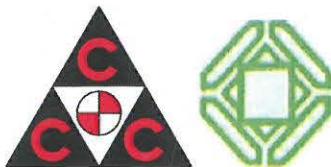




**CONTRACT No GTC 626/2014A**

**CONSTRUCTION OF MEGA RESERVOIR PRPSs  
(PACKAGE A - UMM BIRKA)**

**CONTRACT DOCUMENTS  
(VOLUME 2 OF 19)**



**CONSOLIDATED CONTRACTORS GROUP S.A.L. (OFFSHORE) (CCC) &  
TEYSEER CONTRACTING COMPANY W.L.L.  
JOINT VENTURE**

## TABLE OF CONTENTS

VOLUME	SECTION	ITEM	
VOLUME 1	1	Contract Agreement	
	2	Letter of Award	
	3	Letter of Confirmation	
	4	Secrecy Declaration	
	5	Performance Bond	
	6	Commercial Registration and Power of Attorney	
	7	Summary of Contract	
	8	General Conditions of Contracts	
VOLUME 2 2/6	9	<b>Appendix A: Scope of Work and Specifications</b>	
VOLUME 7	10	Appendix B: Schedule of Prices	
		1. Form of Tender	
		2. Preamble	
		3. Bills of Quantities	
	11	• Contract BOQ (After Currency Adjustment)	
		Appendix C: Insurance	
		1. Preamble	
		2. All Risk Insurance	
		3. Workmen's Compensation Insurance	
		12	Appendix D Administration Instructions
			Appendix E Contractor Resources
			Annexure 1: Contractor's Personnel
Annexure 2: Facilities, Plant & Equipment owned by Contractor			
VOLUME 8	13	Annexure 3: Facilities, Plant & Equipment proposed by Contractor	
		Annexure 4: Subcontractors	
		Annexure 5: Suppliers	
		Annexure 6: Contractor's Company Organization Chart	
		Annexure 7: Contractor's Project Organization Chart	
		Annexure 8: QA/QC Procedure	
		Annexure 9: Utilization of National Products & National Origin	
		Annexure 10: Contractor's General Information	
VOLUME 9	13	Annexure 11: List of Customers and Projects	
		Annexure 12: List of Current Commitment	
		14	Appendix F Drawings
		15	Appendix G Material Equipment Supplied by KAHRAMAA
VOLUME10	16	Appendix H Contract Execution Plan	
		1. Programme of Work	
		2. Method Statement	
		17	Appendix I Materials Supplied by the Contractor
VOLUME 16/17	18	Appendix J General Safety Requirements	
	19	Appendix K Departure from or Qualification to the Specification	
VOLUME 18	20	Acknowledgement of Receipt of Tender Documents	
		Circulars No. 1 to 21	
VOLUME 19	21	Commercial Offer BOQ	
		Pre Award Correspondence	
		Minutes of Pre-Award Meeting	

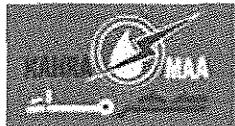
## SECTION 9: APPENDIX A SCOPE OF WORK AND SPECIFICATIONS



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoirs PRPS Package A**  
**(PRPS 1 at Umm Birka)**

## **APPENDIX A1 – PACKAGE A**

## **SCOPE OF WORK & SPECIFICATIONS**



## Table of Contents

1.1	PROJECT DESCRIPTION AND SCOPE OF WORKS .....	3
1.2	TIME FOR COMPLETION.....	32
1.3	WARRANTY PERIOD .....	34
1.4	MATERIAL DELIVERY.....	34
1.5	INSPECTION AND WITNESS TESTING .....	34
1.6	PUBLISHED SPECIFICATIONS, REGULATIONS, NOTICES AND CIRCULARS .....	35
1.7	COPIES OF SPECIFICATIONS .....	35
1.8	INVESTIGATIONS AT THE SITE.....	35
1.9	DATUM LEVELS .....	36
1.10	CLIMATIC CONDITIONS ON SITE .....	36
1.11	SITE FOR ADDITIONAL ACCOMMODATION.....	36
1.12	ACCESS TO SITE.....	37
1.13	SITE BOUNDARIES AND CLEARANCE OF SITE .....	37
1.14	EXISTING PROPERTIES, FACILITIES AND UTILITIES .....	37
1.15	USE OF PUBLIC HIGHWAYS .....	38
1.16	PERMITS.....	38
1.17	ENVIRONMENTAL REQUIREMENTS, ARCHAEOLOGICAL REMAINS AND HISTORICAL SITES .....	38
1.18	EXECUTION PROGRAM OF WORKS .....	38
1.19	STANDARD SPECIFICATIONS .....	39
1.20	MATERIALS AND SUPPLIERS OF MATERIALS .....	39
1.21	NATURAL MATERIALS .....	40
1.22	WORKS TO BE KEPT CLEAR OF WATER.....	40
1.23	DISCHARGE OF WATER INTO EXISTING STREAMS.....	40
1.24	WATER SUPPLY .....	40
1.25	ELECTRICITY SUPPLY .....	41
1.26	GENERAL HYGIENE AND MEDICAL EXAMINATION OF CONTRACTOR'S EMPLOYEES AND LABOUR .....	41
1.27	SANITATION AND FIRST AID FACILITIES FOR CONTRACTOR'S STAFF .....	41
1.28	TESTING OF WORKS .....	41
1.29	CONTRACTOR'S SITE FACILITIES .....	42
1.30	ASSISTANCE FOR KAHRAMAA AND ENGINEER'S STAFF .....	42
1.31	SURVEY INSTRUMENTS.....	42
1.32	SUBMITTALS.....	42
1.33	PROGRESS REPORTS .....	42
1.34	FORMS FOR MONTHLY STATEMENTS.....	43
1.35	EQUIPMENT AND LABOUR RETURNS.....	43
1.36	QUALITY OF MATERIALS, WORKMANSHIP AND TESTS .....	43
1.37	LOADING TESTS FOR EXECUTED CONCRETE STRUCTURES .....	43



1.38	COST OF TESTS FOR MATERIALS AND WORKMANSHIP .....	43
1.39	EXAMINATION OF WORK BEFORE COVERING UP.....	44
1.40	UNCOVERING AND MAKING OPENINGS.....	44
1.41	REMOVAL OF IMPROPER WORK .....	44
1.42	PHOTOGRAPHS.....	44
1.43	PROGRESS MEETINGS.....	45
1.44	CONTRACT SIGNBOARDS .....	45
1.45	OPERATING AND MAINTENANCE MANUAL .....	45
1.46	DRAWINGS FOR THE PROJECT COMPONENTS .....	46
1.47	RECORD DOCUMENTS .....	47
1.48	PROTECTING THE WORKS FROM INCLEMENT WEATHER AND DAMAGE .....	48
1.49	WORKING IN URBAN AREAS.....	48
1.50	ACCESS TO EXISTING BUILDINGS AND ASSOCIATED AREAS.....	48
1.51	CLEANING THE WORKS ON COMPLETION .....	48
1.52	QATAR PETROLEUM (QP) PIPELINES (GAS AND OTHERS).....	48
1.53	PREVENTION OF IMPACTS ON URBAN AMENITY .....	49
1.54	NOT USED .....	49
1.55	CO-ORDINATION WITH OTHER CONTRACTORS .....	49
1.56	SITE SAFETY POLICY .....	49
1.57	TRAINING TO BE PROVIDED BY THE CONTRACTOR .....	51
1.58	QUALITY STANDARDS AND CONTROL.....	52
1.59	DATA FOR SETTING OUT THE WORKS.....	55
1.60	TEMPORARY WORKING AREAS .....	55
1.61	WORK IN PUBLIC HIGHWAYS .....	55
1.62	TRAFFIC CONTROL.....	55
1.63	ADJOINING PROPERTY .....	55
1.64	ROAD CLOSURES .....	56
1.65	OBSTRUCTIONS .....	56
1.66	SITE ROADS AND ACCESS .....	56
1.67	CLAIMS FOR DAMAGE TO PERSONS OR PROPERTY (PROCEDURE).....	56
1.68	SECURITY OF THE WORKS .....	56
1.69	SITE TO BE KEPT TIDY .....	57
1.70	SAFETY.....	57
1.71	OFFICES AND EQUIPMENT FOR KAHARAMAA AND THE ENGINEER .....	57
1.72	STAKEHOLDER MANAGEMENT AND PUBLIC LIAISON .....	62



## **Scope of works and specifications**

### **1.1 Project Description and Scope of Works**

#### **1.1.1 Project Description**

Due to the continuous growth and development in Qatar, and the consequent forecast increase in water demand, Qatar General Electricity & Water Corporation (Kahramaa) is implementing the Water Security Mega Reservoirs Project to provide a minimum of 7 days Strategic Water Storage within its network.

The Project, will construct water storage reservoirs, at five (5) new Primary Reservoir Pumping Stations (PRPS) sites which are located in the vicinity of the Qatar Utility Corridor (QUC):

- Package A - PRPS 1 at Umm Birka
- Package B - PRPS 2 at Umm Slal
- Package C - PRPS 5 at Al Thumama
- Package D - PRPS 3 at Rawdat Rashed
- Package E - PRPS 4 at Abu Nakhla

The new PRPS sites will be connected to existing and future desalination plants through large diameter pipelines (Corridor Mains) that are to be constructed within the QUC.

Water from the PRPS sites will be distributed using a network of Transmission Pipelines.

Kahramaa intend to implement the Mega Reservoir Project under a number of separate contracts for pipeline construction, PRPS site construction and for an integrated SCADA and control system.

The contracts for construction of the pipelines will include several contracts for construction of the Corridor Pipelines and Transmission Pipelines that are located within the QUC, and a contract for construction of Transmission Pipelines that are located outside of the QUC.

This Contract is for the development of details (where indicated), procurement, construction and testing of Package A for the PRPS facility at Umm Birka (PRPS 1).

Depending on the submitted bids and the outcome of the evaluation of the Tenders, Kahramaa at its sole discretion may award one or more PRPS package to a single bidder or one package to one bidder or even not award any of the packages.

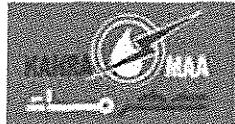
#### **1.1.2 Brief Scope of Work:**

The scope of this Contract is to construct, install and complete the reservoirs, pumping stations, pipework, mechanical, electrical, ICA, civil, structural, architectural and building work for the complete PRPS facility at Umm Birka as detailed on the drawings. The contract includes connections 1 metre inside the site boundary to pipelines laid by others. The contract also includes some elements of design as specified.

The site is within an existing quarry. However excavation will be required to achieve the required formation levels as shown on the drawings.

The Limits of Work (LOW) are illustrated on the Drawings.

The Works shall include, but shall not be limited to, the following:

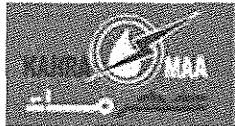


1. Site Establishment
2. All temporary works including design
3. Construction of reinforced concrete reservoirs, valves chambers, and associated leak detection systems.
4. Excavation, backfilling and construction of pipelines, cable ducts, chambers.
5. Supply and installation of carbon steel and ductile iron pipes, valves and fittings including all coating, wrapping and jointing materials, thrust restraint.
6. Connection to existing pipelines constructed by others.
7. Construction of reinforced concrete pumping stations, guard houses, control room, electrical sub-stations, transformer buildings, generator buildings, workshop, chlorination building, water testing facility, instrumentation kiosks.
8. Preparation of shop drawings, procurement, installation, testing and commissioning of all mechanical, electrical, instrumentation and control plant including, but not limited to, pumps, motors, cables, control panels, generators, transformers, switchgear, surge vessels, chlorine storage and dosing equipment, fuel tanks, pumping station pipework, lifting equipment, SCADA system.
9. Construction of all civil works associated with mechanical, electrical, instrumentation, control and automation, including foundations and supports.
10. Design, supply and install all the metal works to include but not limited to platforms, handrails, access ladder, access covers/grating/open mesh, safety chains, steel pipe support, step irons, and fixing to the concrete.
11. Perform surge and transient analysis study and detailing of surge suppression system based on approved selected pumps and equipment for the complete piping system. Construction of reinforced concrete lined drainage lagoons.
12. Backfilling of excavated areas using material stockpiled on Site by others or using selected excavated material.
13. Testing, cleaning, sterilising of the Works.
14. Supply of electrically driven vehicles for site use including all required recharging facilities.
15. Internal and external roads to provide access to, within and around the Site, including parking areas, turning and access areas, tanker filling station, signage and markings.
16. Hard and soft landscaping including planting and irrigation.
17. Site boundary wall including access gates, barrier arms, security.
18. Erection and maintenance of temporary Site boundary fence until the date of the Taking Over Certificate (TOC) for the whole of the works. Dismantling and removal of the Site boundary fence after the date of the TOC.

All activities shall be performed and completed in accordance with the rules, regulations, restrictions, obligations and codes of practices of the State of Qatar and to Kahramaa's Specifications and Standards.

#### **1.1.3 Detailed Scope of Work:**

The Scope of Work required by the Contract shall include but not be limited to the development of details (where specified), procurement, construction and installation of the PRPS facility at Umm Birka (PRPS 1). The Contractor's scope shall include the preparation of bar bending schedules.



The Site layout as shown on the Drawings has been designed to allow for future expansion of the storage facility. Space has been allocated for three additional reservoirs to be constructed for the next design horizon with further allocation for future facilities. Some pipework and other elements of the Works will be constructed such that they can be readily extended at a future date.

#### **1.1.4 General Requirements**

Prior to commencement of the Works, the Contractor shall submit and obtain the Engineer's approval of his overall method statement, which shall cover the full scope of the Works defined herein. The method statement shall include, but shall not be limited to, the proposed procurement and material management procedures, excavation methods, concreting works, pipelaying, building works, design processes, MEICA installation and sequencing of the Works.

In addition to the overall method statement, detailed method statements shall be provided as required by the Engineer for specific works including, but not limited to, making connections into existing pipelines, supporting excavations, testing commissioning and sterilisation procedures and the like. Refer to Appendix H for further details.

The Contractor shall prepare and submit for Kahramaa's review and approval, a detailed Testing and Commissioning Plan. The plan shall include;

- A summary of testing and commissioning objectives.
- Details of the proposed hydraulic testing regime and programme.
- Details of the proposed commissioning regime and programme.
- Resource plans covering testing and commissioning.
- Equipment schedules covering testing and commissioning.
- Health & Safety plan.
- Compliance requirements covering testing and commissioning.
- Sampling and analysis methodologies covering testing and commissioning.
- Documents and reporting.

The Contractor shall be responsible for obtaining all permits as referenced in Section 1.16 below, from the relevant statutory authorities, which are necessary to prepare, execute and complete the Works. Kahramaa will provide Road Opening Permits (RO1) to the Contractor upon Contract award.

The Contractor shall be responsible for paying any fees and expenses to the relevant statutory authorities; whom may include but are not limited to Ministry of Municipalities and Urban Planning, Qatar Civil Defence, Kahramaa; as necessary to prepare, execute and complete the Works.

The Contractor shall be responsible for coordinating and obtaining final Civil Defence approval and building certification from Qatar Civil Defence Department.

#### **1.1.5 Supply of Materials**

The Contractor shall be responsible for supplying all necessary materials for the full completion of the Works to provide a complete installation in accordance with the drawings and specification.



#### **1.1.6 Site Establishment**

The Contractor shall establish offices for his use and the facilities for the use of Kahramaa and the Engineer as detailed herein.

The Contractor shall erect and maintain a site boundary fence and establish all necessary systems to ensure general site security until issuance of the Taking Over Certificate. The Contractor shall remove the boundary fence when instructed by Kahramaa at the end of this Contract.

The Contractor shall be responsible for obtaining approvals for all temporary access roads, and for connections with public roads and highways. For any temporary working areas outside of the Site the Contractor shall be responsible for obtaining access, approvals, constructing, maintaining, removal and reinstatement on completion. The Contractor shall be responsible for coordinating with all land owners/occupiers and governmental departments as necessary for approval of site access roads.

#### **1.1.7 Excavation and Backfilling**

The site is within an existing quarry. However excavation will be required to achieve the required formation levels as shown on the drawings. It is the responsibility of the PRPS Contractor to ensure that he retains a sufficient quantity of suitable excavated material on site for backfilling. Existing and finished ground levels are indicated on the drawings.

The Contractor shall be responsible for selection of the method of excavation and backfilling which shall be to the approval of the Engineer. The Contractor shall demonstrate the effectiveness of his methods; in particular the effective backfilling and compaction methods. Explosives shall not be used.

Where voids are found below formation level or where over-excavation occurs the Contractor shall fill to formation level with selected compacted material or concrete as approved by the Engineer.

Prior to the commencement of concrete works, Anti-Termite soil treatment shall be applied to all excavations. This shall apply the areas around all structures, from the formation level to the finished ground level. Treatment may be completed by either spraying or sprinkling with a minimum solution of at least 5l per square metre.

#### **1.1.8 On site stockpiling**

Excavated material may be retained on site only to the extent that the material is suitable and in sufficient quantity to be used for backfilling. Excess or unsuitable material shall be disposed off site as specified below unless otherwise agreed with Kahramaa.

#### **1.1.9 Off site disposal**

The Contractor shall dispose off site any material that does not meet the requirements of the Specification and/or the requirements of the Engineer, and surplus suitable excavated material all subject to approval by the Engineer.

Material shall be transported and disposed of as directed by Kahramaa either to allocated storage areas for use on other projects or to other licensed disposal locations approved by Kahramaa. Unless otherwise directed, material which is disposed off site shall remain the property of Kahramaa.



### **1.1.10 Reservoirs**

Construction of four reinforced concrete reservoirs to provide a total effective storage capacity of 388 Million Imperial Gallons (MIG). Each reservoir has a plan size of 305m x 150m (internal dimensions). The reservoirs will be constructed partially below the original ground level and partially above. The overall depth of the reservoirs from the top of the base slab to the underside of the roof will be approximately 11.5m. The specific details of the dimensions shall be taken from the drawings in Appendix F.

Each reservoir will be divided into three cells. Each cell will include three internal baffle walls to provide channels to control the water flow. Intermediate columns will be constructed to support the roof structure. Each cell will include inlet and outlet pipeline connections, drain down and scour pipelines. Chambers attached to the reservoir will house butterfly valves and flow control valves. Separate pipework connections will be installed for reservoir high level overflows. The design of the reservoirs is such that they will generally operate with the three cells running in series and all the reservoirs running in parallel. Pipework and valves are included to allow cells to be operated in parallel or to be taken out of service for maintenance.

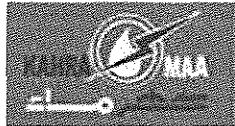
Reservoir No. 1 and No. 2 will also include inlet distribution chambers. The incoming flow from the corridor pipelines will pass into the inlet area and will then be distributed to all four reservoirs by a network of pipework and valves. The inlet areas will include high level overflow channels and pipework connections for discharge of water in the event that the incoming flow exceeds the available storage and distribution requirement. Pipework connections will also be provided for pump suction, re-circulation, scour, drain-down return and for future inlet pipelines.

Reservoirs shall be constructed with a number of movement joints and construction joints, as specified on the structural drawings given in Appendix F.

Each reservoir will have a dedicated underfloor drainage consisting of perforated 100mm ESVC pipe housed in a no fines concrete channel to collect any leakage detected from the foundation slab as result of cracks. The underfloor drainage channel locations are based on construction joints spacing and follow the slope of the reservoir. Each underfloor drainage channel shall gravitate into an inspection detection chamber for leakage monitoring. The inspection chambers will then be linked to combine positive underfloor and land drainage network system as shown on the drawings.

Further a Fibre Optic Cable is to be installed within each underfloor drainage channel for the explicit purpose of leak detection. The leak detection system shall be a distributed temperature sensing system type with a temperature resolution up to 0.01 °C at every 1m along the entire installed length of the sensing cable. The system shall be able to provide a complete temperature profile of each sensing cable every 60 seconds.

Additionally a network of land drains will be installed around the perimeter of the reservoirs consisting of perforated Vitrified Clay (VC) pipe placed 2m above the reservoir base level. The land drains will be constructed of 300mm VC perforated pipework surrounded by 14mm single sized rounded gravel. The land drain pipework around the perimeters of each reservoir will then collect the land drains into dedicated combined manhole for each reservoir as shown on the drawings. A dedicated submersible lift station with a wet well approximately 13m deep and 3m by 2m in plan, which is attached to a section of the main flood relief channel will collect the leakage underfloor drainage and land drainage. This will lift the drainage to the flood relief channel which has a depth of approximately 3.5m from the finish ground level in that location, prior to discharge into the main dedicated lagoon.



No internal coating is required to the internal wall, column, underside of the roof and top of the raft slab. The internal surface of the reservoir shall be fair face finish free from honeycombing and excessive air holes, fines and projection arising from defective mixing and placing of formwork. The finish shall be integral with the body of the concrete and shall not be obtained by means of applied rendering.

External buried surfaces will be protected using a bonded synthetic membrane. The membrane will be a single ply HDPE minimum thickness 1.2mm membrane with adhesive bonding agent. The membrane shall be laid on regular, smooth, formwork or a blinded surface, free from projections, with no gap or voids greater than 10mm.

Exposed external concrete surfaces above the finished paved area of the reservoirs will be finished with hot dip zinc coated steel profiled sheeting, designed to withstand design loading under the required conditions and limits, which includes wind, earthwork, thermal expansion, its own weight and the structural dynamic load.

The steel sheet shall be clad to the external face of the reservoir and shall be installed from 0.3m of the finished paved area to the top of the reservoir as shown on the drawing referenced AR-2012.

Reservoirs roofs will have upstand walls at the perimeter as edge protection. The roof will have a longitudinal fall of 0.2% to drain to perimeter drains. A screed, waterproofing, insulation, geotextile and gravel layer will be laid over the in-situ concrete as detailed on the drawings.

Access to the roof level is via staircases from ground level with further vertical ladders to access the inlet distribution area roof level. The roof slabs include security type access hatches on a concrete upstand giving access to internal vertical ladders. A separate 3m square access opening is provided for equipment. All access hatches shall be of aluminium material class A, dustproof and waterproof, access covers above 1 m<sup>2</sup> shall be electrically operated. GRP Air vents shall be installed and will be provided with insect screens.

#### **1.1.11 Reservoir testing, cleaning and sterilising**

Testing of the reservoirs for leakage shall follow the requirements of QCS Section 5 Part 19. Each individual compartment of the reservoir shall be tested separately whilst the adjacent compartments are empty. Filling shall not take place earlier than 28 days after the casting of the final sections of the structure which will be stressed by the filling of the structure. Testing shall be carried out prior to any external cladding being installed.

Notwithstanding the satisfactory completion of the test, any leakage visible on the outside faces of the structure shall be stopped. Any repairs to the wall section shall be carried out from the inside face

Roofs of reservoirs shall be watertight and shall be tested prior to the installation of any waterproof membrane. As an alternative to the method required under QCS the roof may be tested by lagooning with water to a minimal depth of 25 mm for a period of 24 hours. The roof shall be regarded as satisfactory if no leaks or damp patches show in the soffit. The roof waterproofing and covering shall be completed as soon as possible after satisfactory testing.

Following successful hydraulic testing of a reservoir but before the reservoir is put into service the reservoir shall be disinfected. Reservoirs will be disinfected using AWWA C652 Method 2 which requires individual reservoir cells to be disinfected with a brush or spray application of a 200 mg/l available chlorine solution. This will be applied directly to all surfaces which may be in contact with water when the reservoir is full to overflow level. The reservoir shall be thoroughly cleaned to remove all dust and debris to the satisfaction of the Engineer. All internal soffits and other parts of the reservoir which are above the



top water level will be sprayed with a solution containing 20 mg/l free chlorine. The reservoir shall then be filled to top water level with chlorinated water to give a residual of not less than 20 mg/l of free chlorine. After filling of each reservoir and a holding period of 24 hours the reservoir shall then be drained, flushed out with mains water and refilled with clean water having a chlorine residual of not more than 0.5 mg/l free chlorine. After 24 hours samples shall be taken for bacteriological and chemical analysis. The reservoir is deemed to be disinfected if there are no coliforms in the sample. Should the initial sterilisation be unsuccessful due to residual coliforms being found in the sample the Contractor shall repeat the procedure at his own cost until such time as the test is successful.

The programme for sterilisation and bringing into service shall be agreed with Kahramaa depending on availability of water and commissioning programme for the remaining parts of this Contract and the overall Mega Reservoir scheme.

When the individual reservoirs are ready to test, the Contractor shall submit a method statement giving 14 days' notice to Kahramaa and advising the approximate volume of water required and proposed method of measuring this volume. Kahramaa will confirm their ability to supply this water within 7 days. The methods proposed shall be subject to review and approval by Kahramaa. Should there be any delays by Kahramaa in the provision of water, the Contractor will be allowed to claim for an extension of time, but will not be allowed to claim for any additional costs. The contractor's method shall consider the most economical re-use of water for these activities and shall minimise wastage as far as is reasonably practical.

Chlorinated water used for sterilisation may be re-used within the Site for further testing of pipelines and reservoirs. The Contractor shall process any water to be disposed off Site to reduce the level of residual chlorine before disposal. Disposal arrangements shall meet any requirements of the Ministry of Environment and shall be to the satisfaction of Kahramaa.

The Contractor is responsible for the disposal of all water used for testing and disinfection, including all associated costs. Should the Contractor choose to sell the water to a third party, this must be done with the explicit agreement of Kahramaa and the rate for resale shall be agreed with Kahramaa prior to any commitment being made.

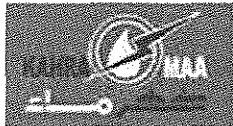
The Contractor shall pay for water at the Kahramaa standard rate current during the Contract and shall make due allowance for this in pricing the testing and sterilisation activities.

#### **1.1.12 Pipelines**

Supply of materials, preparation of construction and shop drawings and complete installation of pipelines in trench laid in single or multiple lines. Works include all jointing, coating, wrapping, thrust blocks, restrained joints where identified on the drawings, testing and sterilisation and all associated temporary and permanent works to provide a complete installation for each pipeline. Fittings valves and the like will include but not be limited to butterfly valves, gate valves, flow control valves, flow meters, bends, short pipes, collars, dismantling joints and blank flanges.

The Scope of Works includes main process pipelines in both ductile iron and coated carbon steel. Additionally drainage pipelines will utilise vitrified clay, extra strength vitrified clay or concrete pipeline materials. The approximate pipeline lengths given below and shall not be used for procurement or construction.

1. 2200mm diameter coated steel pipeline. 2.5km from the inlet ring main distributing flow to the proposed and future reservoirs and also part of the transmission mains suction pipelines.



2. 2000mm diameter coated steel pipeline. 1.6km inlet ring main distributing flow to the reservoirs and also part of the transmission mains suction pipelines.
3. 1600mm diameter ductile iron pipeline. 4.1km from the site boundary, at the connection to the Corridor Mains (LOW), to the reservoir inlet distribution chambers and also delivery from the pumping station to the Transmission Mains (LOW).
4. 1400mm diameter ductile iron pipeline. 0.4km as part of the recirculation pipework
5. 1200mm diameter ductile iron pipeline. 4.6km site boundary at the connection to the Corridor Mains to the reservoir inlet distribution chamber; Transmission Mains pumping station suction and delivery; recirculation pipework.
6. 900mm diameter ductile iron pipeline. 0.6km as reservoir cell overflows and surge vessel connections.
7. 800mm diameter ductile iron pipeline. 2.7km as reservoirs drain and scour pipework.
8. 600mm diameter ductile iron pipework. 0.9km at the tanker filling station.
9. 500 to 150mm diameter ductile iron pipework. Total 0.4km in various locations
10. 100mm ESVC perforated pipeline for reservoir underfloor drainage to the inspection chambers.
11. 300 to 150mm diameter VC pipework for foul sewerage system from operations building, guard houses and workshop and draining to a septic tank to be constructed at the site boundary.
12. 1000mm to 150mm VC pipeline. Storm water drainage from roads and reservoirs roofs runoff and also the overflow collector from the reservoir compartments.
13. 1000mm and above. Concrete storm water drainage from road runoff and also the overflow collector from the reservoir compartments.
14. 2500mm wide flood relief RC channel.
15. 3000 to 4500mm wide overflow RC channel collector from the reservoir IDC.
16. Land drainage VC perforated pipework 500 to 300mm diameter.
17. Polyethylene potable water pipeline. Domestic water supply to operations building, guard houses, workshops and motive water for chlorine dosing.
18. uPVC irrigation pipeline to landscaped areas.
19. Ductile Iron Fire ring main and hydrants along with all necessary isolation valves and supports.
20. 90OD PE80 SDR11 PN16 Chlorine dosing pipelines.

Final pipework connections to reservoirs shall not be made until such time as the initial settlement has occurred after the reservoir has been filled for testing. The Contractor may make temporary pipework connections to facilitate filling and testing.

Some pipelines will be capped to facilitate future extension in later phases as shown on the Drawings. These pipelines will be constructed with blank flanges and a thrust block.

#### **1.1.13 Testing of pipelines**

The specified test pressure for each pipeline section shall be measured above the lowest point on the section. When the individual pipeline sections are ready to test, the Contractor shall submit a method statement giving 14 days' notice to Kahramaa and advising the approximate volume of water required and proposed method of measuring this volume. Kahramaa will confirm their ability to supply this water within 7 days. The



methods proposed shall be subject to review and approval by Kahramaa. Should there be any delays by Kahramaa in the provision of water, the Contractor will be allowed to claim for an extension of time, but will not be allowed to claim for any additional costs. The contractor's method shall consider the most economical re-use of water for these activities and shall minimise wastage as far as is reasonably practical.

The Contractor shall pay for water at the Kahramaa standard rate current during the Contract and shall make due allowance for this in pricing the swabbing, testing and sterilisation activities.

