competent and licensed driver for the vehicle provided for the use of the Engineer. The driver shall be able to speak English and shall be made available during normal working hours and at such other times as may be required by the Engineer to undertake duties under the Contract.

1.065 Boat Crew

The Contractor shall provide experienced crew to operate all boats and craft to be made available for the use by the Engineer. They shall be made available during normal working hours and at such other times as may be required by the Engineer to undertake duties under the Contract.

1.066 Diving Assistance

The Contractor shall provide a diving team to attend the Engineer when undertaking diving work in connection with the Works. The team shall comprise at least the following:

- a competent supervisor
- a stand-by diver
- a competent linesman

Accommodation and Facilities for Contractor

1.067 Working Area(s) and Access

The Contractor's working area(s) is shown on the Drawings. The Contractor shall make arrangements and comply with the requirements of the Employer and relevant authorities for obtaining access to this area. The Contractor shall not be permitted without prior agreement to breach the any boundary fence or wall. Any accidental breach of or damage to a boundary fence, wall or gate shall be rectified immediately by the Contractor.

1.068 Contractor's Office, Stores, Workshops, etc.

The Contractor shall be responsible for providing all necessary offices, stores workshops, casting yards and other temporary works or facilities needed to construct the Works. Details of the proposed use of designated working areas shall be submitted to the Engineer for comment.

1.069 Staff Quarters and Labour Camp

The Contractor shall make arrangements for the provision of living accommodation and other off site facilities and amenities for the Contractor's work force. If temporary labour camps are set up they shall be subject to the

approval of the statutory authorities and shall not be located on the Site or within the Employer's boundaries.

Services for Contractor

1.070 Services for Contractor's Use

The Contractor shall arrange water, electricity and telecommunications services for the performance of the Contract including the provision of any cables, pipes, valves, meters, storage tanks, etc. The Contractor shall be responsible for obtaining all permissions and consents from the relevant supply or service authorities for the use of their respective supplies or services.

Records

1.071 Records

The Contractor shall keep and forward to the Engineer, at weekly intervals, records giving dates and details of all important operations and daily weather conditions.

1.072 Progress Photographs

The Contractor shall arrange for progress photographs to be taken, at monthly intervals or as otherwise directed, to cover all areas and stages of the Works. Where necessary the Engineer shall indicate the subject matter of the photographs. The Contractor shall supply one colour negative and three colour prints at least 18cm x 12cm size of each photograph. The prints shall bear the date of the photograph.

Each set of prints shall be separately bound, approximately A4 size, photograph albums, provided to the Engineer within a maximum of 3 weeks from the date when they were taken.

1.073 Progress Reports

The Contractor shall submit to the Engineer, at the end of each month, a report on progress of the Works during the month, showing the current cumulative progress of important sections of the Works related to the latest Contractor's Programme.

1.074 Returns of Labour and Equipment

The Contractor shall supply to the Engineer, by noon every working day, a return of the men employed the previous day and the work on which they were engaged, specifying the number employed in each trade. The Contractor shall also supply monthly a return showing the number of men and construction equipment employed and the nature and quantity of the work done.

1.075 Submission of Information and Records

All reports, statements, returns, drawings, diagrams, programmes, etc., which the

Contractor shall be required to submit during the Works to the Engineer, are to be in triplicate, unless otherwise agreed.

1.076 As-made Drawings

On Completion of the Works, the Contractor shall prepare and submit within six weeks a complete set of 'as-made' drawings in duplicate including for any Contractor-designed portions of the Works. Once agreed by the Engineer, the Contractor shall provide a negative for each 'as-made' drawing.

Nominated Subcontract Enquiries

1.077 Nominated Subcontract Enquiries

The Contractor shall be responsible for inviting tenders from specialist firms nominated by the Employer for certain nominated subcontracts for which Provisional Sums are included in the Bill of Quantities. Tender documents for nominated subcontracts will be prepared by the Engineer who will also provide the Contractor with an approved list of tenderers. The list will be issued in sufficient time before the issue of the subcontract documents to enable the Contractor to notify the Engineer of any objections in accordance with the Contract.

Drawings, Designs and Standards

1.078 Tender Drawings

The drawings provided for Tender purposes are listed in the Tender Documents.

They are not the "Drawings" as defined in Clause 1.1 of the Conditions.

1.079 Construction Drawings

Construction Drawings (the "Drawings") will be issued by the Engineer to the Contractor after award and from time to time during the Contract to meet the requirements of the current approved Programme. The Contractor shall be responsible for advising the Engineer in reasonable time when Drawings will be required so that the current approved Programme is not delayed.

1.080 Interpretation of Drawings

All Permanent Works shall be constructed to the dimensions shown on the Drawings. Scaling of dimensions from these Drawings if no dimension is marked is at the Contractor's risk. The Contractor shall give the Engineer reasonable notice of any required clarification of the Drawings or any additional information needed to construct the Works or to place orders for materials or supplies.

1.081 Contractor's Designs

The Contract Documents state which portions of the Works are to be designed by the Contractor. Designs shall be undertaken to the criteria stated and to the

satisfaction of the Engineer. Checking of designs by the Engineer shall not relieve the Contractor of responsibility for Contractor's designs.

1.082 Contractor's Working Drawings

The Contractor shall prepare and submit for comment by the Engineer, copies in duplicate (in the first instance) of detailed drawings of Contractor - designed parts of the Permanent Works or those drawings from which shop or fabrication drawings will be prepared.

The Engineer will, where necessary, make any comments on one copy which will be returned to the Contractor who shall make necessary amendments and forward to the Engineer three revised copies and a negative.

If the Contractor wishes to modify or alter any Engineer - designed or specified parts of the Permanent Works, the Contractor shall submit detailed drawings to the Engineer in accordance with the above, drawing attention to the proposed modification and providing such calculations, or other information the Engineer may require.

1.083 Alternative Design Proposals

The Contractor's alternative proposals must be such that:-

- (a) Stated design criteria are met and any additional criteria are stated
- (b) Sufficient drawings, calculations, specifications and samples are submitted to enable the Engineer to evaluate the alternative. The information shall be submitted at the Contractor's expense and in sufficient time to enable the Engineer to make an assessment
- (c) Other terms, conditions and instructions relating to the Contract are not varied
- (d) Any additional costs incurred by the Engineer in checking the alternative proposals, including any consequential work done by the Engineer, shall be at the Contractor's expense and may be deducted from the amount due to the Contractor under the Contract. Alternative design proposals may be accepted by the Engineer provided that they are at least equivalent to the designs specified in respect of stability, durability, maintenance and safety standards and operational characteristics.
- (e) The additional costs incurred by the Engineer in checking the compatibility of the alternative document(s) shall be at the Contractor's expense and deducted from moneys paid to the Contractor under the Contract.

1.084 Standards and Codes of Practice

A full set of all Standards, Codes of Practice and other publications listed in the Contract Documents, or those approved alternatives, shall be provided by the

Contractor for the exclusive use of the Engineer within 14 days of the Commencement Date.

Standards and other Codes and publications relevant to this Section include:

BS 5228: Noise control on construction sites Part 1 Basic information and procedures for noise control

BS 5607 Safe use of explosives in the construction industry

Safety and Health in Building and Civil Engineering Work (I.L.O Code of Practice).

Diving Operations at Work Regulations (Her Majesty's Stationery Office).

Civil Engineering Standard Method of Measurement, 3rd edition (Thomas Telford).

Glossary of Terms

1.085 Marine Structures

Marine structures are seawalls, revetments, breakwaters, jetties, quay walls, dolphins, docks, slipways, beacons, lighthouses, landing steps for berthing of vessels and other similar structures.

1.086 Final Surface of any Work

Final surface of any work is the surface to which the work is to be finished.

1.087 Tidal and Underwater Work

- 1) Tidal work shall be all work between the levels of +0.00 m CD and +3.40 m CD.
- 2) "Underwater work shall be all work below the level of +0.00 m CD.

APPENDIX 1.1

OFFICE FOR THE ENGINEER

General

The main office shall have at least the following net area:-

Office for the Engineer 30 sqm.

Room	Description	Minimum Internal Room size (sq m)
01	Engineer's Room	18
02	Deputy Resident Engineer	12
03	Store	4
04	Toilets	6

The actual layout of the offices and rooms are to be prepared by the Contractor and submitted for approval by the Engineer prior to fabrication and erection.

Office		Equipment
Room 01 Engineer's Room	1 No. 1 No. 3 No. 1 No. 1 No. 1 No. 1 No. 3 No. 1 No. 1 No.	Cork lino flooring. Knee hole desk 2000x1000 with locking drawers. Revolving Chair with arms. Chair with arms. Bookcase 1300mm long with cupboards underneath. Wastepaper basket. 4 drawer lockable steel filing cabinet. 4 tier beanstalk filing tray with base. 13 amp socket outlets. Telephone handset programmable memory type. Fire extinguishers.
Room 02 Deputy Resident Engineer's Room	1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 2 No. 1 No. 1 No.	Cork lino floor covering Kneehole desk 1500x1000mm with locking drawers. Revolving armed desk chair. Chair with arms. Bookcase 1300 mm long with cupboards underneath. Wastepaper basket. 3 drawer lockable steel fixing cabinet. 3 tier beanstalk filing tray with base. 13 amps socket outlets. Telephone handset. Fire extinguishers.
Room 03 Secretary's Room	1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No.	Cork lino floor covering Typist's desk with lockable drawers. Chair with arms. Table 1500x750mm Xerox document reproducer. Canon NP 1215 or equivalent and paper and consumables. 4 drawer steel filing cabinet. Hat and coat rack for 20 persons. Fire extinguisher Telephone Switch board (incoming unit) with 1 exclusive international line and "Hands Free Plus" handset or equivalent. Tone-controlled answering machine. Facsimile machine capable of transmitting different types of documents including charts and graphs at a speed of one A4 size paper in less than 15 seconds.

Office		Equipment
General Office Equipment	2	Scientific Calculators, programmable Casio fx 4000P or equivalent.
	3	Rechargeable battery or battery replacement for above as required.
	1	Paper punch
	3	Heavy duty stapler
	3	Stapler
	3	Ashtrays
		Power point adapters - 13 amps 3 point to 2 pin.
	5	Pencil erasers - As required
		Propelling pencils pentel120 A30 x 0.7mm
	3	Leads for above HB - As required
	4	Scissors, 150 mm blade
	2	Stamps
		Ink Pads.
Lap Top Computers complete with :-	2	
	1	

Office		Equipment
Printers	1 N°.	HP 8700, A3 size Colour Laser or equivalent
		Consumables for above as required.
General		All cabling to suit.
Toilets	2 N°.	Urinals
	1 N°.	"Western Toilet"
	1 N°.	Wash basin
	1 N°.	Mirror
		Consumables for above as required

SECTION 2 – MATERIALS AND WORKMANSHIP, GENERALLY

Quality Generally

- 2.001 Materials
- 2.002 Workmanship
- 2.003 Quality Control

Constructor's Equipment and Temporary Works

- 2.004 General

Sources of Material

- 2.005 General
- 2.006 Proprietary Names

Submissions

- 2.007 Manufacturers and Suppliers
- 2.008 Contractor's Working Drawings
- 2.009 Samples
- 2.010 Alternative Materials

General Requirements

- 2.011 Ordering Materials
- 2.012 Delivery and Storage of Materials on Site
- 2.013 Proprietary Products
- 2.014 Use of Materials for Temporary Works
- 2.015 Damaged or Defective Materials

Inspections and Tests

- 2.016 General
- 2.017 Inspection and Testing off Site
- 2.018 Waiver of Inspection Requirements
- 2.019 Certificates
- 2.020 Markings
- 2.021 Verification
- 2.022 Inspection and Testing on Site
- 2.023 Tests on Completion

Manuals

- 2.024 Operation and Maintenance Manuals

Instruction and Training

- 2.025 Contractor to Demonstrate

Standards and Codes of Practice

- 2.026 Standards

APPENDICES

Appendix 2.1 Manuals

SECTION 2 - MATERIALS AND WORKMANSHIP, GENERALLY

Quality Generally

2.001 Materials

All materials supplied by the Contractor for incorporation in the Permanent Works shall be new and of good quality and in accordance with the provisions of the Contract. For the purpose of this Specification, "materials" shall be deemed to include "Plant" i.e. those items that will be incorporated into the Permanent Works.

2.002 Workmanship

Workmanship shall comply with the requirements of the Specification and all specified (or approved alternative) Standards and Codes of Practice. If no relevant clauses are included in the Specification and if no Standard or Code of Practice is specified, then workmanship shall be to the standard required for the Works to be constructed to the best quality.

2.003 Quality Control

The Contractor shall be responsible for quality control in respect of all materials and workmanship, and shall also be required to demonstrate that the required quality is being achieved. The Contractor shall provide evidence of the suitability of quality control procedures, and those of subcontractors, both before they are instituted and during the progress of the Works. Notwithstanding the inspection and testing carried out by or under the direction of the Engineer, any failure by the Contractor or Contractor's subcontractors or suppliers shall not relieve the Contractor of responsibility to meet the contractual requirements for quality.

Contractor's Equipment and Temporary Works

2.004 General

The Contractor shall be responsible for the design, supply, safe use and maintenance of all the Contractor's Equipment and Temporary Works and shall ensure that they are suitable for the Works. Contractor's Equipment shall be in good working order and shall be operated and maintained in such a manner as to ensure its efficient and safe working. Temporary Works shall be of sound materials and shall be sufficient for the safe execution of the Works.

The Contractor shall, if requested, submit to the Engineer for comment details of any Contractor's Equipment and Temporary Works intended for use on the Works. Such approval shall not relieve the Contractor of responsibility for the adequacy of the Equipment and Temporary Works. The Engineer may direct that Contractor's Equipment or Temporary Works prejudicial in the Engineer's opinion to the quality, safety or progress of the Works, be removed from the Site and replaced and/or augmented by suitable Equipment or Temporary Works.

Sources of Materials

2.005 General

Only agreed sources of supply of materials shall be used. Sources once agreed shall not be changed without the new agreement of the Engineer.

Materials of Pakistan origin shall be used wherever they are available and in accordance with the Specification, except where the use of imported materials is specified.

2.006 Proprietary Names

Proprietary names are stated in the Contract Documents to define the quality and standard of materials required. Alternative materials may be proposed by the Contractor provided that they are in all respects equal to or better than those specified, and spares and replacements are equally available in Pakistan.

In respect of any alternative to the Engineer's design proposed by the Contractor, the Contractor shall reimburse the Employer the costs incurred by the Engineer associated with checking that the proposed alternative is acceptable, with checking the effect of any such alternative on the performance of the Permanent Works, and with carrying out any alterations to the Drawings or other Contract Documents.

