Intended for
Government of Bermuda – Ministry of Public Works

Document type
Specification

Date
July, 2018

KINGS WHARF REHABILITATION BERMUDA

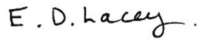
SPECIFICATION FOR MARINE WORKS

RAMBOLL

Revision	04
Date	23/07/2018
Made by	G. Pavey
Checked by	E. Lacey
Approved by	J. Christie
Description	Specification

Revision History

Revision	Date	Purpose / Status	Comments
01	21/06/2018	Preliminary	
02	13/07/2018	Preliminary	
03	20/07/2018	Preliminary	
04	23/07/2018	Tender	

Prepared By	Reviewed By	Approved By
		
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SERIES 000 INTRODUCTION

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000 INTRODUCTION

The Ramboll Standard Specification for Marine Works, from which this specification has been produced, contains 25 General Series, numbered 000 – 2600, 10 Project Specific Series, numbered 3000 – 3900, 10 Ancillary Series numbered 4000 – 4900 and 1 Appendix, Appendix A.

Only those series that are relevant to this particular project are included in this specification. These series included are listed in table 004/1.

Within a series, certain clauses within the Ramboll Standard Specification for Marine Works may not be relevant to this particular project. Where this is the case, the clause has been replaced with the text “Not Used”.

Where any contradictory statements occur within this specification, the Contractor shall bring them to the attention of the Overseeing Organisation for clarification. Pending clarification, the more onerous requirements shall be assumed to apply.

001 SCHEME DESCRIPTION

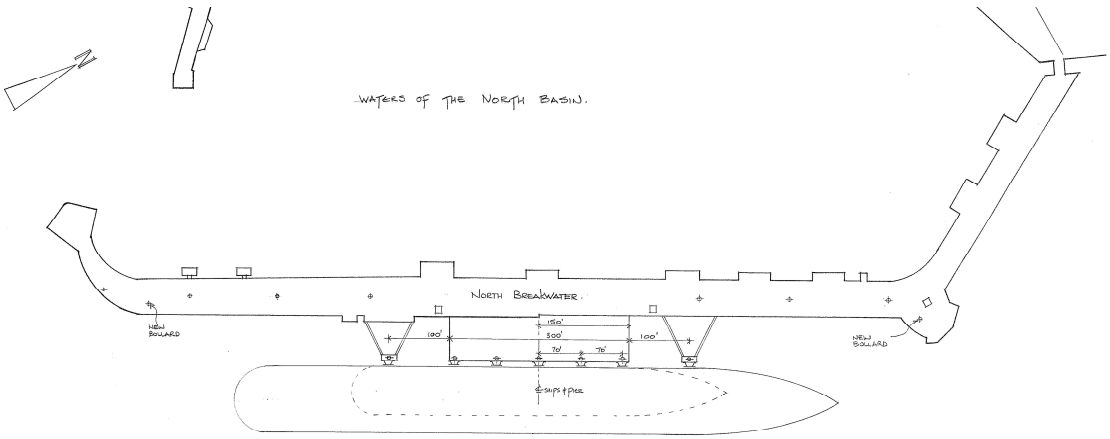
Kings Wharf is located in the Royal Naval Dockyard area on Ireland Island in the west of Bermuda, and is one of two berths which are primarily used by cruise ships visiting Bermuda.

The existing suspended deck at Kings Wharf was constructed in 1987/88 and is a steel frame encased in reinforced concrete, founded on steel H piles. The concrete encasement above water level has suffered severe degradation: large areas of concrete have spalled and reinforcement is exposed and corroded. Therefore it is proposed under this scope of work to replace the entire deck, including the pile encasement, whilst retaining the existing H-piles.

The location and layout of the existing wharf is shown in the figures below:

Figure 1: Location of Kings Wharf (courtesy Google Maps)

Figure 2: Wharf Layout (Woodbourne Associates)



002 ITEMS DRAWN TO THE ATTENTION OF TENDERERS

While also detailed elsewhere in this specification or in the accompanying documents and drawings, the following items are drawn to the Tenderers attention as being of particular significance to this Project:

- Location of the project in Bermuda and need to import the majority of materials
- Limited availability of concrete in Bermuda (both in volume and mix types) and hence minimal in-situ concrete proposed.
- Need for ongoing cathodic protection to the piles to achieve the design life

- Limited residual capacity of existing piles
- Need to carefully break out the existing so as not to damage the existing pile heads
- Laser scan data provided separately that will need to be used to verify exact required beam and slab dimensions for the new deck
- Requirement to clean and potentially implement plating repairs to some pile heads

003 TERMS AND ABBREVIATIONS

The following key terms are used in this Specification:

OVERSEEING ORGANISATION – The Client, or their representative (who may also be the project ENGINEER)

CONTRACTOR – The organisation responsible for constructing the Works

Abbreviations used in this document are listed in table Table 003/1 and their meanings given therein.

Table 003/1 – List of Abbreviations Included in the Contract

Abbreviation	Meaning
ALWC	Accelerated Low Water Corrosion
BS	British Standard
CD	Chart Datum
CP	Cathodic Protection
EHW	Extreme high water
ELW	Extreme low water
EN	European Standard
GGBS	Ground granulated blast furnace slag
HAT	Highest astronomical tide
LAT	Lowest astronomical tide
LOA	Length Overall
MHWN	Mean high water neaps
MHWS	Mean high water springs
MLWN	Mean low water neaps
MLWS	Mean low water springs
MMO	Marine Management Organisation
OD	Ordnance Datum
OPC	Ordinary Portland cement
PFA	Pulverised-fuel ash
SCC	Self-compacting concrete
SHW	Specification for Highway Works (Volume one of the Manual of Contract Documents for Highway Works)
SPERW	Specification for Piling and Embedded Retaining Walls
SRPC	Sulphate-resistant Portland cement
UHMW-PE	Ultra High Molecular Weight Polyethylene

004 LIST OF SERIES REFERRED TO IN THE SPECIFICATION AND INCLUDED IN THE CONTRACT

Table 004/1 comprises a complete list of series that form part of the Ramboll Specification for Marine Works. Those that have not been adopted for this project are marked ‘Not Used’.

Table 004/1 – List of Series Included in the Contract

Series Number	Title
000	Introduction
100	Preliminaries
200	Site Clearance
300	Not used - Dredging and Earthworks
400	Not used - Revetments and Rubble Breakwaters
500	Not used - Scour Protection
600	Not used - Piling and Embedded Retaining Walls
700	Structural Concrete
800	Not used - Hydrodemolition and Breaking Back of Concrete
900	Not used - Concrete Repairs
1000	Resin and Grout Fixing
1100	Structural Steel
1200	Protection of Steelwork Against Corrosion
1300	Not used - Brickwork, Blockwork and Stonework
1400	Not used - Repairs to Brickwork, Blockwork and Stonework
1500	Not used - Timber
1600	Not used - Pontoons
1700	Not used - Brows
1800	Fendering
1900	Quayside and Pontoon Furniture
2000	Not used - Navigation Lights, Buoys and Marks
2100	Not used - Mooring Buoys
2200	Not used - Diving Operations
2300	Not used - Grouting
2400	Not used - Aluminium
2500	Not used - Bathymetric Surveys

005 LIST OF DRAWINGS INCLUDED IN THE CONTRACT

The drawings listed in table 005/1 are included in the contract.

The Contractor shall read the Definition Drawings in conjunction with the text in this Specification. The Contractor shall comply with the requirements set out in the Definition

Drawings except that where the Definition Drawings show parts of existing facilities, services, structures, etc. including any lines, levels, dimensions, locations, etc.

Table 005/1 – Drawings Included in the Contract

Drawing Number	Title
RAM-XX-00-DR-CW-100	Location Plan
RAM-XX-00-DR-CW-101	Existing Topographic and Bathymetric Surveys
RAM-XX-00-DR-CW-200	Structural Layout of Proposed Deck
RAM-XX-00-DR-CW-201	Structural Details - Elevation on Front Beam and Section through Midspan
RAM-XX-00-DR-CW-202	Sections through and Details
RAM-XX-00-DR-CW-210	Enlarged Plan View Precast Units and Furniture
RAM-XX-00-DR-CW-220	Quay Furniture Layout and Edge Protection Details
RAM-XX-00-DR-CW-300	Transverse Beams Type 1 - Reinforcement
RAM-XX-00-DR-CW-301	Transverse Beams Type 2 - Reinforcement
RAM-XX-00-DR-CW-310	Slab Unit Type 1 - Reinforcement
RAM-XX-00-DR-CW-311	Slab Unit Type 2 - Reinforcement
RAM-XX-00-DR-CW-312	Slab Unit Type 3 - Reinforcement
RAM-XX-00-DR-CW-313	Slab Unit Type 4 - Reinforcement
RAM-XX-00-DR-CW-320	Front Capping Beam Type 1 - Reinforcement
RAM-XX-00-DR-CW-321	Front Capping Beam Type 2 - Reinforcement
RAM-XX-00-DR-CW-322	Front Capping Beam Type 3A/B - Reinforcement
RAM-XX-00-DR-CW-323	Front Pile Cap - Reinforcement
RAM-XX-00-DR-CW-330	Ground Beam - Reinforcement
RAM-XX-00-DR-CW-331	Rear Pile Cap - Reinforcement
RAM-XX-00-DR-CW-340	Insitu Reinforcement for between Slabs
RAM-XX-00-DR-CW-341	Insitu Concrete - Front Beam Reinforcement
RAM-XX-00-DR-CW-342	Insitu Concrete - Transverse Beam Reinforcement

RAM-XX-00-DR-CW-343	Insitu Concrete – Ground Beam Reinforcement
RAM-XX-00-DR-CW-400	Pile Jacket Detail
RAM-XX-00-DR-CW-401	Furniture Details - Access Ladders
RAM-XX-00-DR-CW-402	Furniture Details - Fenders and Bollards
RAM-XX-00-DR-CW-500	Services Containment Layout
RAM-XX-00-DR-CW-501	Services Containment Details
RAM-XX-00-DR-CW-502	Services Containment Details - Sheet 2
RAM-XX-00-DR-CW-600	Cathodic Protection - General Arrangement (Wharf)
RAM-XX-00-DR-CW-601	Cathodic Protection - Sections
RAM-XX-00-DR-CW-602	Cathodic Protection - General Arrangement (Dolphins)
RAM-XX-00-DR-CW-603	Cathodic Protection - General Details

006 LIST OF OTHER DOCUMENTS INCLUDED IN THE CONTRACT

The documents listed in table 006/1 are included in the contract.

Table 006/1 – Documents Included in the Contract

Document Number	Rev / Date	Title
N/A		3D Laser Scan
4755	Aug. 86	Historic Drawings by Woodbourne Associates Ltd
1276636822	29 Nov 17	Condition Assessment Kings Wharf, Bermuda iEPC
N/A	6 Sept 17	Underwater Infrastructure Survey Onsite Engineering Services Limited
		Photographs
4235/002/04		Kings Wharf Engineering Checks: Topographic Survey
	2012	Bathymetric Survey by Golder Associates

SERIES 100 PRELIMINARIES

CONTENTS

PRELIMINARIES

101 SITE EXTENT AND LIMITATIONS ON USE

Extent of the Site

The full extent of the site is indicated on drawing number 1620004884-RAM-XX-00-DR-CW-100 which details the marine works required as part of the project development of the suspended deck.

Limitations on the Use of the Site

The Contractor shall conform to the Byelaws and Regulations concerning navigation and shall obey the orders of the Harbour Master or other authorised and competent authority.

The Contractor's operations must be conducted in such a manner that they do not interfere with nor obstruct nor endanger either the use or working of the waterways except by prior arrangement with the Port Authority.

All vessels and floating plant shall display day marks and navigation lights as appropriate to the task in which they are involved. All vessels and floating plant shall be fitted with DSC enabled VHF radios.

The Contractor shall furnish, set, maintain and remove at the completion of the Work or as directed by the Overseeing Organisation at no additional cost to the Overseeing Organisation and Employer temporary buoys or other markers as required by the Port Authority.

The Contractor must liaise with the Harbour Master to ensure that appropriate Notices to Mariners warning of the works are issued in good time. The Harbour Master must be contacted at least 28 days prior to the required issue date of the Notice to Mariners.

The cost of issuing the required Notices to Mariners is to be included in the Tender Price by the Contractor.

All diving and diving operations conducted by the Contractor shall be undertaken within the requirements laid out in the current approved codes of practice.

102 BATHYMETRIC AND TOPOGRAPHICAL INFORMATION

Please refer to the following drawings/information:

- 3D Laser Scan
- 4235/002/04 Kings Wharf Engineering Checks: Topographic Survey
- 2012 Bathymetric Survey by Golder Associates

103 TIDAL, FLOWING AND STANDING WATER

Tidal flows have been reported by others as around 1 knot.

104 LICENCES

The Contractor shall be responsible for applying for and paying for any variations to any environmental licences or other licences in order to add contractors and vessel details, or to vary the method of work detailed within these licences.

The Employer shall be responsible for obtaining any consents necessary, where the works encroaches upon public thoroughfares or elsewhere. The Contractor shall be responsible for obtaining and satisfying the requirements of any permit to work, including the provision, fixing and maintenance of all necessary warning lights, signs etc. required to be placed upon such work.

The Contractor should advise the Overseeing Organisation as soon as possible of any other consents or licences which are deemed as required for the scheme and include costs within the tender for any adherence to or discharge of conditions from these consents identified.

105 EXCLUSION OF THE PUBLIC

Exclusion of the public from the active areas shall be considered by the Contractor to ensure safety of the site during construction.

106 INFORMATION BOARDS

Site information boards must state the Contractors company name and give emergency contact details.

107 ACCESS TO SITE

Access to the site shall be considered by the Contractor as well as the port authority before construction phases begin.

108 NAVIGATION

Access to the site shall be considered by the Contractor as well as the port authority before construction phases begin.

109 STANDARDS, QUALITY ASSURANCE AND APPROVALS

Standards

The contractor shall ensure that all goods or materials used for the works comply with the relevant and current American ASTM standards.

The details of any product or material not complying with the requirement above shall be submitted to the engineer for acceptance, along with all supporting information, testing and approvals.

Quality Assurance

On award of the Contract, the Contractor shall provide the Overseeing Organisation details of his proposed Quality System, specific to this Contract.

The Works shall be carried out in accordance with the Specifications, Standards and Codes of Practice detailed under Works Information together with all relevant Standard Specifications and Statutory Regulations.

110 GOODS, MATERIALS, SAMPLING AND TESTING

As soon as possible after the Contract has been awarded, the Contractor shall submit to the Overseeing Organisation for their approval a list of his proposed suppliers and sources of materials required for the execution of the works. Samples shall be taken in accordance with the appropriate Standard where applicable.

The Overseeing Organisation may require the Contractor to submit samples of any materials to be used on the works for his approval before they are ordered and the Contractor shall allow for any charges he may consider necessary for complying with the requirements. The materials subsequently supplied shall conform to the quality of samples which have been approved by the Overseeing Organisation.

The Contractor may submit names of additional suppliers and sources during the execution of the Contract, but no source of supply shall be changed without the Overseeing Organisation's approval. Where a particular manufacturer's product is specified any proposed alternative shall be submitted to the Overseeing Organisation for approval.

Compliance testing of materials shall be carried out through an approved laboratory.

Storage of Materials

Materials and components shall be stored in such a manner as to preserve their quality and condition to the standards required by the Contract and in accordance with the manufacturer's/supplier's recommendations.

The quality of materials and components stored on the Site shall be consistent with that necessary for efficient working.

All materials shall be stored on a level area in accordance with the manufacturer's recommendations and shall be adequately protected from ingress of water and mechanical damage. All sealants, paints, solvents, etc. shall be stored in lockable flameproof containers.

Any materials stored on temporary storage structures or scaffolds shall be adequately secured to prevent falling and shall not impose loads exceeding the design load of the structure or scaffolds. The Contractor shall keep the amounts of materials stored on temporary structures and scaffolds to a minimum.

Handling of Materials

Handling of materials shall comply with the manufacturer's/supplier's recommendations. Adequate care shall be taken when handling materials to avoid bending, buckling and damage.

Materials delivered or lifted shall be lifted using broad webbing slings with a safe working load suitable to the weight being lifted. All lifting methods shall allow for adequate bracing and protection to prevent buckling, bending and damage.

Samples

It has been confirmed by Government of Bermuda that no samples are required.

111 DESIGN OF PERMANENT WORKS BY THE CONTRACTOR

The Contractor shall design the items listed in Table 111/1 in accordance with the performance specifications listed.

Table 111/1 – Permanent works items to be designed by the Contractor

Structure or Element	Location	Performance Specification and Drawing
Reinstatement of Slab/Pavement	Behind (landside of) the new ground beam	To be developed once the site conditions and requirements are known

The Contractor designed elements shall be subject to a review by the Overseeing Organisation or an appointed representative. The Contractors costs involved in providing information to the overseeing organiation and responding to their queries and comments shall be included.