Upon completion of the pipeline it shall be subject to final tests, as specified in Kahramaa's General Specification for Main Laying Contracts.

Unless otherwise specified Test Pressures shall be as follows:-

- Incoming Corridor Mains between site boundary and the flow control valves – 18.75 bar
- Corridor Mains downstream of the flow control valve and all other process pipework – 3.75 bar
- Delivery Transmission Mains from the pumping station – 18.75 bar
- Bypass pipeline – 18.75 bar
- The test pressure for other pressure pipelines (potable water supply, fire fighting and irrigation) shall be as part QCS 2010 clause 8.4.5.3.
- Irrigation and potable water test pressure shall be 9.75 and 8 bar respectively.
- Fire fighting test pressure shall be 16bar. Fire Ring Main and Hydrants to be tested in accordance with NFPA standards

All Testing shall be completed on buried or restrained pipes.

#### **1.1.14 Pipeline Swabbing, Sterilisation and Commissioning**

All processes should be compliant with the requirements of AWWA C651-05 Disinfecting Water Mains.

Broom sweeping will be accepted to improve flushing (AWWA C651 section 4.4.3.2) prior to disinfection providing particular attention is paid to removal of material from the pipe joints. Flushing will still be required post disinfection to remove the highly chlorinated water from the pipeline being disinfected.

The contractor shall undertake disinfection using either the continuous feed method or the slug dose method described in the referenced standard.

All chlorinated water shall be de-chlorinated prior to discharge to waste. Discharges to waste will only be permitted with prior written agreement of the Ministry of the Environment and the landowner.

The Contractor shall be responsible for the final connection and commissioning of the pipe, unless advised otherwise. This is to include bringing the pipe into full operational use and making all final connections.

The Contractor shall prepare a detailed programme and method statement setting out his proposals for testing and commissioning (hydraulic testing, flushing, disinfection and commissioning) including volumes of potable water required. This will then be integrated into a coordinated programme by the Engineer. The Contractor will be required to update this programme as work proceeds including attending regular coordination meetings.



The provision of all materials, equipment and water required for testing, hydraulic swabbing and sterilization shall be the responsibility of the Contractor.

Water for testing, sterilisation and flushing may be supplied directly through the supply pipelines laid by others, in which case the Contractor shall provide temporary flow metering devices and acceptable protection against back contamination including temporary non return valves all to Kahramaa's approval. The temporary arrangement shall satisfy Kahramaa that there is no possibility of back contamination into the public water supply.

The Contractor will be liable for the payments of all costs associated with metering the water supplied and for the water supplied, and should make due allowance for this in his pricing. Water supplied by Kahramaa which shall be charged at Kahramaa's commercial rates, shall not be wasted and the methods and sequencing proposed by the Contractor shall demonstrate optimum use of this resource.

The contractor shall also be responsible for the ultimate disposal of all water used for testing and sterilisation, including any associated costs. Should the Contractor wish to sell on this water to others, he shall only do so with the explicit agreement of Kahramaa and the agreement of the associated rates for resale, prior to any commitment being made.

#### **1.1.15 Connections to Existing Pipelines**

Connections shall be made into existing pipelines (operational or those laid by others) as defined below.

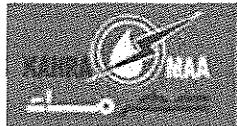
- Two 1600mm diameter and one 1200mm diameter Corridor Mains at the east boundary of the site
- Two 1600mm diameter Transmission Mains at the east boundary of the site
- One 1200mm diameter Transmission Mains at the north east boundary of the site

Connections into operational pipelines are to be made and the affected pipework tested, sterilised, flushed as necessary and brought back into service within possession periods to be agreed with Kahramaa. No connection into an existing pipeline shall be made until Kahramaa has accepted and signed a Notification of Safety Precautions (NOSP) certificate. Contractor shall prepare and issue in the name of Kahramaa the NOSP including a method statement advising the approximate volume of water required and proposed method of measuring this volume. Upon receipt of the NOSP Kahramaa will inspect the Site and confirm their ability to supply this water within 14 days. Should there be any delays by Kahramaa in the provision of water affecting the Contractual Completion Date, the Contractor will be allowed to claim for an extension of time, but will not be allowed to claim for any additional costs. The Contractor will be liable for the payments of all costs associated with metering and should take this into account in his pricing.

The Contractor shall excavate trial pits, survey the existing pipework and ensure that the fittings he proposes to use to connect to the existing pipelines are compatible with the existing pipe installations and will not cause any damage to those pipes. No work shall be undertaken in making connections into existing operational pipelines until full approvals are received and all required tools, equipment and materials including disinfection materials are available on site all to Kahramaa's satisfaction.

The Contractor shall provide all necessary fittings, temporary by-pass pipelines, valving, and cutting of the existing pipelines.

The Contractor shall provide detailed method statements and obtain Kahramaa's specific approval for each connection.



#### **1.1.16 Chambers**

Chambers to be constructed will include but not be limited to:-

- Valve chambers
- Flow meter chambers
- Flow control valve chambers
- Drainage and foul sewerage manholes and inspection chambers
- Cable duct draw pits
- Overflow channels

#### **1.1.17 MEICA Works Generally**

The individual specification sections give details of the submissions required against each item of plant or material. The Contractor shall submit the information required for the approval of Kahramaa and the Engineer. Where the information is inadequate or not approved the Contractor shall, at his own cost, re-submit the information until approval is given.

The Contractor shall supply special tools, consumables and spares recommended for the maintenance and satisfactory working of the equipment supplied for a minimum period of 2 years, in addition to the spares specifically referenced in Appendix B.

Testing and commissioning of the Mechanical, Electrical Instrumentation Control and Automation (MEICA) works shall be in accordance with the individual specifications and standards relating to that item of plant. Where the specification does not fully cover testing and commissioning requirements then these shall be established based on industry standard practice and approved by Kahramaa and the Engineer.

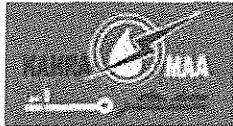
#### **1.1.18 Pumping stations generally**

The Scope of Works for all pumping stations will include selection and detailing of pumps and pipework for the approval of Kahramaa. The final internal layouts for all pumping stations within the Scope of Works shall be determined during the construction phase after the Contractor has refined the surge analysis, all tests, reports, confirmed suppliers' details and verified the best and optimum locations for the proposed facilities to the approval of Kahramaa.

The main pumping station is designed with tension/compression piles based on the provided design loads as shown on the tender drawings. The contractor shall design the piles and submit for the Engineers approval.

The Contractor shall take account of all works related to the installation of future pumps. Where required to avoid unnecessary modifications and shutdowns during installation of future pumps and pipework, the Contractor shall complete the work required for future facilities such as pump foundations, supports, cable trays, sleeves, trunking, empty blank control cubical, etc. The Contractor may propose alternative pipe materials for the pumping stations as an alternative proposal. However the contractor shall make full allowance in his tender price for the re-design and costs that arise from such a proposal, including stress calculations and thrust calculations as well as any consequential affect on designed structures.

The Contractor shall allow for and shall include in his Tender price any re-design and costs arising from any of his proposals which amend the structural layouts and dimensions.



### **1.1.19 Main Pumping Station**

The main pumping station will deliver flow from the PRPS site to Transmission Mains delivering to existing service reservoir and pumping stations (SRPS). The pumping station will accommodate a total of twelve (12) pumps divided into two (2) separate pumping systems. Nine (9) pumps will be installed under this scope and spare slots will be provided for future pumps. The location and size of the pumping station is shown in the Tender Drawings.

Pumps will be divided into two groups with the arrangement as follows:

- Sub-system 1A pumps comprising of 6 sets (4 sets to be installed under this contract and space only for two (2) spare slots for future pumps)
- Sub-system 1B pumps comprising of 6 sets (5 sets to be installed under this contract and space only for one (1) spare slot for future pump)

The pumping station structure and building is described in section 1.1.3.26 below.

The building shall be constructed with the following minimum parameters to provide adequate and safe access to below ground pump room and for loading /unloading equipment from and out of new pump house:

- A 20 tonne overhead double girder indoor mounted crane shall be provided.
- All necessary lighting, ventilation, to the standards set out in the specification
- Fire alarms, fire detection system and fire protection system as specified, including all passive fire protection.
- Access staircases and platforms with handrails to be constructed for accessing the pump room and to facilitate the operation and maintenance of the equipment installed.

The pump station shall be designed to suit the new pumps with following minimum guidelines dimensions and clearances:

- Minimum clear distance between any two VFD pumps foundation shall be 1.5 metres regardless of total length of pump/motor skids
- The pump/motor skid shall not be longer than the plinth.
- The pumps and associated arrangement shall be reviewed and approved by the pump manufacturer.

The work inside the pump station shall include but is not limited to the following:

- 1) 2200 mm suction header with 4 x 700 mm flanged branches along with all required supports, valves, instruments, and fittings etc. for connecting to the four transmission pumps sub-system 1A. Two more 700 mm branch connections are to be provided on the suction header with blank flanges for future pump installations.

Another 5 x 1000 mm flanged branches along with all required supports, valves, instruments, and fittings etc. for connecting to five transmission pumps Sub-system 1B. One more 1000mm branch connection is to be provided on the suction header with blind flange for future pump installation.

The suction header shall be common for the pumps groups described above but separated by motorized butterfly valves.



Two incoming suction lines of 2200 mm, one each on the western side and the eastern side, routed directly from the reservoir compartment outlets for the transmission pumps (Sub-system 1A & Sub-system 1B).

- 2) A 1200 mm discharge header is to be connected with 4 nos. 600mm flanged branches for Sub-system 1A Pumps. Two more branches are to be provided with blind flanges for future pumps installation. The four branches are to be connected to sub-system 1A group of pumps along with all required supports, isolation valves, non-return valves, instruments, and fittings etc. The 1200mm delivery header shall have two outgoing branches.
- 3) A 1800 mm discharge header is to be connected with 5 no. 800mm flanged branches. One more branch is to be provided with blind flange for future pump installation. Five branches are to be connected to sub-system 1B pumps along with all required supports, isolation valves, non-return valves, instruments, and fittings etc.
- 4) A valve chamber shall be provided on the pumping mains of sub-system 1A and sub-system 1B. 1200 mm quick closing valve shall be provided on the pumping delivery main of sub-system 1A pumps within the valve chamber. 2 Nos of 1600 mm hydraulic actuated quick closing valves shall be provided on the pumping delivery main of sub-system 1B pump. The work shall include all the supports and fittings within the valve chamber.
- 5) Two valve chambers shall be provided for the main incoming lines of sub-system 1A and sub-system 1B. Each of these chambers shall be provided with 2200 mm hydraulic actuated quick closing valve and 2200 mm motorized butterfly valve. The work shall include all the supports and fittings within the valve chamber.
- 6) Two drain sumps are to be constructed within the main pumping station structures with adjacent valve chambers. Two sets of two electrically driven vertical submersible pumps shall be installed in the wet well of each sump.

The contractor shall supply, install and commission 2 no. submersible pumps of capacity 9.72 l/s @ 16.4m head for pumping out the smaller quantity of flows received at the wet well from the normal operational drains of the pump hall. The pumps will work as one duty + one standby configuration.

The Contractor shall supply, install and commission 2 no. submersible pumps of capacity 242.1 l/s @ 10.5m head, for pumping out the larger flow quantities received at the wet well during abnormal flood scenarios occurring within the pump hall. The pumps will work as one duty + one standby configuration.

The Contractor shall supply, install and commission the piping for the pumps along with all required supports, isolation valves, non - return valves, instruments, and fittings etc. as shown in the tender drawings and detailed in bill of quantities.

- 7) The Contractor shall supply, install, test and commission 4 nos. single stage, double suction, horizontal shaft, centrifugal split case driven by directly coupled electric motor in the horizontal orientation for Sub-system 1A pumping system. Two additional slot has to be provided for installing future pump. The ultimate capacity of the pump when operating at rated speed shall be 566l/s @ 49m head.
- 8) The Contractor shall supply variable speed pumps as per the details given below for the Sub-system 1A pumps. The pumps shall be capable of providing the flows tabled with the configuration given.



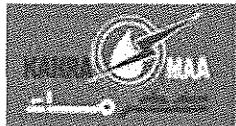
**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoirs PRPS Package A**  
**(PRPS 1 at Umm Birka)**

Design Horizon	Flow, MIGD	Flow, l/s	Head, m	No of duty pumps	Standby	Spare	Pumps to be installed
2016	5.8	299	28	1	2	1	4 pumps are to be installed under this contract. 2 slots are to be provided for future pumps installation.
2026	20.7	1090	36	2	1	1	
2036	39	2056	46	4	1	1	
Design Duty Point		566	49				

- 9) The Contractor shall supply, install, test and commission 5 nos. single stage, double suction, horizontal shaft, centrifugal split case driven by directly coupled electric motor in the horizontal orientation for Sub-system 1B pumps. 1 additional slot has to be provided for installing future pump. The ultimate capacity of the pump when operating at rated speed shall be 1679l/s @ 58m head.
- 10) The Contractor shall supply variable speed pumps as per the details given below for the Sub-system 1B pumps. The pumps shall be capable of providing the flows tabled with the configuration given

Design Horizon	Flow, MIGD	Flow, l/s	Head, m	No of duty pumps	Standby	Spare	Pumps to be installed
2016	40.3	2118	36	2	2	1	5 pumps are to be installed under this contract. 1 slot is to be provided for future pumps installation
2026	68.7	3612	41	3	1	1	
2036	99.6	5238	50	4	1	1	
Design Duty Point		1679	58				

- 11) The Contractor shall perform surge & transient analysis study as per QCS 2010 section 9 part 6 to confirm the surge protection equipment design requirements for the complete piping system comprising of piping, reservoirs and pumping station shown on tender drawings as well as other related existing and future pipelines systems connected or to be connected to this contract piping to the approval and satisfaction of the Engineer. This shall be completed as an update of the preliminary surge model that shall be provided by Kahramaa. The surge report shall be submitted by the Contractor and approved by the Engineer / Kahramaa before procurement of the surge equipment. The sizes and drawings provided for surge protection in the Contract Documents are indicative and for guidance only.
- 12) The Contractor shall design, supply, install, test and commission an electrically operated overhead double girder type crane with a lifting capacity of 20 tonnes.



The Contractor will be responsible for determining and selecting suitable pumps to achieve the required output. The figures given for pumping head are for the total static lift and system head including an assessment of fittings losses within the pumping station. The Contractor shall verify the above figures as part of the surge analysis based on his selected pumps and materials.

Internal pipework within the pumping station has been designed as shown on the drawings. The contractor will be responsible for verifying the pipework layout in relation to the proposed pumps and valves. The contractor will design all pipe supports and brackets including the preparation of shop drawings for the approval of Kahramaa.

The pipework design is based on the use of carbon steel. The Contractor may propose an alternative design based on the use of ductile iron pipework in which case he shall present full details for the approval of Kahramaa. Any alternative proposal shall not result in an increase in the overall footprint of the pumping station and superstructure.

#### **1.1.20 Auxiliary Pumping Station**

Construction of a new auxiliary pumping station (PS) suitable to accommodate total of ten (10) pumps divided into three groups namely recirculation pumps, drain down pumps and scour pumps. Recirculation pumps shall include the provision for future slots.

The 10 pumps will be divided into three groups with the arrangement as follows.

- Recirculation pumps comprising of 6 sets ( 4 sets to be installed under this contract and space only for two spare slots for future pumps )
- Drain down return pumps comprising of 2 sets
- Scour pumps comprising of 2 sets

The pumping station building shall include

- a. Pump house to accommodate pumps to be constructed below ground level approximately 28m x 22m
- b. Control room above ground constructed in blockwork and reinforced concrete.
- c. All necessary lighting and ventilation,
- d. Fire alarms system, fire detection system and fire protection system (including passive fire protection.)
- e. Access staircases and platforms with handrails for accessing the pump room and to facilitate the operation and maintenance of the equipment installed.

The Contractor shall take account of all works related to installation of future pumps. Where required to avoid unnecessary modifications and shutdowns during construction of future pumps and pipework, the Contractor shall complete the installation for future facilities such as pump foundations, supports, cable trays, sleeves, trunking, empty blank cubical, etc.

The pumps shall be installed within the following minimum guidelines dimensions and clearances:

- Minimum clear distance between any two VFD pumps foundation 1.5 m regardless of total length of pump/motor skids
- The pump/motor skid shall not be longer than plinth.
- The pumps and associated arrangement shall be reviewed and approved by pump manufacturer.

The required work inside the pump station shall include but is not limited to following:

- 1) Four submersible recirculation pumps in the dry well in two groups with two additional slots to be provided for future installation of the third pump for each group. The recirculation pumps shall be capable of delivering 1.25 m<sup>3</sup>/s of recirculation rate per



inlet distribution chamber (IDC). With the addition of the future pump, the capacity of the pumping station shall achieve 2.5 m<sup>3</sup>/s of recirculation rate per IDC. The capacity of the pumps shall be 1260 l/s @ 8.06m head. The pumps shall be selected to cover the operation requirements at both TWL and BWL (minimum set by this specification) within the permissible operational range of the pumps. The pumps shall operate as 1 duty + 1 stand by. Reservoir level shall be maintained at minimum 3m during recirculation in order to ensure operation of the pump within the range recommended by the manufacturer.

- 2) Two 1200 mm suction headers are to be provided with 3 x 1000 mm flanged branches. Two branches on each header are to be installed with all required supports, valves, instruments, and fittings etc for connecting to the two recirculation pumps which will be installed under this contract. headers have to be provided with tee connection and blind flange for future extension for connecting the third recirculation pump
- 3) Two 1200 mm common discharge headers are connected with 3 x 800 mm flanged branches. Two 800 mm branches are connected to the recirculation pumps along with all required supports, isolation valves, non - return valves, instruments, and fittings etc. An orifice plate is required on the re-circulation line for throttling purpose to maintain the pressure. In order to minimize velocity in the discharge line to an acceptable level (below 2.5 m/s) and at the same time to achieve the required recirculation flow, throttling with a replicable orifice plate is required and the maximum pressure drop cross the orifice plate is 2.2m.
- 4) Two submersible pumps in the dry well used for the drain down return. The capacity of the pumps shall be 900 l/s @ 10m head. The pumps shall be selected to cover the operation requirements at both TWL and BWL within the permissible operational range of the pumps. The pumps shall operate as one duty and one stand by.
- 5) 800 mm suction header is to be provided with 2 x 800 mm flanged branches. Both the branches are to be installed with all required supports, valves, instruments, and fittings etc. for connecting to the two drain pumps which will be installed under this contract.
- 6) 800 mm discharge header is connected with 2 x 800mm flanged branches. Both the branches are connected to the drain pumps along with all required supports, isolation valves, non - return valves, instruments, and fittings etc.
- 7) Two submersible pumps in the dry well for the remaining scouring discharging to the lagoons. The capacity of the pumps shall be 54 l/s @ 7m head. The pumps shall operate as 1 duty + 1 stand by.
- 8) 250 mm suction header is to be provided with 2 x 250 mm flanged branches. Both the branches are to be installed with all required supports, valves, instruments, and fittings etc. for connecting to the two scour pumps which will be installed under this contract. The suction header shall be provided with an isolation gate valve within the pump room.
- 9) 200 mm discharge header is connected with 2 x 200mm flanged branches. Both the branches are connected to the scour pumps along with all required supports, isolation valves, non - return valves, instruments, and fittings etc. The discharge header shall be provided with an isolation gate valve within the pump room.
- 10) A bypass line shall be provided for the pumps with 200mm piping between the suction and discharge headers. Branch connections to be provided for both suction and discharge headers to facilitate by pass piping. Bypass line shall be provided with 200mm motorised butterfly valve in order to facilitate first stage scouring if required.



- 11) Two sump pumps shall be installed inside the provided sump with a capacity of 10 l/s @ 11.7 m head. The pumps shall work as 1 duty + 1 stand by. The Contractor shall provide isolation valves, non-return valves, fittings and supports.
- 12) The Contractor shall design, supply, install, test and commission an electrically operated overhead double girder outdoor type crane, with a lifting capacity of 10 tonnes, to include the supply and detailing of all vertical supports required.

#### **1.1.21 Surge Suppression**

A surge suppression system shall be provided to the Transmission pumping mains as specified and as identified by the surge analysis. The Contractor shall confirm the adequacy of the surge system based on his proposed pump and equipment supply. Surge vessels shall be installed on concrete bases. The surge suppression system shall include but not be limited to all necessary vessels and associated linings, compressors, pipework connections, valves, support and access steelwork to provide a complete and fully functional system.

#### **1.1.22 Tanker Filling Pumping Station**

- 1) The Contractor shall supply, install, test and commission 4 No. submersible pumps in the dry well for providing potable water for tanker filling. The pumps shall work as 1 duty + 1 duty assist + 1 stand by + 1 maintenance spare. The capacity of the pumps shall be 100 l/s @ 9.96m head.. The pumps shall be selected to cover the operation requirements at both TWL and BWL within the permissible operational range of the pumps. The pumps shall be capable of feeding maximum 10 a rate of not less than 20 l/s. Two more slots shall be provided for the installation of future pumps.
- 2) 600 mm suction header is to be provided with 6 x 300 mm flanged branches. Four branches are to be installed with all required supports, valves, instruments, and fittings etc. for connecting to the four tanker filling pumps which will be installed under this contract. The other two branches have to be provided with blind flanges for the purpose of connecting to future pumps.
- 3) 500 mm discharge header is connected with 6 x 250mm flanged branches. Four branches are connected to the tanker filling pumps along with all required supports, isolation valves, non - return valves, instruments, and fittings etc. The other two branches have to be provided with blind flanges for the purpose of connecting to future pumps. The discharge header shall be provided with an isolation gate valve and a pressure control valve within the pump room. The pressure control valve shall maintain a pressure of 1.1 bar on the upstream side.
- 4) A bypass arrangement shall be provided between the suction header and discharge header as shown in the drawings to enable filling of the tankers by gravity at higher reservoir levels.
- 5) Two sump pumps shall be installed inside the provided sump with a capacity of 10 l/s @ 11.7 m head. The pumps shall work as 1 duty + 1 stand by. The Contractor shall provide the isolation valve, non-return valve, fittings and supports.
- 6) The Contractor shall design, supply, install, test and commission an electrically operated overhead single girder outdoor type crane with a lifting capacity of 1.5 tonnes, to include the supply and detailing of all vertical supports required.
- 7) Control room above ground constructed in block work and reinforced concrete.

#### **1.1.23 Utility Pumping Station**

- 1) The Contractor shall supply, install, test and commission fire hydrant pumps system at the utility pumping station. The pumping station building shall be above ground. The fire pump station shall be fully automatic and shall consist of an Electric Motor



driven pump to act as a duty pump, a Diesel Engine driven pump to act as standby pump and two electric motor driven Jockey pumps for maintaining the pressure on the fire protection system. The contractor shall supply, install and commission all the piping work, valves and supports as detailed and specified in the contract documents, drawings in compliance with NFPA standards.

The Contractor shall supply, install and commission all the piping work, valves and supports as detailed and specified in the contract documents and drawings. To serve this system a dedicated reinforced concrete Fire Fighting tank with a minimum volume of 145 cubic meters, shall be constructed, to include civil, structural and piping.

- 2) The Contractor shall supply, install, test and commission pressure booster pump system for irrigation network with a capacity of 2.6 l/s @ 6.5 bar including all the piping work, valves and supports as detailed and specified in the contract documents and drawings. This shall include the construction of the associated tank and pipework.
- 3) The Contractor shall supply, install, test and commission pressure booster pump system for potable water network with a capacity of 10 l/s @ 3 bar including all the piping work, valves and supports as detailed and specified in the contract documents and drawings. This shall include the construction of the associated tank and pipework.
- 4) The Contractor shall design, supply, install, test and commission an electrically operated overhead single girder indoor mounted crane with a lifting capacity of 3 tonnes to include the supply and detailing of all vertical supports required.
- 5) Control room above ground constructed in block work and reinforced concrete.

#### **1.1.24 Land drainage Lift Station:**

Land drainage and undefloor leakage drainage lift station to be constructed adjacent to the flood relief channel located in the main central road. Three submersible pumps of capacity 9.72 l/s @16.4m head are to be installed in the sump and operated as 2 duty and 1 standby. The pumps shall be electrically driven vertical submersible type.

The Contractor shall supply, install and commission the piping for the pumps along with all required supports, non - return valves, instruments, and fittings etc. as shown in the tender drawings and detailed in bill of quantities.

#### **1.1.25 Chlorination System**

The Contractor shall supply, install, test and commission a gas chlorine based disinfection system. The chlorination system shall cater for the disinfection requirements of the reservoirs, transmission lines and the corridor line. The contractor shall supply a system as the flow requirements and the disinfection strategies mentioned below and accommodate his equipment and associated accessories in the area provided in the chlorination building. The basic design for the chlorination system is shown on the drawings. The Contractor shall confirm or amend the design to suit depending on the proposed supplier and system. If the selected supplier proposes a different configuration then the Contractor shall submit this for approval.

The chlorine storage shall consist of 10 duty cylinders connected to the duty header and 10 cylinders connected to the standby header with additional 10 storage cylinders. The above numbers are based on 1 tonne capacity cylinders. The quantity of cylinders required shall be reconfirmed by the Contractor based on his supplier's system.

The chlorine disinfection system shall be constructed in accordance with the requirements of the general specification and shall include all the associated accessories required for the safe operation of the system. The chlorinator at each dosing location shall be



provided as 1 duty plus 1 standby. The equipment that forms the chlorination system shall be integrated such that there is enough flexibility for operation under various flow scenarios.

The disinfection requirement of the reservoirs shall be such that a minimum residual of 0.2 mg/l shall be maintained within the reservoirs. In order to provide flexibility in operation the disinfection system has been designed to cater for worst case flow scenario for 2036 flow conditions and hence shall be capable of dosing 56 kg/hr. of chlorine subdivided between each of the dosing points and being dosed into gravity flow lines. Each reservoir shall have three dosing point at the inlet of each reservoir cell, i.e. a total of 24 dosing points (8 reservoirs, 3 dosing points per reservoir). The dosing lines to the future reservoirs shall be adequately and safely blinded to be connected in future.

The transmission lines have two sub system namely SS- 01A and SS-01B. The SS-01A shall have a single dosing point capable of dosing chlorine at 4.6 kg/hr. The chlorination system shall be capable of dosing 16.5 kg/hr. equally split between two dosing point of SS-01B. The operating pressure of all the transmission lines shall be a maximum pressure of 8.5 bar.

The Contractor shall supply, install, test and commission 2 no. drench showers at the chlorination building which shall be operated by a walk on platform with stainless steel operating linkages and a stainless steel stay open valve switch which locks open. The showers shall incorporate emergency eye/face wash fountains with a flexible hose. The showers shall be complete with a light and emergency shower/eye wash signs. The drench shower shall be provided with potable water supply of minimum 76 litre/minute @ 2 bar (over a period of 15 minutes). The Eye/face wash station shall be provided with potable water supply of minimum 11.4 litre/minute @ 2 bar (over a period of 15 minutes). The water temperature shall be 16 to 38°C.

The Contractor shall design, supply, install, test and commission a monorail crane with electrically operated hoist, with a lifting capacity of 3 tonnes to include the supply and detailing of all vertical supports required.

#### **1.1.26 Electrical Supply**

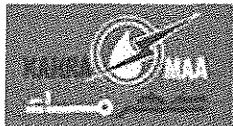
Power shall be sourced from the Kahramaa Network at 11kV. It is expected that the PRPS will require the construction of a new primary substation, with the primary voltage and capacity to be determined.

Space has been allocated on the PRPS site to accommodate a primary substation if it is required, and if Kahramaa is unable to source land elsewhere. Construction of this substation will not form part of this Contract but will be concurrent with this Contract.

Whether or not the primary substation is located on or off site, Kahramaa will bring a number of 11kV cables to the Site boundary. The Contractor will connect to the 11kV cabling at the site boundary and extend it to the main 11kV intake panel located in the MV and Generator Building.

From the main intake 11kV Panel, 11kV cabling shall be provided to:

- Within MV and Generator Building:  
1No. 11/0.415kV transformer for supplies to building and site services.
- Pump Building:  
6 No. 11/3.3kV phase-shift transformers for process pumping,  
1 No. 11/0.415kV transformer for ancillary supplies to process equipment;  
3 No. 11/0.415kV transformers for process pumping; and  
2 No. 11/0.415kV transformers for supplies to Building Services.



- **Remainder of Site:**

4 No. 11/0.415kV transformers shall be located at remote locations around the site for site power requirements. From these transformers, low voltage supplies shall be provided to all buildings and site power requirements.

Standby power generation shall be provided from diesel generating sets, located in the MV and generator building. The proposed operation is to provide a permanently installed secondary means of power to all site power and building services. Limited standby power shall be provided for the movement of water, i.e. sufficient capacity shall be installed to allow energising of 1No. pump in each subsystem or pump group. The strategy of generating power at 11kV will allow the powering of any pump, provided the capacity is adequate, and will ensure that standby / maintenance pumps can be operated in the event of a pump failure. Inhibitors shall be provided within the SCADA system to ensure that only 1No. pump is started while the site is under generator power.

The generators shall generate at 11kV and shall be all linked to a common synchronisation panel, which shall provide supplies to the 11kV intake panel.

Diesel Fuel Storage for the generating sets shall have provision for up to 7 days continuous operation. Space has been allocated for a bulk fuel storage tank.

Low voltage standby generator sets will be provided at the remote substations on the Site to ensure a reliable standby power supply is available during a power failure. At each of these remote generators, there shall be fuel storage for 7 days continuous operation.

All diesel fuel storage tanks shall be protected by a foam fire protection system, to suit NFPA requirements.