Submissions

2.007 Manufacturers and Suppliers

The Contractor shall notify the Engineer at least 21 days in advance of placing orders for any materials for incorporation in the Permanent Works. The Contractor shall, if required by the Engineer, submit for comment by the Engineer at least 7 days before the date for placing the order, the following information:-

- a) Name of manufacturer or supplier proposed
- b) Evidence to prove that the materials proposed comply with the Specification, stating the Standards with which they comply
- c) Confirmation that the materials will be supplied with the specified markings and certificates
- d) Any particulars listed under the general heading "Information to be furnished by the Supplier" where this occurs in the relevant Standard, or as may be Specified, or the Engineer may require
- e) Manufacturer's data and instructions
- f) Fabrication and painting details where appropriate

- g) complete the work can be supplied from the same source, with written confirmation from suppliers if requested

Materials shall not be used in the Permanent Works until agreed by the Engineer. Such agreement shall not relieve the Contractor of responsibility for the materials.

2.008 Contractor's Working Drawings

Where a Contractor has to prepare working drawings, schematic diagrams or schedules for materials to be supplied or work to be undertaken in preparation to receive these materials or items, these shall be submitted by the Contractor to the Engineer at least 21 days before comment is required to be received by the Contractor.

Such proposed drawings, diagrams or schedules must be agreed to in writing before work is put in hand.

2.009 Samples

Samples or test pieces of all materials and workmanship proposed for the execution of the Works shall be taken by the Contractor in accordance with the relevant Standard or when ordered by the Engineer, and submitted to the Engineer by the Contractor in labeled boxes suitable for storage.

Samples must be supplied in sufficient time to allow for testing and comment as directed, due allowance being made for availability of testing facilities and the fact that if samples are rejected further samples will be required. Delay to the progress of the Works arising from the late submission of samples will not be accepted as a reason for delay in the completion of the Works.

The samples when accepted will be kept by the Engineer. All materials and workmanship not corresponding in character and quality with the accepted samples will be rejected. The Contractor shall remove the samples from the Site when they are not longer required.

2.010 Alternative Materials

Where alternative materials are later proposed the requirements of the receding Clauses shall be met before those materials may be used.

General Requirements

2.011 Ordering Materials

Materials shall be ordered in accordance with the information shown on the Drawings issued from time to time by the Engineer. Orders for materials shall not be placed on the basis of items in the Bill of Quantities.

Except where agreed otherwise by the Engineer in writing, the Contractor shall, at the time of placing an order for permanent works materials, furnish to the Engineer copies in duplicate of the order together with two copies of each drawing referred to in the order.

The Contractor shall notify the Engineer of the estimated dates for delivery to the Site of major materials and materials on the critical path for the Works within 7 days of receiving

2.012 Delivery and Storage of Materials on Site

The Contractor shall not deliver materials to the Site until adequate facilities for their proper unloading and storage pending their incorporation in the Works has been provided.

Unloading and storage shall be such as to prevent any damage or deterioration from any cause whatsoever. Stacking shall permit ready inspection and checking and be such that parts are available in proper sequence as required and different items are stacked separately. In addition, methods of storage, protection and handling of materials shall be in accordance with the manufacturer's recommendations and the Specification.

The Contractor shall be responsible for ensuring that adequate quantities of materials are stored on Site to avoid delays to construction.

2.013 Proprietary Products

Proprietary products shall be used, applied or fixed, strictly in accordance with the manufacturer's instructions. The Contractor shall obtain these instructions before or at the time of ordering and shall submit a copy of the instructions to the Engineer.

2.014 Use of Materials for Temporary Works

Materials to be incorporated in the Permanent Works shall not be used for temporary works prior to their incorporation in the Permanent Works.

2.015 Damaged or Defective Materials

Immediately any damage or defect is discovered in materials for incorporation or already incorporated, in the Permanent Works, the Contractor shall submit a written report to the Engineer. Unless agreed otherwise by the Engineer (eg pending inspection/comment by suppliers) they shall be removed from the Site as soon as possible; otherwise they shall be stored separately and clearly labelled until inspection/comment has been received.

If repairs are possible locally and this is agreed in writing by the Engineer such repaired materials shall be subject to inspection and the acceptance of the Engineer before use in the Works.

If the Contractor fails to remove unacceptable materials from the Site within 7 days of formal notification by the Engineer, the Employer may arrange their removal and will then deduct all expenses thereby incurred from the amount of any money due to the Contractor.

The Contractor shall be responsible for all additional costs and delays which occur as a result of the discovery of any damage or defect in materials.

Inspections and Tests

2.016 General

Materials for incorporation in the Permanent Works and all workmanship shall be subjected to the inspections and tests provided for in the Conditions of Contract and the Specification.

2.017 Inspection and Testing off Site

Certain materials for incorporation in the Permanent Works may be inspected, tested or examined by the Engineer at the manufacturer's works or premises or other specified or agreed place off the Site as detailed in the Specification or otherwise required by the Engineer. Such inspections, tests or examinations may include the following:

- a) Imported Materials
 - * Lights
 - * Radar reflectors
- b) Materials of Pakistan Origin
 - * Steel plate

The Contractor shall submit to the Engineer a programme showing the dates on which the manufacture of such items is to commence and the dates on which items will be available for inspection and/or ready for dispatch to the Site. In the case of items whose manufacture takes place in stages over a period, or for which intermediate stages are to be inspected as the work proceeds, the Contractor shall from time to time notify the Engineer the dates at which such inspections can be made.

The Contractor shall give the Engineer at least 2 weeks' notice of imported materials being ready for inspection, test or examination. For local materials at least 72 hours' notice shall be given. Delay to the progress of the Works arising from late notification of availability for inspection will not be accepted as a reason for delay in the completion of the Works.

2.018 Waiver of Inspection Requirements

Subject to the Contractor furnishing the Engineer information as described in the following paragraphs, the requirements of Clause 2.017 may be waived at the discretion of the Engineer.

2.019 Certificates

Except where specifically agreed to the contrary in writing, all materials supplied by the Contractor for incorporation in the Permanent Works shall be accompanied by certificates demonstrating compliance of the materials with the Specification. The certificates shall refer to the materials actually dispatched to the Site and to the markings specified in Clause 2.020. The original and one copy of each certificate shall be submitted to the Engineer for comment prior to dispatch of the materials to the Site, and sufficiently in advance of the time when they are required on Site to avoid delays to the construction programme.

Each certificate shall be signed by an authorised representative of the manufacturer and shall contain the name and address of the Contractor, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies.

Certification shall not be construed as relieving the Contractor from furnishing satisfactory materials if further tests performed on selected samples show that the materials do not comply with the Specification.

2.020 Markings

All materials for which test certificates are to be supplied by the manufacturer shall be indelibly marked with the date of manufacture, batch number and project reference, in such a way that the batch of materials may be readily identified against the certificates. Where permanent protective coatings are applied to materials the markings shall be applied to the coating.

2.021 Verification

The Contractor shall be responsible for providing all information necessary to enable the Engineer to verify that materials which are to be incorporated in the Permanent Works are those referred to on corresponding test certificates.

Where a batch of tested material is subsequently broken down into smaller components for incorporation in the Permanent Works, the Contractor shall submit a schedule identifying where each such component has been incorporated in the Works.

If the Engineer is not able to verify particular materials, the Contractor shall arrange additional tests and examinations to demonstrate that those materials comply with the Specification. Materials which the Engineer is not able to verify may, at the Engineer's discretion, be accepted by the Engineer or certified for payment.

2.022 Inspection and Testing on Site

All materials delivered to, and workmanship on, the Site shall be subjected to inspection and testing by or under the direction of the Engineer or, when so directed, at an approved local testing laboratory.

The Contractor shall be responsible for providing samples and for informing the Engineer in writing on each occasion that inspection or testing is required by the Specification. The Contractor shall give such notice as the Engineer shall agree is sufficient for each category of inspection or tests.

The Contractor shall, when so directed, be required to witness tests performed by or under the direction of the Engineer. If the Contractor fails or refuses to witness such tests, it will be nevertheless be deemed that the Contractor has witnessed them and accepts the results.

The Engineer may carry out, or order from the Contractor, additional samples, inspections or tests where necessary to ensure that materials and workmanship are in accordance with the Specification. The cost of such additional samples, inspections and tests shall be at no cost to the Employer, except where provided otherwise by the Conditions of Contract.

The Contractor shall provide the Engineer with a copy of all materials tests results, signed by an authorised representative of any testing organisation.

2.023 Tests on Completion

Except where specifically agreed to the contrary in writing, the Contractor shall present all Plant and systems including but not limited to new, modified and relocated navigation aids and lights installed under the Contract for Tests on Completion, at least 14 days before the date for the Taking-Over Certificate for the Works. These tests are in addition to any at works tests performed by the manufacturer and interim tests the Contractor may carry out when setting up the system.

Before the Contractor offers Plant and systems for Tests on Completion, all associated systems and installations are to be complete, checked, adjusted and set up. Final paintwork must be complete and a complete lubrication service applied where appropriate. Tests on Completion shall not be carried out until the approved operation and maintenance manuals have been provided.

The Contractor shall submit to the Engineer a detailed Schedule and Programme of Tests on Completion 14 days before the commencement of testing.

The Contractor shall provide, and shall remove on completion, all rigs, test loads, instrumentation and labour assistance necessary for the proper performance of the Tests on Completion.

Testing shall be carried out by the Contractor in the presence of, and to the satisfaction of, the Engineer and, if required by the Employer, in the presence of one or more representatives of the Employer or the Karachi Nuclear Power Plant to demonstrate that the Plant and systems perform in accordance with the Specification and are ready for operation.

Any defects discovered during the Tests on Completion shall be recorded by the Contractor and Engineer and shall be duly rectified by the Contractor. Following rectification the Contractor shall repeat the tests before final handover of the Plant or system.

On satisfactory completion of the Tests on Completion the Contractor shall provide three copies of a Test Schedule completed for all observed tests and data readings. A Test Certificate shall be submitted in triplicate to the Engineer.

Manuals

2.024 Operation and Maintenance Manuals

Except where specifically agreed to the contrary in writing, the Contractor shall provide comprehensive manuals in English covering all aspects of operation and maintenance in respect of all Plant and systems installed under the Contract.

The Contractor shall submit the manuals in draft form at least 1 month before the date for the Tests on Completion. The Contractor shall make such modifications and additions as the Engineer requires and shall re-submit the manuals for final approval by the Engineer at least 14 days before the Tests on Completion are to be carried out. The Contractor shall be entirely responsible for the consequences of any delay by the Engineer in agreeing to commission the Plant and equipment where such delay is due to errors, omissions or defects in the documents submitted by the Contractor. The Contractor shall make any further revision to the manuals as required by the Engineer and shall provide six copies within a period of 28 days after the Tests on Completion have been completed.

The manuals shall describe clearly with step-by-step procedures and diagrams the installation and the starting up, running and shutting down of each item of Plant or system. They shall contain sufficient information to permit the Employer to take over, operate and maintain the Plant or system efficiently and effectively. Planned maintenance programmes and instructions for the removal, repair and replacement of components shall be provided. Full spare parts and tools lists shall be included together with ordering procedures.

The manuals shall be of high quality in both presentation and technical content.

Manuals not meeting this standard shall be rejected. The manuals shall consist of A4 size bound volumes with stiff covers of wipe-clean finish.

Instruction and Training

2.025 Contractor to Demonstrate

Following satisfactory Tests on Completion, the Contractor shall demonstrate to Employer how to operate and maintain Plant and systems without assistance.

Standards and Codes of Practice

2.026 Standards

Standards and other Codes relevant to this Section include:

BS 8000 Code of Practice for Workmanship on Building Sites

APPENDIX 2.1

Parts Manual

The Contractor shall provide a detailed Parts Manual having exploded view illustrations to enable efficient positive identification of parts and part numbers.

Spares price list

A complete price list shall be provided with the Parts Manual on acceptance by the Employer.

Recommended spares holding

Not later than 1 month prior to shipment of the imported equipment the Contractor shall submit to the Engineer for comment a comprehensive recommended spares list. This list shall include any special tools required for maintenance purposes.

Spares for testing and commissioning

The Contractor shall be allowed with the permission of the Engineer during the commissioning and testing period to draw upon the spares provided that replacement parts are provided without delay.

Operational and Maintenance Manuals

General

The Contractor shall provide the Engineer with comprehensive draft manuals in English, covering all aspects of operation and maintenance. The Engineer shall review the draft manuals and the Contractor shall make such modifications and additions as the Engineer shall require and shall re-submit the manuals for final comment by the Engineer. Following any amendments the Contractor shall provide 6 manuals, contained in good quality protective covers. The manuals shall be provided not later than one month after the testing of the equipment.

Operating Manual

The Operating Manual shall be in A4 size supplemented by a bound paperback A5 size booklet which simply and clearly defines all matters necessary to safely and efficiently operate the crane. The booklet shall have separate sections, where possible having numbered short paragraphs setting out instructions on a "do" or "do not" format, indexed as follows:

1. General description
2. Safety
3. "Start up" procedure
4. "Shut down" procedure

The Operating Manual should include photographs to illustrate the operating controls and similar features.

Maintenance Manual

The Maintenance Reference Manual shall be in A4 size, in loose leaf folder format. The Manual shall have main sections for each of the principle engineering disciplines i.e. structural, mechanical, electrical and hydraulic engineering.

Each main section shall have subsections as follows:

- (a) Data section
- (b) Condition monitoring and fault diagnosis
- (c) Schedules of planned maintenance routines
- (d) Detail description of operation and settings
- (e) Component service procedure
- (f) Method of component removal
- (g) Method of repairs, including the use of any special tools
- (h) Method of component replacement
- (i) Test procedures following maintenance and repairs
- (j) Schedule of special tools required

Cross reference shall be made where applicable to relevant drawings in which shall be included the Maintenance Manual text. Photographs shall be included to illustrate maintenance procedures.

Acceptance Site Tests

Before the Contractor offers the equipment for Acceptance Site Tests, all systems and installations (including the electrical system) are to be complete, checked, adjusted and set up. Final paintwork must be complete.

SECTION 3 - SITE CLEARANCE AND DEMOLITION

Table of Contents

3.001	Site Clearance of topsoil, bushes, trees etc.
3.002	Contamination
3.003	Pre-demolition Surveys
3.004	Demolition
3.005	Order of Demolition
3.006	Nature of Materials
3.007	Control of Demolition
3.008	Existing Services
3.009	Disposal of Surplus Materials
3.010	Materials for Retention
3.011	Making Good Voids
3.012	Making Good Damage
3.013	Underground Voids
3.014	Confined Spaces
3.015	Storage Tanks
3.016	Asbestos
3.017	Dust
3.018	Noise
3.019	Artificial Lighting
3.020	Standards and Codes of Practice

SECTION 3 - SITE CLEARANCE AND DEMOLITION

3.001 Site Clearance of topsoil, bushes, trees etc

Not used.