112 DESIGN OF TEMPORARY WORKS

Temporary works shall be the responsibility of the Contractor. The Contractor is to provide, maintain, adapt as necessary, remove on completion of the Works, including consequential reinstatement, all temporary works of any kind and shall make them safe and suitable in every respect to carry the plant required for the Works or for providing access or for any other purpose. The temporary works shall be constructed and maintained to the satisfaction of the Overseeing Organisation.

All temporary works are to be properly designed and constructed to suit their intended purpose.

Materials intended for permanent use in the Works are not to be employed for temporary purposes.

In particular the Contractor shall include for, but not be limited to, the following temporary works:

(i) Provision of barriers for the Works and to suit the phasing and sequencing of the Works by supplying, erecting, maintaining, adapting as necessary and dismantling on completion 2m high 'Heras' or other equal and approved temporary fencing including gate accesses where necessary. In particular the Contractor shall provide, unless agreed otherwise:

a) Barriers around all holes or openings

b) Barriers around all open excavations

c) Barriers around all individual locations where the Works are progressing

d) 2m Heras gates to the Works, to be padlocked at nights, weekends and holidays

(ii) Provision of temporary access points for construction plant and materials to suit the sequencing requirements of the Works. The Contractor shall note that labour and construction plant shall only be allowed to access the working area by designated routes specifically authorised in writing by the Overseeing Organisation.

(iii) All temporary access scaffolding, specialist access staging, access equipment, hydraulic lifting platforms, “cherry pickers”, “scissor lifts” and the like. All scaffolding and staging must be provided by a Contractor approved by the Employer.

(iv) Temporary supports, props and the like.

(v) Temporary flame retardant sheeting around all welding, burning, cutting and grinding operations.

(vi) Temporary dust proof screens.

(vii) Temporary lighting.

(viii) Temporary warning signs and the like.

The Contractor shall note that all temporary works shall be constructed in such a manner and made safe at the end of each working day to allow unimpeded access by the Employer and the Contractor shall include for all necessary removal, adaptation, reinstatement, etc. of temporary works in this respect.

The Contractor shall take every precaution to avoid injury to any water or gas pipes, drains, sewers, culverts, telegraph, telephone or electric cables, ducts, production services, or other apparatus that may be met in the course of the Works, together with any walls, buildings, etc. required to be maintained, during the progress of the Works.

The Contractor will be held responsible for the cost of providing temporary means for the support and protection of any pipes, drains, cables, etc. shown on drawings provided or indicated by the Overseeing Organisation that may be encountered as part of the works and he will also be held responsible for the cost of making good damage to these pipes, drains, cables, etc. Where these or any unknown pipes, drains, cables, etc. are discovered within the area of excavations, they shall be reported to the Overseeing Organisation and dealt with as directed.

If the Overseeing Organisation on inspection of the existing drains, pipes, cables, etc. encountered during the progress of the Works considers that they are in a condition requiring repair, renewal, diversion or other work to maintain their efficiency, such work not being considered due to any action on the part of the Contractor or his workmen, the Overseeing Organisation shall be at liberty to request the Contractor to carry out such work which will be deemed as a change to the Works Information.

Erection of any part of the temporary works shall not be commenced until the Overseeing Organisation’s acceptance for that part has been given. All temporary works shall be properly designed and constructed to transmit any loads directly to the ground.

113 TEMPORARY ACCOMMODATION AND EQUIPMENT FOR THE OVERSEEING ORGANISATION

General

The Contractor shall provide, maintain, service and remove all accommodation, furnishings and equipment as detailed below, for use by the Overseeing Organisation.

The accommodation and equipment shall be provided from the commencement of the Works up to the completion of the Works.

All accommodation shall be regularly cleaned for so long as it is in use and suitable arrangement shall be made for the disposal of waste arising from its occupation.

All furnishings and equipment supplied by the Contractor shall be of a quality and precision appropriate to its proposed use and shall be delivered in a serviceable condition. The Contractor shall maintain all such equipment in serviceable condition and replace, if necessary, any that becomes unserviceable. The Contractor shall ensure that any equipment needing periodic calibration is calibrated on delivery, annually and/or at other times as and when required by the Overseeing Organisation. The Contractor shall ensure that all consumables are replenished as required.

Accommodation, Furnishings and Fittings

The following accommodation shall be provided for the overseeing organisation. This accommodation may be located in shared facilities with the Contractor, but the office space must be provided in a separate room for privacy and security, unless otherwise detailed below.

Table 113/1 – Facilities to be provided to the Overseeing Organisation

Room No	Description	Approximate size (m)
1	Shared meeting room	10.8 x 6.4
2	Document Storage	3.0 x 4.5
3	Kitchen	5.0 x 4.5
4	Civil Inspector	4.0 x 4.5
5	Male toilet	4.0 x 4.5
6	Female toilet	4.0 x 4.5
7	Resident Engineer plus toilet	5.0 x 4.5
8	Assistant Resident Engineer	4.0 x 4.5
9	Secretary	3.0 x 4.5

All accommodation for the use of the Overseeing Organisation shall be thoroughly waterproof and shall have an adequate interior lining. All office equipment shall comply with and be maintained to comply with the Factories Act and any other relevant legislation. They shall be adequately secured at all times to ensure no unlawful or unauthorised entry. The Contractor shall provide for the insurance against all risks, of the contents of the offices including the property of the Employer. This includes personal effects required in the normal course of duty.

Complete security, privacy and confidentiality shall be provided for the Overseeing Organisation.

All accommodation shall be provided with appropriate means of lighting, ventilation and heating.

Office spaces shall be provided with a 120 volt AC electricity supply and 20 amp socket outlets provided on the basis of one double socket for each 5m^2 of office space or part thereof, plus one additional double socket near the door for the use of cleaners. Kitchen spaces shall be provided with a number of socket outlets appropriate to the equipment provided.

The following Furnishings and Fittings shall be provided in the offices for the Overseeing Organisation:

Table 113/2 – Furnishings and Fittings to be provided for the Overseeing Organisation

Item	No.
Workstation (Desk, Office Chair, 4-way surge protected power outlet)	4
Filing Cabinets	2
Storage Cabinets (for PPE, equipment, etc), typical size 4ft wide by 6ft high	1
Coat Hook	1
Waste Paper Baskets	2

All furnishings and fittings shall remain the property of the Contractor.

Shared washroom facilities should be appropriate for the Contractor's needs, but as a minimum should include:

WC suite
Hand basin complete with hot and cold running water
Toilet roll holder and supply of toilet rolls, replenished as required
Towel dispenser, replenished as required
Waste paper bin
Liquid hand soap dispenser, replenished as required
Sanitary bin
Wall mirror
Coat hook
Extractor fan
Lockable door

Shared kitchen facilities should be appropriate for the Contractor's needs, but as a minimum should include:

Sink with hot and cold running water
Kettle
Toaster
Refrigerator
Microwave
Trash Can
Mugs, plates and cutlery
Supply of instant coffee, tea milk and sugar, replenished as required
Liquid hand soap dispenser, replenished as required
Washing-up liquid dispenser, replenished as required

Equipment

The following equipment and consumables shall be provided for the exclusive use of the Overseeing Organisation:

Table 113/3 – Equipment to be provided to the Overseeing Organisation

Item	No.
Fixed-line telephone	1

All equipment shall remain the property of the Contractor.

Where provided, telephones for the use of the Overseeing Organisation shall have a separate connection direct to a telephone exchange of a telecommunication code system with privacy for conversation for the exclusive use of the Overseeing Organisation.

The Contactor shall afford to the Overseeing Organisation use of any survey equipment available on Site as required.

The Contractor must have a cover meter available on the site from start of any concrete placement operations to two weeks after completion of concrete placement for the use of the Overseeing Organisation.

Sets of the following Personal Protective Equipment (PPE) shall be supplied new in sizes as required by the Overseeing Organisation:

Table 113/4 – PPE to be provided to the Overseeing Organisation

Item	No.
High Visibility Jackets	2
Hard Hats	2
Life Jackets	2
Supply of Gloves, Light Eye protection, ear plugs etc – replenished as required.	N/A

All PPE shall remain the property of the Contractor.

114 OPERATIVES FOR THE OVERSEEING ORGANISATION

It has been confirmed by Government of Bermuda that no operatives are required for the Overseeing Organisation.

115 CONTROL OF NOISE AND VIBRATION

Noise

The normal working hours within the Site shall be Monday to Friday between 06:00 and 20:00 hours and Saturday, Sunday and Public Holidays between 09:00 and 20:00 hours. Exceptionally, consent for work outside these hours may be given after any necessary consultation. 7 days' notice is required from the Contractor when seeking such consent.

The noise levels (see Note (i) below) scheduled below for periods outside the normal working hours will only be permitted when consent has been given to exceptional working.

Vibration

None.

116 SETTING OUT

Setting out points are shown on GA drawings.

Historic drawings show approximate existing levels however these are to be verified by the Contractor.

The Contractor shall arrange for setting up his own survey reference points and surveying the existing pile heads once the existing deck is removed.

117 PRIVATELY AND PUBLICLY OWNED SERVICES OR SUPPLIES

The Contractor shall satisfy himself that any work including all temporary works do not damage any existing structures.

The following mains services are known to exist on site:

- Electricity
- Potable Water
- Foul Water
- Drainage

Table 117/1 – Services and Supplies Affected by the Works

Location	Description	Group*	Drawing No.	Notice Required to Commence	Time for Completion
Underslung around perimeter of jetty and to existing building on jetty.	Foul Potable Water LV Power to Building.	E	500	7 days	TBC by Contractor

A Work expected to be completed before the commencement of the Works.

B Work required after commencement of the Works which does not require prior work by the Contractor.

C Work required after commencement of the Works which does require prior work by the Contractor.

D Work expected to be in progress at the commencement of the Works.

E Work to be wholly undertaken by the Contractor.

The Contractor shall make all necessary enquiries and carry out such investigations to satisfy himself as to the nature and extent of all existing services.

The Contractor shall inform the Overseeing Organisation of any diversion or removal of services which he may require for his own convenience or because of his proposed method of working, and shall, in all cases, inform the Overseeing Organisation in advance of his proposals.

Should any service be found to exist which is not indicated or not as indicated in the Contract, the Contractor shall at once give written notification to the Overseeing Organisation.

118 PLANT AND EQUIPMENT

The Contractor shall provide and maintain in good order all plant and ancillary equipment required for the successful execution of the Works.

119 CONTROL OF POLLUTION

The Contractor shall undertake his duties in accordance with local laws and guidelines on pollution.

120 PROGRAMME OF WORKS

The Contractor shall furnish the programmes required by the Contract in electronic format (both native files and in pdf format).

The programme shall be in the form of a precedence diagram and Gantt Charts capable of being monitored and updated continuously during the progress of the Contract. The programme shall show inter alia:

a) The dates by which the Contractor requires information from the Overseeing Organisation to which he is entitled under the Contract

b) The dates on which the Contractor will require access to the various Works Areas and the period of time during which he will require occupation and all other similar constraints that will affect his activities

c) The dates by which the Contractor intends to start and complete the Works

d) A schedule of payments to be made to the Contractor

Network and Bar Charts or another similar network shall describe major plant allocations and requirements.

The Contractor shall give the Overseeing Organisation 10 working days notice prior to start of works on site and shall inform them immediately of any delay to this start date that occurs.

Each month throughout the construction period the Contractor shall submit to the Overseeing Organisation further copies of the programme marked to show the progress to date together with any revisions to the programme that he is required to make. These marked programmes shall be submitted one week before the site progress meetings.

Progress meetings are to be held monthly or at such shorter intervals as may be instructed by the Overseeing Organisation.

The Contractor shall allow in his price and programme for all necessary phasing and sequencing of the Works to accommodate all restrictions imposed on his method of working.

Phasing and sequencing shall be identified on the Contractor's first programme to be submitted in accordance with the Contract Data.

In particular the Contractor shall allow in his price and programme for all necessary phasing, sequencing, etc. in connection with, but not limited to, the following:

(i) Any access restrictions to the Site

(ii) Any statutory and other notifications

(iii) Lead in period of the delivery for materials

(iv) Public access for movement around the site

The Contractor's prices shall allow for all costs in connection with any sequencing requirements and any necessary removal and re-erection of temporary works.

121 HEALTH AND SAFETY RESTRICTIONS, PRECAUTIONS AND MONITORING

The Contractor shall ensure that all health, safety and welfare measures required under or by virtue of the provisions of any enactment or regulations of the working rules of any industry are strictly complied with.

122 CONTRACTOR SITE SUPERVISION AND INSPECTION BY THE OVERSEEING ORGANISATION

Contractor Site Supervision

The Contractor shall provide at all times adequate supervision and planning resources appropriate to the workload to meet his contractual obligations.

The key people the Contractor proposes to use to manage and supervise the works shall be identified in the tender return for approval by the Overseeing Organisation prior to commencement of the works on the Site. The Overseeing Organisation shall be empowered to reject any such key person he considers unsuitable.

The Overseeing Organisation before commencement on Site shall approve the credentials and competence of staff appointed to supervise the works and the Overseeing Organisation shall be empowered to reject any such person he considers unsuitable.

The Contractor shall ensure that the site management team, once approved, shall not be removed from their appointments during the Contract unless it is for reasons beyond his control or unless the Overseeing Organisation agrees that any such change serves the best interests of the Contract. In the event of termination of employment of such personnel for reasons apart from illness or death, the Contractor shall give the Overseeing Organisation a minimum of one month's notice of such intended changes and shall ensure that his conditions of employment for such personnel provide for this requirement.

Any approval by the Overseeing Organisation of the Contractor's proposals shall not in any way relieve the Contractor of his obligations under the Contract.

The Contractor shall be responsible of the supervision and administration of all sub-contractors and statutory authorities, including the progressing of any information or design work that may be necessary to enable them to comply with the master programme.

The Contractor shall be responsible for notifying and co-ordinating all statutory authorities as and when he requires their services on the site. The co-ordination shall be deemed to include for providing the statutory authorities will sufficient information regarding line, level, timing and excavations, etc. To enable them to provide and lay mains, cables, etc., to suit the progress of the works.

The Contractor shall be responsible for co-ordinating the sequencing and setting out of the work of sub-contractors and statutory authorities on site, having particular regard to any conflicts which may arise as a consequence of the detailed interpretation of drawings and information by operatives on site.

The Contractor shall make regular visits to the works of all his sub-contractors to inspect the quality of the works and to check on progress and delivery in relation to the programme and he shall be deemed to have allowed for all costs in connection therewith.

The Contractor shall in sufficient time (two weeks) provide the Overseeing Organisation of a list of information / detail which he requires and details of when this information is required to undertake the scheme to the accepted programme.

Information Requests

The Contractor shall in sufficient time (10 working days) before work begins provide the Engineer of a list of information / detail which he requires and details of when this information is required to undertake the scheme to the accepted programme.

During the works the Contractor shall allow 5 working days for the Engineer to respond to any request for information, although the Engineer shall endeavour to provide a response more swiftly.

Inspection by the Overseeing Organisation

The Overseeing Organisation will appoint a representative to attend site at regular intervals to inspect the Works. The expected regularity and duration of these visits will be advised to the Contractor in advance of the Works to assist in his compliance to Clauses 113 and 114.

However, the Overseeing Organisation shall be allowed to inspect any element of the works at any reasonable time, and the Contractor shall make all reasonable efforts to assist with this inspection. In turn, the Overseeing Organisation shall take all reasonable steps to ensure that any such visits minimise any disruption to the Contractors activities.

123 PROGRESS PHOTOGRAPHS

Whilst there is no formal requirement for the Contractor to submit regular sets of progress photographs, the Contractor shall provide photographs of particular elements where these are requested by the Overseeing Organisation (e.g. of areas which are difficult to access).

124 PAYMENT APPLICATIONS

Please see requirements in the Contract Documents.

125 PROGRESS REPORTS

The Contractor's representatives shall attend the following regular site meetings to ensure the proper management and co-ordination of the Works.

1. Start up Meeting
2. Weekly Progress Meetings including the period during off-site fabrication
3. Monthly Review Meetings
4. Monthly Commercial Review Meetings

Progress reports and records are to be made available at the above meetings to include:

- Percentage completion
- Issues affecting progress
- Health and safety
- Environmental records including noise

The Contractor shall provide suitable accommodation on site for the holding of such meetings.

The Contractor may be required to attend public liaison meetings and present details of the scheme and they are progressing. The Contractor should make due allowance for this within the tender.

126 CONSTRUCTION METHODOLOGY

Before any particular major or critical activity is commenced the Contractor shall provide the Overseeing Organisation with electronic copies of his proposals for execution of the activity including details of the major items of plant and operatives that it is intended to utilise for the Overseeing Organisation's consent.

This information shall be supplied sufficiently in advance of the activity commencing that the Overseeing Organisation may study, discuss and comment on the proposals and the Contractor may thereafter amend his proposals accordingly. Unless agreed otherwise, this period shall be not less than 1 week in advance.

No work shall be put in hand without the prior written consent of the Overseeing Organisation which consent shall not relieve the Contractor of any of his obligations and liabilities under the Contract.

127 APPROVALS AND ACCEPTANCE BY THE OVERSEEING ORGANISATION

Except where specified otherwise within this specification, where information must be submitted to the Overseeing Organisation for comment, acceptance or approval, they shall be allowed a minimum of 5 working days.