#### **1.1.27 Motor control centres**

Control panels shall be installed as shown on the Drawings and detailed in the Specification. Control panels are required at, but not limited to, the following locations:-

- Main pumps control panel
- Pump room drain down control panel
- Chlorination equipment control panel
- Air compressors control panel
- Generator control and changeover panel
- Remote substation generators (2) control and changeover panels
- Utility pumps control panel
- Tanker filling pumps control panel

Where indicated on the drawings additional panel sections shall be provided for future use and/or as spare compartments.

#### **1.1.28 Mechanical, Electrical, Public Health and Fire Fighting (MEPF)**

The MEPF (Building Services) provisions shall include:-

- HVAC
- Fire alarm systems, fire detection systems and fire protection (including passive protection), within buildings/structures
- Lighting and small power



- Plumbing
- IT and telephone systems, not covered under SCADA systems.

All buildings shall be air conditioned using split unit cooling system except the main pumping station and control room which shall use a chilled water system.

All buildings shall be provided with lighting, small power, telephone and IT systems as specified. The scope of work shall include local distribution boards, all cabling, lighting, sockets, switches and provision of a local area network.

Fire fighting/fire protection provisions shall include sprinklers, pipework, fire extinguishers, fire alarms, hose reels, FM 200 fire suppression systems, and passive fire protection.

Internal water supply and drainage shall be provided as detailed and specified.

The Contractor shall verify the design based on the approved equipment selected.

Testing and commissioning of the MEPF works shall be in accordance with the individual specifications and standards relating to the items of plant. Where the specification does not fully cover testing and commissioning requirements then these shall be established based on industry standard practice and approved by Kahramaa and the Engineer.

#### **1.1.29 Street Lighting**

Street Lighting will be provided to ensure the safety of all users of the facility. Street lighting has been designed in accordance with the QHDM. All materials proposed are as per QCS 2010. These are generally as follows:

- Lamp Source: High pressure sodium;
- Columns: Steel to BS 7613 grade 43C; and
- Feeder Pillar: Fibreglass reinforced polyester.

The Scope for this shall include all supply and installation including all associated civil structures, connection to supply and testing.

#### **1.1.30 Control Building / Pumping Station Structure**

The main pumping station is a reinforced concrete structure constructed below existing ground level. It will house the pumps and pipework detailed in 1.1.3.16 above. The approximate internal dimensions of the basement pumping station area are 94m x 29m x 8.2m deep. Valve chambers, stairwells and a 12m wide 3.3m deep cable gallery are adjacent to the main basement area. The cable gallery extends beyond the control building footprint to the MV/generator building.

The control building superstructure shall generally be of blockwork construction with reinforced concrete floor, roof and columns. Architectural elevations, openings and finishes to walls floors and ceilings are shown on the Drawings.

The central section of the superstructure above ground level covers the pumping station and includes access arrangements for personnel and plant. Access ladders, stairs, platforms, handrailing and the like are shown on the Drawings. The Contractor shall prepare detailed shop and fabrication drawings for the approval of Kahramaa. Any additional access ways required to provide a complete and safe installation are deemed to be included in the price and shall be detailed and supplied by the Contractor. All removable sections shall be suitable for manual removal and shall be within manual handling weight limits.



A ground level extended section of the control building to the front (south) side with a curved façade is approximately 87m x 17m. This section houses office and meeting facilities, control room, server room and welfare facilities. A further extension at the rear (north) side is approximately 110m x 20m and contains transformers, VFDs and electrical plant. Fan rooms are located at the east and west ends of the main building.

The building will include two roller shutter doors to the main pumping station areas for vehicular access when loading and removal of plant. Other doors and windows are shown on the Drawings.

#### **1.1.31 Chlorination Building**

The Chlorination Building shall be of blockwork construction with reinforced concrete floor, roof and columns. The approximate dimensions of the building are 35m x 15m. The building will house the chlorine liquid storage in one tonne containers. At the time of issue of the TOC the Contractor is to ensure that the required number of chlorine containers are in place and are all full. The building as specified will be fitted with detectors which will sound an alarm on chlorine leak.

A separate room in the building will house the chlorine dosing equipment. The equipment will include mixing facilities, pumps and flow measurement as detailed in the specification. Controls for the dosing equipment will be in a further room which will be sealed and accessible only from the outside of the building.

An electrically operated overhead single girder indoor mounted crane,, with a capacity of 3 tonnes will be installed to un-load, move and remove the chlorine storage containers. The beam will extend to a loading bay where it will facilitate delivery and unloading of the chlorine drums. The installation of this shall include the detailing and provision of all necessary vertical supports required.

Chlorine dosing lines will be installed from the dosing pumps to the dosing points in the reservoirs and in the main process pipelines as detailed in the Drawings. Chlorine dosing lines will be laid in trench. Where laid under roads the chlorine dosing lines will be laid with a concrete surround.

#### **1.1.32 Miscellaneous Buildings**

The Scope of Works includes the following buildings. The buildings are generally constructed of blockwork walls with reinforced concrete base and roof. Walls will be plastered internally and rendered externally and will be finished in paint except where tiling is specified. Floors will be finished in epoxy coating, or tiles as detailed.

- Workshop building – approximately 40m by 16m in plan and including overhead lifting, industrial door access, workshop area, stores, offices and welfare facilities
- Main guard house – approximately 12m by 7m in plan to be used as the main security access control to the site. The building will include guard room with windows to provide view of approaching traffic, welfare and storage facilities.
- MV/Generator building, approximate overall dimensions 33m x 65m. Incorporating generators, switchgear and cable basement.
- TFS Guard Houses 2 no. each approximately 7m x 5m. These will be sited at the entrance and exit of the Tanker Filling Station (see below) and will include an office for security guards/operators and toilet/welfare facilities.
- Water Testing Facility building approximately 21m x 14m containing laboratories, office, store rooms, welfare facilities and garage, including all associated laboratory equipment required.



- Pumping station control rooms for Auxiliary PS and Tanker Filling PS.
- Remote generator building approximately 15m x 10m to provide standby power for remote substations
- Remote substations, 2 no. each approximately 16m x 7m
- Remote substation/generator building, 2 no. each approximately 25m x 12m
- Air compressor building, approximately 47m x 10m to house compressors for surge vessels, pressure vessels and switchgear.
- Water Quality Monitoring Buildings. 5 no. approximately 3.5m square buildings located adjacent to each reservoir.
- Various small buildings housing SCADA equipment

#### **1.1.33 Tanker Filling Station**

A Tanker Filling Station (TFS) will be constructed for use in emergency situations. The TFS will include road access and manoeuvring areas to facilitate simultaneous filling of ten (10) tankers. The scope includes but is not limited to pipework and valves, roads and associated drains, barriers, gates and guard house including all associated services.

#### **1.1.34 Drainage Lagoons**

Three drainage rectangular lagoons will be constructed within the site. The lagoons will include connections from overflow pipelines/flood relief channels and will be GRP lined with reinforced concrete. Overall depths are approximately 6.5m below adjacent finished ground level for the lagoon 1 and 2 and 3m depth for the stand-by lagoon, and the plan areas of the three lagoons, including side slopes, are approximately:-

- Lagoon no. 1 – 40843.63 m<sup>2</sup>
- Lagoon no. 2 24594.05 m<sup>2</sup>
- Standby Lagoon – 27181.85 m<sup>2</sup>

The contractor shall perform hydrostatic testing of the lagoon after completion. Testing of the lagoons for leakage shall follow the requirements of QCS Section 5 Part 19 and the filling shall not take place earlier than 28 days after the casting of the final sections of the structure which will be stressed by the filling of the structure.

The contractor shall place the GRP lining after successful completion of the hydraulic test; furthermore the top water level in the lagoon shall be taken at maximum 5.5m for the main lagoons and 2m for the standby lagoon.

The contractor shall propose method statement to seal all the incoming pipes/channel entering the lagoon for testing purpose and to avoid the back flow water in the drainage system.

Notwithstanding the satisfactory completion of the test, any leakage visible on the outside faces of the structure shall be stopped. Any repairs to the wall section shall be carried out from the inside face

When the individual lagoons are ready to test, the Contractor may use the Chlorinated water used for sterilisation for pipelines and reservoirs and method statement shall be submitted to the engineer for approval.



The Contractor shall process any water to be disposed off Site to reduce the level of residual chlorine before disposal. Disposal arrangements shall meet any requirements of the Ministry of Environment and shall be to the satisfaction of Kahramaa.

The Contractor is responsible for the disposal of all water used for testing and disinfection, including all associated costs. Should the Contractor choose to sell the water to a third party, this must be done with the explicit agreement of Kahramaa and the rate for resale shall be agreed with Kahramaa prior to any commitment being made.

The lagoons shall be left empty for use at TOC.

#### **1.1.35 Electric Site Vehicles**

The Contractor shall supply electrically powered site vehicles for the use of Kahramaa staff for site operations and maintenance and for transporting visitors within the completed site. The vehicles shall include both passenger vehicles and maintenance vehicles designed to carry small tools and equipment.

The vehicles required are:-

- Three passenger vehicles each with six seat capacity (including the driver).
- Two maintenance vehicles each with four seat capacity and a stake-side cargo bed at the rear.

Charging points will be provided at the parking area inside the main PRPS site gate and at the maintenance workshop. Each charging point shall include provision to charge two vehicles simultaneously.

#### **1.1.36 Instrumentation**

On-line water quality monitoring shall be provided at the inlet and outlet of the PRPS site. These instruments will ensure that the Kahramaa water quality standards are maintained throughout the Mega Reservoirs system.

The following water quality parameters are required to be monitored at the Main Inlets and Main Outlets of the PRPS.:

- Turbidity;
- pH;
- ORP;
- Conductivity;
- Chlorine;
- Chlorine Dioxide;
- Temperature.

In addition to the water quality monitoring instruments listed above, the following parameters shall be measured for operation and control purposes, for more details refer to P&IDs and ICA Specifications:

- Inlet Distribution Chamber Levels;
- Reservoir Levels;
- Reservoir Inlet Flows;
- Lagoon Levels;



- Chlorine Levels and Chlorine Dioxide Levels at Inlet and Outlet of each Reservoir Cell;
- Suction Pressures and Discharge Pressures for all pumps;
- Main Inlet and Main Outlet Flows
- Recirculation Pumps Discharge Flows;
- Tanker Filling Point Flows;
- Surge Vessels Levels, Pressures and Temperatures;
- Chlorine Gas Leak;
- Chlorine Gas Cylinder Weights;
- Potable Water, Irrigation Water and Fire Water Tank Levels;
- Main Pumps Bearing Temperature and Vibration Monitoring.

#### **1.1.37 SCADA System**

The contractor shall supply and install a plant wide Supervisory, Control Automation and Data Acquisition (SCADA) solution for the PRPS site. The plant wide SCADA system for this PRPS site shall be integrated into an overall SCADA system for the Mega Reservoir project under a separate contract.

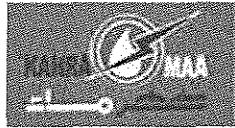
The Contractor shall treat this part of the works as a Procurement, Installation and Construct assignment and shall adhere to the following:

- I. Include all the necessary provisions to complete the functional SCADA Control System incorporating the latest technologies and software versions available at the time of installation.
- II. In collaboration with one of the proposed sub-contractors or any other internationally recognized and credible sub-contractor in this field, develop a complete system and submit for Kahramaa approval.
- III. This specification shall be read in conjunction with the latest edition of QCS, all the relevant project drawings and the project particular specifications. In case of contradiction or discrepancy between QCS and the project specifications, the Contractor shall incorporate whichever is more stringent. Where a question remains on which requirement is the more stringent, Contractor shall submit the issue to Kahramaa representative in writing. The decision of Kahramaa representative shall be considered to be final.

This section describes the requirements and selection for provisioning an IP based SMART SCADA. It covers the Automation in terms of Hardware, Automation Architecture, Networking Architecture and Software and Application Architecture. This section does not cover systems Programming, Control Strategy and Instrumentation Specifications. These items are included in the MEICA specifications.

The specification is to be read in conjunction with the standards and specification for Instrumentation, Control and Automation. The control system is to meet the objectives of Kahramaa for lowering carbon emissions and reducing energy, which is to be achieved by optimizing individual systems efficiencies and link them together to share data across a single networking platform.

The proposal calls for the integration of the systems commonly found in Kahramaa medium to large pumping stations. The systems associated with the pumping stations shall be visualized at Operations and Management level as part of the unified SCADA HMI environment.



The integration will comprise:

- I. Building Automation Systems
- II. Electrical Energy Management Systems , Low Voltage and High Voltage Power
- III. CCTV and Physical Security Intruder Systems
- IV. Fire Alarms and Detection Systems
- V. Process Plant and associated equipment i.e. pumps, chlorination plant, scrubbers, air blowers etc.
- VI. VOIP

#### Fibre Optical Network

The Contractor shall install four fibre optical networks all of which converge on a dual pair of aggregation switches as depicted on the drawings.

The fibre optical networks will cover the following areas:

- I. Ring 1 Main Pump House
- II. Ring 2 South of the Main Pump House
- III. Ring 3 North of the Main Pump House (Reservoirs Area)
- IV. Ring 4 West of the Main Pump House (Surge Vessels, Chlorination Bldg, etc.)

These rings are linked together to form a closed ring topology. Local PLC controllers and field devices of MEPF systems with Ethernet ports are connected directly into one of these segments to communicate to the station SCADA/HMI. Further details of this deployment are given in the particular sections of the specification.

Each LAN networks within the sites referred to as PlantWide is wired in a single redundant ring using Multi mode Fiber 50µm innercore, 125µm Outside diameter 850nm Multimode Fiber 1000Base SX protocol in accordance with the OM3 specification, which has an operating distance of 1kM. Typically the LAN networks do not exceed 850m between hops. The switching platform is Real Time Industrial Ethernet switches meaning that they are aware of real time protocols and will always forward these frames over and above any other frames, using a ring redundancy protocol which ensures restoration of the ring break in 50ms. The Industrial Ethernet switch is a converged network which supports Process Data, CCTV , Physical Security and Process CCTV. In addition it also supports connectivity of MEP Systems and Voice over IP services. The separation of the different traffic types is achieved by using VLANs and Quality of Service.

The rings are converged onto a pair of distribution switches which are then firewalled to the Operations and Management stations. In general all field instruments outside the main pump hall are connected to Kiosks which have racks, UPS, Industrial Ethernet Switches and cooling. The field instruments are connected to PLCs and where required distributed I/Os. These devices are then connected to the Industrial Ethernet switches.

The laying of the fibre optical cabling will be in accordance with QCS.

#### Systems Automation

The Contractor shall provide a Plant wide SCADA and automation system which covers all Process Engineering and MEPF Engineering systems comprising the following:

- I. Process
- II. Energy control, metering and monitoring
- III. Mechanical Systems: HVAC, Cooling Plant



- IV. Power Systems: Standby Generation, UPS , Transformers etc
- V. Physical Security : CCTV and Door Access Controls
- VI. Fire Alarms, Alarm integration
- VII. VOIP

The Contractor shall ensure that above systems are integrated on a single networking platform in order to provide an holistic approach to process visualization and sharing of data to support each system. For example the CCTV cameras will be linked to condition monitoring of large motion devices i.e. pumps and where an alarm is raised by the condition monitoring systems it shall cause the camera to PTZ to the source of the alarm. Similarly critical failure or overheating of a power source shall call up CCTV as well as raise an alarm in the Process Visualization control room either in the Process SCADA HMI or a separate MEP SCADA HMI as depicted on the drawings.

#### Process Visualization

The Contractor shall provide a control for visualization, monitoring and control of all the systems on site as depicted on the drawings. The control room shall comprise a number of workstations acting as either Runtime or Engineering clients. These workstations will be made up of the following:

- I. 2 x 19 inch dual screen Process Visualization SCADA HMI Runtime Clients with 2 55inch large monitors
- II. 2 x 19 inch dual screen Process Engineering Configuration Clients
- III. 2 x 19 inch dual screen Physical Security Clients (CCTV and DAC) with 2 x 55 inch large Monitors
- IV. 2 x 19 inch dual screen Network Security Clients with 1 x 55inch large Monitor
- V. 2 x 19inch dual MEP and Energy runtime clients with 1 x 55 inch large monitor

#### Client Workstations HMI for up to 10k External Tags

The Contractor shall include for a SCADA HMI that supports a total of up to 10K Power Tags for signalling and acknowledging events, running on the latest Windows Platform. The tags will be spread over a number of systems as describe above. In addition the SCADA HMI will support zooming, DE cluttering, panning in process graphics with multi-monitor operations (at least 4 monitors), prevention of unauthorized operations by user administration, operation and observation of several servers. Further details of the SCADA HMI functionality is given in the specification.

#### Local HMI Multi-Panel for Machines and Plants

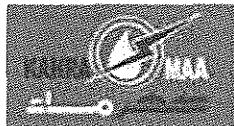
The Contractor shall include for a Local HMI Panel to be located in the process area for operating and monitoring of large plants and machines. The locations and requirements for Local HMIs are depicted on the drawings.

These local panels will support the use as thin client for terminal services, remote maintenance and services via the Internet / Intranet, OPC interfacing to different manufacturers

#### Control Protocols

The Contractor shall ensure that all systems in fractures and components follow open standards and use standardized components. Furthermore, standardized equipment shall be selected for electrical, measuring and control technology.

The following is proposed for the project.



- a. Instrumentation with measuring devices of a manufacturer for defined measurement tasks with fieldbus connection
- b. PROFIBUS DP/PA connection as fieldbus Instrumentation standard
- c. HART connection as fieldbus Instrumentation standard
- d. The control network standard shall be PROFINET I/O or CIP OVER ETHERNET (EthernetIP)
- e. Industrial ETHERNET for connecting the automation level to the process data servers
- f. Automation technology, using hardware that is as uniform as possible and function blocks that can be consistently reused for similar drives and transducers
- g. Uniform network structure for the process connection via the various communication channels, no proprietary protocols
- h. Uniform system structure and hardware for the Control Centre in all areas; use of a minimum number of consistently reused faceplates for the same aggregates and operator control functions
- i. Uniform and integrated operator control and acknowledgement concept
- j. Uniform documentation system (this applies to the plant identification and the type of documentation programs used)
- k. Selection of uniform components

#### **1.1.38 Telecoms**

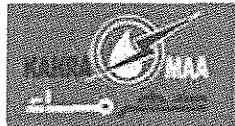
The following describes the LAN/WAN equipment (both active and passive), FO cables, CCTV, Access Control, Intrusion Detection System, Telephones, interconnection to other PRPS-2 systems (mainly SCADA) and interconnection to the Mega Reservoirs WAN network.

There will be a site wide dual optical network which connects all the sites together in a ring. The ring will be redundant both in the East and West Direction.

The site wide network is required to support real time communications between master PLCs at each reservoir site. In addition to this application the network is also required to support CCTV, VOIP and MEP SCADA services to the MWCC.

The requirement for the Optical network is the provisioning of a 80 channel 50Hz spacing C-Band Dense Wavelength Division Multiplexing (DWDM) Optical Transport Network (OTN) operating at discrete wavelengths in the C-band centred around 193.1 THz frequency as per ITU-T Rec.G.694.1 grid, at 50Hz channel spacing. The DWDM system shall support transmission comprising of 10Gb/s and 10GE per channel in the C-band based on ROADM technology. The 10GE and 10Gbps shall be supported simultaneously on the same system with no changes to the common equipment at the optical layer. Each site shall have a 10Gbps Channel port in the East and West Direction. The cabling will be single mode fiber in accordance with G.652.A 0.25dB/km , 1550nm standards.

Above the optical level will be an MPLS layer which is required to extend the Local VLANs across the core and MPLS VPNs to establish connectivity between sites. In general this is required for sharing signals between sites in a scalable fashion. The Client interface for each site will be the Firewalls. For HMI Messaging all traffic and entering the sites over the Site Wide network will be required to pass through the outside interface of the firewalls into the DMZ . The DMZ will be where all data from the control network is made available to the outside optical network via OPC servers. There will be no requirement for the outside environment to go directly into the control network for data gathering. This



communication will be done via DMZ OPC server to Control Network OPC server. The control network OPC server will be responsible for gathering reading and data acquisition from the Master PLCs at each site, which reside on the control network. .

Where there is a requirement for cyclic messaging between Master PLCs this will be by VPLS run over MPLS. The VPLS tunnels will be established on the inside interfaces of the MPLS PE devices. The firewalls will be configured to support transparent bridging of the Layer 2 Ethernet frames for Master PLC to Master PLC communications.

For engineering development from the external operations to the local control networks, this will be by configuration clients located in the DMZ which support Remote Desktop Protocol. These clients will communicate with the control network device through the firewalls.

Intrusion detection at each site will be carried out at two levels for external traffic entering the site this be at the Firewalls, for instruction detection from the either the DMZ or the Local SCADA Operations and Management level this will also at the Control network distribution switches. It is still expected that the total Cyclic time will be 150ms either from the Local SCADA or Remote SCADA control rooms

The Optical network is required to support Physical Security Alarms, Process CCTV and Surveillance CCTV. Typically each site has around 300 HD cameras, The site wide optical network is to be configured with a separate channel for this systems typically 10Gbps channel for each site. The quality of service will be configured on the north facing MPLS PE interface at each site and policed on the south facing interface into the core. The main site P routers again will be responsible for forwarding traffic to the main site MPLS PE routers which again will determine which traffic is sent first to the main site firewalls. It should be noted that the main site firewalls will support 10Gbps interfaces for each site.

It is proposed that each site will have VOIP services, the messaging protocol for the voice services will be SIP. The Call Manager for the VOIP services will be located at the main site. Each IP Phone will support the SIP client application, the phone will send their requests to the SIP server application which resides in the Local Site DMZ. The SIP Server Application will support LDAP, RADIUS, etc. The SIP server application will be responsible for forwarding the messages to the main site SIP server for communications outside of Kahramaa. Communications between site will by SIP proxy server. For more detailed explanation refer to the automation specification.

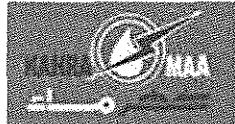
### **1.1.39 Site Works**

10.3km of 7.3m wide access road within and around the PRPS site including all turning areas, grading parking areas, road markings, kerbing and tie-in to external roads. External to the main site the Contractor shall construct approximately 5.4km of permanent access roads to include grading from both side of the lanes from the existing highway to the site entrance including access to the two TFS entrances, the Kahramaa sub-station site and the septic tank location.

4.8km of 5.6m high boundary wall. Wall to be constructed in reinforced concrete panels with concrete pillars. Face of wall to be finished with Kahramaa corporate logo feature.

Access and security gates built into boundary wall. Main access gate to be electrically operated slide opening and controlled from the main guard house. The access gate to the electricity sub-station shall be manually operated and lockable. Additionally electrically operated slide gates are to be provided at the entrance and exit to the TFS.

Footpaths for access to and around buildings, structures and plant as detailed on the Drawings. Footpaths to be a minimum 1.2m width or as shown on the drawings.



Footpaths and the areas between the reservoirs and the access roads will be constructed using interlocking block paving.

The scope shall include construction of all cable ducts and drawpits as detailed.

Hard and soft landscaping shall include:-

- Gravel, grass and concrete finishes to areas around buildings where defined on the Drawings.
- Planting including plants and trees to the landscaped area and around the site entrance and control room. The Contractor shall prepare a detailed landscaping plan for the approval of Kahramaa.
- Irrigation pipework and distribution system including valves and chambers, sprinklers, drip irrigation timers, hose points. The Contractor shall detail the irrigation distribution system based on the approved landscaping plan.

Reinforced concrete drainage channels shall be installed to take overflow from the inlet distribution chambers to the drainage lagoons. A separate channel shall also intercept any overland flow to the north of the main pumping station and discharge to the reservoir overflow channel.

An oil interceptor shall be installed to take drainage from transformers and from surface run-off.

## 1.2 Time for Completion

All the works shall be executed and completed and handed over to Kahramaa within thirty six (36) months from the Effective Date of Contract.

### 1.2.1 Milestone 1 – Bypass Pipeline

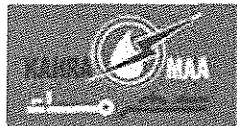
Within twelve (12) months of the Effective Date of Contract the Contractor shall complete the bypass pipeline between the incoming Corridor Main and the Transmission delivery Main SS1A and SS1B as shown on the drawing MQ174-R1-DH-CI-3055 including installation of valves and construction of valve chamber to allow water to be passed into service. To achieve this Milestone the completed work shall include final testing, disinfecting, flushing and final commissioning. The bypass valves arrangement is shown on drawing number series MQ174-R1-DH-CI-6500. A Certificate of Operation will be issued in respect of the Works included under this Milestone 1.

Should the Contractor not be able to achieve this for reasons out of his control such as the connecting pipelines being incomplete, the contractor shall be issued with a Certificate of Readiness.

If the Contractor fails to meet the requirement of this Milestone 1 then the Contractor will be liable to pay Liquidated Damages to Kahramaa at the rates stated in the Notes on Pricing in Appendix B.

### 1.2.2 Milestone 2 – Reservoir 1

Within Twenty One (21) months of the Effective Date of Contract the Contractor shall complete the construction of reservoir number 1 (refer to drawing no. MQ174-R1-DH-CI-6000) ready for hydrostatic testing. To achieve this Milestone 2 the completed work shall include all concrete work, internal finishes, pipework installation such that the reservoir is ready to receive water for testing. The completed work shall also include installation and initial testing of the section of Corridor Main from the site boundary to the Inlet Distribution Area so that water can be received from the Corridor Main contract.



If the Contractor fails to meet the requirement of this Milestone 2 then the Contractor will be liable to pay Liquidated Damages to Kahramaa at the rates stated in the Notes on Pricing in Appendix B.

#### **1.2.3 Milestone 3 – Pumping Station Completion**

Within thirty five (35) months of the Effective Date of Contract the Contractor shall complete the installation, testing and commissioning of the pumps in the Main Pumping Station excluding the 30 days Reliability and Performance tests. To achieve this Milestone 3 the electrical mechanical installation shall be complete in all aspects and the controls fully functional for automatic operation. A Certificate of Operation will be issued in respect of the Works included under this Milestone 3.

If the Contractor fails to meet the requirement of this Milestone 3 then the Contractor will be liable to pay Liquidated Damages to Kahramaa at the rates stated in the Notes on Pricing in Appendix B.

#### **1.2.4 Milestone 4 – Reservoir Completion**

Within thirty five (35) months of the Effective Date of Contract the Contractor shall complete the construction, testing and commissioning of all reservoirs. To achieve this Milestone 4 the reservoirs and connecting pipelines shall be complete in all aspects including testing and completion of all connecting pipework. A Certificate of Operation will be issued in respect of the Works included under this Milestone 4.

If the Contractor fails to meet the requirement of this Milestone 4 then the Contractor will be liable to pay Liquidated Damages to Kahramaa at the rates stated in the Notes on Pricing in Appendix B.

#### **1.2.5 Liquidated Damages**

If the Contractor fails to achieve completion by the completion date specified, the Contractor will be liable to pay Liquidated Damages to Kahramaa at the rate stated in the Notes on Pricing in Appendix B.

#### **1.2.6 Sequence of Certificates**

Certificates as referred within the General Conditions of Contract Article 1, shall be implemented as the clarifications given below. The Contractor should note that this only refers to some of the Certificates required under the contract, and is given to provide clarity. This is not a comprehensive list of the Certificates to be implemented. For the full list, the Contractor shall refer to the General Conditions of Contract and shall apply them as listed therein



Certificates and Major Contractual Dates	Clarification
Effective Date of Contract (EDC)	Not later than 14 days from Contractor's formal confirmation of Kahramaa's Final Letter of Award.
Erection Completion Certificate (ECC)	All initial tests (Tests after Installation) completed.
Notification of Safety Precautions (NOSP)	After ECC or after all major defect has been remedied and prior to connecting the Works to network.
Certificate of Operation (CO)	After connecting the Works to network and completing final testing, disinfecting and flushing.
Commissioning Date	Date of issuing the Certificate of Operation (CO) for the Works.
Taking Over Certificate (TOC)	Actual Completion Date (after satisfactory completion of 30 days Reliability and Performance test).
Final Completion Certificate (FCC)	After Warranty.

### **1.3       Warranty Period**

All Works shall be under the Contractor's Warranty for two (2) calendar years from the date of the Taking Over Certificate in accordance with articles 9.51 to 9.58 of the General Conditions of Contract.

### **1.4       Material Delivery**

Material procurement, approval and delivery procedures shall comply with Article 6 and Appendix I of the General Conditions of Contract. The Contractor shall obtain Kahramaa approvals, as required by Article 1.2.

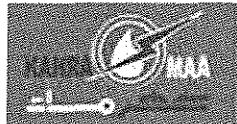
The Contractor shall ensure that orders for Major Equipment shall be finalized within 1 year to suit scheduled dates to be agreed with Kahramaa at commencement.

The Contractor shall submit with his tender names of proposed suppliers for selected materials. Kahramaa reserves the right to reject any of these suppliers at their discretion and without explanation. The presence of a supplier on Kahramaa's approved vendor list does not in any way guarantee acceptance for this specific project however vendors proposed should be taken from this vendor list.

### **1.5       Inspection and Witness Testing**

Kahramaa shall be entitled to attend the premises of any of the Contractors suppliers to witness tests for materials, equipment and plant to be incorporated in the works. The procedures for notice of tests shall be in accordance with the General Conditions of Contract.

The Contractor shall be responsible for providing third party inspectors to witness inspections and testing as required by the Specifications and relevant approved international standards, packaging and shipping of plant and equipment.



No plant or equipment shall be delivered to site unless the Engineer has accepted the test certification and given written approval. This requirement applies regardless of whether the tests have been witnessed.