3.002 Contamination

Contamination discovered on Site shall be removed in accordance with appropriate local regulations.

3.003 Pre-demolition Surveys

The condition of structures and facilities to be retained shall be surveyed prior to any demolition of adjacent works, including taking illustrative photographs where appropriate, in order to assess any claimed damage resulting from such demolition.

A detailed investigation of existing structures and facilities to be demolished shall be undertaken, in order to produce a safe effective method for demolition.

3.004 Demolition

Not used

3.005 Order of Demolition

Not Used

3.006 Nature of Materials

Notwithstanding descriptions of the nature of materials shown on the Drawings demolition shall be carried out in any material found on the site.

3.007 Control of Demolition

The Contractor shall be entirely responsible for the safety of adjoining structures and for the stability of adjoining ground throughout all works of demolition. Such works shall be carried out in an expeditious manner and demolition sites and all roads shall be maintained in a clean and tidy condition.

3.008 Existing Services

The temporary or permanent disconnection or diversion of drains and/or services shall be carried out only on receipt of written permission to do so from the relevant authorities.

The Contractor shall take all steps necessary to protect and maintain continuity of existing services at all times, including keeping them clean of debris.

3.009 Disposal of Surplus Materials

Materials arising from the demolition shall become the property of the Contractor, unless otherwise stated, and shall be removed from the Site.

3.010 Materials for Retention

Materials resulting from site clearance and demolition which are required by the Contract Documents to be reused in the Works or retained for the Employer's use outside the Works shall be protected from damage (as far as that is reasonable) during site clearance and demolition, transport and subsequent storage at the locations described in the Contract Documents.

3.011 Making Good Voids

Not used.

3.012 Making Good Damage

Existing features including pavings, structures and services both on and off the Site damaged as a consequence of site works including any clearance and demolition shall be made good at the Contractor's expense.

3.013 Underground Voids

Underground voids discovered during site clearance and demolition shall be recorded, marked and where necessary guarded and illuminated on site before demolition is undertaken in order to prevent accidents.

3.014 Confined Spaces

Staff working in confined spaces should be fully trained and provided with appropriate gas detection and safety equipment.

3.015 Storage Tanks

Not used.

3.016 Asbestos

Not Used

3.017 Dust

Dust created by demolition shall be kept to a minimum, if necessary by water spraying.

3.018 Noise

Noise and times of working on demolition shall be within the limits stated in relevant regulations. Appropriate personal protective equipment including hearing protection shall be provided.

3.019 Artificial Lighting

Adequate artificial lighting levels appropriate to safe demolition working shall be provided.

3.020 Standards and Codes of Practice

Standards and other codes and documents relevant to this Section include:

The Construction (Design & Management) Regulations 1994

Managing Construction for Health and Safety - Construction (Design & Management) Regulations 1994 Approved Code of Practice Factories Act 1961

The Management of Health and Safety at Work Regulations 1992

Provision and Use of Work Equipment Regulations 1992

Workplace (Health & Safety and Welfare) Regulations 1992

Personal Protective Equipment at Work Regulations 1992

Manual Handling Operations Regulations 1992

Health & Safety at Work etc Act 1974

The Construction (General Provisions) Regulations 1961

The Construction (Lifting Operations) Regulations 1961

The Construction (Working Places) Regulations 1966

The Construction (Health & Welfare) Regulations 1966

The Health & Safety (First Aid) Regulations 1981

The Control of Asbestos at Work Regulations 1987 (Approved Codes of Practices)

The Asbestos (Licensing) Regulations 1983 & 1985

The Abrasive Wheels Regulations 1970

Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972

Protection of Eyes Regulations 1974

COSHH Control of Substances Hazardous to Health (1994)

The Environmental Protection Act 1990

The Control of Pollution Act 1974

The Control of Pollution (Special Waste) Regulations 1980

British Standard Code of Practice for Noise Control on Construction and Open Sites BS 5228 Parts I and IT

The Clean Air Acts 1956 and 1968

British Standard Code of Practice for Demolition BS 6187: 1982

SECTION 11 - STRUCTURAL STEELWORK
Table of Contents

	Materials
11.001	General
11.002	Bolts, Nut Washers
11.003	High Strength Friction Grip Bolts
11.004	Test Certificates
11.005	Testing Bolts
11.006	Foundation Bolts and Anchorages
	Fabrication
11.007	Shop Drawings
11.008	Contractor to Remain Responsible
11.009	Fabrication Programme
11.010	Quality Control during Fabrication
11.011	Notice to Engineer
11.012	Erection Marks
	Workmanship
11.013	General
	Welding
11.014	General
11.015	Standards
11.016	Qualification of Welders
11.017	Supervision
11.018	Equipment
11.019	Welds
11.020	Records
11.021	Procedures
11.022	Electrodes
11.023	Butt Welding
11.024	Welding in Rain
11.025	Fit-up Tolerances
11.026	Temporary Support
11.027	Inspection
11.028	Inspector
11.029	Testing of Connections
11.030	Acceptance Levels - Butt Welds
11.031	Acceptance Levels - Fillet Welds
11.032	Weld Failure
11.033	Remedial Work
	Shear Stud Welding
11.034	Method
11.035	Trial Welding
11.036	Tests and Inspection
11.037	Defective Studs
11.038	Fabrication or Erection Attachments

	Bolted Connections
11.039	General
11.040	Joint Preparation
11.041	High Strength Friction Grip Bolts
	Release for Delivery
11.042	Release for Delivery
	Transport and Storage
11.043	Programme
11.044	Handling and Storage
11.045	Prevention of Contamination
11.046	Small Parts
	Erection
11.047	General
11.048	Drawings
11.049	Assembly and Erection
11.050	Stresses
11.051	Lifting and Runway Beams
11.052	Safety
	Tolerances
11.053	Tolerances
	Protective Coatings
11.054	General
	Standards and Codes of Practice
11.055	Standards and Codes of Practice

SECTION 11 - STRUCTURAL STEELWORK

Materials

11.001 General

Steel plates, rolled and hollow sections and similar products used for structural and other purposes shall be from an approved manufacturer and shall unless otherwise directed be steel S275 complying with BS EN 10025.

Hot rolled structural steel sections shall comply with BS 4 Part 1 and BS 4848 - Part 2 - Structural Hollow Sections and Part 4 - Equal and Unequal Angles.

Steel tubes shall comply with BS 6323:Part 3

11.002 Bolts, Nuts Washers

Bolts for structural and other purposes shall unless otherwise noted be hot dip galvanised metric black bolts to BS 3692 Grade 8.8. Where required ISO metric precision bolts shall be to BS 3692. Metal washers shall be to BS 4320. ISO metric black cup and countersunk head bolts and screws with hexagon nuts shall comply with BS 4933.

11.003 High Strength Friction Grip Bolts

High strength friction grip bolts shall be galvanised and shall comply with BS 4604:Part 1 or Part 2 as specified. Hardened steel washers shall be provided under both the head and nut of each bolt.

11.004 Test Certificates

The Contractor shall supply to the Engineer a manufacturer's test certificate for each consignment of steelwork delivered to the site together with a delivery note stating the weight, type, length and place of origin of the steelwork.

11.005 Testing Bolts

Two bolts and two washers in every hundred may be selected by the Engineer as samples, and the Contractor shall satisfy the Engineer, by test or otherwise, that the bolts etc, comply with the requirements of the Specification.

11.006 Foundation Bolts and Anchorages

The Contractor shall supply and deliver to Site all necessary anchorages and foundations bolts to be built into foundations and all templates required for correct location of anchorages and foundation bolts.

Foundations bolts shall be complete with tubular steel sleeves to permit adjustment in position and with anchor frames, washers, washer plates and nuts.

After foundation bolts and anchorages have been cast into concrete, the bolt ends shall be protected by greasing and wrapping with suitable protective material.

After fixing the base plate, bolt holes shall be grouted with neat cement/epoxy grout. Grout shall be used as soon as possible and not more than 30 minutes after initial mixing of cement and water. Base plates shall be bedded in accordance with BS 5950:Part 2. Temporary erection packers under base plates shall be arranged to be removable on completion of bedding.

Fabrication

11.007 Shop Drawings

The Contractor shall prepare shop drawings, details and calculations for submission to the Engineer prior to commencement of fabrication. Designs shall be in accordance with BS 5950:Part 1 or Part 5.

The drawings shall contain complete information for fabrication including locations, type, size and extent of all welds. The drawings shall clearly distinguish between shop and site joints, and clearly indicate the type of steel to be used for fabricating each component. The preparation for welds shall be shown on the drawings to a large scale.

The Contractor shall make any amendments to the drawings, details and calculations as required by the Engineer. The Contractor shall submit four copies and one reproducible transparency of the final drawings to the Engineer. Fabrication shall not be started until the final shop drawings have been provided, and no alterations shall be made to such drawings without the further submission to the Engineer.

11.008 Contractor to Remain Responsible

Notwithstanding the foregoing the Contractor shall remain responsible for correct fabrication, assembly and erection.

11.009 Fabrication Programme

The Contractor shall provide a programme giving details of source of supply, dates of rollings, sequence and methods of fabrication.

11.010 Quality Control during Fabrication

The Contractor shall provide, prior to commencement of fabrication, details of proposed quality control for all shop work including welding.

11.011 Notice to Engineer

The Contractor shall provide adequate notice to the Engineer so that fabrication processes, tests on materials, welding etc. can be witnessed.

11.012 Erection Marks

Erection marks shall be stamped or painted on all members in a manner agreed by the Engineer

Workmanship

11.013 General

Steelwork shall be fabricated in accordance with BS 5950:Part 2 except as modified herein.

Exposed cut edges of steelwork shall be rounded off by grinding. Ends of members bearing in compression shall be machined so that loads are transmitted over the entire area of contact.

Plates, rolled and hollow sections required to be cut to exact lengths shall be accurately cold sawn or machined. Hot sawing or machine gas cutting is permitted for the ends of beams and other parts in compression.

Tube ends, other than those cold sawn, shall be hand flamecut and dressed to fit accurately the profile of the tube, etc, to which they are to be jointed.

Burrs left by a cold or hot saw shall be removed and gas cuts shall be dressed free from oxidized metal to a neat and workmanlike finish.

Ends of tubes welded to plates, etc, shall be formed so that the tubes butt over their entire area.

The ends of the members shall be prepared generally in accordance with the foregoing requirements and the maximum gap allowable between ends will be 2mm. Fitted stiffening tubes, angles or plates to brackets, flanges to joists, tubes, etc. shall be accurately shaped to fit the profile of the member stiffened.

Landing cleats shall be provided for all beam to column connections.

In tubular structures the ends of all tubes shall be sealed to be airtight. The Contractor shall submit proposals for effective airtight seals of screwed stud connections to the Engineer for comment.

Frames of tube or box connections shall be jig assembled and the ends of all tubes shall be sawn and not flame cut, except for irregular profiles. The minimum thickness of box or tube sections for main members shall be 4mm.

Sealing the ends of tubes shall be carried out under ambient conditions, which reduce the trapping of excessive moisture.

Any holes in steelwork shall be drilled.

Welding

11.014 General

The types, dimensions and lengths of all welds shall be clearly shown on the Contractor's Shop Drawings. Welds shall have 6mm minimum legs unless otherwise shown on the contract drawings and they shall be designed in accordance with the requirements of BS 5950 to resist the loads and forces to be transmitted by the various members. The arrangement of welds of joints shall be designed to taken into account the distribution of all stresses and any eccentricities arising from the welds relative to the axes of the members.

Welding shall comply with BS 5135. The layout, procedure and sequence of all welding operations shall be arranged to so as to eliminate any distortion, residual stress or accidental stress. Approved written welding procedures shall be available in accordance with BS 5135 and tested in accordance with BS EN 288:Part 3.

11.015 Standards

Welding procedures, weld testing and proficiency testing of welders shall comply with the appropriate British Standards listed below for the grades and thicknesses of steel and the types of weld specified:

- BS EN 287 - Approval testing of welders for fusion welding Part 1: Steels
- BS EN 288 - Specification and approval of welding procedures for metallic materials Part 3: Weldings procedure tests for the arc welding of steels
- BS EN 499 - Covered electrodes for manual metal arc welding of mild steel and medium tensile steel
- BS 2600 - Radiographic examination of fusion welded butt joints in steel
- BS 3923 - Methods for ultrasonic examination of welds Part 1: Manual examination of fusion welds in ferritic steel
- BS 6443 - Method for penetrant flow detection
- BS 4165 - Electrode wires and fluxes for the submerged arc welding of mild steel and medium tensile steel
- BS 4872 - Approval testing of welders when welding procedure approval is not required. Part 1: Fusion welding of steel
- BS 6072 - Methods for magnetic particle flow detection
- BS 5135 - Arc welding of carbon and carbon manganese steels

BS 5289 - Visual inspection of fusion welded joints

BS EN288.1 - Approval of welding procedures for metallic materials.
Ground rules for fusion welding.

11.016 Qualification of Welders

Only certificated welders tested and certified by an Authority acceptable to the Engineer shall be employed in fabricating the Permanent Works. Welders shall be tested to meet the requirements of BS EN 288:Part 1 but, in the case of welders engaged on fillet welding only, BS 4872:Part 1 is an acceptable alternative.

Copies of certificates for each welder and for each welding procedure shall be supplied to the Engineer in the format shown in BS EN287 -1. The Engineer will require a re-test of any welder if for any reason he is not satisfied with the performance or standard of workmanship shown by that welder.

11.017 Supervision

The Contractor shall employ an experienced welding foreman or welding supervisor.

11.018 Equipment

Welding equipment shall be sufficient to comply with the required welding procedures and shall be capable of depositing the various types of electrodes used under the conditions of current and voltage specified by the manufacturer of the electrodes. Efficient means shall be provided for the accurate measurement of the current and, in addition, a pair of test tongs shall be supplied by the Contractor and be available for use by the Engineer. Equipment, accessories and connections shall be maintained in proper working order.

11.019 Welds

The arrangements of the runs in multi-run welds shall avoid the formation of slag traps and ensure adequate root penetrations and correct shapes of the welds. The sizes of the electrodes and the number of runs necessary to make each welded joint shall conform with the electrode manufacturer's recommendations. All welds shall be continuous unless otherwise shown on the Drawings. Welds with blowholes or similar defects will be rejected. Penning of the welds involving deformation of the weld surface, whether during de-slagging or subsequently shall not be allowed.