Unless agreed otherwise, 'working days' are defined as Monday to Friday inclusive, excluding bank holidays and the period between 1200 hrs 24th December and 0900 hrs 2nd January. A 'week' is defined as a period of 5 working days.

128 COMMUNICATIONS BETWEEN THE CONTRACTOR AND OVERSEEING ORGANISATION

All submissions and communications by the Contractor with the Overseeing Organisation shall be through the individual named below.

All instructions, acceptances and approvals from the Overseeing Organisation to the Contractor shall be through the individual named below.

The individual named below may delegate some of his responsibilities to other individuals. The names, contact information and level of authority in terms of issuing instructions, acceptances and approvals shall be communicated to the Contractor by the individual named below.

Overseeing Organisations Representative
Name: Carmen Trott
Telephone Mobile: (441) 325-1378
Email: cmtrott@gov.bm
Address: Department of Works & Engineering General Post Office Building 3rd Flr, 56 Church Street Hamilton HM 12, BERMUDA

SERIES 200 SITE CLEARANCE

CONTENTS

SITE CLEARANCE

201 CLEARING

Demolition Plan

The Contractor shall provide a comprehensive demolition plan prepared by a suitably qualified demolition expert, including a detailed method statement, proposed plant and equipment to be used, health and safety measures to be employed and a plan for disposal of the waste generated.

Structures to be Demolished

The Contractor shall demolish, break up and remove buildings and structures as described in Table 201/1 below and superficial obstructions on the Site in the way of or otherwise affected by the Permanent Works. He shall clear each part of the Site at times and to the extent indicated on the Drawings. The extent of any partial demolition of structures is described in Table 201/1.

Table 201/1: Structures to be demolished

Item & Location	Description	Drawing No.	Requirements
Existing Terminal Building	Single Storey blockwork building	Plan extent is shown on drawing CW-200. No detailed drawings available – contractor to undertake survey prior to starting work	Complete removal
Existing concrete and steel suspended deck slab	Steel frame with concrete encasement and insitu concrete slab.	Refer to as-built structural drawings by Woodbourne Associates included in Works Information	Remove entire deck leaving existing piles in place for use in the replacement structure. Pile cut-off levels to be as per the project drawings.

Fences, Hedges and Walls

Where the line of an existing fence, hedge or wall is cut by the Site boundary the severance shall be made good unless otherwise described in table 201/1; either by the continuation of the fence, hedge or wall in a different direction, or by its termination. In the case of a strained wire or chain link fence a straining post shall be installed and the fence re-strained.

Underground Structures

Underground structures, chambers and foundations described in table 201/1 shall be demolished to the depths prescribed, properly cleaned out, and filled. To permit free drainage, holes shall be made at 500 mm centres over the whole area of slabs, basements, etc., which are not removed and which are liable to hold water.

If discovered on site, disused soil and surface water drains, sewers, cables and ducts together with any bed or haunch or surround within 1m of formation level shall be removed and over 1m below formation shall be left unless otherwise specified.

The ends of existing drains and sewers no longer required because of alterations to the drainage layout shall be sealed in a manner to be agreed with the Engineer. All trenches shall be backfilled in a manner to be agreed with the Engineer unless otherwise described above.

The Contractor, subject to any instructions or contrary directions in accordance with the Contract, shall take all measures required by any Statutory Undertaker, the management of other publicly owned services, or owners of privately owned services or supplies, for disconnection and proper sealing off of all redundant drains, services and supplies.

Materials Arising From Site Clearance

Any materials arising from site clearance that are to be retained shall be dealt with as detailed in Table 201/2.

All materials arising from site clearance which are not required to be retained, or are unacceptable for use in the Permanent Works, shall become the property of the Contractor and shall be disposed of by him in an appropriate manner.

Table 201/2: Items to be retained from site clearance

Description	Location	Delivered to:	Requirements
To be confirmed with the Overseeing Organisation prior to commencing demolition works. Likely to include, all fencing, street furniture, block paving (if present), signage and items suitable for re-use in the new building.	Existing Building and Deck	Contractor's Storage area in Dockyard.	

Materials included in table 201/2 shall be carefully dismantled, taken up or taken down, cleaned and retained for re-use, stacked, labelled and protected or loaded, and transported to store as described in table 201/2 and items damaged in this operation shall be replaced. All replacements shall be of equivalent quality to the original materials.

When required in table 201/2, voids left by items that have been removed shall be backfilled immediately in accordance with the appropriate Clauses in Series 300.

Excavated topsoil shall be reserved for re-use. After erection of the walls the topsoil shall be spread over the disturbed ground, any surplus being disposed of in an appropriate manner.

202 HAZARDOUS MATERIALS

The Overseeing Organisation has confirmed that Hazardous Materials are not known to exist at the site. Should the Contractor identify any hazardous materials, these should be brought to the attention of the Overseeing Organisation immediately.

SERIES 700 - CONCRETE

CONTENTS

700 CONCRETE

701 INTRODUCTION

Series 700 of this specification covers all elements of concrete works. Details of the concrete works are shown on the project drawings. All works involving structural concrete shall be carried out fully in accordance with BS EN 13670 or agreed equivalent American ASTM or ACI standard.

All concrete shall conform to BS 8500-1, BS 8500-2, BS 6349-1-4, BS EN 206-1 or ASTM A615.

Where Eurocode or British Standards are referenced these may be replaced by equivalent American ASTM or ACI standards.

702 TERMS AND DEFINITIONS

Terms and definitions are as contained in BS EN 13670 and BS 8500.

703 LIST OF REQUIRED ADDITIONAL INFORMATION

Table 703/1 lists the additional information that is required to fully define the requirements for execution of the work in accordance with BS EN 13670.

Table 703/1: Additional information

Clause	Text	Requirement
1. Scope		
1 (2)	Special requirements:	No additional requirements unless otherwise noted on drawings.
1 (4)	Special technologies:	No additional technologies required
1 (5)	Use of concrete members:	Not to be used to support temporary works or loadings without prior agreement of the Engineer.
2. Normative references		
2 (1)	Relevant national standards or provisions:	In addition to the standards stated in clause 2(1) of BS EN 13670, the following national standards and guidance documents apply: CSA A23.1-14 – Concrete materials and methods of concrete construction/Test methods and standard practices for concrete BS 8500-1 *Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier* or equivalent American ASTM/ACI standard. BS 8500-2 *Concrete – Complementary British Standard to BS EN 206-1 – Part 2: Specification for constituent materials and concrete* or equivalent American ASTM/ACI standard.

Clause	Text	Requirement
		BS 6349-1-4 Maritime works – Part 1-4: General – Code of practice for materials CIRIA C674 *The use of concrete in maritime engineering – a guide to good practice* In each case, the most recent version of each document shall be used.
3. Definitions		
3.17	Reference line location:	Reference lines for setting out are to be defined by the Contractor.
4. Execution management		
4.1 (3)	Skill of personnel:	All personnel involved in the project should have a level of knowledge, training and experience appropriate to ensure that the successful completion of the tasks for which they are responsible.
4.2.1 (3)	Altering Execution Specification:	Requests to alter the Execution Specification by the Contractor shall be submitted to the Engineer in writing. The request shall clearly describe the requested alteration and explain the reason for the request. Changes to the Execution Specification shall be issued by the Engineer as Amendments.
4.2.1 (3)	Documentation distribution:	Copies of all technical documents used for the works (e.g. piling records, concrete test results, as built records etc.) shall be submitted in electronic format to the Overseeing Organisation and Engineer as soon as practical following their production. Furthermore, copies a full set of records shall be provided to the Overseeing Organisation in electronic format as required by the contract. These shall include all records in both native format (where applicable) and pdf.
4.2.2 (1)	Quality Plan requirement:	The contractor shall provide a Quality Plan, in a format agreed with the Overseeing Organisation.
4.3.1 (5)	Execution class:	The execution class for the works is execution class 2 unless otherwise noted on the drawings. The Contractor is responsible for carrying out inspections and measurements to ensure that this execution class is achieved. The extent and requirements of these inspections shall be detailed in the quality plan.
4.3.1 (6)	Inspection personnel:	To be detailed in the Quality Plan to the satisfaction of the Engineer and Overseeing Organisation.
4.3.2 (1) Table 1	Define inspection and acceptance testing:	No additional requirements

Clause	Text	Requirement
4.3.3 (1) Table 2 and Table 3	Inspection scope – additional requirement:	To be specified by the Contractor.
4.4 (3)	Rectification of nonconformity:	All nonconformities shall be rejected unless agreed otherwise with the Engineer. The procedures for rectifying any non-conformities shall be agreed with the Engineer.
5. Falsework and formwork		
5.3 (1) and 5.4 (1)	Method Statement:	Where applicable the Contractor is to provide a method statement for the design and installation of falsework and submit to the Overseeing Organization in accordance with the requirements of this clause.
5.3 (4)	Temporary support of permanent structure:	Any requirements shall be detailed on the drawings.
5.4 (5)	Surface finish:	Surface finishes shall be as indicated on the drawings and in clause 706 of this specification.
5.4 (6)	Special finish or Trial panels:	These are not required for structures covered by this specification.
5.4 (7)	Support of Permanent Structure:	Specify any requirements for temporary support of the structure and / or deflection criteria during construction: Any requirements to be detailed on the drawings.
5.5 (1)	Requirements for special formwork:	To be specified by the Contractor if used.
5.6.2(1)	Temporary hole filling and finish:	No additional requirements
5.7 (1)	Removal:	No loading (including self-weight) shall be imposed on the concrete which would cause a compressive bending stress greater than one-third of the concrete strength at the time of loading, or one-third of the specified characteristic strength, whichever is less. Soffit formwork should be so designed as to facilitate striking, if required, without removal of props being necessary until the times stipulated above have elapsed. No superimposed load shall be allowed on any part of the concrete work prior to the removal of the forms and props and / or until such loading is approved. Where concrete is to have filling placed against it the methods of backfilling shall be approved by the Engineer. The Contractor shall delay the removal of any formwork if, in the opinion of the Engineer, the

Clause	Text	Requirement
		concrete contained has not attained sufficient strength.
5.7 (4)	Sequence of removal:	Side shutters are to be used as insulation on larger pours and the contractor's proposal for stripping shutters on pours greater than 25m^3 shall be submitted to the Engineer at least 2 weeks in advance of the planned pour. Where early removal of formwork are required a procedure for insuring the concrete have reach required strength are to be agreed with the Engineer, and shall be based on strength gain characteristics determined from testing of concrete test cubes.
6. Reinforcement		
6.2 (1)	Type:	Hot rolled and cold worked steel bars All reinforcement shall be grade 60 to ASTM A615 (or grade 75 where noted on drawings). They shall be cut and bent in accordance with BS 8666 or equivalent American ASTM/ACI standard. All reinforcement shall be Class I hot dip galvanised in accordance with ASTM A767 (thickness of 150 microns) Steel fabric Steel fabric reinforcement shall conform to ASTM A615 Grade 60 and shall be cut and bent in accordance with BS 8666 or equivalent American ASTM/ACI standard. Steel fabric reinforcement shall have a minimum nominal bar size of 1/4" / 6 mm. Stainless Steel Reinforcement All stainless steel reinforcement shall be grade 75 to ASTM A615 They shall be cut and bent in accordance with BS 8666 or equivalent American ASTM/ACI standard.
6.2 (3)	Type of anchorage or couplers:	Anchorage devices and couplers shall only be used where indicated on the project drawings. Details of proposed products shall be submitted to the Engineer for acceptance.
6.2 (6)	Reinforcement: Type other than steel:	Material other than steel not to be used for reinforcing bars
6.3 (1)	Bending at temperatures below -5°C:	Bending at temperatures below –5 °C is not permitted.
6.3 (1)	Bending by heating:	Bending by heating of the bars is not permitted.

Clause	Text	Requirement
6.3 (2)	Mandrel diameter for bending bars:	Mandrel diameters for bending bars shall be in accordance with BS 8666 or equivalent American ASTM/ACI standard.
6.3 (3)	Mandrel diameter for bending welded reinforcement and fabric after welding:	Mandrel diameters for welded reinforcement and fabric bent after welding shall be in accordance with BS 8666 or equivalent American ASTM/ACI standard.
6.3 (5)	Straightening of bent bars:	Straightening of bent bars is not permitted.
6.4 (1) and 6.4 (2)	Welding reinforcement:	Welding of reinforcement is not permitted without the agreement of the Engineer.
6.4 (3)	Spot welding:	Spot-welding of reinforcing steel classified as weldable is permitted.
6.5 (1)	Position of reinforcement:	The position of reinforcement, including cover, the position of laps and joints etc. is to be as shown on the project drawings.
6.5 (2)	Running meters of reinforcement:	Reinforcement by running meters is permitted for secondary reinforcement only and in agreement with the Engineer.
6.5 (3)	Special requirements:	Lapping bars should be placed in contact with each other, except where otherwise specified on the drawings.
6.5 (4)	Nominal concrete cover:	The nominal concrete cover is to be as specified on the project drawings.

Clause	Text	Requirement
7. Prestressing		
7.1 (2)	Prestressing: Installation of post-tensioning kits and qualification of personnel	Requirements for installation of post-tensioning kits and qualification of personnel to perform the installation
7.2.1 (1)	Prestressing: Post-tensioning systems	Requirements to the post-tensioning system (Generally a reference to the product call up on the drawings. If not, include the specification for the prestressing system here).
7.2.3 (1)	Prestressing: Steel	Prestressing steel to be in accordance with ASTM A416.
7.2.3 (2)	Prestressing: Alternatives to prestressing steel	State if alternatives to prestressing steel are permitted, and the requirements (e.g. carbon, glass or aramid fibres). Generally not appropriate for most structural applications.
7.2.5 (2)	Prestressing: Tendon support	Additional description of tendon support spacing, if required.
7.4.1 (1)	Prestressing: Assembling of prestressing tendons	Provisions for assembling of prestressing tendons
7.4.1 (3)	Prestressing: Welding at local anchorages	Specify if welding of local anchorage zone reinforcement, anchor plates and spot welding of perforated plates is permitted (Generally not permitted)
7.5.1 (3)	Prestressing: Stressing and end anchorages	As identified on project drawings.
7.5.1 (6)	Prestressing: Concrete strength at transfer	Requirement relating to minimum compressive strength of concrete when application and/or transfer of prestressing force to the structure
7.5.2 (1) & 7.5.3 (1)	Prestressing: Accuracy of elongation of tendons cannot be met	Actions to be taken when accuracy of elongation of pre-tensioning tendons cannot be achieved
8. Concreting		
8.1 (1)	Specification:	Concrete properties shall be as specified in clause 704 of this specification.
8.1 (3)	Specification:	Minimum upper sieve size, D = 8mm
8.2 (1)	Concreting plan:	Concreting plan is required.
8.2 (2)	Trial casting:	Requirements for trial castings to be agreed with Engineer if areas of particular concern are identified. Generally trial castings are not required.

Clause	Text	Requirement
8.2 (4)	Construction joint preparation:	Construction joints shall be as specified in clause 705 of this specification.
8.2 (6)	Additional reinforcement cover:	Any requirements for additional cover (e.g. when casting directly against the ground) are indicated on the project drawings.
8.3 (4)	Taking of samples:	In-situ concrete - Identity testing for compressive strength is required. The rate of sampling is to be 1 for each continues pour with a minimum of 1 sample per 40m^3 of concrete. For each sample taken six 100mm or 150mm cubes are to be made, with 3 tested at 28 days and 3 tested at an earlier ages directed by the Engineer. It shall be in accordance with the requirements given in BS 8500. Identity testing for slump, flow and air content on individual batches of concrete is required once for each batch delivered to site.
8.3 (5)	Contact with aluminium:	No contact with aluminium or its alloys is permitted
8.4.4 (1)	Sprayed concrete application:	Sprayed concrete is not to be used
8.4.5(2)	Slipforming:	Not used
8.4.6 (1) & (2)	Underwater casting:	Any underwater casting or that in the intertidal and near-tidal zone to be in accordance with best practice and the guidance given in CIRIA C674 The use of concrete in maritime engineering – a guide to good practice. Method statements for the work to be agreed with the Engineer. Concrete to be placed underwater shall have adequate workability and take account of potential washout of cementitious materials and fine aggregate. Concrete mix design shall comply with the Concrete Society Technical Report 35 or equivalent American ASTM/ACI standard.
8.5 (2)	Protection from aggressive agents:	The Contractor shall provide adequate cover as necessary to protect concrete whilst being placed and whilst being cured against damage from rainfall, seawater and aggressive agents such as chlorides. Any concrete found to have been damaged by weather, tidal or any other effects shall be cut out and replaced with satisfactory concrete by the Contractor at his own expense.
8.5 (7)	Curing type:	Curing type 3 (Table 19 CSA A23.1 – 14) Extended wet curing – wet-curing period of 7 days at >10degreeC and for the necessary time to reach 70% specified strength.