The Contractor shall arrange for Factory Acceptance Tests (FATs) for all major plant and equipment at the place of manufacture. The Contractor shall include in his rates for items of plant or equipment that require FATs the costs of attendance by a total of two representatives of Kahramaa and/or the Engineer. The Contractor shall pay the costs and incidental costs associated with the FATs. In the event that the FAT is unacceptable as a result of a significant fault, Kahramaa reserves the right to order the tests to be repeated and the Contractor shall bear the costs of carrying out and attendance at the repeated FATs.

The Contractor shall give a minimum of four (4) weeks' notice of the proposed date of carrying out a FAT.

### **1.6 Published Specifications, Regulations, Notices and Circulars**

The Works shall be executed in accordance with the latest edition of the following specifications, regulations, notices, and circulars:

1. The General Specification of Main Laying Materials for Waterworks published by Qatar General Electricity & Water Corporation (Kahramaa), Version 2005.
2. Kahramaa General Specification for Main laying Contracts latest Version.
3. The Qatar Construction Specifications, 4th Edition, 2010, published by the Qatar General Organisation for Standards and Methodology.
4. The Code of Practice and Specification for Road Openings in the Highway.
5. The Survey Manual.
6. The Qatar Traffic Manual.
7. The Qatar Work Zone Traffic Management Guide, published by ASHGHAL (Public Works Authority)
8. QTel, Electrical Cables relative regulations and standard.
9. Qatar Highway Design Manual (QHDM)
10. Construction Specifications Institute (CSI) Masterspec (<http://www.csinet.org/>)
11. Any current and relevant regulation, notice or circular issued by the Ministry of Municipal affairs & Urban planning (including the previous Ministry of Public Works and the previous Ministry of Industry and Public Works), the previous Ministry of Electricity and Water, or the appropriate local Municipality prior to the date of the letter of invitation to Tender.

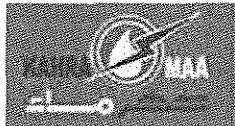
### **1.7 Copies of Specifications**

The Contractor shall be deemed to have his own copy of the specifications, regulations, notices, and circulars listed above.

### **1.8 Investigations at the Site**

Factual geotechnical investigation reports are included in the Contract for the Contractor's guidance without warranty, the Contractor shall interpret the data contained therein and satisfy itself with the ground conditions across the Site.

The Contractor shall undertake any additional investigations and as the Contractor may determine to be necessary including satisfying itself of the location of utilities and obstructions, nature of the ground and suitability of the material for filling and backfilling.



The costs of all investigations and surveys shall be deemed to be included in the Contract Price.

### **1.9 Datum Levels**

The Contractor shall establish a series of benchmarks across the Site as approved by the Kahramaa, and shall be entirely responsible for all levels and settings used by him in the Works.

The Contractor shall leave in place a number of levelled and coordinated benchmarks on completion as agreed by Kahramaa.

### **1.10 Climatic Conditions on Site**

The conditions under which the plant, equipment and labour is required to operate during construction is considered to be tropical climatic conditions, with excessive heat, dust and humidity at times.

The Contractor shall take account of the climatic conditions at the Site for the construction of the works.

- a. The Site conditions shall be assumed to be as follow for tendering purpose:

Maximum ambient temperature	50°C
Minimum ambient temperature	5°C
Design ambient temperature	50°C
Maximum metal temperature under the sun	85°C
Maximum ambient Humidity	100%
Minimum ambient humidity	20%
Design ambient humidity	100%
Design wind velocity	150 km/hr
Yearly rainfall	80-150 mm

- b. The temperature is relatively mild from October to May and hot from June to September.
- c. The relative ambient humidity is generally low from October to May and generally high from June to September.
- d. Under certain climatic conditions, considerable condensation may take place.
- e. A considerable amount of salt is contained in the atmosphere which, together with the relative high ambient humidity, can produce severe corrosion problems.
- f. Distribution and occurrence of rainfall events are very erratic. Rainfall events are generally of a high intensity with a short duration and usually occur between December and March.
- g. The prevailing wind directions are from the north and west.

### **1.11 Site for Additional Accommodation**

In the event of the Contractor making use of a site for accommodation acquired by him or any tip for the disposal of surplus materials, he shall obtain the written consent of the owner and occupier or authority having charge of the land in which such accommodation or tip is situated and shall make a record agreed by the owner, occupier or authority as aforesaid of the condition of that land before entering thereon.



The Contractor shall permit Kahramaa's Representative and the Engineer to use for the purpose of the Contract any such special or temporary wayleave or additional accommodation at no extra cost to Kahramaa.

In the event of the Contractor making use of any special or temporary wayleave or additional accommodation made available to him by Kahramaa for the purpose of the Contract, the land in which such wayleave or accommodation is situated shall be deemed to be part of the Site.

#### **1.12 Access to Site**

The Contractor shall be responsible for providing and maintaining its access to the Site. The Contractor shall be responsible for coordinating with all land owners/occupiers and governmental departments as necessary for approval of access roads.

The Contractor's access road shall also be utilized by staff of Kahramaa and the Engineer. The Contractor shall maintain the access road and for their safe and easy passage until they are no longer required for the purpose of the Contract.

Access roads constructed shall have a minimum carriageway width of 8.0m and shall include cross drainage structures to the approval of Kahramaa as necessary. Unless otherwise instructed by Kahramaa they shall be graded and refurbished to the satisfaction of Kahramaa on completion. Where access roads are instructed to be removed the site shall be reinstated to at least the condition pertaining at the commencement of the works.

The Contractor shall make a record to be agreed by Kahramaa of the Conditions of the surfaces of any private lands or of any public cultivated or maintained lands over which access to the Site lies before any work is commenced to make them suitable for access and it shall keep such surfaces in a reasonable state of cleanliness and repair during the execution of the Works. On the termination of the Contractor's use of such access, unless otherwise instructed by Kahramaa, the Contractor shall restore the surfaces to a condition to the satisfaction of the Engineer and at least equal to that pertaining before his first entry on them. The Contractor shall negotiate such access to the Site over private land as is required when no alternative access exists.

The Contractor shall not enter any private lands without the prior permission of Kahramaa, and without first having obtained the consent of the owner of such lands.

#### **1.13 Site Boundaries and Clearance of Site**

The Site boundary is defined on the Drawings. The Site will have been cleared by others prior to the Contractor gaining access.

The Contractor shall maintain the Site in a neat, tidy, and healthy condition.

#### **1.14 Existing Properties, Facilities and Utilities**

The Contractor shall locate and notify to Kahramaa any existing properties, facilities, underground or overhead utilities or any other obstructions that shall be encountered during the execution of the Works. In undertaking this task, the Contractor shall co-ordinate with utility owners and concerned government departments. In the presence of Kahramaa the Contractor shall co-ordinate with utility owners and concerned government departments. In the presence of Kahramaa the Contractor shall make records of the position and extent of such properties, facilities, underground or overhead utilities or any other obstructions.

The Contractor shall protect, uphold, support, temporarily divert and maintain all existing properties, facilities, underground or overhead utilities or any other obstructions. The Contractor shall make good any damage due to any cause within his control at his own expense or pay any costs and charges in connection therewith.



### **1.15 Use of Public Highways**

The Contractor shall ensure that roads and thoroughfares used by him for the transportation of Constructional Plant, labour and materials are not dirtied as a result of such transport, and in the event of them becoming thus dirtied in the opinion of Kahramaa, the Contractor shall take all necessary steps to clean them, at no extra cost to Kahramaa.

### **1.16 Permits**

The Contractor shall be responsible for locating any services.

The Contractor shall be fully responsible for obtaining all necessary excavation permits and permissions, except those normally obtained by the Kahramaa, prior to commencement of the Works.

These shall include but not limited:

- a. General excavation permits;
- b. Specific excavation permits relating to road crossings, etc.
- c. Provision of all necessary bonds required by the permits;
- d. Permission in respect of erection of site offices, labour camps, stores, etc.;
- e. Permission for shut down of water pipelines from Kahramaa;
- f. Permissions associated with working in proximity to electric and communication cables, gas lines, Ooredoo cables, etc.
- g. Hot work, crane lifting/ critical lifting operation permits;
- h. Permits associated with drill and blast operations.

### **1.17 Environmental Requirements, Archaeological Remains and Historical Sites**

The Contractor shall prepare a construction environmental management plan (CEMP) and obtain any necessary approvals from Kahramaa and the Ministry of Environment. The Works shall be executed in accordance with the approved plan.

The Contractor shall take all necessary precautions not to disturb archaeological remains and historical sites in the vicinity of the Works including those shown on the Drawings.

During construction of the Works the Contractor will check for the discovery of any artefacts such as pottery, bones, beads, and coins. Should any such artefacts be found the Contractor shall inform Kahramaa and the Department of Archaeology and Antiquities of the Ministry of National Heritage and Culture.

### **1.18 Execution Program of Works**

The Contractor shall submit detailed and annotated bar charts and critical path method (C.P.M) by Primavera Program showing a proposed program of design (if any), delivery, construction, installation, commissioning and completion of the Contract.

The Program to be submitted by the Contractor shall include the planned monthly rates and location of progress between the program date for commencement and completion for each major item of work for various stages of construction, including dates by which major items and related drawings if any requiring approval will be submitted. A period not exceeding three weeks shall be allowed from date of receipt of these documents by Kahramaa to enable his approval to be given, subject to the accuracy of the submittal. The program shall be updated throughout the project to ensure that all work items are completed by the Completion Date of the project.



### **1.19 Standard Specifications**

Plant, materials, and workmanship shall comply with the requirements of Qatar Construction Specifications, Kahramaa specifications and British Standards (BS) and Codes of Practice (BSCP) current at a time three months prior to the time of Tender. Kahramaa can accept equivalent International Standards subject to their requirements being no less stringent.

Electrical installations shall comply with the current Kahramaa Standard.

The Contractor shall obtain and keep on site at least one copy of each BS and BSCP and other approved National or International Standard which is referred to in the Specification and of each such other Standard which applies to materials which are being supplied to, or workmanship which is being executed on the works. Copies of these Standards shall at all times be available for inspection and use by Kahramaa but shall remain the property of the Contractor.

All materials and workmanship not covered by a BS or BSCP or equivalent international standard shall be of such kind as is used in first class work and suitable for the climate in the area where the works are to be constructed all shall be subject to Kahramaa approval.

### **1.20 Materials and Suppliers of Materials**

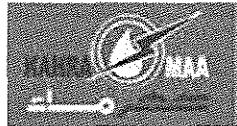
Before ordering or obtaining materials of any description intended for the permanent works, the Contractor shall submit for the approval of Kahramaa the names of the makers or suppliers proposed, together with country of origin, a specification of the materials and details of their place of manufacture. The Contractor will be required to supply to Kahramaa for his retention, a copy of each order placed and a copy, excluding financial details, of each Letter of Credit placed with suppliers.

The Contractor shall provide samples and third party test certificates of the materials at the request of Kahramaa.

For the following materials, the Tenderers are required to submit details of their proposed suppliers during tendering stage. Suppliers shall be selected from the vendor list included in Appendix I. The suppliers proposed will be subject to Kahramaa material department approval:

- Pumps
- Motors
- Ductile iron pipework and fittings
- Carbon steel pipework and fittings
- Valves
- Flexible couplings and flange adaptors
- Low voltage and medium voltage switchgear
- MCCs
- VSDs
- Transformers
- Generators and fuel system
- Chlorination equipment.
- Control system equipment

Ductile iron and carbon steel pipes and fittings shall be manufactured in Western Europe, North America or Japan, unless otherwise specifically approved by Kahramaa. All other MEICA equipment and its component parts, for items referenced in Bills No. 1 to 4 - Supply of Main Pumps, Motors and Spares; and Bill No. 5 - Supply of Major M&E Equipment, shall be manufactured in Western Europe, North America or Japan, unless otherwise specifically



approved by Kahramaa. Certificates of origin shall be provided for all MEICA and pipework items.

All materials, which are to come in contact with potable water, shall be approved for such use by the World Health Organization (WHO), European Guidelines (EU) and The General Specification of Main Laying Materials for Waterworks published by Kahramaa. At Kahramaa's discretion, materials, which have been approved by similar National or International bodies, may be allowed. Kahramaa's decision in such matters is final and the Contractor shall have no right of appeal.

### **1.21 Natural Materials**

In the event that not all materials can be acquired from the Site, the Contractor shall make all arrangements for locating, selecting, and processing natural materials in accordance with the specification and shall submit to the Engineer for approval full information regarding the proposed location well in advance of commencement of working of the material. Approval of a source does not imply that all material in that source is approved. The Contractor's attention is drawn to the fact that royalties will be payable on materials from borrow areas and quarries and that it is his sole responsibility for the payment of such royalties. There shall be no unregulated quarrying and aggregates shall only be obtained from licensed suppliers or if project specific sites are proposed the Contractor will be responsible for obtaining the necessary Environmental Permit.

### **1.22 Works to be Kept Clear of Water**

In addition to that mentioned in the Specification, the Contractor shall keep the works well drained until Kahramaa certifies that the whole of the Works is substantially complete and shall ensure that so far as is practicable all work is carried out in the dry. Excavated areas shall be kept well drained and free from standing water.

The Contractor shall obtain land, construct, operate, and maintain all temporary dams, watercourses and other works of all kinds, including pumping, that may be necessary to exclude water from the Works until construction is complete. Temporary drainage works and plant shall not be removed without the approval of Kahramaa.

### **1.23 Discharge of Water into Existing Streams**

The Contractor shall make provision for the discharge or disposal from the Works of all water and waste products however arising and the methods of disposal shall meet any requirements of the Ministry of Environment and shall be to the satisfaction of Kahramaa. The requirements of this clause shall not limit any of the Contractor's obligations or liabilities and shall be at his cost.

### **1.24 Water Supply**

The Contractor shall provide and maintain at his cost suitable supplies of water for drinking, washing, sanitation and general cleaning in addition to any required for the construction, testing and maintenance of the Works.

All water for drinking shall be clean according to standards.

The Contractor shall supply all temporary plumbing pipework and storage tanks that may be required.

The Contractor shall pay all fees for connection and disconnection for the Site supply and all charges for water consumed.

In case of failure of the available water supply, the Contractor is obliged to provide at his own expense all necessary water requirements to the Site to continue all the works in the project and he may use water tankers for transportation to fulfil this object.



### **1.25 Electricity Supply**

The Contractor shall install, operate, maintain and subsequently remove sufficient temporary supplies of electricity for the temperature control, lighting and ventilation of all offices, stores, laboratories and other temporary buildings used by the Contractor and by Kahramaa, in addition to any supplies he may require in connection with the construction and maintenance of the Works.

The Contractor shall pay all fees for connection, disconnection, and reinstatement as original and all charges for electricity consumed for construction and commissioning.

### **1.26 General Hygiene and Medical Examination of Contractor's Employees and Labour**

Before commencing work on the Site, the Contractor shall ensure that all his employees are instructed in the necessity for the prevention of pollution and they should have a health certificate from the concerned authorities. The Contractor shall immediately dismiss and remove from the Site any employee, who has been polluting or fouling the Sites and shall take appropriate remedial measures to prevent a repetition of the occurrence and to disinfect the areas concerned, all to the satisfaction of Kahramaa.

The Contractor shall not employ upon the Site, or on periodic visits thereto, a person who is known to have any disease or who is suffering from an illness or who are otherwise unsuited on medical grounds to be employed in or around water supply installations.

### **1.27 Sanitation and First Aid Facilities for Contractor's Staff**

The Contractor shall provide on Site, to the satisfaction of Kahramaa, an adequate supply of safe drinking and other water and suitable approved sanitary facilities for the use of the Contractor's staff and workpeople.

The Contractor shall also ensure that sanitary facilities provided for the use of his employees are kept disinfected and clean at all times during the progress of the Works and cleared away on completion of the Contract, including making good the ground thereafter. The location of the facilities must be approved prior to erection.

As well as any facilities provided in a fixed location for the duration of the Contract the Contractor shall provide mobile temporary facilities adjacent to the on-going work. These mobile facilities shall be within 5 minutes travelling time of the location of the work front (excavation, pipelaying, backfilling etc.).

The Contractor shall provide complete first-aid facilities for his staff until the issue of the certificate of completion. The first aid facilities shall be accommodated in a clean and tidy office, held in a dustproof cupboard stocked to the satisfaction of Kahramaa and regularly replenished. They shall include an adequate supply of sterile bandages, disinfectants, spray disinfectants, plasters, scissors, etc.

The toilets and first aid facilities shall be fully available within one week of commencement of work on Site. Additional first aid facilities shall also be available at the on-going work front.

The Contractor's disposal methods and areas or tip shall be approved by Kahramaa. No wastes or sewage shall be disposed of or dumped within the Site.

Any water connections, pipe runs and drainage pipework provided by the Contractor shall be to the approval of Kahramaa.

### **1.28 Testing of Works**

All testing to be undertaken as part of the Works, such as quality control testing, soil compaction, concrete compression, bacteriological testing etc., shall be carried out by a third party laboratory approved by Kahramaa.



### **1.29 Contractor's Site Facilities**

The Contractor shall provide and maintain adequate air-conditioned offices and other temporary accommodation and facilities for the use of the Contractor's staff, in addition to a conference room for site meetings suitable for a minimum of 12 people with table and chairs.

The Contractor shall provide and maintain temporary facilities for the storage of materials, tools and tackle and equipment used by all persons employed on Site including Sub-Contractors. Those used for the storage of cement and other perishable materials and the like shall have raised floors.

The Contractor shall submit proposals for the accommodation of its facilities and support services for approval by Kahramaa and appropriate government bodies prior to establishing the Site. The Contractor shall be responsible for the removal of his site facilities, foundations etc. and for the general reinstatement of the area at the completion of the works.

### **1.30 Assistance for Kahramaa and Engineer's Staff**

The Contractor shall provide every assistance to Kahramaa and the Engineer's staff in carrying out their duties and shall provide a sufficient supply of pegs, poles, paint, lines, spirit levels and other materials, instruments, gauges and small tools for checking and setting out the Works. The Contractor shall also allow for the conveyance of Kahramaa staff within the Mega Reservoir project area for the purposes of the project.

The Contractor shall provide such waterproof clothing, safety helmets, rubber boots, torches and the like as may reasonably be required by them. These articles shall remain the property of the Contractor, and they shall be repaired or replaced by him to the extent necessitated by fair wear and tear.

### **1.31 Survey Instruments**

The Contractor shall provide all survey and measuring instruments of every kind necessary for his own use in the execution of the Works, and for Kahramaa and the Engineer as per QCS, Section 1 part 11 with the following amendment to 11.4.4:-

- 1) 2 No. digital cameras, rechargeable batteries with charger, 24mm wide angle lens with 20x optical zoom, HD video recording with microphone, 12MB built-in memory, 16GB SD memory cards

The Contractor shall also provide at the Site, and maintain for the sole use of Kahramaa and his staff, the instruments needed which shall revert to the Contractor not later than at the issue of the Final Completion Certificate.

Each item shall be approved by Kahramaa before being accepted and shall be new at the start of the Contract.

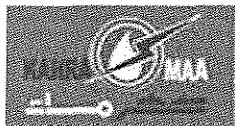
The Contractor shall be solely responsible for all such instruments and equipment and shall ensure that they are at all times in good repair and adjustment and shall make good any loss or damage howsoever caused.

### **1.32 Submittals**

All submittals shall be submitted to Kahramaa as a minimum of two copies and in digital form, or as otherwise mentioned, and the format of the submittal shall be approved / advised by Kahramaa.

### **1.33 Progress Reports**

The Contractor shall submit to Kahramaa during the first three days of each month, a progress report in such form that actual progress to the end of the preceding month may be



compared with the Contractor's Programme for the Site as detailed in Appendix (D). The Contractor shall also submit weekly and monthly HSE reports to Kahramaa (HSE Dept.).

From time to time Kahramaa will call meetings, at a location determined by Kahramaa, as deemed necessary for the purpose of controlling of the Contract. Responsible representative of the Contractor shall attend such meetings.

#### **1.34 Forms for Monthly Statements**

The Contractor shall provide standard forms for his monthly statements. Such forms shall be printed or duplicated to A4 size to the approval of the Engineer as soon as practicable after the order to commence the Works has been given and their layout shall be as agreed with the Engineer.

#### **1.35 Equipment and Labour Returns**

The Contractor shall furnish Kahramaa with the following:

- Detailed schedules having the form and sub-clauses approved by Kahramaa, stating the number of supervisors of the Works, the number and type of the several classes of labour employed by the Contractor and his Sub-Contractors from time to time as required by Kahramaa.
- Data in respect of Contractor's Equipment as may be required by Kahramaa.

#### **1.36 Quality of Materials, Workmanship and Tests**

All materials and workmanship shall be of the respective kinds described in the Contract and in accordance with Kahramaa's instructions and shall be subjected from time to time to such tests as Kahramaa may direct at the place of manufacture or fabrication, or on the Site or at all or any of such places.

The Contractor shall provide such assistance, instruments, machines, labour and materials as are normally required for examining, measuring and testing any work and shall supply samples of materials before incorporation in the Works for testing as may be selected and required by Kahramaa.

#### **1.37 Loading Tests for Executed Concrete Structures**

The Engineer may direct that a loading test be made or cutting cores from the structures or any part thereof if he deems such test to be necessary for one or more of the following reasons:

- Failure of 'Test cubes' to attain the specified minimum strength.
- Premature removal of shuttering.
- Overloading of structure during construction.
- Improper compaction or curing of concrete.
- Any other circumstances attributable to alleged negligence on the part of the Contractor, which, in the opinion of the Engineer may result in a structure being of less than expected strength

#### **1.38 Cost of Tests for Materials and Workmanship**

The cost of making any test shall be borne by the Contractor if such test is clearly intended or provided for in the Contract. In the cases only when Kahramaa asks for a test under load or of a test to ascertain whether the design of any finished or partially finished work is appropriate for the purposes which it was intended to fulfil, Kahramaa shall bear the cost of



such tests if they show the workmanship or materials to comply with the Contract or Kahramaa's instructions.

#### **1.39 Examination of Work Before Covering Up**

No work shall be covered up or put out of view without the approval of Kahramaa and the Contractor shall afford full opportunity for Kahramaa to examine the works and any such things before the Permanent Works are placed thereon. The Contractor shall give due notice to Kahramaa whenever such work is ready or about to be ready for examination and Kahramaa shall advise the Contractor of its requirement to attend for the purpose of examining such work.

#### **1.40 Uncovering and Making Openings**

The Contractor shall uncover any part or parts of the Works or make openings in or through the same, as Kahramaa may from time to time direct and shall reinstate and make good such part or parts to the satisfaction of Kahramaa. If any such part or parts have been covered up or put out of view after compliance and are found to be executed in accordance with the Contract, the expense of uncovering or making openings in or through or reinstating and making good the same, shall be borne by Kahramaa.

#### **1.41 Removal of Improper Work**

Kahramaa shall during the progress of the Works have power to order in writing from time to time:

- The removal from the Site, within such time or times as may be specified in the order, of any plant and materials which, in the opinion of Kahramaa are not in accordance with the Contract and subsequent substitution by proper and suitable plant and materials will be made by the Contractor.
- The removal and proper re-execution, notwithstanding any previous test or interim payment thereof, of any work or plant which in respect of materials or workmanship is not, in the opinion of Kahramaa, in accordance with the Contract.

#### **1.42 Photographs**

The Contractor shall supply colour photographs of such portions of the works, in progress or completed and indicating the work progress, all as may be directed by Kahramaa and specified herein. The digital images and prints shall not be retouched. The digital image of each photograph shall be the property of Kahramaa and shall be delivered to Kahramaa with the prints. No further copies of these photographs shall be supplied to any other person without the written permission of Kahramaa.

The photographs shall be in two categories:

- Progress photographs – 150 mm x 100 mm
- Record photographs – 250 mm x 200 mm

Prints shall be made on photographic paper suitable for producing high quality images. Both categories of photographs shall be properly referenced to the approval of Kahramaa, and on the back of each print shall be a record of the date of the photograph, the direction in which the camera was facing, and an identifying description of the subject, and the reference.

Photographs taken for record purposes as ordered by Kahramaa or as specified herein shall be supplied with two prints, having the reverse of one subscribed with the signatures of the Contractor and Kahramaa (or their authorized representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.



The Contractor shall supply the digital image and two prints of each progress photograph ordered by Kahramaa. The Contractor shall supply two additional prints of progress photographs selected by Kahramaa for incorporation in albums. The Contractor shall supply two sets of albums, which shall include mounted prints and print titles. The albums shall meet the requirements and approval of Kahramaa.

#### **1.43 Progress Meetings**

The Contractor shall attend regular progress meetings on Site, which will be convened by Kahramaa. Monthly meetings will also be held in Kahramaa's Office for which the Contractor shall submit Progress Reports (2 copies + digital form) containing detailed information of progress, resources and progress photographs, at least 72 hours prior to the monthly meetings.

#### **1.44 Contract Signboards**

The Contractor shall supply and erect and maintain Contract Signboards in locations to the approval of the concerned authorities. The design of the Contract Sign Board, in line with Kahramaa standard details, shall be submitted by the Contractor to Kahramaa for approval. The Contractor shall be responsible for the structural stability of the signboards but shall submit details of his proposals for support to Kahramaa for approval.

#### **1.45 Operating and Maintenance Manual**

The Contractor shall provide 4 sets suitably bound operating and maintenance (O&M) manuals for all Plant installed in the Works. The manual shall also be provided in electronic format, including AutoCAD, Word and Excel files as appropriate and pdf versions of all sections of the manual. The overall format and contents of the manual shall be to the approval of Kahramaa. The content shall be in the English language.

Operating instructions shall give a step by step procedure for any operation likely to be carried out during the life of the Works including, commissioning, testing, routine operation, maintenance, dismantling and repair. In particular the method, frequency and requirements relating to maintenance of all Plant shall be detailed in the manual.

Complete and approved O&M manuals shall be submitted prior to the issue of the Taking Over Certificate.

As soon as possible after delivery of an item of the plant to the site, and prior to commencement of commissioning, the Contractor shall submit to the Engineer for his approval, draft copies in duplicated of the Operating and Maintenance instruction, applicable to that item. The documents shall be reviewed by the Engineer and the Contractor shall incorporate all the required additions and alterations. After the Engineer has given written approval of the documents, the Contractor shall supply 4 copies of the final Operating and Maintenance Instructions

A separate section shall be allocated for each type of equipment, which shall contain all relevant information concerning construction and operation of that item.

The manuals shall include but not be limited to the following sections:

- An introduction to and general description of the Plant and its operation. The introduction shall be in both English and Arabic.
- Details of the mechanical and electrical equipment and how they are designed to operate.
- Instructions for routine operation, monitoring and control of processes.
- Details of chemicals used for treatment and limits of their normal dosing ranges.
- Details of safety considerations and safety procedures and equipment



- Instructions for routine maintenance with charts show the quantity and type of lubricant to be used together with the recommended frequency of application.
- Instruction for the stripping, inspection, re-assembly, testing and re-commissioning of the equipment.
- Instructions for the emergency shutdown and start-up procedures including emergency contacts and phone numbers.
- Where applicable, fault finding charts to assist in locating faults.
- Spare parts lists with names and addresses of suppliers and the procedures to be followed for the purchase of such parts.
- A complete list of the equipment supplied with details of manufacturers, model types and serial numbers.
- Copies of all test certificates, pump performance curves, etc...
- Application software listings.
- Maintenance schedules detailing recommended frequency of inspection, maintenance and overhaul.
- Commissioning data and tests.

Reference to Record Drawings shall be included in the instructions.

A collection of manufacturer's pamphlets, instruction sheets and such like will not be accepted in place of Operating or Maintenance instructions but may form part of them.

Information supplied by specialist manufacturers for particular plant items shall be reproduced in the same detail and shall be included in the appropriate section of the instructions.

The operations and maintenance manual shall include names, addresses, E-mail, contact person etc., for all manufacturers as well as those of their authorized representative in the State of Qatar.

#### **1.46 Drawings for the Project Components**

The Drawings for the project components shall include the following:

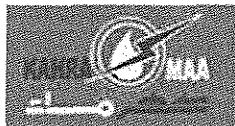
#### **1.47 Issued Drawings**

Drawings supplied to the Contractor as part of the Tender Documents (Appendix F) are for the purposes of tendering. Such drawing shall be deemed to have been issued for the guidance of Tenderers and shall be referred to for the interpretation of the Contract.

Construction issue drawings will be submitted to the Contractor for the purpose of preparation of shop drawings and for construction upon commencement of the Works. Kahramaa may issue additional or revised and amended Drawings during the execution of the Works. All superseded drawings shall be clearly marked "superseded"

#### **1.48 Drawings and Documents submitted by the Contractor**

Contractor shall prepare any detailing and shop drawings including bar bending schedules and associated documents necessary to complete the construction of facilities based upon the construction Drawings issued by Kahramaa. Shop drawings shall be submitted for Kahramaa review and approval in hard and soft copy. Following review the Contractor may be required to amend his drawings and documents to incorporate comments made by Kahramaa. Any alteration required by Kahramaa to be made to drawings and documents submitted by the Contractor for approval shall be made by the Contractor without extra



charge, provided that it does not involve a change in the specification. In the event that the drawings and documents submitted by the Contractor are not of adequate quality or scope then the Contractor may be instructed to employ a suitable consultant to provide acceptable submissions at his own cost.

#### **1.49 Approved Drawings**

A drawing, which has been approved by Kahramaa and has received his stamp of approval, will be termed an "Approved Drawing". A copy of each Approved Drawing will be retained by the Contractor.

Approved drawings may be required to be amended according to instruction given. In such case the Contractor shall submit new or amended drawings for approval and when approval has been given all copies of the superseded Approved drawing shall either be destroyed or clearly marked "Superseded".