11.020 Records

The Contractor shall keep detailed records of all welding operations carried out for the Permanent Works.

11.021 Procedures

No welding shall be commenced without submission to the Engineer, in writing, of the procedures and operators proposed by the Contractor. The submission shall in no way reduce the Contractor's obligations under the Contract.

No change in welding procedure or welding personal shall be permitted without written agreement of the Engineer.

11.022 Electrodes

Electrodes for welding shall be covered electrodes suitable for metal-arc welding complying with BS EN499. A manufacturer's certificate to this effect shall be obtained for each consignment of electrodes. The electrodes shall be suitable for each individual weld and the classification of the electrodes shall be in accordance with BS EN499. Full particulars of such classification shall be submitted to the Engineer before any welding is commenced. For welding in any particular position the electrodes used shall be those recommended by the manufacturer for use in that position.

Electrodes shall be stored and kept under dry conditions and any electrodes which has become damaged by moisture shall not be used unless it is stated by the manufacturer that when the electrode is properly dried there remains no detriment. Any electrode which has part of its flux coating broken away or is otherwise damaged shall be discarded.

Electrode wires and fluxes for submerged arc welding shall comply with BS 4165.

11.023 Butt Welding

Butt welding shall not be interrupted until at least 50% of the weld depth is complete.

11.024 Welding in Rain

No welding shall take place in rain, in seawater spray, or in areas which are being made wet by waves. No welding shall take place within 300mm of tidal water levels.

11.025 Fit-up Tolerances

Weld fit-up tolerances shall be in accordance with BS 5135 unless the approved welding procedure requires otherwise. In no case shall the gap for fillet welding exceed 3mm.

11.026 Temporary Support

To achieve the required weld fit-up clamps, jigs and manipulators shall be used.

They shall remain in position until the entire length of the root run(s) and first pass is complete for all butt welds. They shall be used in such a way that welding can be carried out in the most suitable position. Tack welds shall not be used for butt welds.

Welded temporary attachments shall not be made in areas subject at any time to tensile stresses. Where used, temporary securing welds shall be to the same specification as for permanent welds. The attachments shall be removed with care and the area of the temporary weld ground down and dressed-up as required.

11.027 Inspection

The Contractor shall provide all assistance to the Engineer, for the inspection of welding, at any reasonable time and at all places where welding is being done. The decision of the Engineer regarding the acceptance or rejection of any work will be final.

11.028 Inspector

The Contractor shall ensure that a qualified welding inspector is on the site at all times that welding is being carried out. The inspector shall be capable of supervising all welding procedure tests and of carrying out all weld preparation inspection, visual inspection during and on completion of welding, manual ultrasonic examination or radiographic examination, magnetic particle examination, dye penetrant testing and other relevant methods of testing all in accordance with BS 2600:Part 1, BS 3923:Part 1, BS 4397 and BS 4416.

The inspector shall submit to the Engineer daily reports on weld preparation and weld progress and detailed inspection sheets showing the results of all inspections made to each weld.

The Contractor shall provide all the equipment and materials; necessary to carry out the required tests and inspections.

11.029 Testing of Connections

The names of testing organizations proposed to be used for independent testing of welds shall be submitted to the Engineer prior to testing taking place.

Every weld shall be inspected visually over its full length following the recommendations given in BS 5289, before non-destructive testing is carried out.

Non destructive testing of welds shall be carried out in accordance with all the requirements of Table 11.1.

Non-destructive testing of welds shall be carried out as necessary by the approved testing organisation to demonstrate compliance with the specified acceptance standards. Acceptable methods of testing are magnetic particle testing (BS 6072), penetrant testing (BS 6443), radiographic examination (BS 2600:Part I) and ultrasonic (BS 3923:Part 1) as appropriate and as agreed. At least 16 hours shall elapse between completion and the non-destructive testing of a weld.

Where the extent of inspection called for is less than 100% the test locations shall be agreed with the Engineer.

For tests on butt welds the percentage of examinations refers to the total number of butt welds.

For tests on fillet welds the percentage of examination refers to the total length of fillet welds.

11.030 Acceptance Levels - Butt Welds

Acceptance levels shall be as stated in Table 18 of BS 5135.

11.031 Acceptance Levels - Fillet Welds

Acceptance levels shall be as stated in Table 19 of BS 5135.

11.032 Weld Failure

If the results of any 10% weld length examined by radiographic or ultrasonic methods do not conform to the required acceptance levels, two additional 10% lengths from the same weld shall be examined. In the case of failure of one or both of these additional examinations the weld will be rejected.

11.033 Remedial Work

Remedial work as described in BS 5135 Tables 18 and 19 shall consist of:

- a) Making good small blemishes etc., by grinding and re-welding.
- b) Cutting out original weld, preparing and re-welding.

Any area of unacceptable weld shall be ground out and rewelded. Such grinding shall be done with a tapering transition from the unacceptable to the acceptable part of the weld.

Test specimens shall be prepared, forwarded and tested at a testing station selected by the Engineer. The test specimens shall be supplied, packed and forwarded free of charge and any test not satisfying the Specification shall be paid for by the Contractor.

Shear Stud Welding

11.034 Method

Shear studs shall be welded in accordance with the manufacturer's recommendations for materials, procedures and equipment.

11.035 Trial Welding

When specified by the Engineer and before production welding of studs commences, trials shall be made on samples of material and studs agreed by the Engineer to be representative of those to be used.

Where primers are to be applied to the work prior to the welding of studs they shall apply also to trial welding procedures.

11.036 Tests and Inspection

All studs shall be visually inspected. They shall have a full 360⁰ collar.

At agreed locations 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 6kg hammer and 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. Studs subjected to a bend test shall not be straightened.

11.037 Defective Studs

Studs with defective welding shall be removed as follows and replaced and re-tested.

11.038 Fabrication or Erection Attachments

Welding of attachments required for fabrication or erection proposes shall be as for a permanent weld.

When removal of welded attachments, including studs, is necessary, they shall be flame cut or gouged at a point not less than 3mm 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 20mm it shall also be checked by magnetic particle inspection. Acceptance criteria are [as set out in Table 2 of the National Structural Steelwork Specification]. Attachments shall not be removed by hammering.

Bolted Connections

11.039 General

The minimum size of bolt used on all standards connections shall be 12mm diameter.

Single bolt connections with not be permitted. Bolts in tension will not be allowed, the only exception being foundation bolts and high tensile bolts in haunch connections of portal frames. All bolted joints shall be over-designed by 20%.

Where pin bolting is used for assembly and erection of joints which are finally welded, pin bolts shall be omitted from the strength calculations of the joint.

Holes shall be drilled accurately using a template. Burrs and arises shall be removed from the edges of holes before the parts are assembled and holes shall not be punched unless the Engineer gives permission. No holes shall be gas cut, either during fabrication in shops or during erection at site.

Bolt holes shall be accurately aligned so that all bolts can be inserted without force.

Bolts shall not be driven home. Drift pins used to draw members into alignment shall not be used in a manner which distorts or enlarges bolt holes.

Bolts shall be of sufficient length to show at least two clear threads beyond the nut when fully tightened. When bolts are used in bearing, members shall not bear on the threaded part.

11.040 Joint Preparation

Joint interfaces shall be clean and free from loose scale, loose rust, oil, grease, paint and all other deleterious matter before any joint is assembled.

The members to be connected shall be clamped together to achieve contact over the full bearing area. If there is a remaining gap which may affect the integrity of the joint, the connection shall be taken apart and a suitable pack inserted to achieve contact over the full bearing area.

11.041 High Strength Friction Grip Bolts

High strength friction grip bolts shall comply with the following:

- (a) Non-load indicating connectors shall be installed in accordance with BS 4604:Parts 1 and 2;
- (b) Load indicating connectors shall be installed in accordance with the manufacturer's recommendations but the minimum shank tension shall be in accordance with BS 4604:Parts 1 and 2;

- (c) The Contractor shall demonstrate on site to the satisfaction of the Engineer by means of sample bolts and a calibrated bolt load meter that the minimum shank tension is obtained with the type of fastener chosen and the equipment proposed for tightening. All tools used for measuring tightness shall be regularly calibrated on the types of bolts actually being used.

Facing surfaces shall be prepared in accordance with "Protective Coatings". They shall at the time of assembly be clean and free of loose scale, loose rust, oil, grease, paint, masking tape and all other deleterious matter and of burrs and other defects, unless otherwise specified. Lubricant applied to the bolts shall not be permitted on the facing surfaces.

Parts to be connected shall be firmly drawn together with all bolts partially tightened.

The joint shall be examined and if there is a remaining gap which may affect the integrity of the joint, it shall be taken apart and a pack inserted before recommencing the tightening procedure.

High strength friction grip bolts which have been tightened and subsequently released shall not be used in Permanent Works.

Release for Delivery

11.042 Release for Delivery

At the satisfactory completion of the inspection and testing of off-site steelwork, the Engineer shall issue to the Contractor a notification releasing the steelwork for delivery or shipment to the Site. No steelwork shall be delivered or shipped to the Site until the Contractor has obtained the Engineer's notice.

Transport and Storage

11.043 Programme

The Contractor shall propose a programme and method for transporting steelwork to site.

11.044 Handling and Storage

All wire ropes and chain slings used for hoisting and securing loads shall be covered to prevent scoring, chaffing and other damage.

Softwood timber bearers with a sufficient contact area to prevent crushing shall be provided at all stages of transport and storage. Bearers shall be level and sufficient in number to prevent distortion of members. Beams used to support external steelwork shall be sufficiently high to ensure that the lowest parts of the stored members are above the rainwater splash zone and splashing from passing vehicles.

Members shall be stacked to permit free drainage of rainwater from the surfaces and to avoid ponding. If covers are provided to steelwork, timber bearers or other form of support to ensure that covers are not in contact with steel surfaces, arrangements for ventilating under covers to minimise condensation shall be acceptable to the Engineer.

Projecting stud bolts and cleats shall be avoided where possible.

11.045 Prevention of Contamination

Precautions shall be taken at all stages to prevent steelwork being contaminant by oil, cement, soil, chemicals or other deleterious agents. Should any contamination occur, the contaminant shall be removed immediately by swabbing or brushing and the surfaces washed clean with clean water.

11.046 Small Parts

Bolts, loose nuts, washers of each size, shall be packed separately.

Bins, packages of bolts, nuts, washers and other small parts shall be stored in boxes, crates, kegs or barrels, none of which shall exceed 70 kilos gross weight. A list and description of material contained shall be plainly marked on the outside of each.

Erection

11.047 General

The Contractor shall provide and be responsible for all necessary lifting tackle, gear, lifting beams and selection of points for the erection of the works. The structures shall be designed for the erection loads to which they will be subjected. The Contractor shall provide access holes as required for Plant erection.

11.048 Drawings

Where erection drawings are provided by the Contractor, these shall show size and location of all members, and shall give complete location and details for setting anchor bolts. They shall show elevations of bottom of all bases, bearing plates, top of masonry to receive these plates, extent of all connections and all details necessary for erection.

11.049 Assembly and Erection

The Contractor shall submit a proposed method statement for assembly and installation to the Engineer for comment before commencing the works. This will not relieve the Contractor of responsibility of transport, stack, assemble and erect the work without damage, distortion or over stressing. Any component so damaged, etc shall be replaced or rectified.

11.050 Stresses

Provision shall be made for erection stresses and for sufficient temporary bracing to keep frames and members plumb and in true alignment until completion of erection.

As erection progresses, finished connections shall be adequate to take care of all dead load, wind and erection stresses. Bolted connections must not be left to "weather" for any period of time before final tightening. The Contractor shall be responsible for the stability of the structure at all stages during erection and shall provide (and remove on completion) any temporary bracing, guys and so on.

11.051 Lifting and Runway Beams

Not used

11.052 Safety

The Contractor shall observe the good practices and recommendations for safety in the erection of structural frames given in BS 5531.

Tolerances

11.053 Tolerances

Tolerances for fabrication and erection of steelwork shall be in accordance with BS 5950:Part 2, except as modified below:

- (a) Tops of beams at ground level shall be within $\pm 10\text{mm}$ of specified level
- (b) Difference in level of tops of beams at any storey or frame level shall not exceed 3mm
- (c) Columns shall be plumb within 3mm in 3 metres or 5mm in 10 metres.

TABLE 11.1

WELD TESTING SCHEDULE

Item	Test	Percentage of Weld Length to be examined
<u>Butt Welds</u>		
All Welds	Visual Inspection	100%
All Welds	Magnetic Particle Inspection (M.P.I)	10%
Tubular Sections	Radiographic or Ultrasonic (R or U)	100%
<u>Fillet Welds</u>		
All Welds	Visual Inspection	100%
All Welds	M.P.I.	5%
Tubular Sections	M.P.I.	100%
Plates	M.P.I.	10%

Protective Coatings

11.054 General

Preparation for, selection and application of protective coatings shall be in accordance with Section 35.