Clause	Text	Requirement
8.5 (8)	Special curing requirements:	The curing types allowed are ponding, continuous sprinkling, absorptive mat, or fabric kept continuously wet.
8.5 (16)	Early age cracking reduction:	Special measures to reduce the risk of thermal cracking are not anticipated as being required.
8.8 (1)	Surface finish:	Surface finish requirements shall be as per clause 706 of this specification.
9. Execution with precast concrete elements		
9.1 (2)	Elements:	See Table 701/1
9.4.1 (1) and 9.4.1 (3)	Handling, storage, protection and position:	Members shall be lifted or supported only at points specified on detailed element drawings and shall be handled and placed without impact. When members are stored, they shall be firmly supported at regular intervals to prevent adverse loading. Any unusual constraints on support or handling shall be detailed on the drawings The accumulation of trapped water and deleterious matter in the units shall be prevented. Care shall be taken to avoid rust staining and efflorescence. When a stack is several units high, packings shall be vertically above each other to prevent additional bending stresses in any unit. Where disfigurement would be detrimental, packing pieces shall not discolour or otherwise permanently damage the units.
9.4.2 (3)	Product identification:	To be defined by the Contractor
9.5.1 (1)	Placing and adjustments:	To be prepared by the Contractor
9.5.2 (4)	Erection input:	To be prepared by the Contractor
9.6.3 (3)	Connections:	As per construction drawings. To be used in full accordance with manufacturer's instructions and any requirements detailed on the drawings.
10. Geometrical tolerances		
10.1 (2)	Tolerance class:	General dimensional tolerances as per Table 15 (CSA A23.1 – 14)
10.1 (2) and 10.1 (4)	Special tolerances and locations:	No special tolerances apply unless indicated otherwise on the project drawings
10.1 (3)	Tolerances in Annex G of EN 13670:	Annex G applies
10.1 (4) and 10.1 (5)	Box principle:	Box principle does not apply unless otherwise indicated on the drawings

Clause	Text	Requirement
10.1 (6)	Surfaces with full contact bearing:	Any additional tolerances shall be specified on the relevant drawings
10.1 (7)	Sections cast under water:	Tolerances for sections cast underwater shall be agreed with the Engineer
10.1 (10)	Combination of construction tolerances and structural deflections:	No requirements
10.2 (3)	Secondary lines:	No requirements

704 SPECIFICATION OF CONCRETE

Specification of Concrete

Concrete shall confirm to the requirements of BS 8500-2 or equivalent American ASTM/ACI standard. Concrete shall be specified as Designed concrete.

Designed Concrete

Designed concrete mixes are to be used in the locations listed in table 704/1. The Contractor shall complete the Schedule for the acceptance of the Engineer. All designed concrete shall conform to BS 8500-2 or equivalent American ASTM/ACI standard.

Table 704/1 – Schedule for Designed Concrete

Requirement	Schedule			
Mix Reference	Structural in-situ concrete	Precast concrete	Mass Concrete	Blinding Concrete
Intended Location of Concrete	Various – see table 701/1	Various – see table 701/1	Various – see table 701/1	Where applicable
Intended Working Life of Structure	50 years	50 years	50 years	N/A
Nominal Cover to Reinforcement	As specified on project drawings	As specified on the project drawings	-	-
Applicable Exposure Classes	C-XL/S-3 (XS3 to Eurocodes)	C-XL/S-3 (XS3 to Eurocodes)	-	-
DC-class (where appropriate)	-	-	-	-
Compressive Strength Class of Concrete (minimum)	M50 C40/50 to Eurocodes	M50 C40/50 to Eurocodes	M30 C22/30	M15 C12/15
Minimum Cement Content (kg/m^3)	380	380	-	-
Maximum Free Water/Cement Ratio	0.40	0.40	-	-
Permitted cement or combination types	All in Table A.6 of BS 8500-1. No requirement to add ggbs or fly ash.	IIIA with 46% to 65% ggbs IIIB with > 66% ggbs IIB-V+SR (25% to 35% fly ash)	Any	Any
Aggregate Type	BS EN 12620 or equivalent American ASTM/ACI standard.	BS EN 12620 or equivalent American ASTM/ACI standard.	BS EN 12620 or equivalent American ASTM/ACI standard.	BS EN 12620 or equivalent American ASTM/ACI standard.
Maximum Aggregate Size, mm	20	20	20	20
Additional requirements for concrete subjected to sulphate attack	As per class S-3 (Table 3)	As per class S-3 (Table 3)		
Requirement for air content categories	Category 2 (Table 4)	Category 2 (Table 4)		
Chloride on penetrability requirements	< 1000 coulombs within 91 days	< 1000 coulombs within 91 days		
Chloride Content Class	Cl 0,20	Cl 0,20	Cl 0,50	Cl 0,50
For Lightweight Concrete, the Density Class or Target Density	-	-	-	-
For Heavyweight Concrete, the Target Density	-	-	-	-
Consistence Class	Contractor to confirm	Contractor to confirm	Contractor to confirm	Contractor to confirm
Special Type or Class of Cement or Combination	None	None	None	None
Required Source/Special Type of Aggregate	None	None	None	None
Maximum Cement Content (kg/m^3)	418	418	-	-
Required Admixture	Contractor to confirm. Proposed admixtures to be	Contractor to confirm. Proposed	Contractor to confirm. Proposed	Contractor to confirm. Proposed

Requirement	Schedule			
Mix Reference	Structural in-situ concrete	Precast concrete	Mass Concrete	Blinding Concrete
	submitted to the Engineer for acceptance	admixtures to be submitted to the Engineer for acceptance	admixtures to be submitted to the Engineer for acceptance	admixtures to be submitted to the Engineer for acceptance
Required Fibres	None	None	None	None
Air Entrainment Required [YES/NO]	No	No	No	No
Minimum or Maximum Temperature of Fresh Concrete °C	5°C / 30°C	N/A	5°C / 30°C	5°C / 30°C
Sampling and Testing	Ref. BS EN 13670 & execution spec or equivalent American ASTM/ACI standard.	Ref. BS EN 13670 & execution spec or equivalent American ASTM/ACI standard.	Ref. BS EN 13670 or equivalent American ASTM/ACI standard.	Ref. BS EN 13670 or equivalent American ASTM/ACI standard.
Other Requirements	None	None	None	None

The conformity criteria for a designed concrete shall be in accordance with BS EN 206-1 or equivalent American ASTM/ACI standard.

The Contractor shall record, prior to the supply of any designed concrete, the following information:

(i) the nature and source of each material;

(ii) either:

(a) appropriate existing data as evidence of satisfactory previous performance for target mean strength, current margin, consistence and water/ cement ratio;

or

(b) full details of initial tests carried out in accordance with Annex A of BS EN 206-1;

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

Any change in the source of material or in constituent material shall be subject to a re-assessment of the concrete in accordance with this sub-Clause.

Constituent Materials

Constituent materials shall comply with the requirements of BS EN 206-1 and BS 8500 or equivalent American ASTM/ACI standards.

Admixtures shall conform to BS EN 934-2 or equivalent American ASTM/ACI standard. Where a specified coloured concrete requires a pigment, the pigment shall conform to BS EN 12878 or equivalent American ASTM/ACI standard.

Under no circumstances shall calcium chloride or chloride based admixtures be used in any concrete mix.

In all cases the Contractor shall record the following information:

(a) the detrimental effects caused by adding a greater or lesser quantity of admixture or pigment;

(b) the chemical name(s) of the main active ingredient(s);

(c) whether or not the admixture leads to the entrainment of air

705 CONSTRUCTION JOINTS

The position of construction joints shall be as shown on the drawings and at additional positions determined by the Contractor and agreed with the Engineer.

When concrete is placed in vertical members, walls, columns and the like, the lifts of concrete shall finish level or, in sloping members, at right angles to the axis of the members, and the joint lines shall match features of the finished work, if possible, or be formed by grout checks. Kickers shall be constructed integrally with the lift of concrete below.

Concreting shall be carried out continuously up to construction joints.

Construction joints shall be prepared in either of the following ways:

(i) When the concrete is self-supporting but still sufficiently green, the formwork shall be removed, as necessary to expose the construction joint. The concrete surface shall be sprayed with a fine spray of water or brushed with a stiff brush, just sufficiently to remove the outer mortar skin and expose the larger aggregate without disturbing it. Alternatively where this preparation proves impracticable the hardened surface skin and laitance shall be removed by grit blasting or a needle gun. Hardened surfaces shall not be hacked.

(ii) By the use of proprietary steel open-mesh permanent formwork.

Retarding agents shall not be used unless agreed otherwise with the Engineer.

The joint surface shall be clean and damp but free of standing water immediately before any fresh concrete is placed against it.

706 SURFACE FINISHES FOR CONCRETE

Surface finishes for structures are stated on the drawings.

Formed Surfaces – Classes of Finish

Formwork shall be capable of producing the following finishes where required in the Works:

Class F1 - This finish is for foundations and surfaces against which backfill or other concrete is to be placed or which will not be visible in the finished Works. Formwork shall consist of sawn boards, sheet metal or any other suitable material which will prevent the loss of grout when the concrete is vibrated.

Class F2 - This finish is for surfaces permanently exposed to view. The surface produced shall be free from voids, honeycombing or other large blemishes, discolouration, steps, fins, sharp protrusions or local hollows. The formwork may be sawn boards, metal panels or other approved suitable material.

Class F3 - This finish is for surfaces where visual effect is important. The surface produced by the formwork shall be smooth and of uniform texture and appearance, free from voids, honeycombing, discolouration or other large blemishes. Any small blemishes shall be carefully filled immediately after the removal of the formwork and other marked imperfections such as fins or steps shall be made good. To achieve this finish wrought timber boards, plywood sheets, steel panels or such

other material as is approved by the Employer's Representative shall be used. In large panels, the panels shall be arranged in an approved uniform pattern with vertical or horizontal joints, unless otherwise directed. Joints shall be carefully filled or sealed before concreting. The same type and brand of shutter release agent shall be used throughout the Contract on surfaces of a structure where a Class F3 finish has been specified.

Class F3P

This finish is similar to Class F3 except that in addition to the requirements for Class F3 the formwork is to be lined with a proprietary controlled permeability formwork liner as specified in Clause 1.4.16. The same type and brand of controlled permeability formwork liner shall be used throughout the Contract on surfaces where a Class F3P finish has been specified.

Permanently exposed concrete surfaces to all Classes of finish other than F1 shall be protected from rust marks and stains of all kinds.

All formwork joints for all classes of finish other than F1 shall form a regular pattern with horizontal and vertical lines continuous throughout each structure and all construction joints shall coincide with these horizontal or vertical lines.

Unformed Surfaces - Classes of Finish

Class U1 finish - The concrete shall be levelled and screeded to produce a uniform surface to the profile shown on the Drawings. No further work shall be applied to the surface unless it is used as a first stage for another class of finish.

Class U1B finish

A brushed finish shall be applied to all unformed upper surfaces of concrete unless noted otherwise on the Drawings. After the concrete has hardened sufficiently, the Class U1 finish shall be brushed with a stiff brush, as directed, to give a good running surface. A 100 mm wide strip at the edge of the slab and adjacent to all joints shall be finished smooth with a steel float.

The requirements for the surface finish of rigid concrete pavements shall be a brushed finish as defined above, subject to the approval of the Employer's Representative.

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

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

Alternatively the concrete shall be levelled, screeded and floated to produce a uniform surface and immediately before the waterproofing operation this surface shall receive surface preparation by water jetting or grit blasting to provide a lightly textured finish.

The finished surface shall not deviate from the required profile by more than 10 mm over a 3m gauge length or have any abrupt irregularities more than 3 mm.

Trial Panels

These are not required for structures covered by this specification.

Control of Colour

Not Used.

707 ANCHORAGE AND LAP LENGTHS

The following minimum anchorage and lap lengths shall be used:

Table 707/1 – Anchorage and Lap Lengths

	Good Bond		Poor Bond	
	Lap	**Anchor**	**Lap**	**Anchor**
#4	380	250	540	360
#5	470	320	670	450
#6	570	380	810	540
#7	670	450	960	640
#8	830	550	1180	790
#9	980	660	1400	940
#10	1160	780	1660	1110

Bond conditions “Good” and “Poor” are defined as follows:

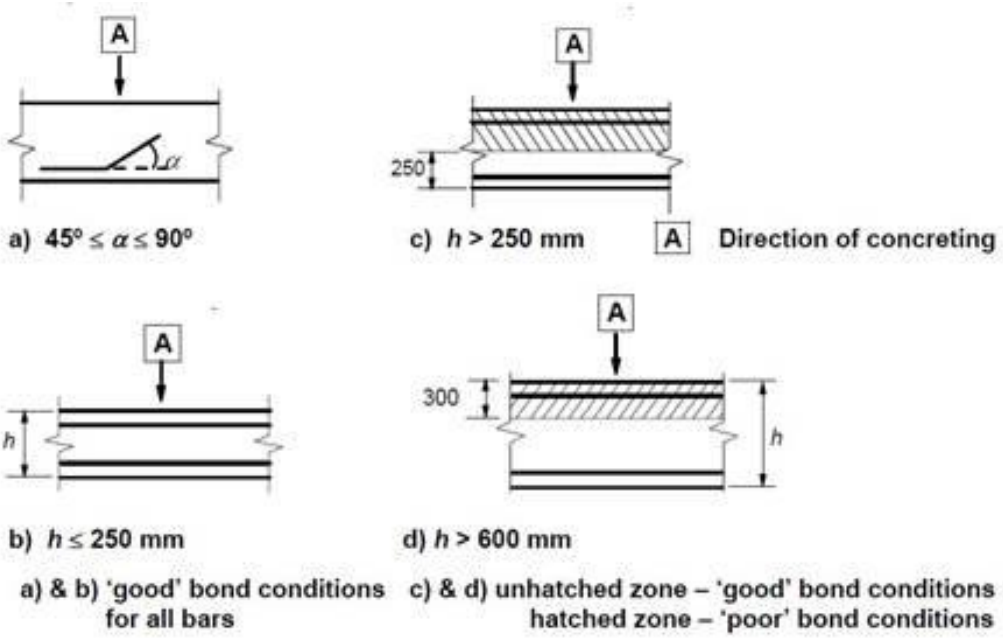


Figure 707/1 – Bond Conditions

SERIES 1000 RESIN AND GROUTING

CONTENTS

RESIN AND GROUT FIXING

1001 INTRODUCTION

Resin / grout fixing is proposed for fixing of furniture (handrails, ladders, lifering posts and alike). Full details are given on the project drawings.

Where possible cast-in fixings shall be used in preference to drill and fixed connections. Cast in fixing must be used for the bollard and fender fixings.

1002 RESIN AND GROUT FIXING - GENERAL

All resin and grout fixing works shall be carried out in accordance with the requirements of Series 1000 of this Specification and in accordance with the instructions of the product manufacturer. Where there is an apparent conflict between the manufacturer's instructions and the requirements of this specification this shall be reported to the Overseeing Organisation at least 7 working days prior to commencement of work.

1003 PREPARATION

A cover meter shall be used to establish the location of reinforcement in the area where the hole is to be drilled. Drilling through reinforcement should be avoided if possible and if there is a conflict the Overseeing Organisation shall decide an appropriate course of action.

Holes shall be rotary percussive drilled and must be clean, dry, and free from dust or any other contaminant. Diamond drilled/cored holes must be roughened.

Before and after drilling holes the Contractor shall ensure that the existing concrete is sound, and that any significant defects such as fractures, cracks and voids in the vicinity of the hole are brought to the attention of the Overseeing Organisation and the measures to be taken decided.

The length of hole shall be as indicated on the drawings.

The diameter of each hole is to be in accordance with the manufacturers recommendations.

The tolerance of hole position shall be ±50mm. The hole diameter may not be enlarged beyond the manufacturer's recommendations hence position should be carefully established prior to drilling.

All holes shall be perpendicular to the surface in which they're drilled to an accuracy of ±10mm per metre depth. The tolerance on depth shall be +20mm, -0mm.

The reinforcing bars and/or anchors shall be free of rust or scale, grease or oil or other surface coating or contamination. The bars and anchors shall not be coupled, bent or damaged.

1004 RESIN MATERIAL

Resin anchoring of bars shall be undertaken using the resin product identified on the project drawings. Where a resin product is not stated on the drawing(s) Hilti HIT-RE500 shall be used. Similar products may also be accepted subject to approval by the Engineer.

If an alternative resin product is proposed by the Contractor then he shall provide the Overseeing Organisation with a comparison including but not limited to the following details to be sourced from the manufacturer:

- Manufacturer
- Product Name
- Contact Details
- Nominal Anchorage Depth
- Mean Ultimate Resistance
- Characteristic Resistance
- Design Resistance
- Recommended Working Load
- Setting Details (hole size, adjustment period, curing time to full load application)
- Installation Equipment
- Outline Installation method

1005 GROUT MATERIAL

Grout anchoring of bars shall be undertaken using the product identified on the project drawings. Where a grout product is not stated on the drawing(s) Fosroc Lokfix grout product shall be used. Similar products may also be accepted subject to approval by the Engineer.