#### **1.50 Record Documents**

##### **1.50.1 As-Built Drawings**

Prior to the issue of the Taking Over Certificate (TOC) the Contractor shall prepare GIS and as-built drawings in accordance with Kahramaa latest Standard and Specifications for Water GIS Data Specifications. Two copies on paper of the draft as built drawings shall be provided. Within 28 days of receiving Kahramaa's comments on those drafts the Contractor shall make the necessary amendments and corrections and submit two further copies for approval. Upon approval, the Contractor shall provide the following:

- i) Four bound sets (A1 size) of as-built drawings on paper.
- ii) Four bound sets (A3 size) of as-built drawings on paper.
- iii) Three sets of CDs (or similar approved format) containing the as-built drawings in AutoCAD 2012 format.

The drawings shall include but not limited to:

- General arrangement and structural drawings of the permanent works. All pipelines, structures and chambers shall be labelled as shown on the issued drawings or as agreed by Kahramaa.
- Details of all installed mechanical, electrical and instrumentation equipment.
- P&IDs and SLDs
- As built plan and profile drawings for each individual pipeline constructed under the Contract. Pipeline drawings shall be drawn to a horizontal scale of 1:1000, or as agreed by Kahramaa. They shall contain the full level of detail and also show details of the coordinated locations of all branches and changes in direction and level.
- Details of all fire and safety equipment and installation.
- Details of all building works including works covered or concealed by the final installation

##### **1.50.2 Record Sheets**

The Contractor shall complete the following Record Sheets:-

- Concreting Record Sheets
- Pipeline Record Sheets
- Factory and Site Acceptance Test Records
- Cable Test Records



- Structure Test Record Sheets
- Pipe Test Record Sheets
- Other records to demonstrate quality control as agreed with Kahramaa

Individual Record Sheets shall be prepared for each length of pipeline and each valve chamber. Record Sheets shall be prepared on an ongoing basis and shall be submitted to Kahramaa's representative for approval.

Submission of completed record sheets shall be a prerequisite for payment for the individual sections of the works in interim valuations.

#### **1.50.3 Protecting the Works from Inclement Weather and Damage**

The Contractor shall take reasonable measures to protect the installed works from being damaged. The Contractor shall carefully cover up and protect the works or any adjoining property exposed by the works from inclement weather or severe weather conditions.

The Contractor shall properly cure all cement-based construction in order to keep shrinkage cracks to a minimum and to ensure that the cement becomes fully set.

#### **1.50.4 Working in Urban Areas**

The Contractor shall ensure that roads and thoroughfares used by him for the transportation of construction plant, labour, materials and excavated materials are not dirtied because of his operations. If, in the opinion of Kahramaa, the Contractor's operations result in dirty conditions, the Contractor shall, upon notification by Kahramaa, take all necessary steps to clean roads and thoroughfares so dirtied, at no extra cost to Kahramaa.

#### **1.50.5 Access to Existing Buildings and Associated Areas**

Not used

### **1.51 Cleaning the Works on Completion**

The Contractor shall clear the Site and work area completely of all his temporary installations on completion of the works and shall grade the area he has occupied to remove all traces of his occupation and leave the Site as close to its original condition as possible.

#### **Control of Noise and Pollution**

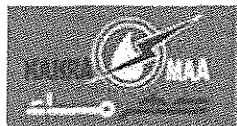
The Contractor shall take all necessary precautions to control the level of noise and pollution, including dust, caused by the progress of the works. Speed limits are to be imposed on all temporary access roads in order to minimize dust pollution.

### **1.52 Qatar Petroleum (QP) Pipelines (gas and others)**

The Contractor shall obtain approvals and excavation permits for all excavation within 25 m of any QP pipelines, and shall comply with all requirements of the permit. The Contractor shall confirm the physical location of the QP pipelines which shall be confirmed in consultation with QP.

At all QP pipelines crossings, or where QP pipelines are proposed, the water pipelines shall have a double wrapping of PVC tape with bitumen rubber adhesive or similar of total thickness 1000 microns giving a zero cathodic effect. Such additional wrapping shall extend a minimum of 3m either side of the QP pipeline.

The Contractor shall duly notify QP of all excavations carried out under the Contract in the vicinity of QP pipelines sufficiently beforehand so that a QP representative can be present for such excavations. Only hand excavation methods are to be adopted in the vicinity of QP pipelines as defined by QP.



### **1.53 Prevention of Impacts on Urban Amenity**

The works should be constructed to avoid, wherever practicable, the destruction of existing trees. Should any urban trees be destroyed by the works, the Contractor will be responsible for the provision of an equivalent replacement tree.

### **1.54 Not used**

### **1.55 Co-Ordination with Other Contractors**

Other contractors associated with the Mega Reservoirs Project will operate concurrently with this Contract with differing degrees of programme overlap. The other contracts will include:-

- Mega Reservoirs SCADA Integration Contract
- Pipelines for Mega Reservoirs Corridor Main 1 (Package A)
- Transmission Pipelines for Mega Reservoirs
- Sub-station construction contract

The Contractor shall liaise with and co-ordinate his activities with all other contractor(s) working at or adjacent to the Site. Kahramaa shall not be responsible for any payment or extension of time arising from or relating to more than one contractor working in close proximity to each other.

### **1.56 Site Safety Policy**

#### **1.57 General**

The Contractor shall submit an organization plan and arrangements for the implementation of a plan that specifies responsibilities and guidance relating to health, safety and environment for all staff, which he shall have approved before commencing any work on the site..

The Contractor must be committed to ensuring that the necessary resources are in place and are devoted to meeting their objectives. This includes the provision of information, training and instructions required as the needs arise. The performance and standards of health and safety in each activity will be monitored and reviewed on a continual basis.

The Contractor shall take every opportunity to liaise with the work force. Kahramaa expects every staff member to play their part and be committed to high standards of health and safety at work.

#### **1.57.1 Traffic Regulations**

The Contractor shall ascertain and comply with any regulations concerning authorities for traffic and parking in addition to the obligation imposed by the Conditions of Contract and by law.

#### **1.57.2 Traffic Control**

The Contractor shall provide and maintain all necessary diversions, diversion signs, barricades, fencing, lighting, flagmen or stop/go signs where the Works affect the safety of traffic on existing roads or temporary diversion roads.

The Contractor is required to safely maintain two way traffic wherever possible and to take account of this in his Traffic Management Proposals.

All Traffic Management proposals will be reviewed by Kahramaa and if acceptable submitted to the Traffic Police for approval.



The Contractor shall provide adequate hard standings, turning areas etc. to Kahramaa's satisfaction for the safe and efficient off-loading, stringing and handling of pipes and fittings and for storage and handling of imported fill materials.

The Contractor shall coordinate his access road construction with that of other contractors so as to provide a continuous access road along the full length of the pipeline as required by Kahramaa.

#### **1.57.3 Noise, Pollution and Nuisance**

The Contractor shall ascertain and comply with any regulations concerning noise, pollution and other nuisance in addition to the obligations imposed by the Conditions of Contract and by law.

#### **1.57.4 Noise**

Compressors, percussion tools and vehicles are to have effective silencers of a type recommended by the manufacturers of the equipment. Pneumatic drills and other noisy appliances shall not be used during days of rest or after normal working hours without consent of Kahramaa's Representative.

#### **1.57.5 Fire Precautions**

The Contractor shall take all necessary measures to prevent personal injury or death or damage to the Works or other property, including but not limited to:

- Provision of fire fighting facilities in all vulnerable areas and as instructed by Kahramaa.
- Marking escapes routes and illuminating them if necessary.
- Instructing workmen in fire precautions and use of fire fighting equipment.
- Displaying notices on fire safety and procedures in the event of a fire on Site.

#### **1.57.6 Nuisance**

The Contractor shall take necessary precautions to prevent nuisance from smoke, dust, rubbish, water, polluted effluent and other causes.

#### **1.57.7 Explosives**

Explosives shall not be used

#### **1.57.8 Protection of the Works**

**Security:** The Contractor shall take all measures necessary, including watching and lighting at night, to prevent unauthorized entry to the Site and to safeguard the Site, the Works, Materials, Plant, Contractor's Equipment and Temporary Works against damage from trespass and theft.

**Protection:** The Contractor shall cover up and protect each section of completed work from damage by water, extreme heat and inclement weather or from damage caused by later operations and shall make good any damage to the satisfaction of Kahramaa.

**Stability:** The Contractor shall ensure that stability and integrity of the Works are maintained during construction and shall provide temporary supports where necessary and shall not overload any part of the Works with materials, Plant or Contractor's Equipment.

**Moisture:** The Contractor shall prevent the Works from becoming excessively wet so as to avoid any instability or excessive movement to the Works.



**Rubbish:** The Contractor shall remove rubbish and debris from the Site as it accumulates and keep the Works clean and tidy. Rubbish, dirt and debris shall be removed from voids and cavities before they are sealed.

#### **1.57.9 Protection of Other Property and Services**

**Roads and Footpaths:** The Contractor shall protect public and private roads, footpaths and the like from damage by site traffic or other causes arising from the execution of the Works and shall repair any damage to the satisfaction of the relevant public authority or private owner.

**Existing Services:** The Contractor shall:

- Notify all service authorities and private owners before commencing any work, which may affect or damage existing drains and services and observe all service authorities' regulations and/or recommendations for work adjacent to existing services.
- Ascertain the positions of all services not indicated in the Contract Documents and check the positions of those, which are so indicated.
- Adequately protect, maintain and prevent damage to all services and shall not interfere with their operation without the consent of the service authority or owners.

#### **1.57.10 If any damage is caused to existing services as a result of execution of the Works, the Contractor shall notify Kahramaa's Representative and the service authority or private owner and make arrangements to repair the damage to the satisfaction of the service authority or private owner as appropriate. Adjoining Property**

**The Contractor shall:**

- Take all reasonable precautions to prevent damage to adjoining property and, if any damage is caused as a result of the execution of the Works, make good to the satisfaction of the owner.
- Obtain permission of the owners if it is necessary to erect Temporary Works or otherwise use adjoining property and pay all charges.
- Advise owners or occupiers of adjoining property of the dates on which work, which may affect them, is to be executed.

Existing Condition of roads, paths, features, services and adjoining property, which is at risk from damage, shall be recorded by photographs or surveys as appropriate as agreed with the owner prior to commencing the Works.

#### **1.58 Training to be provided by the Contractor**

The Contractor shall provide training in relation to the operation of the Works.

Upon the issue of the Erection Completion Certificate the Contractor will be required to provide suitable experienced staff, under the guidance of an operations/training Specialist, to provide hands-on training in operation and maintenance services to Kahramaa staff responsible for the operation and maintenance of the works. The services will be required for a period of at least three calendar months. The Contractor's staff will be resident in the project area and all costs associated with the Contractor's staff will be borne by the Contractor. Three months prior to the expected completion date of the works the Contractor will submit to the Engineer CV's of his proposed staff, who must have the following minimum qualifications.

- Operation / and Maintenance Specialist, Bachelor degree in Engineering or equivalent with 15 years total experience, 5 years in the water supply industry



- Instrumentation Specialist, Bachelor degree in Engineering or equivalent with 15 years total experience, 5 years in the water supply.
- Mechanical and Electrical Specialist, Bachelor degree in Engineering or equivalent with 10 years total experience, 5 years in the water supply.

## 1.59 Quality Standards and Control

### 1.59.1 General

The Contractor shall submit a quality control plan for review and approval of Kahramaa. Inspection and test plans shall include hold, witness, review and certification points.

**Good Practice:** Where and to the extent that materials, products and workmanship are not fully specified they are to be of a standard appropriate to the Works and suitable for the purposes stated in or reasonably to be inferred from the Contract documents, and in accordance with good building practice, including the relevant provisions of current standards, regulations, etc.

### 1.59.2 Setting Out and Accuracy

**Site Survey:** Before commencing Work on Site, the Contractor shall carry out a topographical survey of the Site, in conjunction with, or as instructed by Kahramaa, or of such parts of the Site as Kahramaa may direct, to record the Site limits, dimensions, ground levels, obstructions and other features and to establish base lines and points for future setting out and to record the basis for re-measurement of excavation and earthwork, where applicable.

**Setting Out:** Details of methods and equipment to be used in setting out the Works shall be submitted to Kahramaa. The Contractor shall inform Kahramaa when setting out is complete and before commencing construction and shall provide instruments and assistance for checking the setting out if required by Kahramaa.

**Record Drawings:** The Contractor shall record details of all grid lines, existing ground level, setting-out stations, bench marks and profiles on the site setting-out drawings; retain on the Site throughout the duration of the Contract and hand to Kahramaa on completion.

**Non-Compliance:** Work which fails to meet the specified levels of accuracy must not be rectified without approval. Submit proposals for such rectification or removal and replacement and meet all costs arising, including effects on other work.

### 1.59.3 Materials

**Products** are to be new unless otherwise specified and are to be handled, stored and fixed with care to ensure they are not damaged when incorporated in the work.

**Standards.** For products and materials specified to a national and international standard, certificates of compliance are to be obtained from manufacturers when requested by Kahramaa.

**Single Sources:** Where a choice of manufacturer or source of supply is allowed for any particular product or material, the whole quantity required to complete the work must be of the same type, manufacture and source unless otherwise approved by Kahramaa. Written evidence of sources of supply is to be provided when requested by Kahramaa and sources are not to be changed without approval.



**Checking Compliance of Products and Materials:** The Contractor shall check all delivery tickets, labels, identification marks and where appropriate, the goods themselves, to ensure that all products comply with the Specification. Where different types of any product are specified, he shall ensure that the correct type is being used in each location. In particular, the following shall be checked.

- Sources, types, qualities, finishes and colours are correct, and match any approved samples.
- Accessories and fixings, which should be supplied with the goods, have been supplied.
- Sizes and dimensions are correct.
- Goods are clean, undamaged and in good condition, with intact protective coverings and unbroken seals.
- Materials, which have a limited shelf life, are not out of date.

**Protection of Products and Materials:** The Contractor shall:

- Prevent over-stressing and any other type of physical damage.
- Keep clean and free from contamination and staining.
- Keep dry and in a suitably low humidity atmosphere to prevent premature setting, moisture movement and similar effects. Where appropriate allow free air movement around and between stored components.
- Prevent excessively high or low temperature and rapid changes of temperature in the material.
- Protect adequately from rain, sun and other elements as appropriate.
- Keep different types and grades of materials separately and adequately identified.

So far as possible, keep materials in their original wrappings, packing or containers, with unbroken seals, until immediately before they are used.

**Manufacturer's Recommendations:** Products shall be handled, stored, prepared and used in accordance with manufacturer's recommendations. The Contractor shall inform Kahramaa if this conflict with any other specified requirement and submit copies of manufacturer's recommendations to Kahramaa when requested.

#### **1.59.4 Workmanship**

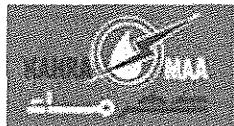
Work is to be carried out by or under the close supervision of experienced tradesmen skilled in the particular type of work.

**Suitability of Previous Work and Conditions:** Before starting each new type or section of work the Contractor shall ensure that:

- Previous related work is appropriately complete, in accordance with the project documents, to a suitable standard and in suitable condition to receive the new work.
- All necessary preparatory work has been carried out including provision for services, damp proofing, priming and sealing.

**Defects in Existing Work:** The Contractor shall report to Kahramaa if any existing work is defective and obtain his instructions before proceeding with new work which may cover up the defective work or which may be adversely affected by the defective work.

**Rectification of Defective Work:** If any part of the work is known or is suspected to be not in accordance with the Contract, the Contractor shall submit proposals to Kahramaa within 5 working days of discovery of the defect, for opening up, inspecting, testing and



rectification and carry out Kahramaa's instructions in relation thereto, including, where so instructed, removal and reconstruction.

#### **1.59.5 Samples and Approvals**

Samples: Where approval of products or materials is specified, the Contractor shall submit samples or other evidence of suitability. Orders shall not be confirmed or materials used until approval has been obtained. Approved samples are to be retained on the Site for comparison with products and materials used in the Works and removed when no longer required.

Where samples of finished work are specified, the Contractor shall obtain approval of stated characteristics before proceeding with the Works and shall retain approved samples on the Site for comparison with the Works. Samples, which are not part of the finished works, shall be removed when no longer required.

Approvals: Where and to the extent that products, materials or work are specified to be approved, or Kahramaa instructs or requires that they are to be approved, the same must be supplied and executed to comply with all other requirements and, in respect of the stated or implied characteristics, either to the express approval of Kahramaa, or to match a sample expressly approved by Kahramaa as a standard for the purpose.

Inspection or any other action by Kahramaa must not be taken as approval of materials, products or work unless Kahramaa so confirms in writing in express terms referring to:

- Date of inspection;
- Part of the work inspected;
- Respects or characteristics, which are approved;
- Extent and purpose of the approval;
- Any associated condition.

Approval, inspection or any other action by Kahramaa shall not in any way relieve the Contractor from his responsibility for the suitability and fitness for purpose of materials, products or work.

#### **1.59.6 Work at Completion**

The Contractor shall clean the Works thoroughly inside and out, removing all splashes, deposits, and efflorescence, rubbish and surplus materials consequent upon the execution of the work. Cleaning is to be carried out using both cleaning materials and methods as recommended by manufacturer of product being cleaned, or in the absence of such recommendations, cleaning materials and methods approved by Kahramaa.

Temporary Markings coverings and protective wrappings shall be removed unless otherwise instructed by Kahramaa.

Partial Possession by Employer: Where the Works are to be completed in sections and any such section depends for its adequate functioning on work located elsewhere on the Site, such other work shall be completed in time to permit sectional completion as required. During execution of the remainder of the Works the Contract shall ensure that:

- Completed sections or parts of the Works have continuous and adequate provision of services, fire precautions, means of escape and safe access.
- Occupants and users are exposed to minimum inconvenience, nuisance and danger.

Unless otherwise directed completed pipelines shall be disinfected, drained and handed over to Kahramaa as "dry legs". The contractor shall attend commissioning of the pipelines during the warranty period.



#### **1.60 Data for setting out the Works**

The Contractor shall carry out all survey and levelling work to establish reference points in order to fulfil his obligations.

#### **1.61 Temporary Working Areas**

Where any part of the Works are to be constructed on, over, under, in or through land other than the specified areas or public highways, the Contractor shall arrange for temporary occupation and approval from the owner or occupier of temporary working areas and such areas shall be deemed to be part of the Site during the period of occupation.

The Contractor shall arrange also for the serving of any notices required by law in connection with temporary working areas and the Contractor shall give to the occupier of each such area 15 days written notice of his intention to enter and shall ensure that his method of working causes the minimum of disturbance to the land and to its owners and occupiers. Where necessary similar arrangements shall apply to provide access routes to temporary working areas and such routes shall be deemed to form part of the temporary working areas.

The extent of each temporary working area and the period of time for its occupation shall be such as Kahramaa considers necessary having regard to the Contractor's reasonable requirements which shall be submitted to Kahramaa as soon as practicable after commencement of the Works and to the Contractor's programme.

The Contractor shall reinstate temporary working areas to a tidy condition as soon as possible after other work in those areas has been completed so as to keep the period of occupation to a minimum.

#### **1.62 Work in Public Highways**

Where any work is to be carried out in or adjacent to a public highway (which term for the purpose of the Specification shall be deemed to mean any street, road, footway or verge maintainable at public expense), the Contractor shall comply with, amongst other things, the requirements and recommendations of the police or other authorized body regarding traffic safety measures for road works current at the time such work is carried out.

#### **1.63 Traffic Control**

Wherever single file traffic is necessary on a highway by reason of the construction of the Works, the Contractor shall provide and maintain a minimum carriageway width in accordance with local and national Road Traffic requirements and the concerned Authorities. In the absence of any instructions, a carriageway width of not less than four metres shall be achieved, or wider where necessary, at curves and junctions, and shall provide, operate and maintain sufficient suitable traffic signs.

When alternate one-way working of traffic is required, the Contractor shall provide, operate and maintain sufficient and suitable traffic signs and electric traffic control lights. Manually operated "Stop-Go" signs will be permitted only if previously agreed with Kahramaa. All written traffic signs shall be in Arabic and English.

#### **1.64 Adjoining Property**

If the Contractor's work will cause unavoidable interference with access to adjoining property, the Contractor shall first give seven days' notice in writing to the occupier of such property and shall provide temporary means of access for vehicles and pedestrians.



#### **1.65 Road Closures**

No provision has been made for the closure of any road but if the Contractor wishes to apply for any road closure he shall make all the proper arrangements for the same with the appropriate person and concerned authorities.

The Contractor shall bear the full responsibility for and cost of any road closure which may be permitted and shall indemnify Kahramaa against any claim whatsoever arising there from. The Contractor shall not be entitled to any extra payment as a result of permission for a road closure being refused.

#### **1.66 Obstructions**

Should there be any obstructions, which would prevent the Contractor from reasonably carrying out the Works, then the Contractor shall inform Kahramaa at the earliest opportunity in order that the Permanent Works may be relocated or the obstruction removed.

#### **1.67 Site Roads and Access**

The Contractor shall arrange for, construct, maintain and afterwards remove and reinstate all other accesses required for and in connection with the execution of the Works. Reinstatement shall include restoring the area of such roads and access to at least the degree of safety, stability and drainage that existed before the Contractor entered the Site.

The Contractor shall maintain temporary site access roads for the safe and easy passage of staff of Kahramaa and the Engineer, until completion of construction and testing of the respective item of Works.

Permanent roads forming part of the permanent Works may be used for temporary access subject to the approval of Kahramaa, but all such roads shall be complete and undamaged when handed over at the time of Completion.

#### **1.68 Claims for Damage to Persons or Property (Procedure)**

Any claim received by Kahramaa in respect of matters in which the Contractor is required under the Contract to indemnify Kahramaa will be passed to the Contractor who shall likewise inform Kahramaa of any such claim which is submitted directly to him by a claimant.

The Contractor shall do everything necessary, including notifying the insurers of claims received, to ensure that all claims are settled properly and expeditiously and shall keep Kahramaa informed as to the progress made towards settlement, failing which Kahramaa shall be entitled to make direct payment to claimants of all outstanding amounts due to them in Kahramaa's opinion and without prejudice to any other method of recovery to deduct by way of set-off the amounts so paid from sums due or which become due from Kahramaa to the Contractor. If the Contractor receives a claim, which he considers to be in respect of the matters in which he is to be indemnified by Kahramaa under the Contractor, he shall immediately pass such claim to Kahramaa. All information as aforesaid shall be given in writing and shall be copied to Kahramaa.

#### **1.69 Security of the Works**

Watching of the Works shall be provided by the Contractor at his own expense. If Kahramaa considers it necessary it will order in writing that additional watchmen be provided all at the Contractor's expense.

Unfenced openings and surface obstructions accessible by the public shall be attended by day and night and shall be adequately lit at night and where applicable with hazard warning lights to pedestrians and traffic and in accordance with applicable Traffic Police Regulations.



The Contractor shall take all necessary precautions to prevent use of access roads by the public. Notwithstanding the precautions taken the Contractor shall ensure that the access roads are designed, constructed and maintained in a safe condition at all times. The Contractor shall strictly enforce speed limits.

#### **1.70 Site to be Kept Tidy**

Throughout the progress of his work, the Contractor shall keep the Site and all working areas in a tidy condition and free from rubbish and waste materials.

Any Temporary Works, Contractor's Equipment, materials or other things which for the time being are not required for use by the Contractor may with the written consent of Kahramaa be removed from the Site but otherwise shall be maintained in an orderly fashion and shall be properly and securely stored.

#### **1.71 Safety**

Kahramaa shall be notified by the Contractor immediately after any accident occurs whether on Site or off site in which the Contractor is directly involved and which results in any injury to any person whether directly concerned with the Works or a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

Transportation of any materials by the Contractor shall be in suitable vehicles which when loaded does not cause spillage and all loads shall be suitably secured. Any vehicle, which does not comply with this requirement or any of the local traffic regulations and laws, shall be removed from the Site.

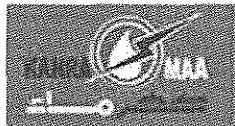
#### **1.72 Offices and Equipment for Kahramaa and the Engineer**

Within one month of the date of order to commence, the Contractor shall have provided and erected, in locations approved by Kahramaa, site offices for the exclusive use of Kahramaa and the Engineer. The Contractor shall submit his proposals for the site offices to Kahramaa for approval before starting construction. Unless otherwise instructed the main site offices and facilities provided for Kahramaa and the Engineer shall be in the vicinity of the Contractor's main site offices and facilities established for the Contract.

The Site offices for Kahramaa and the Engineer shall comprise an office block at a location to be agreed with Kahramaa. The offices shall generally comply with QCS Section 1 Part 11 Type 2 facilities except as shown below. Contrary to 11.2.3.2 of the aforesaid the offices and contents shall remain the property of the Contractor.

The site offices shall comprise

- Large reception area with area for display boards and seating facilities for visitors
- 2 executive offices of 25 square metres, with en-suite toilet and wash facilities,
- 6 Engineers offices each 16 square metres,
- 5 Inspector offices each of 12 square metres,
- 1 meeting room of 60 square metres,
- 1 meeting room of 25 square metres
- 1 Prayer room minimum 16 square metres
- 1 Document control room 16 square metres
- 1 Print room 12 square metres
- 1 Store room 12 square metres



- 1 Sample room 12 Square metre
- 1 Archiving store 12 square metres
- WC, toilet, (male and female)
- Shower room and changing facilities (male and female)
- Kitchen facilities with adjacent eating area

(Total area is equivalent to 500 square metres).

Proposed building layouts, structural details and finishes shall be submitted to Kahramaa within two weeks of the Effective Date of contract for review and approval.

Before placing any orders or delivery any materials or fittings for the office the Contractor shall obtain the approval of Kahramaa in writing as to the location and type of the structure and the furniture, fittings, and equipment to be supplied.

The Contractor shall provide adequate temporary office facilities to meet Kahramaa's requirements until the permanent site offices are completed to a standard that is accepted for Kahramaa's occupation. The offices and the materials, surface fittings and furniture shall be supplied new and shall be maintained in a clean and sanitary condition.

The office and contents shall be maintained until the Works have been completed and the Certificate of Operation has been issued. The offices shall be removed upon issuance of the Taking-Over Certificate.

The Contractor shall insure the site offices and contents against fire, burglary and other risks.

### **Office Structure**

The structure may be prefabricated or bespoke construction as proposed by the Contractor and approved by Kahramaa.

The structure shall be well insulated weatherproof ion accordance with QCS. The construction, windows and doors shall be dust-proof. The windows shall be fitted with fly screens. All doors and windows shall be lockable

The Main entrance shall have double doors and a lobby with an area for changing and storage of PPE for 15 people

The offices shall be heated and air conditioned and lit by electricity. The office air-conditioned shall be by split unit air conditioners with heating and cooling functions to maintain a maximum steady dry bulb temperature of 23°C at a relative humidity of 50% under the expected climatic conditions expected at the Site.

Extract fans capable of 10 air changes per hour shall be provided in the kitchen and toilets.

Adequate effective lighting and power outlets shall be installed and tested in accordance with the latest requirements of Kahramaa.

The walls and ceilings shall be painted with emulsion paint which shall be recoated and maintained as necessary throughout the duration of the Contract.

### **Utility Connections**



**Water supplies**  
**As QCS.**

**Sanitation Facilities**

The main offices shall have flush operated WC's connected either to a public sewer or to an approved septic tank provided by the Contractor (which shall be demolished and refilled to Kahramaa's satisfaction at the end of the Contract).

The sanitation facilities shall be cleaned and maintained to the satisfaction of **Kahramaa.**

**Electricity**  
**As QCS.**

**Telephone**

The Contractor shall arrange for the provision and maintenance of three (3) land lines, an exchange and internal telephone system to the main office

All costs shall be covered by the Contractor, except the Contractor may recover the net cost of any international calls made by Kahramaa or the Engineer.

**Internet**

As QCS. The speed of supply shall be agreed with Kahramaa prior to installation.

The Contractor shall provide a computer network with central printing facilities

**Furniture and Equipment**

The offices shall be fully furnished and equipped according to Kahramaa's requirements including the following:

**Conference Room**

1 conference table with 16 chairs.

White board fitted to full width at the end wall of conference room.

Projector

1No. 53 inch television screen located for exclusive use within the conference room

Conference call facilities

**Each Executive/Project Managers office**

1 Executive Desk

1 Executive chair

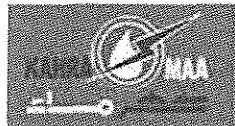
1 lockable filing cabinet

1 Book case

1 settee + 2 chairs

1 Coffee table

1 Circular conference table with 6 chairs.



- 1 Computer with required software programs, scanner and colour laser printer
- 1 Refrigerator
- En-suite Toilet and wash facilities

#### **Each 16 Square Metre Office**

- 1 lockable metal filing cabinets with four drawers and all fitments;
- 1 Medium size desk with separate pedestal unit
- 3 Chairs
- 1 bookcase
- 1 Computer with required software programs
- 1 Small circular conference table
- 1 Refrigerator

#### **Each 12 Square Metre Office**

- 2 Medium size desks each with separate pedestal
- 1 book case
- 3 desk chairs
- 2 computers with required software programs

#### **Document Control Room**

- 1 knee-hole desk
- 5 lockable filing cabinets
- 3 drawing racks
- 1 table
- Fixed shelving

#### **Reception**

- 1 lockable metal filing cabinet with four drawers and all fitments;
- 1 reception desk with counter and separate pedestal unit
- Sofa/armchairs to seat 8 people
- Coffee table
- Display facilities for photographs, drawings, models
- Water cooler
- Magazine rack

#### **Print Room**

- 1 A3 heavy duty colour photo copier
- 1 A3 Colour Scanner
- 1 A3 colour laser printer
- 1 A3 Black and White laser Printer
- 1 A0 plotter, of the design-jet type suitable for A0 paper. It shall be quiet in operation (HP Designjet T790 or similar).