Standards and Codes of Practice

11.055 Standards

Standards relevant to this Section include:

- | | | |
|-------------|---|---|
| BS EN 287-1 | - | Approval testing of welders for fusion welding steels |
| BS EN 288 | - | Approval of welding procedures for metallic materials |
| BS4 | - | Structural steel sections |
| Part 1 | - | Hot-rolled sections |
| BS EN 499 | - | Welding consumables. Covered electrodes for manual metal arc welding of non alloy and fine grain steels. Classification |
| BS 638 | - | Arc welding power sources, equipment and accessories |
| BS 2600 | - | Radiographic examination of fusion welded butt joints in steel |
| Part 1 | - | Methods for steel 2mrn up to and including 50mrn thick |
| BS EN 24014 | - | Hexagon head bolts. Product Grade A and B |
| BS 24015 | - | Hexagon head bolts. Product Grade B.Reduced shank (shank diameter, pitch diameter) |
| BS EN 24016 | - | Hexagon head bolts. Product Grade C |
| BS EN 24032 | - | Hexagon nuts, Style 1. Product Grades A and B |
| BS EN 24033 | - | Hexagon nuts, Style 2. Product Grades A and B |
| BS EN 24034 | - | Hexagon nuts. Product Grade C |
| BS 2853 | - | The design and testing of steel overhead runway beams |
| BS 3692 | - | ISO metric precision hexagon bolts, screws and nuts |
| BS 3923 | - | Methods for ultrasonic examination of welds |

Part 1	-	Manual Examination of Fusion Welds in Ferritic Steels
BS 4165	-	Electrode wires and fluxes for the submerged arc welding of carbon steel and medium tensile steel
BS 4190	-	Specification for ISO metric black hexagon bolts, screws and nuts (obsolescent)
BS 4604	-	The use of high strength friction grip bolts in structural steel work Metric series.
Part 1	-	General Grade
Part 2	-	Higher Grade (Parallel shank)
BS 4848	-	Hot-rolled structural steel sections
Part 2	-	Hot finished hollow sections
Part 4	-	Equal and unequal angles
BS EN288		Approval of welding procedures for metallic materials
Part 1	-	General rules for fusion welding
BS 4871	-	Approval testing of welders working to approved welding procedures
Part 1	-	Fusion Welding of Steel
BS 4872	-	Approval testing of welders when welding procedure approval is not required
Part 1	-	Fusion welding of steel
BS 4933	-	ISO metric black cup and countersunk head bolts and screws with hexagon nuts (obsolescent)
BS 5135	-	Arc welding of carbon and carbon manganese steels
BS 5289	-	Code of Practice. Visual inspection of fusion welded joints
BS 5531	-	Code of practice for safety in erection structural frames
BS 5606	-	Guide to accuracy in building
BS 5950	-	Structural use of steelwork in building

Part 1	-	Code of practice for design in simple and continuous construction: hot rolled sections
Part 2	-	Materials, fabrication and erection: hot rolled sections
Part 5	-	Code of practice for design of cold formed sections
BS 6072	-	Method for magnetic particle flow detection
BS 6323	-	Seamless and welded steel tubes for automobile, mechanical and general engineering purposes
Part 3	-	Hot finished seamless steel tubes
BS 6443	-	Method for penetrant flaw detection
BS 7191	-	Weldable structural steels for fixed offshore structures

SECTION 12 - DRIVEN PILING

Table of Contents

	General
12.001	General
12.002	Piling Method
12.003	Programme
12.004	Driving Equipment
12.005	Jetting
12.006	Driving Trials
12.007	Damage to Piles
12.008	Driving Sequence and Risen Piles
12.009	Damage to Mains, Services etc
12.010	Driving
12.011	Tolerances
12.012	Forced Corrections
12.013	Obstructions
12.014	Final Set
12.015	Temporary Bracing of Marine Piles
12.016	Marking
12.017	Handling and Storage
12.018	Leaders and Trestles
12.019	Installation Records
12.020	Record Drawings
	Steel Piles
12.021	General
12.022	Pile Shoes
12.023	Ordering
12.024	Dimensional Tolerances
12.025	Straightness
12.026	Fabrication
12.027	Locking Bars
12.028	Matching of Pile Lengths
	Welding
12.029	General
12.030	Fabrication of Piles on Site
12.031	Longitudinally Welded Piles
12.032	Spirally Welded Piles
12.033	Lengthening of Piles
12.034	Extension Welds
12.035	Acceptance Standards for Welds in Bearing and Tension Piles
12.036	Acceptance Standards for Welds in Bearing and Tension Piles
12.037	Rejection of Piles
12.038	Pile Coating
12.039	Head Preparation
12.040	Flame Cut Holes and Edge

Precast Concrete Piles

12.041	Not used
12.042	Not used
12.043	Not used
12.044	Not used
12.045	Not used

Pile Testing

12.046	Not used
12.047	Not used

Static Load Pile Testing

12.048	Not used
12.049	Not used
12.050	Not used
12.051	Not used
12.052	Not used
12.053	Not used
12.054	Not used
12.055	Not used
12.056	Not used
12.057	Not used
12.058	Not used
12.059	Not used
12.060	Not used
12.061	Not used
12.062	Not used
12.063	Not used
12.064	Not used
12.065	Not used
12.066	Not used
12.067	Not used
12.068	Not used
12.069	Not used

Dynamic Pile Testing

12.070	Not used
12.071	Not used
12.072	Not used
12.073	Not used
12.074	Not used
12.075	Not used

Standards and Codes of Practice

12.076	Standards
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SECTION 12 - DRIVEN PILING

General

12.001 General

All materials, procedures and workmanship shall be in accordance generally with the other Sections of this Specification and BS 8004. However, the requirements of this Section shall take precedence. Safety precautions shall comply with statutory regulations and BS 5573 and BS 8004.

Driven piling undertaken in this contract shall compose: tubular steel monopiles to support beacons, transits and leading lights.

12.002 Piling Method

Prior to commencing work, the Contractor shall supply for the Engineer's comment details of the method of piling, proposed plant, procedures for setting out, checking positions and so on.

12.003 Programme

The Contractor shall provide the Engineer with a programme showing the proposed sequence and timing of piling operations.

12.004 Driving Equipment

The Contractor shall select the driving equipment to meet the specified penetration requirements.

12.005 Jetting

Piles shall not be driven by jetting.

12.006 Driving Trials

The Contractor shall carry out trials with proposed driving equipment to ensure that the methods and equipment used are capable in practice of driving the piles to the specified penetration.

12.007 Damage to Piles

Piles shall reach is required depth without damage. If in the opinion of the Engineer damage occurs because of inadequate use or selection of piling equipment, the Contractor shall make appropriate amendments and shall trim the head of any pile damaged during driving and extend the pile as necessary. Driving shall not continue on a damaged pile head.

12.008 Driving Sequence and Risen Piles

Piles shall be driven in a sequence which minimizes potential for heave and lateral displacement of the ground.

Levels and measurements shall be taken to determine the movement of the ground or any pile resulting from the driving process.

When a pile has risen as a result of adjacent piles being driven, the Contractor shall make appropriate corrections and alter procedures to prevent reoccurrences in subsequent work.

12.009 Damage to Mains, Services etc

Hand excavation shall be undertaken to locate services in areas where prior investigation has indicated these might exist. All necessary liaisons shall take place with the owners/managers of such services at the Contractor's cost. If during piling damage is caused to mains, services or adjacent structures, the Contractor shall be liable for the consequences and for the cost of repair.

12.010 Driving

Driving shall ensure that the hammer blow is applied axially to the pile.

Each pile shall be driven continuously until the required set or depth has been reached, unless the Engineer is satisfied that the rate of penetration prior to the cessation of driving will be substantially re-established on its resumption or the suspension of driving is beyond the control of the Contractor. A follower (long dolly) shall not be used unless the set is revised to take into account any reduction in the effectiveness of the hammer blow.

The Contractor shall inform the Engineer as soon as possible if an unexpected change in driving characteristics is noted.

The Contractor shall give adequate notice and provide all facilities to enable the Engineer, when required, to check driving resistances.

Redrive checks, if required, shall be carried out to Engineer's instructions.

12.011 Tolerances

The maximum permitted deviation of the centre of the pile head from its theoretical position shall be 75mm in any direction. The maximum permitted deviation of the finished pile from the vertical shall be 1 in 75 and from a specified rake shall be 1 in 25 for piles raking up to 1 in 6 and 1 in 15 for piles raking more than 1 in 6.

Piles deviating from these tolerances can be rejected. Rejected piles shall be extracted and the Contractor shall drive replacement piles complying in all respects with the requirements of the Specification. No payment will be made for or in connection with any rejected pile.

12.012 Forced Corrections

Forced corrections to piles may only be made with the Engineer's written approval.

12.013 Obstructions

If any unexpected obstruction to driving is encountered; the Contractor shall immediately notify the Engineer and submit proposals for overcoming the difficulties, including the following:

- (a) Excavation to uncover the cause of the obstruction
- (b) Breaking out an obstruction in whole or part and removal, followed by backfilling (if instructed by the Engineer)
- (c) Boring, drilling or chiselling through obstructions (with or without a casing).

12.014 Final Set

The final set of each pile shall be recorded as the number of blows required to produce a penetration of 25mm measured over a distance of at least 250mm.

When a final set is being measured, the following requirements shall be met.

- (a) The exposed part of the pile shall be in good condition without damage or distortion
- (b) The dolly and packing, if any, shall be in sound condition
- (c) The hammer blow shall be in line with the pile axis and the impact surfaces shall be flat and at right angles to the pile and hammer axis
- (d) The hammer shall be in good condition and operating correctly

The temporary compression of the pile shall be recorded, if required

12.015 Temporary Bracing of Marine Piles

Free standing piles in marine locations shall be temporarily braced or stayed immediately after driving to prevent loosening of the piles in the ground and to ensure that no damage resulting from oscillation, vibration or movement can occur.

12.016 Marking

Each pile shall be clearly and indelibly marked with its number and its overall length shown near the pile head. In addition, before being driven, each pile shall be graduated at 1 metre intervals and at intervals of 250mm along the top 3 meters of its length.

12.017 Handling and Storage

All piles shall be stacked in groups of the same length and on adequate supports. Handling, transporting and pitching of piles shall be carried out so that damage to piles is minimised.

12.018 Leaders and Trestles

At all stages during driving and until incorporation in the superstructure, a pile shall be adequately supported and restrained by means of leaders, trestles, temporary supports or other guide arrangements to maintain position and alignment and to prevent buckling. Arrangements shall be such that damage to the piles is minimised.

12.019 Installation Records

The Contractor shall keep records of the installation of each pile and shall submit two signed copies of those records to the Engineer not later than noon of the next working day after the pile was installed. Any unexpected driving conditions shall be noted.

The record for each pile shall be in a form agreed with the Engineer. It shall contain the following information [adjusted to suit the type of pile concerned]:

- (a) Contract
- (b) Pile reference number (location)
- (c) Pile type
- (d) Nominal cross-sectional dimensions or diameter
- (e) Pile length
- (f) Date and time of driving, or redriving
- (g) Ground or sea bed level at commencement of installation of pile
- (h) Working level
- (i) Depth from working level to pile toe
- (j) Final toe level
- (k) Pile head level
- (l) Pile cut-off level
- (m) Type, weight, drop and mechanical condition of hammer and equivalent information for other equipment
- (n) Number and type of packings used and type and condition of dolly used during driving the pile
- (o) The blow count for every 250mm of penetration over the last 3 metres of every pile, and for every 250mm of penetration over the whole length of pile for test piles
- (p) Set of pile in number of blows per 25mm of penetration
- (q) If required, temporary compression of ground and pile from time of a marked increase in driving resistance until pile reaches its final level
- (r) All information regarding obstructions, delays and other interruptions to the sequence of work
- (s) Concrete filling details
- (t) Length and details of reinforcement

12.020 Record Drawings

On completion of the piling the Contractor shall submit a drawing recording the final depth of all piles relative to ordnance datum, the location of each pile, and its deviation from its specified position.

Steel Piles

12.021 General

Steel piles shall be of mild steel Grade S275 to BS EN 10025:Part 2 shall be of the type, length and cross-sectional dimensions shown on the Drawings and shall be supplied in complete unjointed lengths, unless otherwise agreed in writing by the Engineer. Where locking bars are used, these shall also be of the same steel.

12.022 Pile Shoes

Cast steel shoes shall be of steel to BS 3100 Grade A7. Flat plate and welded fabricated steel shoes shall be to BS EN 10025 Grade S275 or S355.

12.023 Ordering

Except where piles are to be driven to specified depths, the Contractor shall order piles based on pile driving criteria estimated from the known soil conditions. Criteria will be re-evaluated as the work proceeds and the results of the early driving trials have been received. If necessary a supplementary order shall be made.

Excess pile lengths ordered shall become the property of the Contractor who shall remove them from site.

12.024 Dimensional Tolerances

All piles shall be of the type and cross-sectional dimensions specified. For standard rolled steel sections the dimensional tolerances and weight shall comply with the relevant Standard. The tolerance on length shall be -0 and + 75mm unless otherwise specified. For proprietary steel sections the dimensional tolerances shall comply with the manufacturer's standards. The rolling or manufacturing tolerances for proprietary sections shall be such that the actual weight of section does not differ from the theoretical weight by more than +4% or -2.5% unless otherwise agreed. The rolling or manufacturing tolerances for steel tubular piles shall be such that the actual weight of section does not differ from the theoretical weight by more than +5% or -5%. For tubular piles the external diameter at any section as measured by using a steel tape on the circumference shall not differ from the theoretical diameter by more than $\pm 1\%$.

12.025 Straightness

The deviation from straightness shall not exceed 1/600 of a length not exceeding 10 metres. When two or more such lengths are joined the deviation from straightness shall not exceed 1/960 of the completed length, unless otherwise agreed by the Engineer.

12.026 Fabrication

Where welding is permitted, the root edges or root faces of lengths of steel piles that are to be butt welded shall not differ by more than 25% of the thickness of piles not exceeding 12mm thick or by more than 3mm for piles thicker than 12mm. When piles of unequal thickness are to be butt welded the thickness of the thinner material shall be the criterion. Pile lengths to be joined shall be selected so that the differences in dimensions are matched as evenly as possible.

12.027 Locking Bars

Any locking bars (eg joining King or H piles into pairs) shall be welded to the piles in the manufacturer's workshop. Welding between locking bars and sheet piles may be carried out on site.

12.028 Matching of Pile Lengths

Longitudinal seam welds of individual tubular piles forming a completed pile shall whenever possible be evenly staggered, but if in order to obtain a satisfactory match of the ends of piles or the specified straightness, the longitudinal seams are brought closely to one alignment at the joint, then they shall be staggered by at least 100mm.

Welding

12.029 General

Welding shall comply with the requirements of "Structural Steelwork", and this Section, which shall take precedence.

12.030 Fabrication of Piles on Site

If the pile lengths are to be made up on the Site, test procedures and dimensional tolerances for the supply of pile material shall conform to the Specification. Adequate arrangements shall be made for supporting and aligning lengths of piles.

12.031 Longitudinally Welded Piles

All welds shall be full penetration butt welds and, with the exception of continuous tube-making processes, longitudinal welds shall be made with extension plates at the starting and finishing points of each seam.

During factory production of welded tube piles at least one radiograph approximately 300mm long shall be required on each completed length as a spot check on weld quality. This shall be taken on a circumference or longitudinal weld and its position shall be as directed by the Engineer.

12.032 Spirally Welded Piles

Prior to forming a spirally welded pile, the edges of the strip shall be straight.

Tubes shall be tested by continuous ultrasonic examination over the whole weld, supplemented where necessary by radiographs to investigate any defects revealed by the ultrasonic examination.

12.033 Lengthening of Piles

Piles shall be lengthened using full penetration butt welds. Sections to be joined shall be maintained in true alignment and position. Where steel sheet piles are spliced by butt welding, the interlocks shall not be welded unless a sealing weld is required.

12.034 Extension Welds

Site extension welds shall be examined for defects by ultrasonic methods.

12.035 Acceptance Standards for Welds in Bearing and Tension Piles

a) H-Piles : Splice Welds

General good workmanship standards shall be applied to extension pile alignment, weld gap, weld profile and undercutting. Table 12.1 defines allowable variation in these factors.