If an alternative resin product is proposed by the Contractor then he shall provide the Overseeing Organisation with a comparison including but not limited to the following details to be sourced from the manufacturer:

- Manufacturer
- Product Name
- Contact Details
- Nominal Anchorage Depth
- Mean Ultimate Resistance
- Characteristic Resistance
- Design Resistance
- Recommended Working Load
- Setting Details (hole size, adjustment period, curing time to full load application)
- Installation Equipment
- Outline Installation method

1006 METAL ELEMENTS

All anchor rods (length and diameter) shall be indicated on the relevant drawings.

All anchor rods shall be provided with double nuts/ nyloc nuts to prevent them loosening under cyclic loading and vibration.

All fully embedded reinforcing bars shall be galvanised Grade 60 to ASTM A615 (fy= 414 MPa) deformed bars of the length, shape and diameter indicated on the relevant drawings.

All partially embedded connecting threaded bars and/or embedded bolts shall be stainless grade A4/80 or equivalent grade to American ASTM standards.

1007 MIXING AND APPLICATION

The resin or grout shall be thoroughly mixed and applied/injected fully in accordance with the manufacturer's recommendations and good practice.

The bars or anchors shall be centrally located in the hole and the void around the bar completely filled with the anchor material leaving no voids.

Once in place the bar or anchor shall not be disturbed until the material has fully set.

Where indicated on the drawings, the annulus around the rod within the steel plate being fixed to the structure shall also be filled with resin of grout in order to ensure uniform distribution of shear forces between the fixings.

1008 TESTING

The Highways Agency Interim Advice Note 104/07 "The anchorage of reinforcement and fixings in hardened concrete" states:

"It is recommended that preliminary load tests on trial anchorages are carried out. In the event that this preliminary load testing does not produce satisfactory results, there is then the opportunity to take corrective action (e.g. increasing the embedment depth) before installing the works anchorages. Further tests on works or sacrificial anchorages can be carried out as work proceeds. Tests on sacrificial anchorages (as opposed to works anchorages) should be considered when testing works anchors are not possible due to geometric constraints (e.g. restricted access or bent bars). Where testing of sacrificial anchorages is proposed in lieu of testing works anchorages, ensuring an appropriate quality of workmanship for the works anchorages is particularly important. Tests on trial or sacrificial anchorages should, as far as reasonably practicable, replicate the conditions and installation methods applicable to the works anchorages. Wherever possible, trial/sacrificial anchorages should be located on the structure in the vicinity of the proposed works anchorages"

Tension load tests in accordance with BS 5080 Part 1 - Structural Fixings in Concrete and Masonry or equivalent grade to American ASTM standard shall be carried out.

A total of 5 tests should be carried out on each diameter and embedment length of resin or grout fixed bars or rods prior to the commencement of the main works. Tests may be on the works or sacrificial bars at the sole discretion of the Overseeing Organisation at the time of the works.

Following the initial 5 tests, 5% of the resin or grout fixings forming the main works should be tested. These bars should be distributed evenly through the course of the works, and between all working teams carrying out the work.

All sacrificial anchorages should preferably be fixed into areas of the structure similar to those portions of the structure into which the works anchors/ bars will be fixed. All sacrificial anchorages should be prepared by the same personnel who will prepare the works anchorages, using the same equipment and techniques, and should as far as practical replicate the installation conditions of the main works anchorages.

The location of the test anchorages shall be proposed by the contractor for approval by the Overseeing Organisation.

The test load to be applied shall be 80kN.

Each tested reinforcing bar/anchor shall be loaded incrementally in tension in accordance with BS 5080 Part 1: 1993 or equivalent grade to American ASTM standards up to the test load. The number of load increments shall not be less than 10.

Incremental loads shall be held for not less than 30 seconds and the test load for not less than 5 minutes.

Readings shall be taken immediately after applying load and at the ends of the time intervals stated above.

The total movement of the anchored reinforcing bar/anchor, less the calculated elongation of the bar/fixing during the test (based on the length of bar/fixing between the concrete surface and the point of load application), shall not exceed 5% of the nominal diameter of the bar/fixing.

Any evidence of slip during loading up to the test load, as demonstrated by a significant change in the slope of the load/extension curve, shall constitute a failure.

If the failure load of any of the tested bars/anchor is less than the test load specified then, the further action shall be agreed with the Overseeing Organisation and pull-out testing repeated.

The Overseeing Organisation shall be provided with the results of the pullout tests. The results for each test shall include a graph of load/extension.

SERIES 1100 STRUCTURAL STEEL (CONCISE PROJECT VERSION)

CONTENTS

STRUCTURAL STEEL

1101 INTRODUCTION

The Kings Wharf Rehabiliation works include minimal structural steelwork. The structural steelwork (excluding furniture and fixings) is limited to the following elements:

1. Pile Jacket Formwork: this is temporary formwork that will be left in place. Although sacrificial the forwork shall be galvanised for aesthetic reasons.
2. Plating repairs to the top of existing H-piles
3. Bracket supports for side service trench: these shall be galvanised.

As the quantum of structural steelwork is minimal and does not form key structural elements of the wharf a shortened specification section 1100 is provided compared the normal document.

Where Eurocode or British Standards are referenced these may be replaced by equivalent American American ASTM or ACI standards.

1102 STANDARDS AND GUIDANCE

Steelwork shall be in accordance with American Standard ANSI/AISC 360-16 Specification for Structural Steelwork.

1103 STEEL MATERIALS AND GRADES

Material test reports or reports of tests made by the fabricator or a testing laboratory shall constitute sufficient evidence of conformity with one of the ASTM standards listed in Section A3.1a of ANSI/AISC 360-16.

Structural steel shall be a minimum of Grade 50 (yield strength >345 MPa) according to ASTM A572 or agreed equivalent standard or higher grade if indicated on the drawing.

1104 CORROSION PROTECTION

All structural steelwork shall be galvanised with a minimum thickness of 150microns. Refer also to series 1200 of this specification on corrosion protection in regards to surface preparation and other galvnaising requirements.

All anchors/fixings into concrete shall be stainless steel.

Isolation between different types of metals shall be ensured.

1105 WELDING

Weld sizes and types are as indicated on the relevant drawings.

When butt welds are required to be used as splices to accommodate available lengths of constituent products, the locations shall be agreed with the Engineer.

All weld irregularities, undercutting and porosity shall be eliminated to improve corrosion resistance. All weld spatter shall be removed.

Welding production tests shall be carried out in accordance with the qualification standard for the process concerned.

1106 BOLTED CONNECTIONS

Bolt sizes, types and grade are as indicated on the drawing.

Bolt, washer and nut material conforming to one of the ASTM listed under Section A3. 3 of ANSI/AISC 360-16

Galvanised Bolts shall meet the requirements of ASTM F3125 Grade A325 as a minimum (yield strength >120 ksi).

Stainless steel bolts shall be grade A4/80 to ISO 3506-1 or higher (yield strength = 640N/mm^2, ultimate tensile strength = 800kN/mm^2) or equivalent agreed standard.

Locking devices shall be provided on the nuts to prevent them loosing due to cyclic loading (e.g. from waves). Welding of nuts, bolts or washers is not permitted.

Only tolerance holes are permitted (approx. 2 to 3mm larger than bolt shank diameter), slotted or oversized holes shall not be used without approval of the Overseaing Organisation.

Washers shall be placed under the nut or head of the bolt, whichever is rotated. Bolts shall be adequately tightened.

For marine structures, packings may not be left in place without prior agreement of the Engineer.

1107 FABRICATION AND ERECTION

Shop drawings, fabrication, shop painting and erection shall satisfy the requirements stipulated in Chapter M of ANSI/AISC 360-16.

Inspection of elements for the pile sleeves shall ensure that the fit between half-shells is accurate.

1108 QUALITY ASSURANCE

Quality control and quality assurance activities shall satisfy the requirements stipulated in Chapter N of ANSI/AISC 360-16.

SERIES 1200 CORROSION PROTECTION

CONTENTS

PROTECTION OF STEELWORK AGAINST CORROSION

This series covers general corrosion protection requirements. Specific details are provided in construction drawings. Corrosion protection will be used throughout Kings Wharf for the marine furniture and fixings.

The corrosion protection measures described in these section of the specification shall be applied to all steel work that is not permanently submerged, unless otherwise indicated on the project drawings.

Table 1201/1 – Corrosion Protection Requirements

Element	Corrosion Protection Approach	Resulting Design Life / time to first maintenance
Exisitng Piles	Provision of Cathodic Protection system	
Fixings into concrete (cast-in and/or drill and fix)	To be stainless steel grade A4/80 (bolts) or 1.4404 (bar) or better or equivalent grade to American ASTM standards.	50 years
Bollards	To be painted with Marine Grade Paint	Repainting every 10 to 15 years
Chains	Galvanised or Stainless Steel chain to be used	15 years
Ladders	To be Stainless Steel grade 1.4404 or better or equivalent grade to American ASTM standards.	50 years
Hand rails	To be painted with Marine Grade Paint	Repainting every 10 to 15 years
Reinforcement pre-cast elements	None Mild steel to be embedded in high quality concrete (with fly ash) with adequate cover.	50 years
Pre-stressing strand	None Mild steel to be embedded in high quality concrete (with fly ash) with adequate cover.	50 years
Reinforcement (in-situ) Reinforcement starter bars from pre-cast	To be Stainless Steel	50 years
Casing for pile sleeves	To be galvanised and fixings galvanised	N/A - non-structural element in permanent case

1200 WORK PLAN

Ref. EN 1090 part 2 F.1.4 or equivalent American ASTM standard.

1201 SURFACE PREPARATION

Preparation of Carbon Steels prior to painting and metal spraying

Surfaces shall be prepared in accordance with EN ISO 12944-4, EN ISO 8501 and EN ISO 8503-2 or equivalent American ASTM standard as appropriate.

Procedure tests shall be undertaken on blast cleaning processes to establish the surface cleanliness and surface roughness achievable. These shall be repeated at intervals during production.

The results of procedure tests on blast cleaning processes shall be sufficient to establish that the process is suitable for the subsequent coating process.

Measurement and assessment of surface roughness shall be undertaken according to EN ISO 8503-1 and EN ISO 8503-2 or equivalent American ASTM standard.

If coated materials are to receive further treatment, the surface preparation shall be appropriate to the subsequent treatment.

NOTE 1 Abrasive cleaning and wire brushing are not appropriate to sound metallic or organically coated components. However, if repairs to coatings are needed, it may be necessary to remove debris or corrosion deposits locally to reveal the basic steel substrate before carrying out the repair.

If overpainting of zinc coated steel is carried out, the cleaning of the surface requires particular attention. Surfaces shall be cleaned (removal of dust and grease) and possibly treated with a suitable etch primer or sweepblasting according to EN ISO 12944-4 or equivalent American ASTM standard to surface roughness “fine” in accordance with EN ISO 8503-2 or equivalent American ASTM standard. The pre-treatment shall be checked before subsequent overcoating.

NOTE 2 Pre-coated galvanized steel strip is often supplied with a chromate passivation.

Preparation of Carbon Steels prior to painting galvanising

Surfaces shall be prepared in accordance with EN ISO 8501 and EN ISO 1461 or equivalent American ASTM standards.

With pickling used prior to galvanizing, high strength steels may become susceptible to hydrogen-inducing cracking (see Annex C of EN ISO 1461:1999).

Preparation Prior to Welding

If a component is subsequently to be welded, the surfaces of the component within 150 mm of the weld shall not be coated with materials that will impair the quality of the weld (see also EN 1090 Part 2 7.5.1.1).

Welds and adjacent parent metal shall not be painted before de-slagging, cleaning, checking and acceptance of the weld (see also EN 1090 Part 2 10.2 - Table 22).

1202 SURFACES IN PRELOADED CONNECTIONS

Not Used.

1203 PREPARATION OF FASTENERS

Generally all fasteners shall be stainless steel unless otherwise agreed, hence no preparation should be required.

Fasteners to the casings of the pile sleeves may use galvanised fastenings.

1204 PAINT SYSTEMS

Durability of coatings

Where coatings are specified they shall have a design life of 15 years or greater.

Definition

The term ‘coating’ shall include the primer and the coats specified.

Specialist labour

The preparation of surfaces and the application of the coats to form the coating shall be carried out by specialist labour having experience in the preparation of the surface and the application of the coating specified.

Surface Preparation

The surface shall be prepared in accordance with clause 1601.1.

Paint System

The following paint systems shall be used.

System Reference A	
Items:	Bollards
Preparation:	Abrasive Blasting to Sa 2½
Coating:	Zinc Primer 80 microns plus 2-pack Epoxy Coat 240 microns [Trelleborg recommendation]
System Reference B	
Items:	Handrails

Preparation:	Abrasive Blasting to Sa 2½
Coating:	1st Coat: Primer: International Paint Interzinc 52 1 layer x 80µm thick 2nd Coat: Top Coat: International Paint Interzone 954 1 layer x 450µm thick

Storage

Each container of paint shall be marked on the side to show the following:

a) The name of the manufacturer,

b) The paint manufacturer's reference number,

c) Intended purposes, type pf pigment and binder,

d) Batch number, date of manufacture, expiry date and pot life,

e) Colour, gloss, drying times and flash point.

Paint and associated materials shall be stored in sealed containers marked as stated in this specification and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturer's recommendations and shall not be used after the recommended expiry date has been exceeded. The materials shall be stored in a locked store. Fire fighting equipment to the approval of the engineer shall be provided at all locations where paint and associated materials are stored.

Trials

A painting trial shall be carried out for each painting system to demonstrate the proposed materials and methods of application will produce a painted surface which complies with the specified requirements.

Paint trials shall be carried out at the place where painting to the permanent work will be carried out by the persons and suing the equipment which will be used to carry out painting to the permanent work.

Paining trials shall be carried out on blast cleaned surfaces.

If the painted surface produced in a painting trial does not comply with the specified requirements for the paintwork, the cause of failure shall be established by the contractor and particulars of proposed changes shall be submitted to the engineer for review. Proposed changes to the paint formulation, other than ad adjustment in the amount of thinner, shall be carried out at the paint manufacturer's works before the final painting trail and before the first batch of paint is delivered.

Painting shall not commence until the painting surface produced in painting trials complies with the specified requirements for paintwork.

Unless previously agreed with the engineer, the materials and methods of application used in a painting trial which complies with the specified requirements shall not be changed.

Protection during coating

All work associated with surface preparation and coating shall be undertaken inside a waterproof structure.

Application and type of primer

Within 4 hours after surface preparation, before visible deterioration takes place, the surface shall be coated with an appropriate primer or the specified coating. No coating shall be applied to a metal surface which is not thoroughly dry.

Primed steel surfaces shall be overcoated within 8 weeks.

The primer shall be compatible with the specified coating and shall be such that if subsequent welding or cutting is to be carried out it shall not emit noxious fumes or be detrimental to the welding.

Control of humidity and temperature during coating

No coating shall be applied when the surface metal temperature is less than 3°C above the dew point temperature or above 50°C.

No coating shall be applied if the ambient temperature is below that recommended by the manufacturer for the product to be applied.

No coating shall be applied when the humidity could have an adverse effect on the coat.

No coating shall be applied when in the opinion of the engineer the conditions are likely to result in a paint finish which not meet the performance requirements.

When heating or ventilation is used to secure suitable conditions to allow coating to proceed, care shall be taken to ensure the heating or ventilation of a local surface does not have an adverse effect on adjacent surfaces or work already done.

Parts to be welded

The coating within 200 mm of a weld shall be applied after welding. The method of application shall comply with the manufacturer's recommendations.

Thickness, number and colour of coats

The nominal thickness of the finished coating and if necessary of each coat shall be as specified. The average coat or finished coating thickness shall be equal to or greater than the specified nominal thickness. In no case shall any coat or finished coating be less than 75% of the nominal thickness. Each coat shall be applied after an interval that ensures the proper hardening or curing of the previous coat, and within 72 hours (unless the interval to ensure proper hardening exceeds this).

Where more than one coat is applied to a surface, each coat shall be of a different colour from the previous coat. The colour sequence and final coating colour shall be established prior to application of coatings.

Stripe Coatings

Immediately after the first undercoat of the paint system to steelwork has dried, a stripe coat of undercoat paint shall be applied by brush to edges, corners, crevices, exposed parts of bolts, nuts, rivets, and welds. Another stripe coat of finishing paint shall be applied n the same manner after the last undercoat has dried.

Storage

The packing of painted components into bundles shall not commence until the paint manufacturer's declared hardening time has expired. Adequately well ventilated space, protected against the influence of weather, shall be provided to allow the coating to harden sufficiently. Appropriate measures shall be taken to prevent damage to the coating during packing and handling.

NOTE Cold formed components are often produced as nesting profiles. Tightly packing components into nested bundles before the paint treatment is sufficiently hardened may result in damage.

1205 METAL SPRAYING

NOT USED

1205 GALVANISING

Galvanizing shall be undertaken in accordance with EN ISO 1461 or equivalent American ASTM standard.

Galvanising shall be done after completion of all cutting, drilling, forming, punching and welding operations performed in the fabrication shop, but before any assembly by bolting. Warped or twisted shapes resulting from the galvanising process are not acceptable and shall be straightened prior to shipment.