### **Kitchen**

2 refrigerators each of capacity 150 litres;  
1 electric or gas stove.  
1 water boiler  
2 water dispensers  
1 micro wave oven  
Tables and chairs for eating areas

### **General**

The contractor shall provide all other facilities and equipment including, pin boards, white boards, fire extinguishers, smoke alarms, waste paper baskets and refuse disposal facilities.

### **Services**

The Contractor shall supply soft drink (tea, coffee, cold drink) and daily maintain, clean all rooms, furniture, fittings and WC's, throughout the period of the Contract for all offices. The Contractor shall provide full time attendance at each office to carry out these duties.

The contractor shall provide and maintain all required kitchen equipment and crockery.

The Contractor shall provide and replace as necessary gas cylinders and office supplies adequately, plus separate toilet facilities and bottled potable water for the exclusive use of the Engineer.

Vehicle and pedestrian access to the office shall be maintained and kept free of obstruction at all times.

The Contractor maintain the computers, scanners, printers and photocopiers for the duration of the Contract and provide all consumables shall necessary for their operation.

### **Computers Scanners and Printers**

The Contractor shall install legal copies of operating system and software as required, with the following as a minimum:

- (a) Latest version of Microsoft Windows Operating System
- (b) Latest version of Microsoft Office Professional
- (c) Latest Version of Adobe Acrobat Professional

Software shall be of latest version and Arabic enabled

All computers, scanners and printers within the main office shall be networked.

Additionally 2 No new licensed copies of Prima Vera Project Management Enterprise and 2 No copies of AutoCAD 2012 software shall be provided and installed on computers to be agreed with the Engineer.

The Contractor shall provide all necessary voltage stabilisation equipment to ensure trouble free operation of the computer equipment.

### **Stationary Supplies**



The Contractor shall supply stationary for the Engineer for the duration of the Contract. Stationary items shall include, but not limited to, the following:

- (a) Files and file dividers (A4 and A3 size).
- (b) Paper (A4 and A3 size).
- (c) Writing pens, marker pens, highlighter pens (various colours).
- (d) Pencils (various colours).
- (e) Pencil sharpeners.
- (f) Erasers.
- (g) Staplers and staples.
- (h) Hole punches.
- (i) Paper clips and bulldog clips.
- (j) A4 Note books

### **Car Parking**

A shaded car park for 25 cars shall for the sole use of Kahramaa's staff and visitors shall be constructed adjacent to the office building. The parking areas shall be paved or have a finished surface as approved by the Kahramaa. Shades shall be to the approval of Kahramaa

### **Construction Monitoring**

The Contractor shall note that the construction activities will be also monitored and recorded by time-lapse and/or on-line web cameras which will be provided and installed by others. For this purpose, the Contractor shall provide required number of tower type scaffolding temporary structures for up to 15 cameras, each complete with a platform at a height of 12 metres above ground level with handrail and caged ladders designed for light duty (two men) load.

The Contractor shall be responsible for the continuous provision of the power supply and dedicated 4G internet connection for the on-line web camera at all times.

The tower scaffolds shall fully comply with Kahramaa Standard HSE-M1-P10 included in the Appendix J. The Contractor shall erect the tower scaffolds at locations as instructed by the Kahramaa or the Engineer and shall relocate the same during the construction Works (if needed) in order to provide proper coverage of major on-going construction areas.

### **1.73 Stakeholder management and public liaison**

The Contractor shall comply with all Stakeholder Management requirements as directed by Kahramaa. The Contractor shall ensure Stakeholder satisfaction and requirements are met throughout the different stages of the Works starting at initiation, execution, closure and maintenance. Stakeholders include, but not limited to, the following:

1. The public (including but not exclusive to business owners and operators; residents; public entities; community entities)
2. Kahramaa Departments Contractor should liaise with a single entity in Kahramaa – i.e. projects department
3. Utility, approving and licensing agencies
4. Relevant municipalities and Authorities
5. Ministry of Municipality and Urban Planning



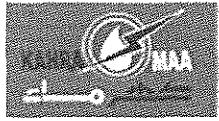
6. Ministry of Interior

7. Ministry of Environment

At project initiation; the Contractor shall identify all relevant Stakeholders. The Contractor is solely responsible for identifying all project relevant Stakeholders who have an influence and/or interest in his project. The Contractor shall submit a Stakeholder Management Plan within 14 days of the Contract Award, with particular focus on providing support for public awareness and providing sufficient information for required notifications to the public of the implications of the work on individuals, traffic, noise and traffic diversion

Contractors may not engage in public communication activities without the express direction and approval of Kahramaa on content, materials and activities

Any and all public complaints are to be immediately notified to Kahramaa via email noting date and time; full name, address and contact details of complainant; nature of complaint and other required details



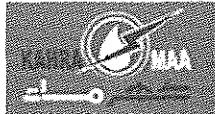
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Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
(Packages A, B, C, D & E)

## **APPENDIX A SECTION 2**

## **CIVIL & STRUCTURAL SPECIFICATION**



<b>2</b>	<b>CIVIL and STRUCTURAL WORKS.....</b>	<b>4</b>
2.1	CAST IN PLACE CONCRETE .....	4
2.1.1	GENERAL .....	4
2.1.2	PRODUCTS.....	10
2.1.3	EXECUTION.....	25
2.2	PRE-CAST STRUCTURAL CONCRETE .....	50
2.2.1	GENERAL .....	50
2.2.2	PRODUCTS.....	53
2.2.3	EXECUTION.....	53
2.3	POST TENSIONED CONCRETE .....	56
2.3.1	GENERAL .....	56
2.3.2	PRODUCTS.....	58
2.3.3	EXECUTION.....	60
2.4	GROUT.....	63
2.4.1	GENERAL .....	63
2.4.2	PRODUCTS.....	64
2.4.3	EXECUTION.....	65
2.5	STRUCTURAL STEEL FRAMING .....	68
2.5.1	GENERAL .....	68
2.5.2	PRODUCTS.....	74
2.5.3	EXECUTION.....	84
2.6	CORROSION PROTECTION OF STRUCTURAL STEEL .....	96
2.6.1	GENERAL .....	96
2.6.2	PRODUCTS.....	98
2.6.3	EXECUTION.....	99
2.6.4	CORROSION PROTECTION SCHEDULE .....	108
2.6.5	PROFORMA FOR CORROSION PROTECTION SYSTEMS GUARANTEE .....	112
2.7	SUBSTRUCTURE WATERPROOFING .....	112
2.7.1	GENERAL .....	112
2.7.2	PRODUCTS.....	115
2.7.3	EXECUTION.....	119
2.8	PROTECTION OF INTERNAL SURFACES OF WATER HOLDING STRUCTURES .....	124
2.8.1	Reservoirs and Potable Water Holding Structures .....	124
2.8.2	Structures in contact with sewage.....	124
2.8.3	Structures in contact with surface water, land drainage and leak detection .....	124
2.8.4	Structures in contact with irrigation and fire fighting.....	124
2.9	EARTHWORKS.....	124
2.9.1	GENERAL .....	124
2.9.2	PRODUCTS.....	127
2.9.3	EXECUTION.....	131
2.10	BORED PILES .....	147
2.10.1	GENERAL .....	147
2.10.2	PRODUCTS.....	152



2.10.3	EXECUTION.....	153
2.10.4	WORKING PILE TESTING AND ACCEPTANCE CRITERIA.....	161
2.10.5	PRELIMINARY PILE TESTING AND ACCEPTANCE CRITERIA .....	168
2.10.6	DYNAMIC PILE TESTING AND ACCEPTANCE CRITERIA.....	177
2.11	DUCTILE IRON PIPEWORK.....	180
2.11.1	Joints .....	180
2.11.2	Lengths of Pipes .....	180
2.11.3	Markings .....	181
2.11.4	Pipes for Cutting on Site .....	181
2.12	COATINGS FOR DUCTILE IRON PIPES AND FITTINGS DURING MANUFACTURE.....	181
2.12.1	General .....	181
2.12.2	Lining Material.....	181
2.12.3	External Protection to Pipes and Fittings.....	181
2.13	CARBON STEEL PIPES .....	181
2.14	VITRIFIED CLAY PIPES AND FITTINGS.....	182
2.15	CONCRETE PIPES AND FITTINGS .....	182
2.16	PIPE BEDDING.....	182
2.17	ANCHORAGE SYSTEMS .....	182
2.18	WRAPPING OF ALL BURIED PIPE JOINTS.....	183
2.18.1	Flanges and Couplings .....	183
2.18.2	Spigot and Socket Joints .....	183
2.18.3	Heat Shrinkable Sleeves .....	183
2.19	VALVE CHAMBER NAME PLATES .....	183
2.20	FIBRE OPTIC CABLE DUCT .....	184
2.20.1	HDPE Duct .....	184
2.20.2	Cable Route Markers .....	184
2.20.3	Cable Protection Tiles.....	184
2.20.4	Warning Tape .....	185
2.21	STAIRCASSE, , LADDER, GRATING, OPEN MESH FLOORINGAND HANDRAILING .....	185
2.22	MONITORING POINTS .....	186
2.23	RESERVOIR ACCESS COVERS .....	186
2.24	RESERVOIR AIR VENTS.....	186
2.25	FIXING METALWORK INSIDE THE RESERVOIR .....	187



## **2 CIVIL and STRUCTURAL WORKS**

Unless otherwise stated in the Project Documentation, the Contractor shall comply with every requirement of the Qatar Construction Specification (QCS) that is relevant to the type of work forming any part of the Contract and shall adopt whichever permissible option or alternative is best suited to the needs of the work being undertaken.

### **2.1 CAST IN PLACE CONCRETE**

#### **2.1.1 GENERAL**

##### **2.1.1.1 SUMMARY**

- A. Qatar Construction Specification (QCS) forms the basis of the Specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) Section 5.
- B. Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed in accordance with the details shown on the Drawings and these Specifications.
- C. Cast-in-place concrete shall be ready mixed concrete, from an Approved batching plant, generally as defined in BS 5328, BS EN 206 and BS 8500 but as amended in these Specifications.
- D. In addition to the General Conditions, the Contractor shall also refer to the following related sections

Subsection 2.9 - Earthworks

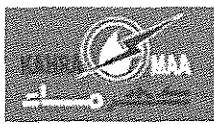
Subsection 2.10 - Bored Piles

Subsection 2.7 – Substructure Waterproofing

##### **2.1.1.2 REFERENCES**

###### **Standards**

AASHTO T 277	Rapid determination of chloride permeability of concrete
ACI 305R-91	Hot weather concreting
ASTM C 31	Standard Practice for making and curing concrete test Specimens in the field
ASTM C 39	Standard Test methods for compressive strength of cylindrical concrete specimens
ASTM C 40	Test for organic impurities in sands for concrete
ASTM C 88	Test for soundness of aggregates by use of sodium sulfate or magnesium sulfate
ASTM C 94	Ready-mixed concrete
ASTM C 123	Test for lightweight pieces in aggregate
ASTM C 127	Specific gravity and absorption of coarse aggregate



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)

ASTM C 128	Specific gravity and absorption of fine aggregate
ASTM C 131	Method of resistance to degradation of small size coarse aggregates by abrasion and impact in the Los Angeles machine.
ASTM C 142	Clay lumps and friable particles in aggregates
ASTM C 150	Portland cement
ASTM C 172	Standard Practice for sampling freshly mixed concrete
ASTM C 186	Test for heat of hydration of hydraulic cements
ASTM C 227	Test for potential alkali reactivity of cement-aggregate combination (mortar bar method)
ASTM C 231	Test for air content of freshly mixed concrete by pressure method
ASTM C 232	Test for bleeding of concrete
ASTM C 295	Petrographic examinations of aggregates for concrete
ASTM C 289	Test for potential reactivity of aggregates (chemical method)
ASTM C 535	Resistance to degradation of larger size coarse aggregate by abrasion and impact in the Los Angeles machine
ASTM C 586	Test for potential alkali reactivity of carbonate rocks for concrete aggregate (rock cylinder method)
ASTM C 1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1260	Potential Alkali reactivity of cement-aggregate combinations (NBRI method)
BS 12	Portland cement *
BS 146	Portland blast furnace cement
BS 812	Testing aggregates *
BS 882	Aggregates from natural sources for concrete
BS 1014	Specification for pigments for Portland cement
BS 1305	Batch type concrete mixers *
BS 1377	Method of test for soils for civil engineering purposes
BS 1881	Testing concrete
BS 3148	Methods of tests for water for making concrete
BS 3892	Pulverised fuel ash
BS 4027	Sulphate-resisting Portland cement
BS 4246	High Slag Portland - blast furnace cement
BS 4248	Specification for supersulphated cement
BS 4449	Carbon steel bars for the reinforcement of concrete
BS 4483	Steel fabric for the reinforcement of concrete
BS 4550	Part 2 Methods of testing cements - chemical tests
BS 5075	Part 1 Accelerating admixtures, retarding admixtures and water reducing admixtures Part 2 Air-entraining admixtures Part 3 Super plasticizers
BS 5135	Arc welding of carbon and manganese steel
BS 5328	Part 1 Guide to specifying concrete Part 2 Method for specifying concrete mixes



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

	Part 3 Specification for the procedures to be used in producing and transporting concrete
	Part 4 Specification for the procedures to be used in sampling, testing and assessing compliances of concrete
BS 5606	Accuracy in building
BS 5975	Code of Practice for falsework
BS 6089	Guide to the assessment of concrete strength in existing structures
BS 6100	Glossary of building and civil Engineering terms
BS 6588	Portland pulverised fuel ash cements
BS 6610	Pozzolanic pulverised fuel ash cement
BS 6699	Ground granulated blast furnace slag for use with Portland cement
BS 7123	Metal arc welding of steel for concrete reinforcement
BS 7542	Method of test of curing compounds for concrete
BS 7973	Spacers and chairs for steel reinforcement
BS 8002	Design of earth retaining structures
BS 8004	Foundations
BS 8007	Design of concrete structures for retaining aqueous liquids
BS8102	Protection of Structures against Water from the Ground
BS 8110	The structural use of concrete
BS 8500	Complementary British standard to BS EN 206-1
	Part 1 Method of specifying and guidance for the specifier
	Part 2 Specification for constituent materials and concrete.
BS 8666	Bending dimensions and scheduling of bars for the reinforcement of concrete
BS EN 12350	Testing Fresh Concrete
BS EN 12390	Testing Hardened Concrete
BS EN 12620	Aggregates for Concrete
BS EN 206	Concrete specification, performance, production and conformity
BS EN 450	Fly Ash for Concrete
DIN 1048	Testing of concrete: Testing of hardened concrete
NS 3045	Silica Fume for Concrete
SABS 1491	Part 11 Portland Cement Extenders: Fly Ash

Obsolete, but referred in other references.

Other References

QCS 2010: Qatar Construction Specification 2010.

BRE Special Digest 1: Concrete in aggressive ground.

BRE Digest 54: Damp proofing solid floors.

BRE Digest 357: Shrinkage of Natural Aggregates in Concrete.

BRE Digest 330: Alkali Aggregate Reactions in Concrete.

CIRIA report C660: Early-age thermal crack control in concrete.

CIRIA special publication SP31: Guide to Concrete construction in the Middle East.



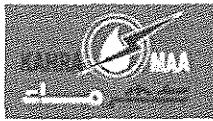
- CIRIA report R108: Concrete pressure on formwork.
- CIRIA report R165: Concrete mixes - planning and design for transporting, concrete placing and finishing.
- Concrete Society Technical Report 30: Alkali Silica Reaction - minimizing the risk of damage to concrete.
- Concrete Society Technical Report 163: Guide to the Design of Concrete Structures in the Arabian Peninsula.
- Concrete Society: Spacers for Reinforced Concrete.
- Institution of Civil Engineers: Specification for Piling and Embedded Retaining Walls.
- Institution of Structural Engineers/Concrete Society: Standard Method of Detailing Structural Concrete.
- US Army Corps of Engineers CRD-C 39-81: Test Method for the Coefficient of Linear Expansion of Concrete.
- EFNARC specification and guidelines for self-compacting concrete.

#### **2.1.1.3 SUBMITTALS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prior to starting work on the Contract, the Contractor shall submit for approval details of the proposed sources of all materials, together with full documentary evidence that the materials will comply with the Specification.
- C. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials are used. The submission shall include a comparison table to show its compliance with the specified material.
- D. Shop Drawings and As-Built Drawings shall be prepared by the Contractor giving reinforcement disposition as required in Subsection – Bar Schedules and Shop Drawings, and submitted for the Engineers approval. A survey report on dimensions, position and verticality of all structural elements shall be submitted prior to next stage of work, for the Engineer's review and approval.
- E. Prior to commencing each work stage on Site, the contractor shall submit for approval method statements relevant to the proposed executions of work on Site. Each method statement shall include relevant Inspection and Test Plan and the Safety risk assessment.

#### **2.1.1.4 QUALITY ASSURANCE**

- A. Comply with pertinent provisions of QCS 2010 – Quality Requirements.
- B. Comply with pertinent requirements of the authorities having jurisdiction. Obtain all necessary approvals from these authorities.
- C. The Contractor shall provide a qualified independent testing laboratory, experienced with local construction conditions and materials, to design the concrete mixes, verify procedures, conduct tests and submit reports for the design mixes to ensure compliance with the Specification.
- D. Constituent materials shall be obtained from suppliers operating quality systems in accordance with QCS 2010 - Quality Requirements.
- E. The Contractor shall submit weekly/ monthly report on concrete production and concrete quality including all test reports and material certificates.



- F. The Contractor shall engage an Approved independent third party for the verification of concrete mix design and its production and placement at different stages of the work execution.

#### **2.1.1.5 DELIVERY, STORAGE AND HANDLING**

##### **A. Cement and Cement Replacements**

1. Bulk cement shall be stored in weatherproof purpose built silos that shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo. Cement stored in silos shall be adequately protected against rain, humidity and dewfall. Silo charging and discharging points shall be properly sealed. Silo aeration equipment shall, if necessary, incorporate de-humidifiers. Cement silo charging pipes shall be clearly marked with the cement type. Precautions shall be taken to reduce the effect of solar radiation on the temperature of the silos.
2. The Contractor shall provide sufficient storage capacity to ensure that his anticipated programme of work is not interrupted due to lack of cement.
3. The temperature of cement shall not exceed 55°C at the time of incorporation within the mix. The Contractor shall assess the heat of hydration and its effect on concrete temperature for various mixes in different sections and measures taken to limit the concrete temperature to be within the limits.
4. Each consignment of cement shall bear manufacturer's name and identification number. Type of cement shall be the same as mentioned in the Approved analysis report. Each separate consignment of cement shall be tested by the manufacturer before delivery and certified copies of such tests shall be submitted to the Employer's Representative before any part of the consignment is used in the Works. The Employer's Representative reserves the right to order a re-test of cement at any time. Approval of cement does not relieve the Contractor of the responsibility to produce concrete of the specified strength and quality.
5. Cement shall be delivered in bulk but not exceeding 100 tons, or with the Employer's Representative approval, may be supplied in sealed bags that shall bear the manufacturer's name and the date of manufacture. Each consignment shall be accompanied by a copy of the manufacturer's test certificate and certificate of guarantee.
6. Each consignment of cement shall be identified and used in order of delivery. The Contractor shall submit certification and test results for each consignment of cement for the Engineer's approval.
7. In no case shall bagged cement be stored in stacks more than eight bags high.
8. Any consignment not used within 2 months from the date of manufacture will not be allowed to be used in the Works.
9. Cement stored for longer than 28 days shall be tested for "loss on ignition" prior to use to check for deterioration and any cement which fails the test shall not be used in the works.



10. Only one brand of cement as Approved by the Employer's Representative shall be used throughout the Works unless otherwise authorised by the Employer's Representative in writing.

B. Aggregates

1. Aggregates shall be delivered in clean and suitable vehicles. Different types or sizes of aggregates shall not be delivered in one vehicle.
2. Aggregates shall be assembled in such quantities that sufficient material Approved by the Employer's Representative is available to complete any continuous pour necessary for any element. The batching plant shall be of adequate size to permit the stockpiling of sufficient, unsegregated materials, having proper and uniform moisture content, to ensure continuous and uniform operation. Aggregates shall enter the mixer in a manner Approved by the Employer's Representative and in such a manner to ensure that no matter foreign to the concrete or matter capable of changing the desired proportions is included. In the event two (2) or more sizes or types of coarse or fine aggregates are used on the same project, only one (1) size or type of each aggregate may be used in one continuous concrete pour unless otherwise Approved by the Employer's Representative.
3. Aggregates shall be stored on a hard, dust-free surface and shielded from dust and the direct rays of the sun. If a dust-free environment cannot be achieved re-screening and washing of aggregates shall be carried out prior to their use.
4. All aggregates shall be stockpiled before use in order to prevent segregation of material, to ensure uniform moisture content and to provide uniform conditions for proportioning plant control. Variations in moisture content shall be controlled and compensated for by continuous read-out moisture meters in either the aggregate storage bins or the weigh hoppers.
5. The use of equipment or methods of handling aggregates that result in the degradation and contamination of the aggregates is strictly prohibited. Bulldozers with metal tracks shall not be used on coarse aggregate stockpiles. All equipment used for handling aggregates shall be Approved by the Employer's Representative.
6. Stockpiling of aggregates shall be in the manner Approved by the Employer's Representative, and in addition, every precaution shall be taken to prevent segregation. Segregation shall be prevented by making no layer higher than one and one-half (1.5) metres and if two (2) or more layers are required, each successive layer shall not be allowed to "cone" down over the next lower layer.
7. Aggregates shall not be stockpiled against the supports of proportioning hoppers and weighing devices.
8. Aggregates of each grade and type of material shall be kept separate until batched. Stockpiles shall be protected against contamination from soil, evaporate salts, vegetable matter or other deleterious material. The floors of bins shall be 75mm thick mass concrete (or similar and Approved) and shall be laid to fall to the outer edge or provide a free draining apron.
9. Segregated aggregates shall not be used until they have been thoroughly remixed and the resultant pile is of uniform and acceptable gradation at



any point from which a representative sample is taken. The Contractor shall re-mix aggregate piles when instructed by the Employer's Representative.

10. Contractor shall provide all data as specified in QCS 2010.

## **2.1.2 PRODUCTS**

### **2.1.2.1 CEMENT**

#### **A. General Requirements**

1. The cement to be used throughout the Works shall be Portland Cement obtained from manufacturers Approved in writing and shall be as described under one of the following headings.
2. Ordinary Portland Cement (OPC): Cement complying with either BS 12 or ASTM C150 Type I but containing not less than 7% and not more than 12% by weight of tricalcium aluminate (C<sub>3</sub>A).
3. Moderate Sulphate Resisting Portland Cement (MSRPC): Cement complying with BS 12 or ASTM C150 Type II but containing not less than 5% and not more than 9% by weight of tricalcium aluminate (C<sub>3</sub>A). In either case the cement shall not contain more than 2.7% by weight of sulphur trioxide (SO<sub>3</sub>).
4. Sulphate Resisting Portland Cement (SRPC): Cement complying with either BS 4027 or ASTM C150 Type V, but containing not more than 4% by weight of tricalcium aluminate (C<sub>3</sub>A).

#### **B. Additional Requirements**

1. In addition to the above requirements for cement to be used in permanent Works the acid soluble alkali level measured as (Na<sub>2</sub>O + 0.658 K<sub>2</sub>O) shall not exceed 0.6% by weight. Also the heat of hydration at 7 days in accordance with ASTM C186 shall not exceed 290 kJ/kg and the fineness (specific) in accordance with BS 4550 shall not be less than 280 m<sup>2</sup>/kg.
2. Cement shall be free of lumps. It shall be supplied in the manufacturer's sealed and unbroken bags or in bulk.
3. Cement that has become hardened or lumpy or fails to comply with this Specification in any way shall be removed from the Site.
4. High alumina cement shall not be used.

#### **C. Combinations of Cement with Ground Granulated Blastfurnace Slag (GGBS) or Pulverised Fuel Ash (PFA)**

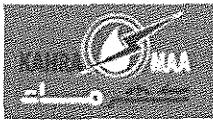
1. All GGBS incorporated into the concrete mix shall be in accordance with BS EN 15167 or ASTM C989.
2. All PFA incorporated into the concrete mix shall be in accordance with BS 6588, BS EN 450, ASTM C311 and ASTM C618.
3. Where specified by the Employer's Representative, GGBS or PFA may be combined in the concrete mixer with Portland cement complying with BS 12 as an alternative to the use of factory combinations. GGBS and PFA shall not both be added to the same concrete mix. The procedure given in Clause 4.4.3 of BS 5328 Part 1 shall be followed.



4. The alumina ( $\text{Al}_2\text{O}_3$ ) content of the GGBS shall not exceed 14%.
  5. No GGBS shall be added to any mix containing cements to BS 6588 or BS 6610, or any other cement combinations containing PFA.
  6. No PFA shall be added to any mix containing Portland Blast Furnace cements to BS 146, BS 4246 or BS 4248 or any other cement combination containing GGBS.
  7. Combination of cement with GGBS or PFA shall be carried out under controlled conditions and the proportions used shall be within the limits prescribed in BS 146, BS 4246, BS 4248, BS 6588 or BS 6610 as appropriate.
  8. No GGBS, PFA or cement combination including either of them shall be included in concrete mixes containing sulphate-resisting cement to BS 4027.
  9. Supersulphated cement to BS 4248 shall not be combined with any other type of cement.
- D. Combinations of Cement with Silica Fume (SF)
1. Where specified by the Employer's Representative the concrete mix may contain an Approved silica fume. The silica fume shall originate from production of silicon from Ferro-silicon alloys and shall have silicon dioxide content not less than 90%.
  2. Silica Fume shall comply with ASTM C1240 standard specifications.
  3. The Contractor shall submit proposals for the supply of silica fume to the Employer's Representative for approval.
  4. Chemical/physical analysis shall be provided for the following:

<b>Parameter</b>	<b>Criteria</b>
Specific gravity	2,200 kg/m <sup>3</sup> minimum
Bulk density (densified powder)	500-650 kg/m <sup>3</sup>
Specific surface	18m <sup>2</sup> /gram minimum
CaO	2.0% maximum
SiO <sub>2</sub>	90% minimum
Al <sub>2</sub> O <sub>3</sub>	1.0% maximum
Fe <sub>2</sub> O <sub>3</sub>	1.5% maximum
MgO	2.0% maximum
SO <sub>3</sub>	1.5% maximum
Alkali as Na <sub>2</sub> O (includes K <sub>2</sub> O)	4.5% maximum
C	3% maximum
Activity Index	Minimum 95% after 28 days
Loss of ignition	Maximum 4%
Percentage of particles greater than 44μm	Maximum 2%
Moisture content	Maximum 2%
Chloride content	Maximum 0.1%

5. Densified Silica Fume shall not exceed 8% by total weight of cementitious material.
6. Methods of test shall be in accordance with Norsk Standard NS 3045 or BS 4550 where applicable.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

7. Certification shall be provided for each consignment of silica fume delivered.
8. The silica fume supplied shall be from a single furnace and shall not be sub-supplied. The process of production of silica fume, i.e. the furnace product of which the silica fume is a by-product, shall not vary.
9. The method of incorporation of the silica fume into the mix shall be subject to the approval of the Employer's Representative. The Contractor shall submit a method statement describing the plant and equipment proposed for batching and mixing and the timing of addition of the silica fume to the mix. The method statement shall be supported by a letter from the silica fume supplier approving the methodology.
10. Silica fume shall be used in conjunction with a superplasticising admixture specially formulated to aid dispersion of the silica fume throughout the mix. Details of the proposed admixture shall be submitted to the Employer's Representative for approval.
11. The Contractor shall require that the silica fume supplier provides periodic on-site monitoring of batching, mixing, placing and curing of the concrete and reports on the above shall be submitted to the Employer's Representative for inspection. The representative of the silica fume supplier shall have the necessary technical expertise and local experience.

**E. Waterproof Concrete (WPC)**

1. Waterproof Concrete (WPC) shall prevent water penetration through the concrete and shall provide a dry internal environment in accordance with Grade 3 of Table 1 of BS 8102.
2. The admixtures for waterproof concrete and other related ingredients shall be obtained from a single supplier selected from the list below. No other supplier's admixtures or related ingredients may be used:
  - a. Al Gurg Fosroc.
  - b. Cementaid.
  - c. David Ball.
  - d. BASF Middle East.
3. Any admixture or ingredient used in the WPC must be shown by an independent authority to have been used in concrete exposed to a similar environment to that pertaining to the project, i.e., exposed to a severe coastal or marine environment in the Middle East, for a minimum of 10 years without measurable reduction in performance of the product and without significant deterioration of the cement matrix and/or embedded reinforcing steel. The dosage of the admixture shall be as advised by the material manufacturer, to achieve the required waterproofing.

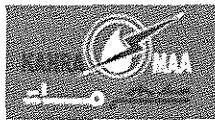


4. The concrete as placed and cured in the actual structure is required to comply with the Specification clauses for Concrete Mix Design, Trial Mixes and Durability Tests by achieving a score less than or equal to 4.0 when evaluated in accordance with the formula for WPC described in the Durability Tests clauses. The Employer's Representative reserves the right to take cores to confirm compliance. In the event of non-compliance, the Contractor shall carry out remedial measures as described elsewhere in the Specification.
5. The appointed Subcontractor shall submit, in addition to the field trials and laboratory test results, a proven actual application of the admixture under similar conditions (short-term and long-term conditions) that demonstrates the compliance or exceed the durability and workmanship requirements and watertightness standard, to the Engineers for Approval.