The following acceptance levels for slag, porosity and planar defects shall be mandatory on welder and procedural tests, with the selected recommended electrode, and on an agreed number of the initial site welds. If these are satisfactory, subsequent testing may be reduced at the Engineer's discretion. Any subsequent departure from procedure shall require further check tests.

i) Slag Inclusions

One line of slag the full length of the weld with a maximum width of 3mm will be permitted. The total length may be aggregated from inclusions at differing depths in the weld, ie occurring between different runs, provided that no more than two lines of slag overlap at any point in the cross-section

ii) Porosity

The maximum permitted porosity level is 5% of the projected weld area, averaged over any 75mm of the weld run, with a maximum individual pore size of 6mm or one quarter thickness, whichever is the lesser

iii) Planar Defects

A single buried defect indication of maximum height 4mm or one quarter thickness, whichever is the lesser, of unlimited length. Intermittent defects may not overlap. Any surface cracks will be cause for repair or rewelding

12.036 Acceptance Standards for Welds in Energy Absorbing Structures

a) Tubular Piles - Site Circumferential Welds

Depending on pile diameter these may be made single-sided with a backing bar, or from both sides. They represent the most highly-stressed class of weld, particular in tension situations in dolphins, and all efforts shall be make to keep weld quality as high as possible. The following defect limits shall be applied.

i) Slag Inclusions

Intermittent slag, maximum width 3mm, to a total aggregate length of 100mm in any 300mm. No more than two lines of slag may overlap at any one point in the weld

ii) Porosity

Maximum allowable porosity density will be 5% of the weld area, projected radially, in any 75mm run of weld, with a maximum individual pore size of 3mm or one eight of wall thickness, whichever is the lesser

iii) Planar Defects

Indications of lack of sidewall or root penetration to the extent of 25mm in any 100mm, with a maximum depth of 4mm or 20% of wall thickness, whichever is the lesser. Any cracking to the surface shall be cause for repair

Table 12.1 Weld Geometry Factors

Root gap	6mm +0/-2 with backing bar 3mm +2/-0 without backing bar
Root face	0-3mm; Overlap not allowed
Undercut	0.8mm (max)
Overfill	5.0mm (max)
Excess penetration	5.0m (max)
Fatigue situations	Additional attention will be paid to the external geometry of weld joint, eg profile of reinforcement and inside penetration, angle of reinforcement, etc

12.037 Rejection of Piles

If the results of any weld test do not conform to the specified requirements, two additional specimens from the same length of pile shall be tested. In the case of failure of one or both of these additional tests the length of pile covered by the tests shall be rejected.

12.038 Pile Coating

Surface preparation and coating of steel piles shall be as specified in "Protective Coatings". Piles shall be adequately protected during transportation and handling.

Any coat damaged by subsequent processes or which has deteriorated to an extent such that proper adhesion of the coating may not be obtained or maintained, shall be removed. The steel surface shall be prepared to the original standard and recoated with the specified sequence of coats.

The coating within 200mm of a weld shall be applied after welding.

12.039 Head Preparation

Pile heads shall be cut to within 20mm of the levels specified. All steel cast into concrete shall be clean and free from loose mill scale, loose rust, dirt oil and grease. Where steel sheet piles are cast into concrete, paint coatings shall be cut back to 100mm above the soffit level of the concrete.

12.040 Flame Cut Holes and Edges

Holes in steel piles for bolts, or similar, tie rods and steel reinforcement may be flame cut provided:

- (a) Maximum hole diameter does not exceed the diameter of the fixing plus 6mm, and an oversize washer is used
- (b) The flame cut edges are dressed smooth so as to ensure an even bed for any washer

Precast Concrete Piles

12.041 General

Not used.

12.042 Storage

Not used.

12.043 Lifting

Not used.

12.044 Driving

Not used.

12.045 Lengthening of Concrete Piles

Not used.

Pile Testing

12.046 Test Piles

Not used.

12.047 Supervision

Not used.

Static Load Pile Testing

12.048 Plant and Equipment

Not used.

12.049 Reaction System

Not used.

12.050 Kentledge

Not used.

12.051 Tension Piles and Group Anchors

Not used.

12.052 Working Piles

Not used.

12.053 Spacing of Kentledge Support and Reaction Piles

Not used.

12.054 Equipment for Applying Load

Not used.

12.055 Cut-off Level

Not used.

12.056 Pile Head for Compression Test

Not used.

12.057 Pile Connection for Tension Test

Not used.

12.058 Measurement of Load

Not used.

12.059 Adjustability of Loading Equipment

Not used.

12.060 Measurement of Pile Movement

Not used.

12.061 Measurement by Optical or Levelling Method

Not used.

12.062 Measurement by Dial Gauges

Not used.

12.063 Protection of Measuring Equipment

Not used.

12.064 Vertical Pile Test Procedure

Not used.

12.065 Lateral Pile Test Procedures

Not used.

12.066 Notice of Preparation and Test

Not used.

12.067 Records

Not used.

12.068 Test Results

Not used.

12.069 Test Completion

Not used.

Dynamic Pile Testing

12.070 Preparation of the Pile Head

Not used.

12.071 Data

Not used.

12.072 Set Measurements

Not used.

12.073 Timing of Tests

Not used.

12.074 Hammer Size

Not used.

12.075 Results

Not used.

Standards and Codes of Practice

12.076 Standards

Standards and other Codes relevant to this Section include:-

BS 4360: 1990 Specification for weldable structural steels

BS 5930: 1981 Code of practice for site investigations

BS 8004: 1986 Code of practice for foundations

SECTION 15 - FENDERS, BOLLARDS, QUAY FURNITURE

Table of Contents

Timber Fenders

15.001	Quality
15.002	Not used
15.003	Workmanship Generally
15.004	Dimensions
15.005	Connections

Standards and Codes of Practice

15.006	Standards
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SECTION 15 - FENDERS, BOLLARDS, QUAY FURNITURE

Timber Fenders

15.001 Quality

Timber used for fenders shall be approved hardwood of mature growth, having a density of at least 1050kg/m³ at 25% moisture content, free from defects and air seasoned. The timber shall be formed or supplied in the sizes and lengths shown on the Drawings and no joints other than those detailed will be permitted. All arises shall be slightly rounded unless shown otherwise on the Drawings.

15.002 Treatment with preservative

Not used.

15.003 Workmanship, generally

Workmanship shall be in accordance with BS 5268 Part 2.

15.004 Dimensions

Dimensional tolerances shall be in accordance with BS 5450.

15.005 Connections

The packing of joints and connections in timber members will not be allowed.

The diameter of bolt holes shall be sufficient to permit the bolt to be driven through easily, but not larger than 1.06 times the bolt diameter. Holes shall be drilled in one direction until the lead screw shows through. It shall then be completed from the other side.

Bolts and nuts to BS 4190 of the size and grade shown on the Drawings and galvanised to BS 729 shall be used. Galvanised [square] plate washers [75mm x 75mm] x 5mm shall be provided against timber faces.

All bolt fixings shall be countersunk, the countersinks being filled with approved bituminous mastic. The countersinking shall be of such depth as to provide minimum 50mm cover to the bolt head face.

Screws, where required, shall be countersunk, and of sheradised steel.

Standards and Codes of Practice

15.006 Standards

Standards relevant to this Section include.-

BS 729	Specification for hot dip galvanised coatings on iron and steel articles
BS 4190	Specification for ISO metric black hexagon bolts, screws and nuts
BS 5268	Structural use of timber
Part 2	Specification for Sizes of hardwoods and methods of measurement
Part 5	Code of practice for preservation of timber
BS 5450	Code of practice for permissible stress design, materials and workmanship
BS 5589	Code of practice for the preservative treatment of structural timber

SECTION 19 - NAVIGATION AIDS

Table of Contents

	General
19.001	Scope
19.002	Documentation
19.003	Packing
19.004	Lanterns
19.005	Solar Power System for Lanterns
19.006	Buoys
19.007	Installation Tolerances
	Standards and Codes of Practice
19.008	Standards

SECTION 19 - NAVIGATION AIDS

General

19.001 Scope

This Section concerns the supply, manufacture, inspection and testing at the manufacturer's works, installing and connecting up, testing and putting into operation, painting and completion in full working order of navigation aids. Items include:-

- a) Navigation lights complete with day marks, rechargeable batteries and solar powered charging systems and radar reflectors.

19.002 Documentation

The Contractor shall supply the following documents:

- (a) Manufacturer's details prior to placing orders of each item including:
 - (i) Catalogues and descriptive literature
 - (ii) Range
 - (iii) Details of construction
 - (iv) Protective coatings
 - (v) Power consumption
 - (vi) Battery consumption
 - (vii) Solar power details
 - (viii) Dimensions
 - (ix) Lloyd's Register of Shipping Manufacturer's Approval Certificate
 - (x) Name and address of closest certified spare parts stockiest
- (b) Within 8 weeks of placing orders and before despatch:-
 - (i) Full dimensioned certified drawings
 - (ii) Operating and maintenance instructions
 - (iii) Lloyd's Register of Shipping Manufacturer's Approval Certificate
- (c) Following installation:-

Commissioning Reports and Test Certificates

19.003 Packing

All equipment shall be packed suitable for the proposed method of transport.

19.004 Lanterns

a) General

A marine lantern shall be lightweight, of short focal length, with wide vertical light divergence. The lantern shall be provided with a polycarbonate plastic flanged base with bottom cable entry. The base shall house a flasher unit to provide a light with characteristics as shown as stated on drawing for buoy mounted lanterns and on the Drawings for beacon mounted lanterns.

The lens shall be acrylic and tinted to the colour as stated on drawing and the Drawings. The lens shall be provided with a bird spike and be mounted in a removable weatherproof manner.

Control of the lamp shall be via a sun-switch so that the lantern only operates during the hours of darkness or bad visibility. The range of each lantern shall be in excess of 5 nautical miles over 360⁰ unless otherwise stated in as stated on drawing.

The lantern shall operate at 12 volts DC from a rechargeable lead acid battery mounted in a glass reinforced plastic box to be located below the lantern and forming its support. The lantern shall be fitted with a flasher/lampcharger, with an automatic lamp change, providing six lamps and over 250 pre-programmed flash characters. The battery shall be recharged using a photovoltaic panel mounted on the same support as the lantern and battery box and shall be provided with its own bird spike. On buoys, the batteries shall be located inside a watertight compartment within the buoy tower section and above the water line.

b) Sector Lights

Additional requirements for sector lights are as follows:

Sector lights shall be designed to provide a 2.5 degree clear sector for marking the channel and a red and green sector to either side. Total horizontal divergence to be 14 degrees.

Design of optics shall insure a high definition between each colour. The sector light body should be designed for a marine environment and manufactured from heavy duty marine grade aluminum. All mating surfaces to be fitted with a gasket.

c) Range Lights

Additional requirements for range lights are as follows: .

Lantern bodies shall be manufactured from a corrosion resistant, marine grade aluminum with built in levelling hardware and a slip ring mounting for ease of adjustment.

A parabolic reflector manufactured from borosilicate glass to focus the light beam shall be provided where necessary. A high durability coating shall ensure a 92% reflectivity or greater in visible light.

The lantern shall be fitted with a spreader lens to the angle specified on the drawing and a flasher/lamp changer, with automatic lamp change, providing six lamps and over 250 pre-programmed flash characters.

19.005 Solar Power System for Lanterns

The solar panels and battery shall be sized to suit the prevailing site conditions and the following criteria:

Specified Range	Refer to Schedule or drawings
Voltage	12 volts
Lamp Current	To be advised by Manufacturer
Character	Refer to Schedule
Duty period of lantern	14 hours per day

Solar panels shall utilize semi-crystalline silicon solar cells laminated between sheets of ethylene vinyl acetate and tempered glass. They shall be fitted with a marine grade aluminum frame and provided with bird spikes.

Solar panels shall be supplied with regulation to protect the batteries from overcharging and with additional capacity to compensate for battery ageing and solar power variations.

Batteries shall be maintenance free.

All metallic parts shall be hot dip galvanised. Polycarbonate, acrylic and glass reinforced plastic parts shall be self coloured.

Navigation lights located onshore shall be mounted on steel supports as shown on the Drawings. The supports shall be fitted and protected against corrosion in accordance with the provision of this Specification.

19.006 Buoys

1. Design Criteria

Not used

2. Basic Requirements

Not used

3. Buoyancy Chamber

Not used

- 4. Skirt**
Not used
- 5. Counterweights**
Not used
- 6. Manhole**
Not used
- 7. Lifting and Mooring Eyes**
Not used
- 8. Buoy Serial Numbers**
Not used
- 9. Trestle Shoes**
Not used
- 10. Trestle**
Not used
- 11. Studs/Bolts and Nuts**
Not used
- 12. Painting**
 - 12.1 Prior to fabrication and assemble, all steel plates are to be shot blasted to Swedish Standard SA 2V2 and shop primed with INTERNATIONAL Interplate epoxy NEA 407 / NEA 409.
 - 12.2 After fabrication, prepare the weld and damaged areas to ST 3 using power tools and touch up with the following coat to respective areas:

Above water-line	-Interplus EPA 056 / EPA 058
Below water-line	-Intershield EGA 780 / EGA 781
 - 12.3 The plates are then to be coated with the following coats of Marine International paint. All paints to be provided by Supplier.

12.3.1 Above Water Line

- (a) One coat of Intergard EPA 001/740 MIO at 125 microns d.f.t.
- (b) One coat of Intergard EMB 000/744 HB WHITE at 100 microns d.f.t.
- (c) Two coats Interlac HXA Series Fluorescent Finish at 50 microns d.f.t. Colour of paint will be determined later by Acceptance Committee.

12.3.2 Below Water Line

- a) One coat of Intershield EGA 101 / 103 RED at 150 microns d.f.t.
- b) One coat of Intertuf modified epoxy JXA 464 / 465 at 100 microns d.f. t.
- c) Two coats of Intersmooth HISOL BFA 956 PLUM at 125 microns d.f. t. per coat.