Metal coatings which will be overcoated with paint shall be passivated.

Galvanising shall be carried out after the part has been cut, drilled, bent, welded and fabricated, apart from bolting up, so that all exposed surfaces are given the protective coating which shall be uniform, adherent, smooth, free from flux stains and shall weigh not less than 0.6 kg per square metre of area covered for steel articles 5mm thick and over.

Allowance for the thickness of the metal coating shall be made in the sizes of the threads of metal coated threaded components. Nuts shall not be tapped oversize by more than 0.4mm.

Metal coatings required on part of a component shall be completed before the rest of the component is painted.

Repair of Galvanised Surfaces

Welds, cuts, abrasions or otherwise small damaged areas of galvanised surfaces shall be repaired in the Fabricator’s shop prior to shipping with an approved zinc base solder galvanising compound, flame spray galvanising or equivalent procedure acceptable to the Engineer. However, defects resulting from faulty galvanic processing shall be rectified by the correct reapplication of the process to the approval of the Engineer.

Site repairs to damaged areas of metal coatings shall involve the coatings being rubbed down to remove excessive roughness, cleaned and made good by the use of an aerosol zinc rich paint containing an aluminium pigment, to give a repair coating thickness of 100 microns.

Galvanized surfaces of cold-formed components shall be provided by using precoated steel strip or by hot dip galvanizing after manufacturing.

NOTE 1 Coating masses, finishes and surface qualities are specified in EN 10326 and EN 10327 or equivalent American ASTM standards.

If hot dip galvanizing after manufacturing is specified, it shall be undertaken in accordance with EN ISO 1461 or equivalent American ASTM standard and requirements for procedure qualification of the dipping process shall be specified.

NOTE 2 Light gauge cold-formed components often lack inherent stiffness. Long components composed of thin material can be susceptible to twisting due to stress relieving at the elevated temperature of the zinc bath.

Requirements for the inspection, checking or qualification of the preparation to be carried out before subsequent overcoating shall be specified.

1206 INSPECTION AND CHECKING

General

Inspection and checking shall be undertaken in accordance with the quality plan and F.7.2 to F.7.4. The execution specification shall specify any requirements for additional inspection and testing.

Inspection and checking, including routine checking to F.7.2, shall be recorded.

Routine checking

Routine checking of corrosion protection shall comprise:

a) checks that prepared steel surfaces which are to receive corrosion protection treatment have the specified degree of cleanliness, assessment in accordance with EN ISO 8501 or equivalent American ASTM standard and the specified surface roughness, assessment in accordance with EN ISO 8503-2 or equivalent American ASTM standard;

b) thickness measurement of:

1) each layer of the paint coating in accordance with ISO 19840 and EN ISO 2808 or equivalent American ASTM standards;

2) thermal spraying in accordance with EN ISO 2063 or equivalent American ASTM standard;

3) galvanizing in accordance with EN ISO 1461 or equivalent American ASTM standard.

4) Visual inspection that paint treatment complies with the provisions of EN ISO 12944-7 or equivalent American ASTM standard.

Reference areas

In accordance with EN ISO 12944-7 or equivalent American ASTM standard, the execution specification shall define any reference areas to be used to establish the minimum acceptable standard for the work. Unless otherwise specified, reference areas shall be specified for corrosion protection systems in Corrosivity Categories C3 to C5 and Im1 to Im3.

Painted Components

The finished coating shall be generally smooth, of dense and uniform texture and free from sharp protuberances or pin-holes. Excessive sags, dimpling or curtaining shall be retreated.

Any coat damaged by subsequent processes or which has deteriorated to an extent such that proper adhesion of the coating is in doubt shall be removed, and the surface shall be cleaned to the original standard and recoated to provide the specified number of coats.

The completed coating shall be checked for thickness by a magnetic thickness gauge. Areas where the thickness is less than that specified shall receive additional treatment.

When specified, the completed coating shall be checked for adhesion by means of an adhesion test to 'BS EN ISO 2409, BS 3900-E6 or equivalent American ASTM standard', carried out on 10% of the piles. The adhesion of any completed coating shall not be worse than Classification 2. If adhesion tests on the initial batch are satisfactory, then on further batches 1% of the piles shall be tested. Adhesion tests shall not

be carried out until seven days after coating. On completion of testing the test area shall be made good to the standard specified in Appendix 16/6. Areas where the adhesion is defective shall be repaired and reinspected.

Galvanized components

Unless otherwise specified, due to the risk of liquid metal assisted cracking (LMAC), galvanized components shall be subjected to post-galvanizing inspection.

NOTE Information on LMAC is given in [51].

The component specification shall specify the following:

a) components for which post-galvanizing inspection is not required;

b) components or specific locations that shall be subjected to additional NDT, the scope and method of which shall be specified.

The results of post-galvanizing inspection shall be recorded.

If evidence of cracking is identified, then the component and all similarly shaped components fabricated with similar materials and weld details shall be identified and quarantined as nonconforming products. A photographic record of the cracking shall be made and a specific procedure shall then be used to establish the scope and origin of the problem.

Codes, Standards

Eurocodes are to be used where applicable, in particular:

BS EN ISO 12944 – Paints and varnishes. Corrosion protection of steel structures by protective paint systems.

BS EN ISO 8504 – Preparation of steel substrates before application of paints and related products.

BS EN 1990 – Basis of Structural Design

BS EN 1993 – Design of Steel Structures

Equivalent American ASTM standards to the above may also be used.

For marine aspects not covered by Eurocodes, use BS 6349.

1207 CATHODIC PROTECTION

Please see Cathodic Protection System Specification document reference 390/SPEC/01 (appended) by Corrosion Prevention Limited for requirements.

SERIES 1800 FENDERING

CONTENTS

1801 INTRODUCTION

Introduction

The following is a specification for the design and installation of the fenders. The employers requirements and reference design are set out in the following drawings:

Table 1801/1 – Fender Requirement Drawings

Drawing No	Drawing Title
1620004884-RAM-XX-00-DR-CW-401	Furniture Details - Ladders and Edge Protection

All steel work shall be carried out in compliance with this Series and the appropriate Clauses of Series 1100. For corrosion protection see Series 1200.

Terms and Abbreviations

In addition to the terms specified in clause 003 of Series 000 – Introduction of this specification, the following term applies:

FENDER SUPPLIER – The organisation responsible for the design and supply of the fender system.

1802 GENERAL EMPLOYERS REQUIREMENTS AND REFERENCE DESIGN

Design Working Life

The design working life of the elements of the fender system is specified in the table below.

Table 1802/1 – Design Working Life of Works Elements

Element	Design Working Life	Minimum period to reapplication of protective coatings	Period to first routine maintenance	Unacceptable Repair/ Replacement within Design Working Life
Fender system	30 years	N/A	Maintenance intervals and maintenance activities to be stated by Fender Supplier for agreement	Replacement of worn or corroded elements
Fender Panel steelwork	30 years	10 years		Cutting out or replacement of corroded steelwork or fixings
Fender chains and fixings	30 years	15 years		Cutting out or replacement of corroded steelwork or fixings

Design vessel data and berthing energies

Berthing energies onto the berthing fenders shall be calculated in accordance with BS6349-4.

The following design vessels and data shall be used in the calculation of fender arrangement and berthing loads.

Table 1802/2 – Design Vessels and Berthing Data

Details of the design vessels are presented in the following table. The Oasis Class has been added to this table as there is a potential of future extension to the wharf to accommodate these vessels.

Vessel	Cruise Line	LOA (m)	Beam @ Waterline (m)	Design draught (m)	Displacement (tonnes)	Height above WL (m)
Voyager of the Seas	RCCL	311	38.6	8.6	64,474	63.0
Breakaway Class	NCL	324	39.7	8.3	67,700	54.5
Quantum Class	RCCL	348	41.4	8.5	73,000	-
Freedom of the Seas	RCCL	338.9	38.6	8.6	70,981	63.7
Oasis Class	RCCL	360	47	9.3	100,000	72.0

The following design berthing conditions shall be assumed:

Berthing velocity:	As per BS 6349-4 Section 5.2, no less than 100mm/s.
Berthing Angle:	3 degree
Factor of safety:	1.5
Wind speed:	35 knots

According to these conditions fender reactions are estimated as follows:

- *Freedom Class Windage = LOA x Height above WL = 338.9 x 63.7 = 21588 m^2*
- *Maximum Wharf fender force = 50 tonnes (from MM study)*
- *Oasis Class Windage = LOA x Height above WL = 360 x 72 = 25920 m^2*
- *Estimated Reaction force for Oasis Class = 25920 / 21588 x 50 =* ***60 tonnes.***

Water Levels

The following water levels shall be considered in the design.

Table 1802/3 – Design Water Levels

	Minimum (mCD)	Maximum (mCD)
Vessel Berthing	+0.1	+1.78

Maximum Fender Spacing

Fender spacing shall be as specified on the drawings.

Other Requirements

Type of fender shall be as stated below or similar approved:

- 5ft Diameter x 10ft Long Seaguard High Capacity Foam Filled Fenders

Type of anchors shall be as stated below or similar approved:

- See Drawing(s).

Type of chain shall be as stated below or similar approved:

- See Drawing(s).

Type of shackle shall be as stated below or similar approved:

- See Drawing(s).

Fender Supplier's Design Submission

Acceptance to the proposed fender system shall be sought from the Overseeing Organisation.

As a minimum, the following information shall be provided for acceptance by the Overseeing Organisation:

- Calculation of berthing energies, including distribution of energy between adjacent fenders where applicable and verification of fender performance.
- Full design drawings
- Material and product specifications
- Fender spacing and minimum vessel hull clearances to quayside structures
- Maximum hull pressures
- Maximum loads applied to quay structure
- Fixing proposals
- Necessary maintenance proceedures and intervals
- Details of corrosion protections systems
- Manufacturing tolerance of the fender

Where appropriate, the above shall be demonstrated for all design vessels over the full range of design water levels.

1803 STANDARDS AND CODES OF PRACTICE

British and other standards and codes of practice referred to in this specification and to be used in the Fender Supplier's design are as follows:

BS 6349-1-1	Maritime Works – General – Code of practice for planning and design for operations
BS 6349-1-2	Maritime Works – General – Code of practice for assessment of actions
BS 6349-1-4	Maritime Works – General – Code of practice for materials
BS 6349-4	Maritime Works - Code of practice for design of fendering and mooring systems
PIANC Report of Working Group 33	Guidelines for the Design of Fender Systems

In all cases, the most current version of the documents are to be used.

1804 FENDER SYSTEM

General

The design of the fender systems shall fully comply with the recommendations given in BS 6349-4, with reference to PIANC "Guidelines for the Design of Fender Systems" where this is non-contradictory and shall fully comply with the Employers Requirements given above.

The Derived Design was based on the characteristics of foam fender units. The Contractor may choose to use another fender, subject to demonstrating full compliance with the Works Information.

Rated energy and deflections shall be reduced, where necessary, using manufacturer's factors, totake account of temperature, berthing speed and angular compression (vertical and horizontal).

The quay structure shall be designed to withstand the fender reactions resulting from both characteristic and design berthing energy.

All fenders shall be installed in accordance with the manufacturer's recommendations.

The fenders shall be fitted with restraining chains; including shear chains, weight chains and antiuplift chains.

Chains and fixings shall be designed to resist horizontal and vertical shear calculated using a friction factor recommended by the manufacturer. The factor of safety against chain breaking shall be greater than 3.0.

A weak link in the form of a shackle shall be provided in chains to avoid damage to any fixings cast into the quay structures.Shackles fitted to the upper chains are to have recessed pins to prevent snagging of mooring ropes. Where fender chains are to be tensioned after installation, suitable tensioning devices are to be provided by the fender manufacturer and fitted to the chains. Where shock absorbers are recommended by the manufacturer these shall be supplied and fitted.

Transport, Storage and Installation of Fenders

Fenders and their components shall be handled, stored and installed in accordance with the manufacturer's instructions.

Adequate provisions should be made for spare fenders.

Great care shall be taken to prevent cutting or tearing of the rubber, particularly in the area of embedded plates and around bolt holes and washer recesses in the fender base, flanges or fins.

Fenders shall be handled in such a way as to prevent them from being distorted, overstressed or damaged in any way. All slings, ropes or chains for handling fenders shall be rubber or nylon sheathed.

Maintenance, Inspection and Replacement

The Fender Supplier shall ensure adequate access to all parts of the fender systems for inspection. The Contractor shall include in the overall Operations and Maintenance Manual a feasible outline of how future maintenance and replacement of the fendering systems could be carried out.

1805 MATERIALS AND COMPONENTS

General

The sources of supply of materials shall not be changed until the Fender Supplier has demonstrated that the materials from the new source can meet all the requirements of the Specification.

Materials failing to comply with the Specification shall be removed promptly from the site.

Rubber Fender Units

Rubber Fender Units shall be compression moulded from natural or synthetic rubber compounds in compliance with PIANC WG33 *Guidelines for the Design of Fender Systems*.

The rubber shall be fully vulcanised and homogeneous with no foreign particles and free from voids, cracks and cuts. Steel plates shall be fully embedded and fully adhered to the rubber during the vulcanisation process to avoid separation between the rubber and steel.

Rubber fenders shall be tested in accordance with the requirements of PIANC WG33 *Guidelines for the Design of Fender Systems*. Documentation shall be provided to prove that the combination of fender type and energy absorbing material has been successfully tested in accordance with this, verified by an independent body to the approval of the Overseeing Organisation. If such documentation cannot be provided, then a specific test shall be carried out for this project.

The particulars shall be submitted to the Overseeing Organisation for approval of the source and type of rubber fenders at least 40 days before the first delivery of the rubber fenders to the Site.

A certificate showing the manufacturer's name, the date and place of manufacture and showing that the rubber fenders, including the rubber used in manufacturing the fenders, comply with the requirements stated in the Contract, shall be submitted for each batch of rubber fenders delivered on the site.

Quality Management

The fender manufacturer shall apply a system of Quality Management which conforms to ISO 9000/9001 or a recognised equivalent. This system must be certified by an acknowledged and accredited organisation.

Records of Fender Units

All fender units shall be permanently marked with a unique reference so that they can be individually identified both during construction and once incorporated into the permanent works. For the latter case, the marks are to be clearly legible to someone standing on the quay. For all fenders, full records of manufacture and installation are to be kept on forms to the approval of the Overseeing Organisation. These records shall include:

a) Identification marks

b) Manufacturer, location of manufacture

c) Size and rubber grade of fender unit

d) Method of manufacture

e) Mould reference where appropriate, supervisor in-charge

f) Date(s) of manufacture

g) Location of unit in works and date of installation, where appropriate

h) Test results

i) Confirmation that the fender has been subject to a break in cycle, including details

j) Any other relevant information

k) Authorised signatures confirming details are correct

Preliminary forms shall be submitted to the Overseeing Organisation prior to delivery of the fender units to site. Final forms shall be submitted within two weeks of installation of the fenders.

Fender Bearing Panels

Each foam fender shall react against a flat bearing face either directly onto the quay structure or, where necessary, against a fender bearing panel. The fender bearing panel shall be designed to resist the fender design reaction force, which shall be considered as a line load across the width of the face panel at any level to the retaining structure.

Fender Chains

Chains connecting fenders to the quay structures shall only be incorporated in the fender manufacturer's design insofar as they are necessary for the correct functioning of the fender system. The number of chains shall therefore be minimised.

All chains shall comply with either BS 6405, BS 1663, JIS G3105 or other equivalent Standard and written proof in the form of a test certificate shall be furnished by the fender manufacturer.

After fabrication, all fins caused by welding shall be removed and the weld shall be smoothly finished all round.

All shackles, pins, eyebolts, tensioning devices and U-bolts and the like shall be such as to provide strength and performance at least equal to the chain to which they are attached.

Fixings

All fixings (including cast in anchors) shall be stainless steel grade A4-80 to BS EN 3506-1-1998 or equivalent grade to American ASTM standard.

Anchorage to the concrete shall be made by cast-in stainless steel sockets.

Appropriate isolation washers, etc. shall be provided where required to prevent bimetallic corrosion. The Contractor shall use tack welding or Nylok or similar approved fastening systems to ensure nuts are locked to bolts.

Cast-in fixings shall be stainless steel and shall be designed with a minimum factor of safety of 5.0 to ensure that the chain or a weak shackle, fails prior to the cast-in fixings.

SERIES 1900 QUAYSIDE FURNITURE

CONTENTS

1900 INTRODUCTION

This series covers general quay furniture requirements. Specific details are provided in drawings and other specifications.

This specification does not refer to fenders or fender panels which are covered by a separate specification.

1901 GENERAL REQUIREMENTS

This specification addresses the installation of edge protection, mooring bollards, lifebuoys, ladders, chains and ropes on the quay walls where applicable.

1902 BOLLARDS

Bollards are to be installed, as per the relevant drawings.

All works shall be in accordance with the manufacturer's recommendations. Bollards shall be manufactured from cast iron to BS EN 1561 or equivalent American ASTM standard.