#### **2.1.2.2 AGGREGATES**

##### **A. General Requirements**

1. Except as may be modified hereunder, the aggregate (fine and coarse) for all types of concrete shall comply in all respects with BS 882 "Concrete aggregates from natural sources" and shall also comply with QCS 2010.
2. The aggregates used in the permanent works shall be naturally occurring crushed materials obtained only from Approved sources. Aggregates subject to high drying shrinkage such as quartz shall not be used. Aggregates shall be clean, hard, and durable and shall not contain iron pyrites, iron oxides, mica, shale, coal or other laminar, soft or porous materials or hollow shells, or materials likely to cause staining or otherwise disfigure the concrete surface.
3. Limestone shall not be used for aggregate.
4. Before any material from a particular source is used, the Contractor shall obtain representative samples of fine and coarse aggregates and carry out the necessary tests and analyses to show that the samples comply with the Specification. During the progress of the Works, the grading and chemical characteristics shall be checked at frequent intervals.
5. The results of these tests shall be submitted to the Employer's Representative and his approval shall be obtained before any of the material is used in the Works. Part of each sample will be required for concrete trial mixes and part shall be retained for comparison with subsequent deliveries.
6. Sampling for testing and analysis shall be carried out, where applicable, in accordance with BS 812 Part 102, BS EN 12620, BS EN 933, or with ASTM D75 and ASTM C702.
7. The maximum size of the aggregate shall not be larger than:
  - a. 20% of the narrowest dimension between sides of the member for which the concrete is to be used.
  - b. 75% of the maximum clear distance between reinforcing bars or the side form.
  - c. The nominal aggregate size specified for the mix.

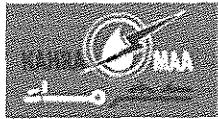


8. Fine Aggregate shall be clean sharp natural and/or crushed sand and shall be within BS882 Table 4 zones C and M only.
9. Beach sand shall not be used in concrete mixes.
10. Coarse aggregate shall be crushed aggregate obtained from a quarry Approved by the Employer's Representative.
11. Unless otherwise authorised by the Employer's Representative coarse aggregate shall be delivered to the batching plant in separate sizes according to the maximum specified aggregate size for each grade of concrete.
12. Coarse aggregate shall be prepared as single sized aggregate and blended to produce normal size grading. The combined grading shall be within the appropriate grading limits given in BS 882.
13. The Contractor may mechanically wash aggregate to remove salts and other impurities in order to meet the requirement specified.
14. No part of the aggregates shall contain any mineral known to have a potential to cause alkali silica, alkali silicate, alkali carbonate, or any other damaging chemical reaction between alkalis and aggregates. The Contractor shall demonstrate to the Employer's Representative satisfaction that the cement-aggregate combination will be stable and not liable to excessive internal expansion due to alkali-aggregate reaction. The Contractor's proposals for demonstrating this shall be submitted and shall take account of the time necessary for any testing. Under exceptional circumstances, the demonstration may be based on previous long-term experience of the materials. Otherwise, the Contractor shall undertake a programme of tests using an independent testing laboratory in accordance with the following requirements:
  - a. Aggregates shall comply with the requirements of Table 1.
  - b. Aggregates shall be initially assessed for reactivity in accordance with ASTM C289 and C1260 and if potential reactivity is indicated, and then tests in accordance with ASTM C227 and C586 shall be carried out.
15. The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period in which concrete is being produced for the Permanent Works. The tests set out below shall be performed on aggregates from each separate source. The frequency of testing of aggregates shall be in accordance with Table 2.

#### **2.1.2.3 WATER FOR CONCRETE**

- A. Water shall be clean and free from salt and other impurities to the satisfaction of the Employer's Representative. It shall be tested in accordance with BS 3148 or ASTM C94.
- B. Water used for mixing and curing of concrete shall have a pH value in the basic range of 7 to 9 and the soluble solids shall not exceed the following limits:

Total dissolved solids	2000 mg/L
Chlorides (as Cl)	1000 mg/L
Sulphate (SO <sub>4</sub> )	2000 mg/L



**Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)**

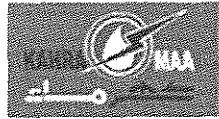
Alkali Carbonates & Bicarbonates                    500 mg/L

The temperature of water for concrete shall not be less than 5° C or more than 25° C at the time of mixing. Water temperature may be controlled by the gradual addition of chilled water or flaked ice but no ice particles shall be present when the water is added to the mix. The ice to be used shall be the product of water that complies with the above acceptance criteria



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Seri No	Requirement	Test Methods		Permissible Limits	
		BS/EN	ASTM	Fines	Coarse
1.	Grading	EN 933	C136	Standard	Standard
2.	Material finer than 0.075mm Natural, uncrushed/crushed	EN 93	C117& C136	max 3%	max 1%
	Crushed rock			max 5%	max 2%
Or	Materials finer than 0.063mm, Natural, Uncrushed/Crushed, or used for Foundation, retaining structure or structure exposed to weather			max 3%	max 1.5%
	Crushed Rock or used for structure elements not exposed to the weather.			max 5%	max 1.5%
3.	Clay lumps and friable particles		C142	max 1%	max.1%
4.	Light weight pieces		C123	max 0.5%	max 0.5%
5.	Organic impurities	BS	C40	Colour Standard not darker than plate no. 3 <sup>2</sup> .	
6.	Water absorption (Saturated Surface dry)	EN	C128/C1	max 2.3%	max
7.	Sand Equivalent	EN	D 2419	Min. 70%	N.A
8.	Specific gravity (apparent) for Normal weight concrete: Used for reinforced concrete Used for non-reinforced concrete	EN	C128/C1	min 2.6 min 2.4	min min
9.	Shell content in aggregates:	EN		max 3%	max



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

10.	Particle shape : -Flakiness index Used for reinforced concrete Used for plain or non-reinforced concrete				max max
	-Elongation index Used for reinforced concrete Used for plain or non-reinforced concrete				max max
	-Elongation/Flakiness Factor	See			
11.	Acid soluble chlorides, Cl: For reinforced concrete made with (1) SRPC cement (2) OPC & MSRPC cements For mass concrete made with (1) SRPC cement (2) OPC & MSRPC cements	Part App C		(1) max. 0.03% (2) max. 0.03%  (1) max. 0.03% (2) max. 0.05%	(1) max 0.01% (2) max  (1) max 0.02% (2) max 0.04%
	For prestressed concrete & steam cured structural concrete			max. 0.01%	max.
12.	Acid soluble sulphates, SO <sub>3</sub>	BS 812 Part		max. 0.3%	max.



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSS  
(Packages A, B, C, D & E)

13.	Soundness, MgSO <sub>4</sub> (5 cycles) Sodium sulphate Na <sub>2</sub> SO <sub>4</sub>		C88 C88	max. 12% max. 10%	max.
14.	Mechanical strength 10% fines value or Impact value Los Angeles abrasion	BS 812 Part Part	C131/C5		min.  max.
15.	Drying shrinkage	BS 812 Part		max. 0.05%	max.0.
16.	Potential reactivity Aggregates, chemical method Cement-aggregate combination		C289 C227,	Innocuous 6 month expansion 0.10% max.	Innocu

**Table 1 Limits For Physical, Chemical And Mechanical Properties Of Aggregates For Concrete**

Note:

1. Not more than 5% of particles shall have ratios (w:b:l)\* greater than 1:2:3 (flakey) and 1:1:3 (elongate) when tested by visual inspection of 100g of sand under a microscope where the ratio w:b:l represents width : breadth : length.
2. Use of fine aggregate failing in the test is not prohibited, provided that:
  - a. The discolouration is due principally to the presence of small quantities of coal, lignite, or similar discrete particles.
  - b. When tested for the effect of organic impurities on strength of mortar, the relative strength at 7 days, calculated in accordance with ASTM C87, is not less than 95%.
3. Applicable only for high strength concrete using 10mm aggregates. For 20mm aggregates, the 10% fines value will be at least 150kN.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

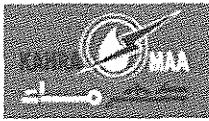
<b>Serial</b>	<b>Property</b>	<b>Test Method</b>	<b>Test Frequency Rate</b>
1.	Grading	AASHTO T27, ASTM C33,C136, BS EN 933-1	-Each Source -Visible change in gradation -Every change in Job
2.	Material finer than 0.075 mm	AASHTO T11, ASTM C117, BS EN 933-1	-Each Source -Visible change in gradation 1 test daily
3.	Clay lumps and Friable Particles	ASTM C142, AASHTO T112	-Each Source -Visible change in material 1 test weekly
4.	Lightweight pieces	AASHTO T113, ASTM C33, C123 BS EN 1744-1	-Each Source -Visible change in material -1 test weekly -1 test every 4000m <sup>3</sup>
5.	Organic impurities	AASHTO T21, T71 ASTM C40, C87 BS EN 1744-1	-Each Source -Visible change in material -1 test monthly -1 test every 16,000m <sup>3</sup>
6.	Water absorption	ASTM C128/ C127	-Each Source -Visible change in material -1 test daily -1 test every 1,000m <sup>3</sup>
7.	Specific gravity	ASTM C128/ C127	-Each Source -Visible change in material -1 test daily -1 test every 1,000m <sup>3</sup>
8.	Shell content	BS EN 933-7	-Each Source -Visible change in material -1 test weekly -1 test every 4,000m <sup>3</sup>
9.	Particle shape	BS 812 Part 105.1 & 105.2	Each 2 months or per 100 m <sup>3</sup> whichever is more frequent
10	Acid soluble chlorides, Cl <sup>(2)</sup> : Qualitative	BS 812 Part 117	On each delivery of aggregate
	Quantitative	Appendices A/B BS 812 Part 117	Each 6 concrete days if result is



		Appendix C	the limit and each month if result is less than 75% of the limit.
11	Acid soluble sulphates SO <sub>3</sub>	BS 812 Part 118	Each 12 concrete days if result is more than 75% of the limit & each 2 months if result is less than 75% of the limit
12.	Soundness, Mg SO <sub>4</sub> (5 cycles)	ASTM C88	Each 48 concrete days
13.	Mechanical strength 10% Fines or impact value  Los Angeles abrasion	BS 812 Parts 111, 112  ASTM C 131/C 535	Each 72 concrete days  Each 72 concrete days
14.	Drying shrinkage <sup>(1)</sup>	BS812 Part 120	At the start of the project and whenever there is a change in the source of supply
15	Potential reactivity of aggregates <sup>(1)</sup> :	ASTM C295, C289	At the start of the project of aggregates and wherever there is a change in the source of
	- of carbonate - of cement/aggregate combination	ASTM C586 C227, C1260	
16.	Moisture variation by moisture meters		In accordance with the Specification but not less than twice daily

**Table 2 Frequency of Routine Tests on Aggregates**

1. Drying shrinkage and Potential Reactivity of aggregates shall be determined initially at the start of the project or whenever there is a change in the source of supply or where in the opinion of the Employer's Representative the material is deemed to be changed.
2. The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load in order to prevent excessive amounts of chloride contaminating the concrete. For this purpose the Contractor shall use the rapid field test (Quantab test). In the event of disagreement regarding the results of the field test, the chloride content of the aggregate shall be determined in the laboratory as described in BS 812 (the Volhard test).



#### **2.1.2.4 ADMIXTURES**

- A. The Contractor shall obtain the Employer's Representative approval prior to the use of admixtures in each mix. The suitability of the admixture shall be verified by trial mixes. The Contractor shall submit certification and test results for each consignment, for the Engineer's approval.
- B. Admixtures shall be stored to avoid deterioration and segregation.
- C. Admixtures shall be used strictly in accordance with the manufacturer's instructions unless directed otherwise by the Employer's Representative.
- D. Neither calcium chloride nor any admixture containing chlorides shall be used. The supplier shall satisfy the Employer's Representative that any admixture or ingredient used, or their combination, does not detrimentally affect the strength or other properties of the concrete.
- E. Both the amount of admixture to be added and the method of use require the approval of the Employer's Representative for whom the following data shall be provided:
  - 1. The chemical name(s) of the main active ingredient(s) in the admixture.
  - 2. Whether or not the admixture contains chlorides.
  - 3. The typical dosage and detrimental effects of under-dosage and over-dosage.
  - 4. Whether or not the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage.
  - 5. Long-term and short-term effects of the admixture on concrete, and the effect of different types of cement and aggregate.
  - 6. Storage life and any special storage requirements.
  - 7. Safety precautions in handling.
  - 8. Availability of on-site technical service.
- F. Admixtures shall comply with one of the following Standards: BS 1014, BS 3892, BS 5075 or ASTM C494 as appropriate.
- G. Air entrainment agents shall be such that the air content can be maintained within the limits specified even if the mixing time is extended to 30 minutes.
- H. Admixtures from different suppliers shall not be used in the same concrete mix. Two or more admixtures from the same supplier may be used subject to successful trial mixes and approval from the supplier and the Employer's Representative.

#### **2.1.2.5 REINFORCEMENT BARS**

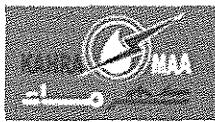
- A. All steel reinforcement shall conform to the requirements of the Specifications for Grade B500 to BS 4449:2005, unless otherwise shown on the Drawings or specified by the Contractor's Representative.
- B. The mill test report for three different samples shall be furnished to the Employer's Representative for each consignment of steel reinforcement bars proposed for use on the project. Samples from each size and type of proposed reinforcement shall be locally tested and test results submitted for the Engineers approval.



- C. The bars in each consignment shall be legibly tagged in accordance with CARES requirements (or similar international certification organisation) by the manufacturer and/or fabricator before being offered for inspection. The tag shall show the manufacturer's test number and consignment number and other applicable data that will identify the material with the certificate issued for that consignment of steel.
- D. The fabricator shall furnish copies of a certification which shows the heat number or numbers from which each size of bar in the shipment was fabricated. The heat number of reinforcement to be used for different elements shall be clearly identified and given on the BB Schedule and delivery notes. A record on the traceability of the heat numbers of the reinforcement used at Site for each structural element shall be submitted to the Engineer.
- E. The Contractor shall provide certificates confirming that samples taken from the bars delivered to the Works pass all the tests required in BS 4449. The frequency of sampling and the method of quality control shall be in accordance with BS 4449. The Employer's Representative reserves the right to inspect, sample and instruct testing of the reinforcement steel upon its arrival at the work Site, in accordance with clause B of BS 4449. All such sampling and associated testing costs shall be borne by the Contractor.
- F. All reinforcement bars shall be free from detrimental dirt, mill scale, loose rust, paint, grease, oil or other foreign substance, fins, or tears. There shall be no evidence of visual flaws in the bars, test specimens or on the sheared ends of the bars.
- G. All reinforcement shall be cleaned before use to remove rust, oil, grease, salt and other deleterious materials. Where pitting has occurred the bars shall be rejected. Blasting may be required when the reinforcement is in position, or partially cast in. Partially set concrete adhering to exposed bars during concreting operations shall be removed.
- H. Water cleaning of reinforcement to remove chloride contamination shall be carried out prior to pouring of concrete. Cleaning water shall be the same quality as mixing water for concrete.
- I. The minimum thickness of concrete cover to reinforcement shall be as shown on the Drawings and shall comply with QCS 2010 requirements. Only Approved spacers shall be used.
- J. All reinforcement to be used below ground or in water retaining structures shall be epoxy coated in accordance with ASTM A934 / A934M – 13, including written certifications for coating material and coated bars, sample of coating material, and 0.25 Kg of patching material.

Epoxy coated reinforcement shall be fixed using plastic or nylon ties to avoid damage and shall be supported using plastic or plastic coated chairs, runners, bolsters, spacers, hangers and rebar supports as required.

All bars shall be checked and inspected on site for handling defects, coating abrasion, coating thickness and continuity of coating after the bars have been erected and all handling is completed. Repairs to coated areas shall be completed as directed by the Kahramaa site representative. Concrete shall not be placed until suitable repair has been completed.



Patching and repair to be performed in accordance with the instructions of patching material manufacturer.

Areas to be patched shall be clean and free of surface contaminants. Treat areas in accordance with patching material manufacturer's instructions before oxidation occurs. The total surface area covered by patching material not to exceed 2 percent of the total surface area of the rebar. Welds and adjacent bare rebar areas to also be patched after any welding is completed.

Steel reinforcement for all reservoirs (external and internal elements, underground structures (external element only), piles and chambers shall be protected by epoxy coating and shall be tested in accordance with ASTM A755/A755M-07.

Steel reinforcement for all above ground structures shall be un-coated bars.

#### **2.1.2.6 WELDED WIRE FABRIC**

- A. Welded wire fabric to be used for the reinforcement of concrete shall conform to the following requirements.
- B. Dimensions: Welded steel wire fabric shall conform to the size and dimensions shown on the Drawings.
- C. Properties: Wire fabric furnished under this Specification shall conform to both BS 4483 and BS 4449, with a characteristic strength of 485 N/mm<sup>2</sup> and shall be delivered to Site in flat mats.

#### **2.1.2.7 SPACER BLOCKS**

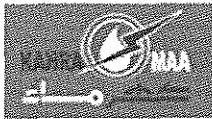
- A. Spacers as Approved by the Employer's Representative shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.
- B. Spacer blocks made from cement, sand and small aggregate shall match the mix proportions of the surrounding concrete so far as is practicable be comparable in strength, durability and appearance. Their surface shall be roughened to ensure satisfactory bond with the surrounding concrete.

#### **2.1.2.8 SURFACE TREATMENTS**

- A. Refer to clause 2.1.3.14 for classes of concrete finishes.
- B. Refer to clause 2.1.3.15 for architectural surface finishes.

#### **2.1.2.9 MECHANICAL COUPLERS FOR REINFORCEMENT**

- A. Couplers are only to be supplied from a manufacturer with a QA/QC system accredited by an internationally recognized accreditation agency.
- B. The contractor is to furnish three (3) copies of all test certificates for each size and type of coupler proposed, demonstrating their compliance with the



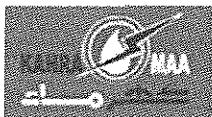
requirements of relevant British Standards, and the particular performance requirements of this specification.

- C. The performance criteria for couplers for each representative gauge length assembly comprising of reinforcement size, grade and profile to be used and a coupler of the precise type to be used the following minimum criteria must be attained.
- D. Permanent elongation after loading to 60 percent of the yield strength of the bar ( $0.6fy$ ) in tension must not exceed 0.1mm.
- E. The strength of the coupled bar in both tension and compression must exceed 125 percent of the yield strength of the bar ( $1.25fy$ ) for grade 250B, 500A and 500B reinforcement or 95 percent of the ultimate actual tensile strength of the reinforcement bars.
- F. The couplers in each consignment shall be legibly tagged by the manufacturer and/or fabricator before being offered for inspection. The tag shall show the manufacturer's test number and consignment number and other applicable data that will identify each coupler with the certificate issued for that consignment.
- G. The Contractor shall provide certificates confirming that samples taken from the couplers delivered to the Works pass all the tests required by this specification. The frequency of sampling and the method of quality control shall be in accordance with British Standards and agreed with the Employer's Representative prior to commencing.
- H. The minimum on Site testing requirements are as follows:
  - 1. Prior to installation in the permanent works, 3 tests of each coupler size and type to be used are to be completed by an Approved independent testing laboratory with results submitted for review and approval by the Employer's Representative. Failure of any one of these tests will result in the immediate testing of no less than 25 couplers from the failed batch to determine if manufacturing defects exist.
  - 2. Once initial testing is successfully completed and couplers are Approved for use in the permanent works 1 sample for every 200 couplers of each coupler type and size shall be tested. If one coupler test fails 25 from the failed batch must be tested immediately to determine if a manufacturing defect exists in the current delivery. The subsequent rate of testing will then be reassessed.
- I. The Employer's Representative reserves the right to inspect, sample and instruct testing of the coupler assemblies upon its arrival at the work Site. All such sampling and associated testing costs shall be borne by the Contractor.

#### **2.1.2.10 CONCRETE COVER TO REINFORCEMENTS**

The concrete cover to reinforcement shall be in accordance with the table below:

Description	Nominal Cover
External faces exposed to weathering cast against ground	75 mm
External faces exposed to weathering cast against blinding	65 mm



External faces exposed to weathering cast against formwork or screed	50 mm
Internal faces exposed to potable water	40 mm
Internal beams and columns	40 mm
Internal walls and slabs	40 mm

## 2.1.3 EXECUTION

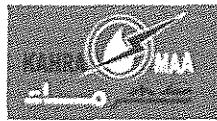
### 2.1.3.1 CONCRETE

- A. The Contractor shall provide concrete that is described by the Employer's Representative by reference to a combination of characteristic properties. These shall include but are not limited to the performance requirements described in Table 3.
- B. Concrete Mix Design
  1. Mixes for structural concrete shall be designed by the Contractor to meet the performance requirements specified in clause 3.1 above.
  2. The Contractor is responsible to the Employer's Representative for demonstrating that the proposed mix meets with the performance requirements.
  3. Concrete shall comply with BS 8110 except where BS 8007 or this Specification differs. Sampling for test purposes shall comply with BS EN 12350-1 (on Site) & BS 1881 Part 125 (in laboratory).
  4. If air-entrainment is specified the average air content at the time of placing measured in accordance with either Method A or Method B of BS 1881 Part 106 shall be  $5\% \pm 1\%$  for concrete containing 20mm maximum size aggregate.
  5. Concrete for water-retaining elements shall be watertight and shall comply with the recommendations of BS 8007.
  6. Concrete for paving or precast units shall be tested to BS EN 12390-5.
  7. If concrete specimens are cured at higher temperatures or for longer periods than BS 1881 Part 111 requires, the adjusted Characteristic Compressive Strength (CCS) shall be calculated as follows:

$100f'/f$	=	$A + B \log \{24D(T+12)/1000\}$ where
$f'$	=	adjusted CCS
$f$	=	specified CCS
$T$	=	curing temperature in $^{\circ}\text{C}$
$D$	=	age at testing in days
A&B	=	are coefficients given in the following table.

The equation applies only to OPC, MSRPC and SRPC

Recorded Cube Strength (MPa)	A	B
Less than 15	10.0	67.5



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Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

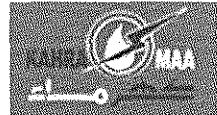
15 to 35	20.0	60.0
Greater than 35	30.0	52.5

This calculation may be applied for curing at temperatures up to 27°C.



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
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Class of Concrete	Purpose	Exposure Conditions to BS 8110 Part 1 Tables 3.2 & 6.1	Min CCS at 28 Days (MPa)	Concrete Mix	Max Rapid Chloride Permeability to AASHTO T277 (Coulombs)	Max Water Permeability to DIN 1048 (mm)	Max Initial Surface Absorption to BS 1881 Part 208 (ml/m <sup>2</sup> /s)	30 min Water Absorption to BS 1881 Part 122 (%)	Max Drying Shrinkage to BS 812 Part 120 (%)	Min Cement Content (kg/m <sup>3</sup> )	Max Water/Cement Ratio
A	Blinding	External in contact with ground	20	SRPC	*	*	*	*	*	250	0.5
B	Piles	Very Severe: External in contact with ground	40	GGBS+OPC+SF or PFA+OPC+SF	1000	10	0.15	1.5	0.04	370	0.45
C	Basement Envelope which includes a waterproof membrane (WPM). Elements include: Reservoirs (base, walls, roof slab and columns), raft slab, pile caps, basement walls, and retaining wall caps.	Very Severe: External in contact with WPM	40	WPC  GGBS+OPC+SF or PFA+OPC+SF	500	5	0.02	1.2	0.04	370	0.40
D	Superstructure columns, slabs, walls and ramps	Severe: External and internal uncontrolled environment	40	GGBS+OPC or PFA+OPC	1200	10	0.15	1.5	0.04	370	0.45
G	Superstructure columns, slabs, walls, beams	Moderate: Internal controlled environment	40	OPC	1200	10	0.15	1.5	0.04	370	0.45



H	Manholes, inspection chambers, valve chambers to include potable, irrigation, fire fighting and main process pipeline chambers	Very Severe: External in contact with WPM	40	GGBS+OPC or PFA+OPC	1000	10	0.15	1.5	0.04	370	0.45
I	Screeed protection concrete	-	20	OPC	*	*	*	*	*	250	0.5
J	Prestressed Beams	Moderate: Internal controlled environment	50	GGBS+OPC or PFA+OPC	1200	10	0.15	1.5	0.04	380	0.40
H	Screeed protection	-	20	OPC	*	*	*	*	*	250	0.5

#### Notes

1. An asterisk \* in the above table denotes that the pertinent provisions of Section 3.9 will prevail.
2. The above concrete mix types and minimum cement content are suggested by the Employer's Representative. Except for WPC, other mixes may be proposed by the Contractor and submitted for approval.
3. For two target strengths at 28 days refer the structural Drawings for the Schedule.

#### Abbreviations

GGBS: OPC concrete blend with Ground Granulated Blastfurnace Slag. The amount of GGBS by % of cement shall be as follows:

CEMIII/B (BS EN 197) - 66% to 75%

OPC: Ordinary Portland Cement Concrete

SF: Concrete with 5% to 10% Silica Fume

SRC: Sulphate Resisting Portland Cement Concrete

WPC: Waterproof Concrete: A triple blend concrete with a Permeability-Reducing Admixture for Hydrostatic conditions (PRAH). The admixture shall be a high performance integral water proofer (Pore-Blocking type).

WPM: Waterproof Membrane

PFA: OPC concrete blend with Pulverised Fly Ash. The amount of PFA by % of cement shall be as follows:

CEMIV/B-V (BS EN 197) - 40% to 36%

CCS: Characteristic Compressive Strength



8. Before placing concrete the Contractor shall obtain approval of the mixes proposed for each class of concrete and the average target strengths. The mixes shall be designed to achieve the minimum workability for the Contractor to place and compact the concrete with the equipment proposed for use.
9. The design mean strength shall exceed the minimum CCS specified in the performance requirements by a margin of 1.64 times the standard deviation expected from the concreting plant, except that no standard deviation less than 3.5 MPa shall be used as a basis for designing a mix.

**C. Trial Mixes**

1. Preliminary laboratory tests shall be carried out to determine if the mixes satisfy the Specification with the Approved materials.
2. Trial mixes shall be tested to determine the following properties of mixes proposed for initial field tests:
  - a. Bleeding in accordance with ASTM C232 (non-vibrating) shall not exceed 0.5%.
  - b. Drying shrinkage in accordance with BS 812 Part 120.
  - c. Air content if applicable BS 1881 Part 106.
  - d. Free water/cement ratio.
  - e. Workability tests BS EN 12350 Part 102, 103, 104 and 105.
  - f. Fresh and hardened concrete densities BS EN 12350 Part 106.
  - g. Compressive strength BS 1881 Part 116. The CCS of the concrete shall be determined on test specimens obtained and prepared in accordance with BS 1881 Part 108.
  - h. Tensile strength BS 1881 Part 118.
  - i. Water Permeability DIN 1048.
  - j. Water absorption BS 1881 Part 122.
  - k. Initial surface absorption BS 1881 Part 5.
  - l. Chloride Permeability to AASHTO T277.
  - m. Chloride and sulphate levels to BS 1881 Part 124.
  - n. Coefficient of linear expansion to US Army Corps of Engineers CRD-C 39-81.
  - o. Heat of hydration.
  - p. Other tests as dictated by concrete performance requirements or directed by the Employer's Representative.
3. If the values obtained do not comply with the Specification or are not to the full satisfaction of the Employer's Representative then the mixes shall be re-designed.
4. Before commencement of concreting Approved trial mixes shall be prepared under full-scale Site conditions and tested in accordance with the relevant standards.
5. Three trial batches of each mix shall be made and from each batch a minimum of 6 cubes shall be tested for strength. Three cubes shall be



tested at 7 days and three cubes at 28 days by a laboratory Approved by the Employer's Representative. The results shall be submitted to the Employer's Representative within 24 hours of testing. Additional cubes shall be required as instructed by the Employer's Representative for durability testing.

6. Further trial mixes shall be made if the range (the maximum minus the minimum of the three cube results in any batch) exceeds 15% of the average of that batch, or if the range of the three batch averages exceeds 20% of the overall average of the batches.
7. Actual Characteristic Strength
  - a. The average 28 day cube strength achieved in the trials shall be designated as the Target Mean Strength and from this the Actual Characteristic Strength shall be calculated for each mix.
  - b. The Actual Characteristic Strength equals the Target Mean Strength minus a margin of 1.64 times the standard deviation, except that the margin shall not be less than 4MPa.
  - c. In no case shall the Actual Characteristic Strength be less than the minimum CCS specified in the performance requirements.
  - d. The Actual Characteristic Strength so determined shall be used throughout the duration of the project as the primary indicator of control of mix proportions and water/cement ratio.
8. The Employer's Representative will review the Contractor's trial-mixes and all test results. The Employer's Representative will then determine which of the trial mixes shall be used. If none of the trial mixes for a class of concrete meets the Specifications, the Employer's Representative will direct the Contractor to prepare additional trial-mixes. No class of concrete shall be prepared or placed until its job-mix proportions have been Approved by the Employer's Representative.
9. The approval of the job-mix proportions by the Employer's Representative in establishing those proportions, in no way relieves the Contractor of the responsibility of producing concrete which meets the requirements of these Specifications.
10. The Employer's Representative may also require practical tests to be made on the Site by filling trial moulds incorporating the reinforcing details to confirm the suitability of the mix for the Works. In these tests, the type of plant used for mixing, the method of placing and compaction used and the type of formwork intended for use in the Works shall be used.
11. All costs connected with the preparations of trial-mixes and the design of the job-mixes shall be borne by the Contractor.
12. When the mix has been Approved, no variations shall be made in the proportions, the source of the cement and aggregates, or in the type, size and grading zone of the latter without the consent of the Employer's Representative who prior to giving such consent may require further tests to be made.
13. The heat of hydration test sample shall comprise a 1m x 1m x 1m test cube, insulated with polystyrene. Temperature measurements shall be carried out in accordance with the Specification clauses for controlling heat and shall determine the peak temperature generated within the test sample.