12.4 Application of paint shall be strictly to follow the recommendations laid down by the paint manufacturer.

13. Air Tightness and Buoyancy Test

Not Used

14. Mooring

Not Used

15. Sinker

Not Used

19.007 Installation Tolerances

Navigation Aids to be attached to fixed structures shall be installed in positions and to levels specified or agreed by the Engineer within the following tolerances:

- (i) Plan position $\pm 10\text{mm}$
- (ii) Level $\pm 10\text{mm}$

Standards and Codes of Practice

19.008 Standards

Standards relevant to this Section include:

IALA Aids to Navigation Guide

SECTION 31 - METALWORK

Table of Contents

	General
31.001	Scope
31.002	Fabrication
31.003	Mild Steel
31.004	Stainless Steel
31.005	Galvanizing
31.006	Welding of Galvanised Steel
31.007	Not used
31.008	Painting
	Fixings
31.009	Fixings and Fixing Bolts
31.010	Holes
31.011	Positioning
31.012	Inserts
31.013	Not used
	Bearings
31.014	Not used
31.015	Not used
31.016	Not used
31.017	Not used
31.018	Not used
	Hand-railing
31.019	Steel Hand-railing
31.020	Not used
31.021	Fixing Bolts
	Ladders
31.022	Steel Ladders
31.023	Vertical Fall Arrest System
	Ironmongery
31.024	Scope
31.025	General
31.026	Not used
	Miscellaneous
31.027	Not used
31.028	Open Grating Flooring
	Standards and Codes of Practice
31.029	Standards

SECTION 31- METALWORK

General

31.001 Scope

This Section covers metalwork (excluding structural steelwork)

31.002 Fabrication

Fabrication drawings and details of steel items shall be submitted for the Engineer's comment before fabrication. Steel and fabrication shall comply with the requirements of BS EN 10025 and BS 5950. All sharp edges shall be removed from *holes* and cut faces.

Welded fabrications to be galvanised shall be continuous by welded to avoid forming crevices. Enclosed tubular construction to be galvanised shall be provided with vent holes.

31.003 Mild Steel

Mild steel items shall be Grade S275 to BS EN 10025.

31.004 Stainless Steel

Stainless steel items in marine environments shall be Grade 316 S31 to BS 970:Part 1.

31.005 Galvanizing

Steel items, including fixings, bolts, nuts and washers, plates, brackets, etc. to be galvanised shall be hot dip galvanised to BS 729. The Contractor shall determine the required thickness of galvanizing for the following environment conditions:-

- i) Sea water splash zone, or frequent salt spray
- ii) Sea water, immersed

31.006 Welding of Galvanised Steel

Where welding of exposed parts has been carried out after galvanizing, the affected area shall be treated as specified in Section 35 "Protective Coatings".

31.007 Steel Windows and Doors

Not used.

31.008 Painting

Metal items to be painted shall be painted in accordance with "Protective Coatings".

Fixings

31.009 Fixings and Fixing Bolts

Fixings may be:

- (a) Expanding anchor
- (b) Bonded using resin-based grout/mortar
- (c) Cast-in

Resin-based fixings shall be tested in accordance with BS 5080:Part 1.

The components of an expanding anchor or cast-in fixing shall be of materials which do not cause bi-metallic corrosion between the fixing and the item being fixed.

31.010 Holes

Holes for fixings in concrete and masonry may be drilled insitu. The diameter and depth of holes drilled shall be appropriate for the fixings and in accordance with manufacturer's instructions where proprietary fittings are used. Holes shall be carefully cleaned and blown out before the fixings are inserted. Alternatively, holes may be formed when casting concrete.

31.011 Positioning

No holding-down fixing or hole for any fixing shall be within 15mm of any reinforcing bars in a reinforced concrete structure.

31.012 Inserts

Any proprietary inserts for bolts or other fixings shall be of a material and of a type agreed by the Engineer and used in accordance with the manufacturer's instructions.

Blocks and strips to be cast into concrete shall not be timber, shall not rot or otherwise deteriorate, and shall be of a dovetail section to key into the concrete.

31.013 Cast-in Sockets

Not used.

Bearings

31.014 Sliding Bearings

Not used.

31.015 Neoprene Bearings

Not used.

31.016 Tolerances for Bearings

Not used.

31.017 Grease Packing

Not used.

31.018 Grease

Not used.

Hand railing

31.019 Steel Hand railing

Not used

31.020 Aluminum Hand railing

Not used.

31.021 Fixing Bolts

Not used

Ladders

31.022 Steel Ladders

Ladders shall be of grade S275 steel to BS EN 10025 and shall comply with BS 5395, except where detailed otherwise on the Drawings. Ladders shall be galvanised.

Ladders shall be installed accurately in location, alignment, elevation, plumb, level, true and free of warp.

31.023 Vertical Fall Arrest System

Vertical fall arrest system shall be the EN353-1 track and 0086 trolley manufactured by Unistrut, UK or similar approved, and fitted to every ladder complete with track system and trolley. 3 No harnesses, compatible with the track system shall be provided. All components shall be constructed from materials suitable for the designated environment.

Ironmongery

31.024 Scope

Ironmongery includes metallic fittings and fixtures for doors, windows, cupboards, wardrobes and rails, holders and hooks. Locks and latches to BS 5872, hinges to BS 7352, thief resistant locks to BS 3621 etc.

31.025 General

All ironmongery shall be of agreed manufacture, fitted in an approved manner. All locks shall be provided with two keys. Ironmongery shall include all necessary and suitable matching screws.

All ironmongery with moveable parts shall be tested, cleaned and adjusted.

Samples of all ironmongery ordered shall be provided to the Engineer for comment, and agreed samples thereafter be regarded as the standard for the work.

31.026 Roller Shutter Doors

Not used.

Miscellaneous

31.027 Chequer Plate Flooring

Not used.

31.028 Open Grate Flooring

Open grating flooring shall be Lionweld diamond mesh flooring type 20R, galvanised, or similar approved manufactured to BS 4592, to sustain a loading of 5kN/m^2 . Flooring clips shall be of the type suited to the shape and orientation of the supporting member and in accordance with manufacturers recommendations. All clips, nuts and bolts shall be galvanised. Use of clips which protrude above the level of the open steel flooring is not permitted. Adequate secondary steelwork (in addition to that indicated on the Drawings) shall be provided such as to permit the design loading to be sustained. Adequate framing shall be provided around all openings.

The ends of all cut bars shall be trimmed and deep binding bars shall be provide where necessary to maintain uniform flooring levels.

Standards and Codes of Practice

31.029 Standards

Standards and other documents relevant to this Section include:

BS 729	-	Hot-dip galvanised coatings on iron and steel articles
BS970	-	Wrought steels for mechanical and allied engineering purposes
Part 1	-	General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels
BS 1387	-	Screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
BS 1449	-	Stainless and heat-resisting steel, sheet and strip
BS 3621	-	Specification for thief resistant locks
BS 6105	-	Corrosion resistant stainless steel fasteners
BS 6510	-	Steel windows, sills, window boards and doors
BS 5080	-	Structural fixings in concrete and masonry
BS 5395	-	Stairs, ladders and walkways
BS 5872	-	Locks and latches for doors in buildings
BS 5950	-	Structural use of steelwork in building
BS 6323	-	Seamless and welded steel tubes for automobile, mechanical and general engineering purposes
BS 6744	-	Austenitic stainless steel bars for the reinforcement of concrete
BS 7352	-	Strength and durability performance of metal hinges for side hanging applications and dimensional requirements for template drilled hinges
BS EN 10025	-	Hot rolled products of non-alloy structural steels. Technical delivery conditions
PD6484	-	Commentary on corrosion of bimetallic contacts and its alleviation

SECTION 35 - PROTECTIVE COATINGS

Table of Contents

	Introduction
35.001	General
	Paint Supply
35.002	Approval of Supply
35.003	Protective Coating Schedule
	Delivery and Storage of Paint
35.004	All Paint to be from Same Manufacturer
35.005	Paint Containers
35.006	Paint Store
35.007	Shelf Life of Paint
	General Cleaning
35.008	Surface Deposits
35.009	Surface Defects
35.010	De-greasing Surfaces
35.011	Washing Steel Surfaces
	Surface Preparation
35.012	General
35.013	Hand Cleaned Surfaces
35.014	Power Tool Cleaned Surfaces
35.015	Excessive Wire Brushing
35.016	Blast -cleaning
35.017	Sample Blast-Cleaned Panel
35.018	Surface Roughness of Blast-cleaned Steel
35.019	Abrasives for Blast-cleaning
35.020	Preparation of Blast-cleaned Surfaces
	Paint Application
35.021	Supervision
35.022	Trials and Quality Control Samples
35.023	Paint Application General
35.024	Method of Application
35.025	Conditions for Painting
35.026	Multiple Coats
35.027	Intervals Between Coats
35.028	Stripe Coats
35.029	Coverage Rates
35.030	Surface Defects
35.031	Application Areas
35.032	Final Coat after Erection
35.033	Records
35.034	Damaged Blast Primer Surfaces
35.035	Repair of Damaged Areas
	Galvanising
35.036	General
35.037	Pre-galvanising Requirements

35.038	Finish
35.039	Post-Fabrication Galvanising
35.040	Nuts, Bolts and Washers
35.041	Damaged Metallic Coatings
	Testing
35.042	Measurement of Thickness
35.043	Dry Film Thickness
35.044	Testing Method
35.045	Testing Hot-Dip Galvanised Coatings
	Testing of Paints
35.046	Samples for Paint Delivered to Site
35.047	Check Samples
	Treatment of Joints
35.048	Splice Joints
35.049	Bolted Joints
35.050	Ordinary Bolted Joints
35.051	High Strength Friction Grip Bolted Splices
35.052	Welded Joints
	Transport, Handling and Storage
35.053	Transport & Handling
33.054	Storage
	Safety and Health
35.055	Safety and Health
	Standards and Codes of Practice
35.056	Standards
	Appendices
35.1	Protective System

SECTION 35 - PROTECTIVE COATINGS

Introduction

35.001 General

This Section covers protective coatings to steelwork and metalwork.

All protective coating operations shall be executed in accordance with BS 5493, except where varied by this Specification, or agreed manufacturer's instructions.

Prior to applying any coating system, the Contractor shall undertake a trial for comment by the Engineer.

Paint supply

35.002 Approval of supply

The following details for each type of paint shall be submitted to the Engineer before orders are placed:

- (a) Manufacturer: Name and address.
- (b) Brand name and reference number.
- (c) Method of application.
- (d) Mass per litre (kgs).
- (e) Pack size (litres)
- (f) Volume Solids.
- (g) Nature of binder.
- (h) Nature of main pigment in total pigment
- (i) Wet film thickness (range).
- (j) Dry film thickness (range).
- (k) Theoretical spreading rate (at minimum thickness ignoring waste due to spilling, loss in tins and pipes).
- (l) Application instructions (including mixing ratios for two pack materials and mixing methods for each type of paint).
- (m) Flash Point
- (n) Drying times; surface dry, hand dry and over coating.
- (o) Temperature limits for painting.
- (p) Humidity limits for painting.
- (q) Cleaning solvent (or thinners).
- (r) Shelf life and storage requirements.
- (s) Hazard data sheet.
- (t) Manufacturer's instructions and information on any other matter.

35.003 Protective coating systems

Painting shall be in accordance with the protective coating systems provided at the end of this Section. Three weeks shall be allowed for the Engineer to comment on the Contractor's proposals. Orders shall not be placed until the Engineer has agreed to the proposed paint system.

Delivery and storage of paint

35.004 All paint to be from same manufacturer

All paints forming a paint coating system other than primers shall be supplied by the same manufacturer which shall be agreed by the Engineer. All paints including primers within a system shall be compatible between coats and with the metal substrate (including pre-primed metalwork). The source of supply of any paint or the formulation shall not be changed without obtaining the agreement of the Engineer.

35.005 Paint containers

All paint shall be delivered III containers not exceeding 25 litres sealed by the manufacturer.

The name of the manufacturer, date of manufacture, colour, type of paint, batch number, shelf life and information regarding special storage requirements shall be clearly shown on each container. The markings on the containers shall clearly identify any paint prepared with a special consistency for spray application.

Two-pack paints shall be supplied in sealed containers. Each pack shall contain the correct proportions for mixing a full batch of paint.

35.006 Paint store

Paint shall be stored in sealed containers in a lock-up store not exposed to extreme temperatures. The temperature in the store shall be kept between 4°C and 27°C. Any special storage conditions recommended by the manufacturer shall be observed. Paint shall be used in order of delivery.

35.007 Shelf life

Paint which has not been used within the 'shelf life' period specified by the manufacturer or within 18 months of the date of manufacture, whichever is the lesser, shall be replaced.

General cleaning

35.008 Surface deposits

Any surface deposits of concrete or other adherent matter including weld slag and spatter shall be removed.

35.009 Surface defects

All surface defects, including cracks, surface laminations, shelling fins at saw cuts, burrs and sharp edges likely to be detrimental to the protective coating system, shall be removed. Weld surfaces shall be ground smooth.

35.010 De-greasing

Unless specified to the contrary, all surfaces contaminated by oil or grease shall be washed with an emulsion cleaner. Oil or grease may, in locations acceptable to the Engineer, be removed by washing with a proprietary water soluble mixture of solvent and detergent, followed by rinsing with clean water.

35.011 Washing

Steel surfaces having soluble salt deposits shall be thoroughly cleaned using potable water and, where conditions permit, hosepipes and scrubbing brushes. In locations where the use of hosepipes are not permitted by the Engineer, the surfaces shall be scrubbed using potable water and allowed to dry.

Surface Preparation

35.012 General

The method and standard of the surface preparation and priming are specified in the protection coating systems at the end of this Section.

35.013 Hand cleaned surfaces

Hand cleaned surfaces of well-weathered steel with no adherent mill scale and considerable pitting as Grade C or D, shall be scraped, and wire-brushed, with all dust removed from the surface to give a Grade CSt2 or DSt2 finish, in accordance with SIS 055900.

35.014 Power tool cleaned surfaces

Power tool cleaned surfaces well-weathered steel with no adherent *mill* scale and considerable pitting as Grade C and D, shall be cleaned using chipping hammers, needle guns or abrasive discs followed by power wire-brushing, with all dust removed to give a Grade CSt3 or DSt3 finish, in accordance with SIS 055900.

35.015 Excessive Wire Brushing

Excessive wire brushing resulting in a burnished finish and/or an unacceptable degree of surface roughness shall be made good until the surface complies with one of the above standards of surface finish.

35.016 Blast-cleaning

Blast-cleaned steel surfaces shall comply with the requirements of Swedish Standard SIS 055900 as specified in the protective coating systems at the end of this Section.

Blast cleaning shall be carried out after all fabrication has been completed.

35.017 Sample blast-cleaned panel

A sample blast-cleaned steel panel measuring not less than 150mm x 150mm x 6mm adequately protected by a sealed transparent wrapping shall be prepared before any permanent work is put in hand. The approved sample shall then be retained on the site for comparison with the prepared steelwork.

35.018 Surface roughness of blast-cleaned steel

The surface roughness measured by any of the methods defined in BS 7079:Part 6 shall not exceed 75 microns nor shall the maximum profile exceed 25% of the total dry film thickness for steel surfaces which are to be painted.