All bollard holding down bolts shall be galvanised and shall be installed on/into the quay wall reinforced concrete capping beams in accordance with the manufacturer's requirements and as detailed in the project drawings. Templates shall be used where appropriate to ensure that bolts are in the correct position. The Contractor shall take care to minimise any conflict with reinforcement.

The holding down bolts shall not project above the top of the base plate. All bolt recesses shall be filled with a mixture of pitch and sand (or a sealant approved by the Engineer) to form a smooth surface to the top of the base plate.

Unless otherwise agreed, the bollards shall receive two coats of black bitumastic solution to BS 3416. The second coat shall be applied after installation.

If not already marked by the manufacturer, bollards are to be permanently marked with their applicable normal safe working load.

1903 SAFETY LADDERS

Safety ladders and chains shall be provided at the locations shown on the project drawings listed in Table 1906/1. The form of the ladders shall be as shown in the project drawings. Ladders shall comply with the requirements of BS6349 part 2: 2010.

Handgrips shall be fixed to facilitate access onto the quay from the ladder. Ladders and handgrips shall be positioned clear of bollard positions and mooring line obstructions.

Ladders and handgrips shall be in steel and in accordance with the Dock Regulations 1988 published by the UK Health and Safety Executive or equivalent American guidance.

Ladder rungs, stringers and supporting brackets for fixed ladders shall be from stainless steel grade 316L (1.4404) or equivalent grade to American ASTM standard as a minimum.

All ladders shall be galvanised after fabrication.

Ladders shall be supplied, stored and installed in accordance with the manufacturer instructions.

Ladders shall have fender strips either side to prevent damage by small vessels.

1904 HAND-HOLDS

Safety chains (grab chains) should be provided between safety ladders as per recommendations of BS 6349-2 and as shown on the drawings.

1905 VEHICLE BARRIER

Vehicle Barriers shall be provided along the sides of the wharf (set back from the berthing face to avoid clashes with mooring lines). These shall be Tata Protect 365 N2 Parapet System or equivalent approved by the Overseeing Organisation.

1906 LIFE BUOY

Life buoys shall be provided as indicated on the drawings. These shall be contained Glasdon Guardian 750 Housing or equivalent approved by the Overseeing Organisation and housing a 30" life buoy.

1907 DRAWINGS

The drawings listed in table 1900/1 show the quay furniture requirements.

Table 1907/1 – Furniture Requirement Drawings

Document Number	Title
1620004884-RAM-XX-00-DR-CW-210	Enlarged Plan view Precast Units and Furniture
1620004884-RAM-XX-00-DR-CW-220	Quay Furniture Layout and Edge Protection Details
1620004884-RAM-XX-00-DR-CW-401	Furniture Details - Ladders and Edge Protection
1620004884-RAM-XX-00-DR-CW-402	Furniture Details - Fenders and Bollards

APPENDIX 1

Cathodic Protection Specification 390/SPEC/01

CORROSION PREVENTION LIMITED

Cathodic Protection Specialists

PROJECT NAME:	**KINGS WHARF - BERMUDA**
DOCUMENT TITLE:	**CATHODIC PROTECTION SYSTEM SPECIFICATION**
DOCUMENT REF:	**390/SPEC/01**
ENGINEER:	**RAMBOLL UK LIMITED**
CLIENT:	**GOVERNMENT OF BERMUDA MINISTRY OF PUBLIC WORKS**

0	**Approval**	**I Spring**	**J Preston**	**25/06/18**
REV	**ISSUED FOR**	**PREPARED**	**CHECKED**	**ISSUE DATE**

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CONTENTS

1. SCOPE

The scope of the cathodic protection (CP) works comprises the following:

1.1 General

The Contractor shall supply, install, test, commission and performance verify a galvanic anode cathodic protection system to control corrosion for a series of steel piles to be constructed to support the Kings Wharf berthing structure and two associated dolphins at Kings Wharf, Ireland Island, Bermuda.

The cathodic protection system is designed to provide protection to all external immersed surfaces below mean sea level (MSL) (+0.1m O.D). The system is designed to provide cathodic protection to a polarised potential more negative than -900mV with respect to the Ag/AgCl/seawater electrode for a design life of 25 years. The system is designed to control both general marine corrosion and microbially influenced corrosion (MIC) including Accelerated Low Water Corrosion (ALWC) of the external steel surfaces of the support piles, below MSL.

1.2 Definitions

Where used throughout this specification the following definitions apply:-

Client:	Government Of Bermuda; Ministry Of Public Works.
Client Representative:	A third party appointed by the Client to represent them and provide advice or undertake inspections on their behalf.
CP System Designer:	Corrosion Prevention Limited (CPL).
Contractor:	The contractor appointed by the Client to undertake the works.
Anode Manufacturer:	The specialist manufacturing company appointed by the Contractor for the manufacture of the anodes. The Contractor shall retain full responsibility for ensuring that products provided by their appointed Anode Manufacturer fully comply with the requirements of this Specification.
Drawings:	The drawings that define the cathodic protection installation and which should be read in conjunction with this Specification. The Drawings are detailed in Section 8.

1.3 System Type

The CP design is based upon the use of Aluminium-Zinc-Indium galvanic anodes; specific requirements for the anodes are detailed in Section 4.1.

2. STANDARDS

The works shall be undertaken in accordance with the following International Standards and codes of practice:

i) BS EN ISO 13174:2012 Cathodic Protection of Harbour Installations

ii) BS EN 12496: 2013 Galvanic Anodes for Cathodic Protection in Sea-Water and Saline Mud
iii) BS EN 15257: 2006 'Cathodic Protection - Competence Levels and Certification of Cathodic Protection Personnel'
iv) BS EN 13509:2003 Cathodic Protection Measurement Techniques
v) DNVGL-RP-B401: June 2017 'Cathodic Protection System Design'. Note: this document is referenced only in respect of anode quality and inspection and test plan as referenced in this Specification.
vi) NACE International TM 0190-2017, Impressed Current Laboratory Testing of Aluminium and Zinc Alloy Anodes
vii) BS EN ISO 9000:2015 Quality management systems. Fundamentals and vocabulary
viii) BS EN ISO 9001:2015 Quality management systems. Requirements
ix) BS EN 10204:2004 Metallic products. Types of inspection documents
x) BS EN 10025 (all parts) Hot rolled products of structural steels.
xi) BS EN 1011-1:2009 Welding. Recommendations for welding of metallic materials. General guidance for arc welding
xii) BS EN 1011-2:2001 Welding. Recommendations for welding of metallic materials. Arc Welding of Ferritic Steels
xiii) BS EN ISO 9606-1:2017 Qualification testing of welders. Fusion welding. Steels
xiv) BS EN ISO 15607: 2003 Specification and Qualification of Welding Procedures for Metallic Materials. General Rules
xv) BS EN ISO 15609-1: 2004 Specification and Qualification of Welding. Procedures for Metallic Materials. Welding Specification. Arc Welding
xvi) BS EN ISO 15613:2004 Specification and qualification of welding procedures for metallic materials. Qualification based on pre-production welding test
xvii) BS EN ISO 15614-1:2017 Specification and qualification of welding procedures for metallic materials. Welding procedure test. Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
xviii) BS EN ISO 14341:2011 Welding consumables. Wire electrodes and weld deposits or gas shielded metal arc welding of non alloy and fine grain steels. Classification
xix) BS EN ISO 2560:2009 Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification
xx) BS EN ISO 8501-1: 2007 Visual Assessment of Surface Cleanliness
xxi) BS EN ISO 9934-1: 2016 Non-destructive testing. Magnetic particle testing. General principles
xxii) BS 4190:2014 ISO metric black hexagon bolts, screws and nuts. Specification
xxiii) BS 3692:2014 ISO metric precision hexagon bolts, screws and nuts. Specification
xxiv) BS EN ISO 898-1:2013 Mechanical properties of fasteners made of carbon steel and alloy steel. Bolts, screws and studs with specified property classes. Coarse thread and fine pitch thread
xxv) BS 4320:1968 Specification for metal washers for general engineering purposes. Metric series
xxvi) BS EN 10088-1:2014 Stainless steels. List of stainless steels
xxvii) AWS D3.6M: 2010 Underwater Welding Code 5th Edition

3. FUNCTION

3.1 Performance Criteria

The cathodic protection system is designed to provide protection to all external immersed surfaces below mean sea level (+0.1m O.D.). The installation shall be undertaken in order that the installed system meets the performance criteria presented in BS EN ISO 13174:2012 Cathodic Protection of Harbour Installations as follows:

The principal performance criterion for the cathodic protection system shall be the achievement of Instant OFF (IR error free) steel/electrolyte potentials of -0.900 Volts with respect to an Ag/AgCl/sea water reference electrode, or more negative, subject to a negative limit of -1.100 Volts with respect to Ag/AgCl/sea water.

3.2 Design Life

The CP system is designed to have a minimum 25-year design life from time of commissioning. All components and materials used in the construction of the CP systems shall have a compatible minimum design life in the environment into which they are to be installed.

4. MATERIALS

4.1 Anodes

4.1.1 Anode Characteristics

The anodes shall have the following minimum characteristics:-

i) a closed circuit operating potential -1.090 volts Ag/AgCl/sea water or more negative;
ii) a capacity of 2500 A Hrs/Kg or greater in sea water in the range 25-30 ohm-cm; and
iii) a utilisation factor of 0.9.

The anodes shall be suitable for the cathodic protection of steel in sea water to the criteria defined in 3.1 with a temperature in the range 15-30^{o}C for a minimum period of 25 years and to deliver the above characteristics during this period.

4.1.2 Design Responsibility

The Anode Manufacturer shall have no design responsibility for the CP design which determines the number, weight, shape and location of the galvanic anodes.

The Anode Manufacturer shall have sole responsibility for all aspects of the material supply along with the testing as defined in this Specification.

The Anode Manufacturer’s responsibility shall include the safe, undamaged, delivery to the site, or fabrication facilities or some other location nominated by the Contractor and

agreed by the Client or the Client's representative of all the anodes in order to meet the requirements defined in this Specification and accompanying Drawings, generally and specifically.

4.1.3 Anode Requirements, Locations and Drawings

The Drawings detailing the anodes are presented in Section 8 of this specification. These drawings detail the number and dimensions for the anodes.

The Drawings provide details of the required cast anode, their cores along with dimensions and anode weights including required all tolerances.

4.1.4 Anode Quality

4.1.4.1 Manufacturers Quality Assurance

Anode manufacturers shall, as a minimum, provide:-

- third Party Certification to BS EN ISO 9001 for their anode manufacturing operations, covering the site at which anodes shall be cast; and
- a current Type Approval Certificate by Det Norske Veritas (DNV) for the proposed anode alloy detailing compliance with the requirements of clause 4.1.1.

Tenderers shall submit with their tender details of their proposed anode supplier which shall include as a minimum the above information and a sample quality plan for the fabrication of anodes.

The anode manufacturer shall operate a quality management system to BS EN ISO 9001 and shall prepare and submit an Inspection and Test Plan for the fabrication of the required anodes in accordance with the requirements detailed in clause 4.1.4 for the approval of the Client or the Client's representative prior to the commencement of any anode manufacture.

4.1.4.2 Anode Composition

The anode material shall be an Al-Zn-In alloy to the manufacturer's chemical composition for which the type approval certificate demonstrating compliance with clause 4.1.1 has been granted subject to its compliance with the properties defined on table B1 for Alloy A1 in Annex B of BS EN 12496.

For clarity the composition of Alloy type A1 is reproduced below:-

i) Zinc in the range 2.0 to 6.0% weight
ii) Indium in the range 0.01 to 0.06% weight
iii) a maximum Fe content of 0.12% weight
iv) a maximum Si content of 0.12% weight
v) a maximum Cu content of 0.006% weight
vi) a maximum Cd content of 0.002% weight

vii) for all other impurities or micro-additions a maximum of 0.02% weight for each element shall be permitted to a maximum total of 0.1%.
viii) balance Aluminium

4.1.4.3 Anode Fabrication

Prior to commencement of anode manufacture the contractor shall submit the anode manufacturer's Inspection and Test Plan covering as a minimum the following aspects of the manufacture:-

- Document Approval
- Material Receipt
- Insert Preparation
- Pre-Production
- Production Casting
- Post-Casting Assembly
- Packing and Storage
- Inspection and Testing
- Electrochemical Testing
- Final Inspection
- Dispatch/Delivery

The anode manufacturer shall be responsible for the insert design to meet the requirements and tolerances detailed herein and on the Drawings.

The fabrication of anodes shall comply with the following standard:-

- BS EN 12496:2013 "Galvanic anodes for cathodic protection in seawater and saline mud"

Electrochemical testing shall comply with the requirements stated in Section 5 of BS EN 12496 and physical properties shall be tested in accordance with the guidance in Annex A of the same standard and be undertaken in full. The following specification sections provide clarification for the frequency of testing and sampling required.

4.1.4.4 Chemical Analysis and Performance Testing

Chemical composition testing shall be undertaken as detailed on section 5.2 of BS EN 12496. The testing frequency shall be as stated in the fourth paragraph of section 5.2 of the standard and shall confirm compliance with 4.1.4.2 above.

Performance testing shall be undertaken on a one sample per 10 tonne of alloy basis in accordance with the requirements of clause 5.4 paragraph 4 of BS EN 12496, i.e. the use of a galvanostatic test such as that defined in NACE Standard Test method TM0190 and shall confirm compliance with 4.1.1 above.

4.1.4.5 Anode Identification

Each anode shall be marked with its unique heat and sequence number allowing full traceability from manufacture to installation.

4.1.4.6 Anode Weights

The tolerances for galvanic anode weights both individually and collectively shall comply with the requirements of clause A.1 of BS EN 12496. Note that all anodes shall be individually weighed to demonstrate compliance.

4.1.4.7 Anode Dimensions and Straightness

The tolerances for anode dimensions and straightness shall comply with the requirements of clause A.2 of BS EN 12496. A minimum sample of 10% of each anode type shall be measured.

Notwithstanding compliance with the above tolerances, the contractor shall ensure that the anode straightness and overall shape are suitable to enable the anodes to be installed as detailed for the relevant mounting system.

4.1.4.8 Insert Dimensions and Position

Tolerances for anode insert dimension and position shall comply with the requirements of clause A.3 of BS EN 12496. A minimum sample of 10% of each anode type shall be measured in addition to the confirmation of tolerances for anodes sectioned as detailed in 4.1.4.12.

4.1.4.9 Insert Materials

Anode inserts shall be fabricated from non-rimming, weldable, mild steel to BS EN 10025 grade S235 or S275 with a carbon equivalent (Cev) not exceeding 0.45 using the Cev formula as clause 5.5 in BS EN 12496.

The Anode Manufacturer may as they deem necessary provide sets of 2 No. 10mm diameter plain rod pegs tack welded to the anode core in order to ensure that the core location tolerances are within the limits set in clause 4.1.4.8 above. Certificates of conformity for insert materials shall be provided.

4.1.4.10 Welding of Insert Materials

Should welding of insert materials be required as determined by the anode manufacturer’s insert design, for example, to maintain the correct position of the anode core within slender anodes, it shall be carried out in accordance with the requirements of clause 5.5 of BS EN 12496. It is not anticipated that any such welds will be structural and hence non-destructive testing (NDT) of the welds will not be required. However, if any structural welds are required to be made to the inserts as detailed by the anode manufacturer, then, the type and frequency of NDT is to be agreed with the Client or the Client’s representative prior to the commencement of fabrication.

4.1.4.11 Insert Surface Preparation

Insert surface preparation shall be in accordance with clause 5.5 of BS EN 12496.

4.1.4.12 Surface Irregularities
Anode surface irregularities shall not exceed the limits detailed in clause A.4 of BS EN 12496.

4.1.4.13 Cracks

The appearance of cracks in cast anodes shall be permitted only if in accordance with the restrictions detailed in clause A.5 of BS EN12496 and specifically clause A.5.2 relating to stand off and flush mounted anodes.

4.1.4.12 Anode Sections and Internal Defects

Anodes as detailed herein shall be sectioned in accordance with clause A.6 of BS EN 12496 and inspected for compliance with the requirements of that clause.

2 No. anodes from the first casting of each different cross section shall be selected for anode sectioning.

Photographic records shall be kept of all cut ends.

4.1.5 Inspection and Documentation

4.1.5.1 The Client or the Client's representative shall be entitled to access all premises at which manufacture of the anodes and their cores is being undertaken in order to inspect the works and ascertain compliance with this Specification.

4.1.5.2 Irrespective of any comments on submitted documents or inspection by the Client or the Client's representative, it is the sole responsibility of the Anode Manufacturer, to fully comply with this Specification and to adequately document compliance.

4.1.5.3 The following clauses shall comprise the minimum supplied documentation (the Quality Management Documentation Record for the Contract) to be supplied by the Anode Manufacturer and made available for review by the Client or the Client's representative at the time of despatching the anodes to the designated destination site.

4.1.5.4 Certificates of Conformity certifying that the anodes comply in all respects with this Specification and the Purchase Order along with:

i) analysis certificates as Clause 4.1.4.4;
ii) electrochemical performance certificates as Clause 4.1.4.4;
iii) record of the weight and dimensional checks as Clauses 4.1.4.6 and 4.1.4.7;
iv) a photographic record and brief visual inspection report of the sectioned inspections as Clause 4.1.4.12; and
v) steel certificates for the anode core materials

Certification documentation shall comply with the requirements of BS EN 10204:2004.

4.1.5.5 All documentation shall be in a pre-approved format agreed by the Client or the Client's representative at time of submittal of the inspection and test plan. No anodes shall be allowed to be despatched to the work site without all of the above documentation having been provided and accepted by the Client or the Client's representative. As the Electrochemical Testing typically takes 5 days, the Contractor shall ensure in programming the works that these data are available ahead of delivery.

4.2 Support Steelwork

4.2.1 General

The designed anodes shall be individually mounted using bracket sets on the support piles.

The Drawings provide fabrication details for the bracket systems to be used.

Fabrication of all elements shall be carried out above water. It is anticipated that the majority of fabrication shall be carried out off-site, however fitting of anodes to brackets may be acceptable as site works subject to approval of the Contractor's proposed methodology. Site fabrication shall be subject to the same quality requirements as off-site fabrication.

The Contractor shall ensure by inspection of the retained anodes that these anodes are compatible with the bracelet system as detailed on the drawings.

4.2.2 Quality and Inspection of Fabrication

Prior to commencement of steelwork fabrication, the contractor shall submit an Inspection and Test plan detailing as a minimum the following aspects of the fabrication:-

- certificates of conformity for all materials used;
- certification of welders;
- results of weld visual and MPI testing;
- dimensional checks of the completed fabrications; and
- fabrication numbering.

No fabrication shall commence until the inspection and test plan is approved.

Where fabrication and assembly are to be carried out both on and off site, separate inspection and test plans shall be provided. Note: On-site fabrication is not envisaged for these works.

4.2.3 Steel Quality

The steelwork shall be fabricated from weldable structural steel plate or sections, which shall be non-rimming and as per BS EN 10025 grade S235 or S275 with a carbon

equivalent (Cev) not exceeding 0.45 using the Cev formula as clause 5.5 in BS EN 12496.

4.2.4 Welding

Prior to commencement of any fabrication welding the Contractor shall submit a weld procedure and method statement for the work detailing the methods to be used and joint types to be made. The weld procedures shall be prepared by a welding specialist. The details of the welding specialist shall be submitted to the Client or the Client's representative for approval. The specification and qualification of welding procedures and weld procedure testing shall be undertaken in accordance with BS EN ISO 15614-1 and BS EN ISO 15613.

All welders shall hold certificates of approval to BS EN ISO 9606-1 obtained within the previous two-year period, for all weld types which they are required to produce. Certificates of approval shall be from an independent inspection authority using registered welding engineers. Tests shall be carried out by a laboratory accredited by the United Kingdom Accreditation Services (UKAS) for weld testing.

All fabrication welding shall be in accordance with the requirements of the welding specialist and BS EN 1011 Parts 1 (2009) and 2 (2001). Welding shall be undertaken in accordance with procedures in accordance with BS EN ISO 15607 and BS EN ISO 15609-1. All welding processes shall comply in all respects to the requirements of BS EN 2560 or BS EN ISO 14341.

4.2.5 Weld Testing

Fabrication welding shall be subject to the following testing:

Visual inspection of 100% of welds and
MPI inspection of 10% of all welds.

MPI testing shall be carried out in accordance with BS EN ISO 9934-1 (2016). Testing shall be carried out by a third party as approved by the Client or the Client's representative.

4.2.6 Bolts

All bolts and fastenings shall comply with the requirements of BS 4190, BS 3692, BS EN ISO 898-1 and BS 4320. Where required the grade of bolts to be used shall be detailed on the Drawings.

4.2.7 Fabrication Numbering

Each separate fabrication leaving off-site facilities shall be uniquely and indelibly numbered such that it is traceable to all quality records.

The numbering system shall be proposed by the Contractor as part of their Inspection and Test Plan.

4.2.8 Inspection and Documentation

The Client or the Client's representative shall be entitled to visit any premises at which material fabrication for the contract is being undertaken. Notification shall be given to the Client or the Client's representative at least 72 hours prior to the intended dispatch of the first shipment to site-to enable a site inspection to be undertaken.

Quality documentation detailing compliance with the requirements of the foregoing sections shall be submitted to the Client or the Client's representative prior to the delivery of materials to site.

No fabrication shall be permitted on the work site until such time as all quality control documentation has been received by the Client or the Client's representative and approved.

4.3 Monitoring Test Points

4.3.1 General

Monitoring test points shall be provided as detailed in the Drawings. The Contractor shall note that these test points are to be cast into the main wharf reconstruction works, and so will need supply and installation at separate time to the anode system.

Materials for test points shall be manufactured from stainless steel to grade 1.4404 as defined in BS EN 10088.

5. INSTALLATION

5.1 Installation Inspection and Test Plan

The contractor shall produce an inspection and test plan for the installation works. This shall cover the following key items as a minimum:-

- the installation level of each anode;
- the depth from the anode to the bed for each anode;
- individual anode reference (as per clause 4.1.4.5) against location position, i.e. which anode is installed on which pile and with which bracket set;
- confirmation of the installed weld length, for structural welds between anode mounting and piles;
- confirmation of the installation of continuity welds between anode or anode mounting and piles, as required;
- underwater inspection staff qualifications and responsibility.

The inspection and test plan (ITP) shall be submitted to the Client or the Client's representative for approval prior to the commencement of any installation works.

5.2 Anode Installation – General

Individual anodes for all piles shall be installed using fabricated steel bracket sets as detailed in section 4.2 above.

All piles on the main wharf structure on rows E, D and C are to be provided with two anodes. No anodes are to be installed on piles on Rows B or A. Piles at the head of the dolphin are to be provided with three anodes and those supporting the dolphin arm are to be provided with two anodes.

The type and number of anodes for each pile type is to be as per the table below:

Pile Type/Row	Number of Piles	Anode Type Req'd	No. of Anodes Per Pile
Wharf Row E	19	1	2
Wharf Row D	16	2	2
Wharf Row C	16	3	2
Dolphin Head	8	3	3
Dolphin Arm	4	2	2

The anode types refer to the different anode fabrication dimensions detailed on the Drawings.

The Drawings detail the installation for typical piles on each row including the required level and orientation for all anodes. Should it not be possible to install any anode arrangement at the designed level due to obstruction or local bed level, the Contractor shall notify the Client or the Client's representative immediately providing details of the obstruction preventing installation.

No anodes shall be installed at levels other than those shown on the Drawings without the prior written consent of the Client or Client's representative.

5.3 Installation Records

Daily installation records shall be kept and issued to the Client or Client's representative on a weekly basis. The following minimum information shall be recorded:-

- work area;
- references of anodes installed by pile number;
- installed reduced level of top of anode for each individual anode; and
- name of welder where underwater welding is undertaken.

5.4 Weld Trials

Prior to undertaking any underwater welding for the installation of anode systems, weld trials shall be carried out on site to approve individual divers for undertaking the works.

No diver without specific approval of the Client or the Client's representative shall undertake any underwater welding works on the project.

Each diver welder shall be certified by a recognised certification body as being competent to execute structural welds of the required type to a depth up to 10m. Prior to the commencement of any welding for the permanent works each diver welder shall perform four sample structural weld test pieces at the required working depth for the permanent works.

The Contractor shall be responsible for providing independent testing of the test pieces to demonstrate compliance with the requirements of this clause of the specification.

Welded test specimens shall be subject to visual, sectioned microscopic and micro-hardness examination at an approved testing facility in accordance with the AWS D3.6M: 2010 requirements for class B welds. Failure of multiple weld test pieces to pass all tests shall be cause of rejection of the associated welder. The Contractor shall provide copies of all test reports to the Client or the Client's representative. The Contractor may select any of the underwater welding methods detailed in AWS D3.6M: 2010 providing compliance with the remaining requirements of this specification are achieved.

The welds shall be structural welds as used for the mounting of brackets in accordance with the Drawings. The sample pieces shall comprise 200 x 100 x 12mm thick carbon steel flat plate and samples of brackets. Welds shall be required as specified in AWS D3.6M:99 for single pass 5/16" welds and ½" steel plate. The welding system shall correspond with the system to be used for the permanent works.

5.5 Production Welds

All welding shall confirm to the requirements of AWS D3.6M: 2010 and to the additional requirements of this specification. All welds shall be class B fillet welds. All welding shall be performed in accordance with an approved welding procedure, qualified prior to production welding in accordance with the requirements of AWS D3.6M: 2010. The weld procedure shall be prepared by an underwater welding specialist.

The Contractor shall submit the following for the Client or the Client's representative approval:-

- c.v. for the underwater welding specialist;
- details of the test assemblies for on-site welder qualification;
- product data sheet for welding electrodes;
- test and inspection reports;
- results for all required examinations for class B fillet welds;
- welders qualification certificates; and
- welding procedures.

Production welds shall have minimum leg length and weld lengths as shown on the Drawings. The Contractor shall ensure that all brackets are tight and flush to the pile surface with a maximum 1mm gap between pile and bracket.

During all welding operations, the contractor shall be responsible for ensuring the return current connection is made mechanically and directly to the pile on which welding is being undertaken.

All elements of the installation works shall be subject to a 100% visual inspection by the Contractor's inspector who shall be approved by the Client or the Client's representative. The Contractor's quality plan shall ensure that these inspections are documented.

The Contractor shall provide any measures necessary to degauss piles prior to welding, should residual magnetism within the piling result in conditions that prevent welding.

5.6 Pull-off Testing

The Contractor shall provide a hydraulic jack system suitably modified to suit the bracket design by which a tensile pull off load of 1,500 kg can be applied to selected brackets in order to demonstrate the sufficiency and quality of the bracket welding. The Client or the Client's representative or their Representative shall select 4 No. anode positions during the course of the works for testing in this manner.At these positions both the top and bottom bracket shall be subject to tensile pull-off test.

5.7 Electrical Continuity – General

Electrical continuity between the piles shall be provided during the civils construction work. This shall take the form of reinforcement bars with welded connections to the piles. These connections shall be continuity tested during installation

All continuity testing shall be carried out using a d.c. resistance meter having a short circuit current of not less than 200mA.

The electrical continuity shall be tested using the reverse polarity resistance technique. Continuity shall be measured and then the test lead polarity reversed and retested. Electrical continuity of connections shall be demonstrated by all readings:-

(i) having a resistance reading less than 1.0 ohm;

(ii) not changing by more than 1.0 ohm when the instrument leads are reversed;

(iii) not changing by more than 1.0 ohm in 15 seconds; or

(iv) not being unstable.

The Contractor shall keep records of all tests carried out and shall submit to the Client or the Client's representative, in an agreed format, all readings and measurements taken and shall repeat such tests as required, prior to the reinstatement of any test point or repair area.

6. PERFORMANCE TESTING

6.1 General

The Contractor shall be responsible for undertaking performance testing at the periods defined below. Access shall be by workboat to enable direct access at water level to each pile on which anodes have been installed.

6.2 Survey Timing

A complete survey of the CP potential levels on the steel pile structures shall be carried out using hand-held measuring instruments and portable reference electrodes at the following times:-

i) Initial Performance Testing – 1 month after of completion of installation works; and
ii) End of Defects period survey – not more than 1 month prior to the end of the defects liability period of the contract.

6.3 Survey Personnel

The surveys shall verify that the installed CP system complies fully with the Client's Requirements. The work shall be undertaken by or be directly supervised on site by a CP Specialist certificated as Level 3 in the marine sector in accordance with BS EN 15257 as defined below. Any data not collected by the CP Specialist shall be collected by a Senior CP Technician as also defined below.

The CP Specialist shall hold a current certification of cathodic protection personnel competence at Level 3 in accordance with BS EN 15257: 2006 (marine metallic structures sub-sector) and shall have a minimum of 5 years' responsible and demonstrable experience in galvanic anode CP systems for steel in seawater marine port or harbour structures.

It is noted that BS EN 15257:2006 'Cathodic Protection - Competence Levels and Certification of Cathodic Protection Personnel' is now superseded by BS EN ISO 15257:2017 and the levels of certification defined within the 2006 Standard have changed. This specification refers to the levels of certification detailed within the 2006 Standard as at time of writing certifications to the levels detailed in the 2017 Standard are not yet obtainable. Once certification to the 2017 Standard is obtainable then certification to the equivalent level for the cathodic protection specialist personnel defined herein shall be required.

The Contractor may utilise other Senior CP Technician personnel for the survey directly trained by the Cathodic Protection Specialist who meet the following minimum requirement:

• Certificated to BS EN 15257 competence levels and certification of cathodic protection personnel at Level 2 for Marine metallic structures with at least 3 years' experience in installation and testing of cathodic protection for marine structures.

The CVs and certification of the Level 3 CP Specialist and any Level 2 Senior CP Technicians shall be submitted to the Client or the Client's representative for review and consent.

The surveys shall be directly witnessed on site by the Client or the Client's representative. The Contractor shall provide adequate provision for access to witness the testing.

6.4 Survey Instrumentation and Calibration

The monitoring of the CP system performance shall be by measurement of pile-to-steel potentials using portable Ag/AgCl/sea water or Ag/AgCl/0.5M KCl reference electrodes and a voltmeter. All measurements shall be taken generally in accordance with the requirements of BS EN 13509. The reference electrodes used shall be calibrated daily on site against two Ag/AgCl/0.5M KCl reference electrodes. The instrumentation used shall have a minimum input impedance of 10 Meg Ohm, a minimum resolution of 1mV and an accuracy, confirmed by a valid calibration certificate issued by a properly authorised Instrumentation Calibration test facility, of 1mV or better at 0.900 Volts. The instrumentation shall be calibrated daily against a portable calibrator such as a Time Electronics 1044. All calibration data, including daily data, shall form part of the reports of the CP monitoring activities.

6.5 Survey Measurements

The measurements shall include, as a minimum:

A steel/seawater/pile survey making direct metallic contact to the pile being surveyed and placing the reference electrode within 0.5m of the pile at the locations noted below. This survey is likely to require access by boat and/or divers.

i) On every pile; with the reference electrode deployed at the following levels:
   - MLWS +/- 0.5m;
   - Midway between MLWS and the bed level; and
   - At the current bed level.

A steel/seawater/pile survey making contact to the test points in the deck shall also be undertaken with the reference electrode deployed over the quay edge as follows:-

ii) At 5m intervals along the quay wall; with the reference electrode deployed at the following levels:
   - MLWS +/- 0.5m;
   - Midway between MLWS and the bed level; and
   - At the current bed level.

On completion of each survey, the Contractor shall provide a detailed Commissioning Report or Monitoring Report for acceptance by the Client or the Client's representative as detailed in Section 7.5.

7. DOCUMENTATION

7.1 Post Installation Documentation

Following completion of the installation works the following documentation shall be issued by the Contractor:-

- An Installation Report; and
- As-Built Drawings;

The documents shall be issued within 14 days of completion of installation of the final anode.

7.2 Installation Report

The installation report shall include as a minimum the following information:-

SECTION A- INSTALLATION

- a narrative description of the installation;
- materials and component data including quality assurance test results, batch numbers, serial numbers and calibration data;
- copies of all daily installation record sheets as per clause 5.3;
- as-built drawings as outlined below; and
- photographic records.

The draft installation report for review by the Client or the Client's representative shall be issued prior to undertaking of the commissioning testing.

7.3 As-Built Drawings

The Contractor shall produce as-built drawings which shall show the works as completed. The Drawings shall include the following as a minimum:-

- the location of all anodes, including details of installation levels; and
- fabrication details of all steel work items.

As-built drawings shall be submitted both as hard copies and electronically in AutoCAD dwg version 2007 onward format.

The draft As-Built drawings for review by the Client or the Client's representative shall be issued prior to undertaking of the commissioning testing.

7.4 Monitoring Reports

7.4.1 Commissioning Report

After completion of the 1-month performance testing a commissioning report shall be prepared that shall provide:-

- Results from the commissioning survey, including calibration checks (presented to the Client or the Client's representative in Microsoft Excel tabular format in both electronic and hard copy forms);
- A narrative description of the testing undertaken; and
- A summary of the extent to which the protection criterion has been met.

The commissioning report shall be issued within 14-days of the completion of the commissioning testing.

7.4.2 End of Defects Period Survey Report

After completion of the 1-month performance testing a commissioning report shall be prepared that shall provide:-

- Results from the commissioning survey, including calibration checks (presented to the Supervisor in Microsoft Excel tabular format in both electronic and hard copy forms);
- A narrative description of the testing undertaken; and
- A summary of the extent to which the protection criterion has been met.

The end of defects period survey report shall be issued within 14-days of the completion of the site testing.

8. SCHEDULE OF CONSTRUCTION DRAWINGS

The following drawings should be read in accordance with this specification.

1620004884-RAM-XX-00-DR-CW-600	Cathodic Protection Layout
1620004884-RAM-XX-00-DR-CW-601	Cathodic Protection Sections
1620004884-RAM-XX-00-DR-CW-602	Cathodic Protection Details
1620004884-RAM-XX-00-DR-CW-603	Cathodic Protection on Dolphin