On previously painted or rehabilitated steel the degree of surface roughness shall be agreed with the Engineer prior to the commencement of work.

35.019 Abrasives for blast-cleaning

The type and size of abrasive shall comply with the requirements of BS 7079. All abrasives shall be clean and free from salts. The Contractor shall carry out a series of tests using various sizes of abrasives smaller than the maximum defined in BS 7079, to determine which gives the best profile; this size of abrasive shall be used for all subsequent blast-cleaning. The grading of abrasives for equipment which use abrasives more than once shall be checked at regular intervals and fresh abrasives added to ensure that the correct grading is maintained.

35.020 Preparation of blast-cleaned surfaces

Steel surfaces shall after completion of blasting be cleaned using bristle brushes or vacuum cleaned to ensure that all traces of abrasive material and blast-cleaning products are removed.

Oil, grease and surface contamination shall be removed by washing with an emulsion cleaner and the surfaces shall, if necessary, be further blast-cleaned to achieve the specified standard.

Paint Application

35.021 Supervision

The Contractor shall provide a suitably experienced supervisor to ensure that the coating systems are applied in accordance with the paint manufacturer's instructions.

The Main Contractor shall alert the approved paint supplier 7 days prior to start of application and permit the approved paint supplier to inspect the work in progress, and prepare inspection reports. The approved paint supplier shall forward a copy of each inspection report to the Engineer. Technical support from the paint supplier shall not relieve the Contractor from contractual

responsibility to ensure that the coatings are applied in accordance with the specification.

35.022 Trials and quality control samples

The Contractor shall carry out paint application trials with the equipment and labour to be used in the Works. The Contractor shall supply suitable blast-cleaned steel and sufficient paint for the trials and shall demonstrate the application of each coat of paint of a designated paint system in accordance with the specification and the paint manufacturer's instructions. No painting of the Permanent Works steelwork shall commence until the trials have been completed satisfactorily.

Sample panels shall be not less than 2m² and should where appropriate include galvanized mild steel.

35.023 Paint application general

Immediately before application of each coat of paint, the Contractor shall ensure that:

- (a) The surfaces meet the standard of preparation described in the Specification.
- (b) The surfaces are free from harmful residues, including dust, grit and paint degradation products.
- (c) The surfaces are free from detrimental contamination including salts.
- (d) The surfaces are free from moisture detrimental to the coating to be applied.
- (e) The interval between surface preparation and painting is appropriate to the degree of exposure of the site and the material to be painted. In marine environments, the interval between surface preparation and painting shall not exceed 30 minutes. The primer shall be applied prior to oxidation of the steel substrate.

35.024 Method of application

Unless otherwise described in the Contract, each coat of paint in a system shall be applied by one of the following:

- (a) Brush
- (b) Airless spray
- (c) Air pressure spray

The coating shall be applied in accordance with the manufacturer's instructions, including temperature and humidity limitations.

35.025 Conditions for painting

Paint shall not be applied under the following conditions unless, with the written agreement of the paint manufacturer:

- (a) When the ambient temperature falls below 5-C, or the relative humidity rises above 70% in an enclosed workshop or 90% on site.
- (b) During rain, mist, or in a dust laden atmosphere.
- (c) When the amount of moisture likely to be deposited on the surface by condensation or rain before or after painting may have a harmful effect on the paint.
- (d) When wind borne dust may have a harmful effect on the paint.

35.026 Multiple coats

Where more than one coat is to be applied, each shall show a clear change of colour from the one before.

35.027 Intervals between coats

The intervals between coats shall normally be as instructed by the manufacturer, taking into account the conditions of application. Notwithstanding the latter, no further coats shall be applied until the previous coating has dried or cured to the correct degree.

35.028 Stripe coats

As soon as the first undercoat has dried an extra stripe coat of paint shall be applied by brush to edges, corners, crevices, exposed parts of bolts, and welds, using a similar undercoat but in contrasting shade. Successive coats shall have different shades for identification.

35.029 Coverage rates

The Contractor shall ensure that the specified average dry film thickness of each coat is attained.

Wet film thickness gauges shall be supplied by the Contractor and used to check the rate of paint application.

35.030 Surface defects

Each coat of paint of a specified system of whatever applied thickness shall be free from all surface defects, particularly cratering, pin-holing, blistering, sagging, and dry spray.

The finished system shall have an even and uniform appearance.

35.031 Application areas

Where possible paint shall be applied within covered areas where protection is given from the drying effects of the sun and wind. The location of work areas for surface preparation and paint application shall be well separated to avoid contamination of surfaces. The Contractor shall take all necessary precautions to prevent contamination, particularly by spray, of adjacent works and areas.

35.032 Final coat after erection

Where component parts of any structure are coated prior to erection, the final coat shall be applied insitu, unless otherwise agreed by the Engineer.

35.033 Records

The Contractor shall keep detailed records of materials, batch numbers, and site conditions at time of application of all coatings. The records shall be provided to the Engineer in duplicate upon completion of each coating system.

35.034 Damaged blast primer surfaces

Where the blast primer applied to blast-cleaned steel has become damaged or deteriorated to such an extent that corrosion has commenced, the surface shall be blast- cleaned to the original standard and painted with the approved primer. Where it is not possible to blast clean, mechanically wire brush to Swedish Standard St2 and apply Interplus 256 or similar, surface tolerance epoxy.

35.035 Repair of damaged areas

Any coated surfaces damaged at any stage of the work shall be repaired by preparing the affected area and 25mm of sound paint beyond that area in all directions, and re-coating in step coats to provide an overlap of at least 50mm on the existing coating.

Galvanizing

35.036 General

After final fabrication and blast cleaning, all items specified shall be hot-dip galvanised in accordance with BS 729, to give a thickness of 210 microns in accordance with BS 5493.

35.037 Pre-galvanizing Requirements

Before proceeding with galvanizing the Contractor shall provide full details of the surface preparation and coating methods proposed and shall commence work until the Engineer's permission has been received.

35.038 Finish

All galvanised surfaces shall present a uniform and continuous coating, clean and free from drops of spelter or sharp edges.

35.039 Post-Fabrication Galvanizing

Steelwork shall be galvanised after fabrication (including all cutting, welding, drilling, grinding, and other operations) is complete. Surface defects shall be removed and if of welded construction, the steelwork shall be free from slag and pin-holes. Tapped holes shall be fitted with fasteners before dipping.

35.040 Nuts, Bolts and Washers

All nuts, bolts and washers shall be galvanised in accordance with BS 729 before despatch to Site. Threads of galvanised items shall be cut to make allowance for the thickness of galvanizing to avoid stripping the threaded portion upon assembly.

33.041 Damaged Metallic Coatings

If any zinc coatings are damaged during handling or delivery they shall be replaced by the Contractor, unless the Engineer allows minor damage to be made good. Repairs to areas greater than 40mm² shall not be permitted.

Areas damaged by welding or minor damage, shall be repaired as follows:

- (a) Heat the damaged areas with a flame torch at approximately 300°C and clean with a wire brush
- (b) Rub the area with an approved zinc stick, taking care that the metal is evenly distributed

The stick or rod shall be applied by an experienced person In accordance with manufacturer's instructions.

If permitted by the Engineer, a repair using a minimum of three coats of zinc rich paint shall be applied in accordance with BS 4652 to provide protection equivalent to the undamaged coating.

Testing

35.042 Measurement of thickness

The thickness of dry or wet paint films shall be measured as specified in BS 3900:Part C5. Wet film thickness shall be measured by comb or wheel gauges.

35.043 Dry film thickness

Magnetic gauges shall be calibrated on the steel surfaces after completion of preparation. Before painting readings shall be taken to establish the datum reading for the surface. The datum reading shall be deducted from the instrument reading when the nominal dry film thickness of a paint film is measured. Magnetic gauges shall be tested daily on both blast cleaned surfaces and on top of calibrated paint shims using the same shim thickness as the expected paint dry film thickness.

A dry paint film shall be accepted as complying with the specified nominal dry film thickness if measurements taken at regular intervals over any square metre show that the average of the readings equals or exceeds the specified nominal thickness. In no case shall any reading be less than 75 per cent of the nominal thickness.

35.044 Testing method

When the Engineer is satisfied that dry film thickness measurements show that the specified film thickness for each coat of the system is being consistently obtained, wet film thickness gauges may be used for routine measurements with dry film thickness measurements being taken at less frequent intervals. The Engineer's acceptance of the wet film thickness measurements shall not, however, relieve the Contractor of his responsibilities under the Contract.

35.045 Testing hot-dip galvanized coatings

Testing of the nominal thickness of galvanised coatings shall be carried out with either a magnetic pull-off gauge or other non destructive testing, in accordance with BS 729.

Testing of paints

35.046 Samples for paint delivered to site

For quality assurance purposes the Contractor shall provide, unopened, 5 litre samples of each type of paint to be used for the Works. In addition the Contractor shall supply 500ml samples for application control purposes.

Quality assurance of paint as delivered, is by verification of the composition data and application characteristics given in paint manufacturer's formulations. Checks shall be carried out on paint samples taken from the previously unopened 5 litre tins provided to the Engineer.

35.047 Check samples

Spot check samples shall be taken by the Engineer from painters' kettles or from airless spray gun nozzles in order to check the paint actually being applied. The sealed samples shall be tested by an approved testing authority,

which shall test the paint in accordance with BS 3900 for any single pack product. Two pack materials must be tested immediately on site before curing.

Treatment of Joints

35.048 Splice joints

As soon as possible after splice joints have been completed, the parent and joint material, exposed parts of bolts, nuts and washers, weld and weld affected areas shall be brought to the same state of preparation and painting as the adjoining completed surfaces.

35.049 Bolted joints

As soon as possible after they have been completed, the perimeter of all bolted joints shall be sealed against the ingress of water with paint or with an approved non-slump mastic filler which is compatible with the paint, such as Dunlop Adhesives Ltd DP 392.5 one part nitrite sealant. In addition, at high strength friction grip bolted splices, the gap between the two members shall be sealed throughout, but no mastic shall be applied to the faying surfaces.

The sealant shall be applied in accordance with the manufacturer's instructions.

Over painting of sealant shall not take place until the sealant has sufficiently cured.

35.050 Ordinary bolted joints

At ordinary bolted joints in steelwork and metalwork the protective coatings to all surfaces of the members shall be completed before bolting takes place.

Bolt holes shall, wherever possible, be drilled before the member is painted. If holes are drilled after painting, the edges of the holes shall be prepared and painted before bolting.

35.051 High strength friction grip bolted splices

The faying surfaces in high strength friction grip bolted connections shall comply with the requirements of BS 5493.

If load indicator washers are employed, any gap between the washer and the steel shall be sealed either with an approved mastic sealant or with paint.

35.052 Welded joints

At joints in members which are to be welded after the member has been painted, the paint coating shall be kept 100mm clear of the weld. The restricted area shall be masked during spraying. Paint coats shall be stepped back at 30mm intervals starting with 2nd coat of paint.

At joints in members which are to be welded after the member has been galvanised, galvanizing shall be removed for a distance of 5mm back from the edges of weld areas.

Transport, handling and storage

35.053 Transport and handling

Coated surfaces shall not be permitted to be in contact during transport or handling.

Wrapping, packaging or crating shall be used to reduce damage during transit. The positions of packing pieces shall ensure the steelwork is not distorted. Galvanized steel items shall be stored and transported in well ventilated conditions to reduce the risk of white rust.

35.054 Storage

Fabricated steelwork which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner, and covered where necessary, to ensure that no pools of water or dirt accumulates on the surfaces. Spacer pieces shall be placed to prevent contact between members. Covers shall be well ventilated and not in direct contact with the coated surfaces.

Safety and Health

35.055 Safety and Health

Coatings shall be applied in accordance with relevant health and safety requirements, particular for activities that generate dust or fumes.

Standards and Codes of Practice

35.056 Standards

Standards and other documents relevant to this Section include:

BS 729	-	Hot dip galvanized coating on iron and steel articles.
BS 2523	-	Lead based priming paints
BS EN 22063	-	Metallic and other inorganic coatings. Thermal spraying. Zinc, aluminum and their alloys
BS 2569:Part 2	-	Sprayed metal coatings - Protection of iron and steel against corrosion and oxidation at elevated temperatures

BS 3436	-	Ingot zinc
BS 4921	-	Sheradised coatings on iron and steel articles
BS 3900:Part C5	-	Methods of test for paints.
BS 7079:Group C	-	Surface roughness characteristics of blast-cleaned steel substrates
BS 4604:Part 1	-	The use of high strength friction grip bolts In structural steelwork (general grade)
BS 4652	-	Zinc rich paint
BS 5493	-	Protective coating of iron and steel structures against corrosion.
SIS 05 5900	-	Pictorial surface preparation standards for painting (Swedish) steel surfaces.

APPENDIX 35.1

PROTECTIVE SYSTEMS

Protective System P2

Use: All steel work.

At Site

Preparation: Heavily pitted areas to be stripe coated by brush, to ensure good 'wetting' of surface, particularly if incompletely dry.

Degrease according to SSPC-SPI solvent cleaning
Where necessary remove weld splatter and smooth weld seams and edges. Dry or wet blast clean to SA2 ISO 8501-1: 1988 (Swedish Standard SIS 05 5900) recommended profile 75-100 microns. If salt water is used in the blasting process or contamination with salt water is possible the surface shall be thoroughly washed with fresh water prior to application of specified system.

Painting: 1 coat hydrocarbon resin modified epoxy
Nominal d.f.t: 500 microns
Shade: Black
Volume Solids: 85%
VOC: 165 gms/litre
Method of Application: Airless spray

Protective System G 1

Use: For all galvanised steel quay furniture, crane rail soleplates and structural fasteners, unless specifically not required

Galvanizing
Preparation: Following removal of burs, slag and grease, abrasive blast clean to SIS 05590 SA 2.5

Galvanizing: The hot dip galvanizing process shall be carried out generally in accordance with BS 729, except that the minimum thickness for the zinc coating shall be 210 microns.

Preparation: Remove dirt and debris and clean thoroughly with an emulsifying degreasing agent to remove all grease and foreign matter.

The articles may be lightly sweep blasted after cleaning and degreasing or etched as follows:

Coatings: Coat 1 Apply T Wash or a two-pack etch primer conforming to BS 5493 type AP3A, care being taken to obtain a dry film thickness (dft) of between 8 microns and 1 micron. Excessive film build up must be avoided.

Coat 2 High build surface tolerant epoxy micaceous iron oxide consisting of a two-pack epoxy undercoat to give dft of 100 microns. Pigmentation natural

Coat 3 Recoatable polyurethane finish, dft 50 microns, black.