#### 14. Tolerances in Proportioning the Materials

1. Cement and aggregates shall be measured to the tolerances stated in mixing concrete below.
2. The mixing water shall be measured by weight or by volume. In either case the measurement shall be accurate to within one (1) percent throughout the range of use.
3. Admixtures shall be dispensed by a system Approved by the admixture supplier and the Employer's Representative and shall be capable of dispensing the admixture to an accuracy of 1% by weight or by volume.

#### 2.1.3.2 MIXING CONCRETE

- A. Cast-in-place concrete shall be ready mixed concrete, batched off the Site, generally as defined in BS 5328, BS EN 206 and BS 8500 but as amended in these Specifications.
- B. The weighing and water-dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in BS 1305 and checked against accurate weights and volumes when required by the Employer's Representative.
- C. The mass of cement and of aggregate indicated by the mechanism employed shall be within a tolerance of 2% of the respective mass per batch agreed by the Employer's Representative. The mass of the fine and coarse aggregates shall be adjusted to allow for the free water contained in them. The water to be added to the mix shall be reduced by the quantity of free water contained in the fine and coarse aggregates, which shall be determined by the Contractor by a method Approved by the Employer's Representative immediately before mixing begins and further as the Employer's Representative requires.
- D. Unless otherwise agreed by the Employer's Representative, concrete shall be mixed in a batch type mixer manufactured in accordance with BS 1305. The mixing blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerance by adjustment. The period of mixing, judged from the time that all the ingredients including water are in the mixing drum shall be as ordered by the Employer's representative and shall be in accordance with the mixer manufacturer's recommendations.
- E. Mixers that have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed.
- F. The method of discharge from the mixer shall be such as to cause no segregation whether partial or otherwise of the concrete materials.
- G. The Contractor shall ensure that the constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position. Precautions shall include the shading of aggregate stockpiles and the use of chilled water.
- H. The Concrete shall be carried in purpose-made agitators, operating continuously, or truck mixers. The concrete shall be compacted and in its final position within 1 hour of the introduction of cement to the aggregates, unless a longer time is agreed by the Employer's Representative. The time of such introduction shall be

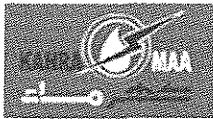


recorded on the delivery note together with the weight of the constituents of each mix.

- I. Concrete shall only be mixed at a batching plant approved by the Employer's Representative.
- J. Unless specially authorised by the Employer's Representative, the concrete shall be mixed and the water added to the mixer at the batching plant. No additional water shall be added at any stage from batching to placing. When the Employer's Representative is asked to authorise dry batching, he will require to be satisfied that appropriate steps will be taken to ensure the quality, consistency and strength of the concrete as placed and that the water will be added to the dry ingredients under properly controlled conditions.
- K. Truck mixer units and their mixing and discharge performance shall be to the satisfaction of the Employer's Representative. Mixing shall continue for the number and rate of revolutions recommended in the manufacturer's instructions, in the absence of which mixing shall continue for not less than 100 revolutions at a rate of not less than 7 revolutions per minute.
- L. Pumping concrete through delivery pipes may be permitted but only with the prior approval of the Employer's Representative.
- M. Re-mixing of concrete that has commenced to set shall not be allowed and in no case shall such concrete be used in the Works.

#### **2.1.3.3 PREPARATION AND PERMISSION TO CONCRETE**

- A. Prior to the commencement of concrete works, the Contractor shall provide the Employer's Representative with fully detailed proposals of the logistics for concrete conveyance, method of placing, compacting, finishing and curing the concrete. The method statements, which shall be subject to the approval of the Employer's Representative, shall cover all principle types of concrete elements, e.g. foundations, walls, columns, beams, slabs etc.
- B. As a minimum requirement, preparations for concreting shall follow the guidelines given in ACI 305R-91 Section 4.
- C. The concrete-mixing plant, mixers, pipelines, pumps chutes and transport equipment shall be shaded and/or painted white. Pump lines and other surfaces shall be kept cool by insulating them or by covering them with hessian kept damp by spraying with water.
- D. Surfaces on which concrete is to be placed shall be moist but free of standing water at the time of concreting. This shall be achieved by spraying the forms and reinforcement prior to placing concrete. Shading shall be provided to prevent solar heat gain of forms and reinforcement and to prevent evaporation / drying.
- E. When daytime temperature and drying conditions are critical the concreting shall be scheduled to begin during the late afternoon to prevent the occurrence of severe thermal effects. Consideration should also be given to night-time concreting.
- F. The Contractor shall give the Employer's Representative at least 24 hours written notice before concreting to allow time for final inspection and approval.



#### **2.1.3.4 TRANSPORT AND PLACING**

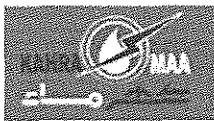
- A. The method of transport and placing concrete shall be to the approval of the Employer's Representative. Concrete shall be so transported and placed that contamination, segregation or loss of the constituent materials does not occur.
- B. All formwork and reinforcement shall be clean and free from standing water immediately before placing concrete.
- C. Prior to placing any concrete on natural surfaces a blinding layer of concrete shall be laid to a minimum of 75 mm thickness unless otherwise specified on the Drawings. This blinding shall be suitably cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust or impurities prior to subsequent concrete placement.
- D. No concrete shall be placed in a foundation until the extent of excavation and the character of bearing material have been Approved and no concrete shall be placed in any structure until the placement of reinforcing steel, embedments and the adequacy of the forms and falsework have been Approved.
- E. Concrete shall not be placed in any part of the Works until the Employer's Representative approval has been given. If concrete has not started within 24 hours of such approval being given, approval shall again be requested. Concreting shall then proceed continuously over the area between construction joints. Fresh concrete shall not be placed against in-situ concrete that has been in position for more than 30 minutes unless a construction joint is formed in accordance with the Specification. When the concrete has been in place for 4 hours, or less as directed by the Employer's Representative, further concrete shall not be placed against the cold joint for at least a further 20 hours.
- F. Concrete
- G. Concreting in Hot Weather
  - 1. Hot weather is defined as any combination of the following conditions that tend to impair the quality of the freshly mixed or hardened concrete:
    - a. High ambient temperature.
    - b. High concrete temperature.
    - c. Low relative humidity.
    - d. Wind velocity.
    - e. Solar radiation.
  - 2. When the rate of evaporation of surface moisture from concrete is expected to approach 1 kg/m<sup>2</sup>/hr (using Fig. 2.1.5 in ACI 305R-91) or when the shade air temperature is 35°C and rising, precautions shall be taken, including the following:
    - a. Dampening the forms.
    - b. Reducing the concrete temperature to the lowest practical level by procedures such as: shading the aggregate; cooling the mixing water before use and screening the mixing plant and transporting vehicles from wind, rain and sun.
    - c. Erecting wind breaks and sunshades at the concrete placing location.
    - d. Reducing the time between the placing of the concrete and the start of curing to the minimum possible.



- e. Minimising evaporation (particularly during the first few hours subsequent to placing the concrete) by suitable means such as applying moisture by fog spraying or use of evaporation retarders.
3. All precautions to be taken shall be subject to the Employer's Representative approval and the Contractor shall demonstrate that all Approved precautions are available for use prior to the Employer's Representative granting approval to any concreting operations.
4. In the event that conditions become such that these requirements cannot be met, concreting shall be suspended immediately and not resumed until the requirements can be met again. Under such circumstances, additional precautions shall be taken to avoid the hot weather concreting conditions being exceeded on future pours.

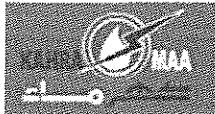
#### H. Control of Temperature

1. The temperature of the concrete when placed shall not exceed 32°C nor shall concrete be mixed or placed when the shade air temperature is 40°C or above, or is expected to reach such a level during concreting and 3 hours after placing, without special permission from the Employer's Representative.
2. For all concrete sections the Contractor shall take precautions to limit the effects of heat of hydration.
3. The Contractor shall determine the expected heat of hydration for the concrete batch by testing at least 1m<sup>3</sup> insulated concrete cubes, in accordance with the Specification clauses for the trial mixes. The concrete temperature may also be checked and monitored in-situ where required for sections of more than 1M thick by installing thermocouples to the permanent structures.
4. For concrete sections greater than 1000 mm thick (*including any part of tapered sections greater than 1000 mm*), the Contractor shall submit to the Employer's Representative for approval detailed proposals of the measures to be taken. These measures shall include but are not limited to: building mock-ups; control of concrete mix constituents; curing water; formwork type; surface insulation; and, cooling by embedded pipes. All submissions shall be based on measured values of heat of hydration generated by the proposed mix to meet the criteria set out below:
  - a. Maximum temperature difference between the core and the surface of any pour. Design target 15°C. Field maximum 25°C.
  - b. Maximum temperature difference between a new pour and a previous pour. Design target 12°C. Field maximum 15°C.
  - c. Absolute maximum temperature anywhere in a pour. Design target 60°C. Field maximum 70°C.
  - d. The Contractor shall install instrumentation in the Works to verify compliance with the above criteria. Temperature measurements shall be made by means of thermocouples positioned in a line perpendicular to the concrete faces. The thermocouples shall be fixed: at the concrete faces; at the centre of the section; and at equal intervals of approximately 300mm.
  - e. Temperatures shall be measured and logged continuously from the start of the pour until instructed to stop by the Employer's



Representative. The Contractor shall submit to the Employer's Representative for approval details of the proposed methods and equipment for the measuring and logging of temperatures. An automatic data logger or other suitable device shall log data. The equipment shall be capable of reading all thermocouples in less than one minute and results shall be submitted to the Employer's Representative on a daily basis.

- f. If temperature measurements exceed any of the criteria above then action shall be taken in accordance with the clauses on defective concrete.
- I. Concrete shall be compacted in its final position within 30 minutes of discharge from the mixer unless carried in purpose made agitators operating continuously, when the time shall be within 1 hour of the introduction of cement to the mix and within 30 minutes of discharge from the agitator.
- J. Precautions shall be taken to ensure that the loss of slump due to temperature rise during transport, pumping and placing does not exceed 25mm.
- K. Except where otherwise agreed by the Employer's Representative, concrete shall be deposited in horizontal layers to a compacted depth not exceeding 400mm where internal vibrators are used or 300mm in all other cases.
- L. Unless otherwise agreed by the Employer's Representative, concrete shall not be dropped into place from a height exceeding 1.5m. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. Where steep slopes are required for placing concrete with chutes, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of the movement. Chutes and the use of chutes must be Approved by the Employer's Representative. All chutes shall be kept clean and free from coating of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.
- M. Concrete shall not be pumped through aluminium alloy conduits.
- N. No concrete shall be placed in flowing water. Underwater concrete shall be placed in position by tremie or by pipeline from the mixer.
- O. Full details of the method proposed shall be submitted in advance to the Employer's Representative and his approval obtained before placing begins. Where the concrete is placed by the tremie, its size and method of operation shall be in accordance with BS 8004. During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended until the Employer's Representative permits them to be continued.
- P. Approved measures shall be taken to avoid premature stiffening of concrete placed in contact with hot, dry surfaces. Surfaces including reinforcement against which concrete is to be placed shall be shielded against the direct rays of the sun and shall be sprayed with water to prevent excessive absorption by the surfaces of water from the fresh concrete.
- Q. A complete pour record shall be kept of the date, time, temperature and conditions of placing, the concrete in each portion of the work and shall be available for inspection by the Employer's Representative at any time.
- R. No concrete shall be mixed or placed when the light is insufficient, unless an adequate and Approved artificial lighting system is operated and such night work is Approved by the Employer's Representative.



#### **2.1.3.5 EXTENT OF POURS**

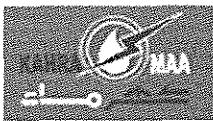
- A. The extent of individual pour, height of lift and sequence of pour shall be submitted to the Employer's Representative for approval. The pouring sequence shall be arranged to minimise thermal and shrinkage strains.
- B. The Concrete Works have been designed as continuous construction in accordance with BS 8007 and CIRIA C660. Therefore, consideration should be given to maximising the size of pours and minimising the number of construction joints.

#### **2.1.3.6 COMPACTION OF CONCRETE**

- A. All concrete shall be compacted to produce a dense homogeneous mass. Unless otherwise agreed by the Employer's Representative, it shall be compacted with the assistance of vibrators except for piles. Sufficient vibrators in serviceable condition shall be on Site so that spare equipment is available in the event of breakdown. A 50mm diameter internal vibrator shall be deemed capable of compacting 20 m<sup>3</sup>/hr. Internal vibrators shall be capable of producing not less than 10,000 cycles per minute.
- B. Vibration shall not be applied by way of the reinforcement. Where immersion vibrators are used, contact with reinforcement and all inserts shall be avoided.
- C. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow to its position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.
- D. External vibration shall not be used unless permitted by the Employer's Representative for special circumstances but shall be capable of producing not less than 3000 cycles per minute.

#### **2.1.3.7 CURING OF CONCRETE**

- A. Immediately after compaction and for 14 days thereafter, concrete shall be protected from the harmful effects of weather, including rain and rapid temperature changes, and from drying out. The methods of protection shall be subject to the Employer's Representative approval. The Employer's Representative approval will be conditional upon the proposed curing method proving to be satisfactory on Site.
- B. The method of curing used shall minimise the loss of moisture from the concrete. On concrete surfaces that are to be waterproofed or coated, curing membranes shall not be used unless agreed by the Employer's Representative. Details of all curing methods to be used shall be subject to the approval of the Employer's Representative.
- C. Concrete surfaces shall be kept damp using soaked hessian sheeting. Polythene sheet covering shall be used where directed by the Employer's Representative to minimise evaporation. The hessian sheeting shall be maintained continuously damp for a minimum period of 14 days after casting, using water of the same quality as that allowed in mixing the concrete. Water used for curing purposes shall be within 5°C of the placed concrete temperature.



- D. Subject to the approval of the Engineer, curing with an Approved proprietary product may be used as an alternative to curing with water. The curing material shall not be detrimental to concrete.
- E. The concrete curing compound shall be of an Approved type, which shall be readily distinguishable upon the concrete surface for at least four hours after application. The curing compound shall be compatible with concrete admixtures and with subsequent surface finishes. The curing compound shall be removed using a method Approved by the Employer's Representative prior to application of the finishes. The colour, if any, shall become inconspicuous within seven days after application.

#### **2.1.3.8    EARLY LOADING**

- A. During the first 28 days after compaction, the concrete shall at no time be subject to loading, including its own weight, which will induce a compressive stress in it exceeding 0.25 of its compressive strength at the time of loading or of the specified 28 day strength whichever is lower. The strength of the concrete and the stresses produced by the loads shall be subject to the agreement of the Employer's Representative.
- B. No load shall be placed until the Employer's Representative so permits, but in no case shall any load of any kind be placed until the curing has been completed. The Contractor shall not place any temporary loads or open any section of the Works to traffic or construction equipment until permitted by the Employer's Representative.
- C. In addition to the above, the Contractor is responsible for conforming to the performance requirements for concrete in general and for the creep requirements in particular.

#### **2.1.3.9    FIELD QUALITY CONTROL**

- A. Independent Testing Laboratory
  - 1. Comply with pertinent provisions of QCS 2010 – Quality Requirements.
  - 2. Comply with pertinent requirements of the authorities having jurisdiction. Obtain approvals from these authorities.
  - 3. The Contractor shall provide a qualified independent testing laboratory, experienced with local construction conditions and materials, to conduct tests and submit reports for the concrete mixes to ensure compliance with the Specification. The use of the proposed laboratory is subject to the approval of the Employer's Representative.
  - 4. Constituent materials shall be obtained from suppliers operating quality systems in accordance with QCS 2010 - Quality Requirements.
  - 5. The contractor shall submit the concrete pour records for the Engineers review.
- B. Transporting and Curing of Samples
  - 1. Samples shall be taken on Site at the point of delivery. Test cubes shall be made, cured, stored, transported and tested to BS 1881 Parts 108, 111 and 116.
  - 2. The Contractor shall establish a Site curing facility. Test cubes shall not to be de-moulded at periods of less than 24 hours and shall not be transported before 48 hours have elapsed.



**C. Sampling Cubes**

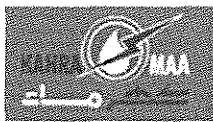
1. A sample of concrete shall be taken at random on eight separate occasions during the first five days of using a mix, at least one sample being taken each day.
2. Thereafter one sample shall be taken at random for each class of concrete in accordance with Table 4 of the Specification.
3. In addition to the above requirements, at least one sample shall be taken from each individual structural unit, or part of a unit, when the latter is the product of a single pour.
4. From each sample, three cubes shall be made for testing at 28 days and two for testing at 7 days for control purposes. The contractor may prepare extra cubes for any future tests.
5. The frequency of sampling may be required to be varied if directed by the Employer's Representative.
6. The procedures shall be repeated when materials or design mixes are changed.

**D. Cube Strength Results**

1. The results will be acceptable only if both of the conditions below are met:
  - a. The mean field cube strength at age of 28 days shall exceed the Actual Characteristic Strength given in par. 3.1.3.7 by a margin of 1.64 times the Standard Deviation, except that no Standard Deviation less than 4MPa shall be used in calculation.
  - b. If the above criteria are not satisfied, the unit represented by the sample is questionable and any or all of the following actions may be instructed by the Employer's Representative at the Contractor's expense:
    1. Changing the mix.
    2. Improving quality control.
    3. Cutting and testing cores from placed concrete.
    4. Non-destructive testing of placed concrete.
    5. Cutting-out and replacing defective concrete.
2. If any individual 28 day cube strength from a sample exceeds the Target Mean Strength achieved in the trial mixes by more than 10 MPa then any or all of the actions listed above may be instructed by the Employer's Representative at the Contractor's expense.
3. In the event cutting and testing of cores are required, the Contractor shall cut cores from Approved locations, and test them to BS1881 as modified by BS 6089.

**E. Flexural Tensile Strength Tests**

1. Samples shall be taken and two beams cast to determine the tensile strength of the concrete at 7 days and 28 days, as specified in BS 1881 Part 118.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

2. The samples shall be taken in accordance with the minimum test requirements for concrete in the Specification and shall coincide with samples taken for test cubes.

**F. Durability Tests**

1. Samples shall be taken in accordance with the minimum test requirements for concrete in the following section and shall coincide with samples taken for test cubes. The concrete shall be tested for durability properties as directed in the following table.

<b>TYPE OF CONCRETE</b> <b>DESCRIPTION OF TEST</b>	<b>OPC Concrete</b>	<b>Silica Fume Concrete (SF)</b>	<b>GGBS Concrete</b>	<b>PFA Concrete</b>	<b>Waterpro of Concrete (WPC)</b>
Rapid Chloride Permeability (RCP) to AASHTO T277 Max Charge Pass (Coulombs) at 28 days	3,800	1,000	1,200	1,200	800
Water Permeability (SWP) to DIN 1048 Max Penetration (mm) at 28 days	20	10	10	10	8
Initial Surface Absorption Test (ISAT) to BS 1881 Part 208: Maximum ISAT at 28 days: 10 minute test (ml/m <sup>2</sup> /s)	0.3	0.15	0.15	0.15	0.02
30 Minute Absorption (WA) to BS 1881 Part 122: 30 minute test (at 7 days unless noted otherwise)	2.0%	1.5%	1.5%	1.5%	1.0%

2. The durability test results will be deemed to be acceptable only if both of the following conditions are met:

- The average value of all of the results for each test on each type of concrete is less than or equal to the pertinent value in the above table.
- Each test shall be given a weighting of unity and the overall score of the four durability test results on each set of samples shall be evaluated in accordance with the following formula:

$$\text{Score} = (\text{RCP}/800) + (\text{DIN}/8) + (\text{ISAT}/0.02) + (\text{WA}/1.0)$$

Where

RCP = measured value from the Rapid Chloride Permeability test to AASHTO T277 in Coulombs

DIN = measured value from the Water Permeability test to DIN 1048 in mm



WA = measured value from the Water Absorption test to BS1881 Part 122 expressed as a percentage

ISAT = measured value from the Initial Surface Water Absorption test to BS1881 Part 208 expressed in ml/ (mm<sup>2</sup>.s)

The score for each set of samples shall comply with the following values:

Type of Concrete	Score to be less than or equal to
OPC	20
SF	10
GGBS	12
PFA	12
WPC	4

3. For blended mixes, such as OPC/SF/GGBS or OPC/SF/PFA, the most onerous test conditions shall apply.
4. The chloride and sulphate levels in the concrete mix to BS 1881 Part 124 shall be in accordance with the table below:

Type of Concrete	Chlorides as Cl (a)	Sulphates as SO <sub>3</sub> (a)
For reinforced concrete - made with OPC/MSRPC - made with SRPC	0.10 0.06	3.70 3.70
Prestressed concrete & heat-cured reinforced concrete.	0.06	3.70
For mass concrete(b)	0.10	3.70

5. When silica fume is used it shall not be included as cement binder for the purpose of chloride and sulphate limitations.
6. The OPC and MSRPC cements can also contain chlorides, the relevant standard BS 12 allows up to 0.1% Cl. Therefore any chloride content present in the cement has to be taken into account while computing total Cl in the mix.

#### G. Other Tests

1. The Contractor shall submit to the Employer's Representative for approval his proposed methods for complying with the creep strain criteria of the performance requirements of the Specification. These shall include, but are not limited to:



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

- a. Tests to establish the strength of the concrete and the static modulus of elasticity of the concrete to BS 1881: Part 121 at 7 days, 28 days, 3 months and 6 months.
- b. Sufficient tests shall be undertaken to allow an accurate assessment of the creep strain to be made prior to, and during, the concreting operations. These tests shall only cease when directed by the Employer's Representative.
2. When instructed by the Employer's Representative concrete shall be tested for drying shrinkage and wetting expansion, for which 75x75mm prisms shall be prepared and tested in accordance with BS 812 Part 120. The maximum acceptable limits shall be:
  - a. Drying Shrinkage: 0.04%.
  - b. Wetting Expansion: 0.03%.
3. Cubes may be required and trials carried out to determine stripping times for formwork, the duration of curing and to check testing and sampling errors.
4. The air content of air-entrained concrete shall be determined in accordance with BS EN 12350-7:2009 for each batch produced until consistency has been achieved, when one in five batches may be tested. The maximum value shall not exceed 2%.
5. Compaction factor, slump, Vebe or other workability tests shall be carried out as required during concreting of permanent Works to control workability at the batching plant and at the Site of the pour. For each sample the temperature of the concrete shall be measured and recorded with the time the test was performed. The degree of workability shall be as for the trial mixes; permitted tolerances shall be in accordance with BS 5328.

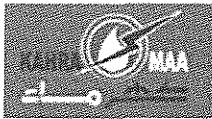
**H. Minimum Test Requirements for Concrete**

1. Samples shall be taken and 4 (four) cubes made for strength testing for each class of concrete and for each particular application at a frequency shown in Table 4:

<b>Type of Structure</b>	<b>Element</b>	<b>Sampling To Represent a Volume of Concrete (m<sup>3</sup>)</b>	
		<b>Cube Strength Tests</b>	<b>Durability Tests</b>
Critical elements	Columns, piles	10	50
Normal structural elements	General	50	250
Heavy concrete construction	Raft	100	500

**Table 4 Rate of Sampling Concrete**

2. The point of sampling of fresh concrete shall be at delivery into the Works unless otherwise directed by the Employer's Representative.
3. Cement: One 2 kg sample for quality testing to ensure compliance with Part 2 of the Specification shall be taken from each 1,500 bags or equivalent weight or one day's output of the cement Plant for each class of cement, whichever is the lesser.



4. Water: One 5 litre sample shall be obtained prior to use from each source for quality testing in accordance with the "Water For Concrete" section of the Specification.
5. Samples of concrete, cement and water shall be taken and tested as described in the above sub-section at least once a week during concreting operations.
6. In addition to the cubes made for strength testing, samples shall be taken and specimens made for durability testing.

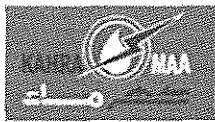
#### **2.1.3.10 DEFECTIVE CONCRETE**

- A. The action to be taken in the event of non-compliance of test results with the Specification, including but not limited to cube results, shall be determined by the Employer's Representative and may range from qualified acceptance to rejection and removal of all or part of the affected works as described in the "Field Quality Control" section of the specification.
- B. The Contractor shall provide at his own expense all tests and rectification works including records, samples, including core samples, and their results as may be required by the Employer's Representative, whether the concrete be finally accepted or not.

#### **2.1.3.11 REINFORCEMENT**

- A. Bar Schedules and Shop Drawings
  1. The Contractor shall Schedule the reinforcement in accordance with BS 8110 and BS 8666 and the information on the Drawings, this Specification and subsequent instructions.
  2. The Contractor shall include for all necessary supports, chairs and spacers, and his price and rates for reinforcement thus shown shall include for these.
  3. The Contractor shall prepare reinforcement detail Drawings and other relevant shop Drawings to the following scales:

a. Walls and slabs	1:100
b. Beams and column elevations	1:50
c. Beam and column sections	1:25
  4. Shop Drawings shall show all openings for services, upstands or plinths for equipment and cast-in items and be fully coordinated with relevant trades.
  5. Reinforcement details Drawings shall be in accordance with the Standard Method of Detailing Structural Concrete published by the Institution of Structural Engineers/Concrete Society. Sketches will not be acceptable.
  6. Bar bending Schedules and coordinated shop Drawings shall be submitted for the Contractor's Representative approval. An average of 21 days shall be allowed for the Contractor's Representative review of this documentation.
  7. The Contractor shall correct these Schedules incorporating the Contractor's Representative comments and resubmit as reasonably required to ensure a high standard of work. He shall programme his work and submit Schedules for approval allowing time for such verification, rectification and



resubmission as necessary. Such approval shall not relieve the Contractor of his contractual responsibility.

8. No concreting shall be allowed to proceed until such a time that the shop Drawings and bending Schedules for that particular section of works are Approved.

**B. Bar Cutting and Bending**

1. Reinforcement shall be cut and bent in accordance with BS 8666. Cutting or bending by the application of heat is not permitted. Welding of reinforcement shall only be permitted when Approved in writing by the Employer's Representative. If such approval is given then the workmanship shall be in accordance with BS 5135. The Contractor shall submit full technical details of his proposed procedures prior to seeking approval.
2. Hot rolled high yield bars shall not be straightened or bent again, having once been bent. If the Employer's Representative gives approval to bend mild steel reinforcement projecting from the concrete, the internal radius of bend shall not be less than four times the nominal size of the bar.

**C. Placing and Fixing Reinforcement**

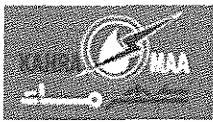
1. Reinforcement shall be placed and maintained in the position shown in the Contract Drawings. Unless otherwise permitted by the Employer's Representative, all bar intersections shall be tied together using 1.2mm diameter steel wire and the ends of the tying wire shall be turned into the main body of the concrete and not allowed to project towards the surface.
2. Spacer blocks or other supports Approved by the Employer's Representative shall be provided and used to retain the reinforcement at proper distances from the forms. The Contractor shall secure the cage/reinforcement by providing adequate supports. All reinforcement shall be so rigidly supported and fastened that displacement will not occur during construction. Reinforcing steel shall be inspected in place and must be Approved by the Employer's Representative before any concrete is deposited.
  1. No splices shall be made in the reinforcement except where described in the Contract Drawings or where Approved by the Employer's Representative.
  2. Reinforcement temporarily left projecting from the concrete at construction or other joints shall not be bent out of position during the periods in which concreting is suspended, except with the approval of the Employer's Representative.

**D. Electrical Continuity of Reinforcement**

1. The Contractor shall provide and ensure the electrical continuity of all reinforcing steel.

**2.1.3.12 CONSTRUCTION AND MOVEMENT JOINTS**

- A. The position and detail of any construction joints not described in the Contract shall be subject to the approval of the Employer's Representative and shall be so arranged to minimise the formation of shrinkage cracks to an acceptable level.
- B. The timetable for the depositing of concrete between construction joints should be so arranged that no face of concrete shall be left for more than 30 minutes

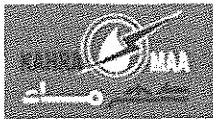


before fresh concrete is deposited against it. Pauses for meals, servicing of machines, changes of shift, etc. and the distribution of concrete among the positions where work may be proceeding simultaneously must be carefully organised to ensure that the above-mentioned interval shall not be exceeded.

- C. When the continuous placement of concrete in any structural member is interrupted or delayed, for any reason, for a period longer than 30 minutes, the Employer's Representative shall declare such joint a cold joint and the Contractor shall immediately remove the previously partially placed concrete from the forms. No extra payment will be made for the initial placement or the removal of concrete that is wasted because of a cold joint. The Employer's Representative may suspend all or any part of subsequent concrete work until he deems the Contractor has corrected the cold joint occurrence.
- D. Where dowels, reinforcing bars or other adequate ties are not required by the Drawings, keys shall be made by embedding water soaked bevelled timbers in soft concrete. The key shall be sized as shown on the details, or as directed by the Employer's Representative, which shall be removed when the concrete has set. In resuming work the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance or other soft material with stiff wire brushes, and if deemed necessary by the Employer's Representative, shall be grit blasted followed by pre-wetting for a period of at least 12 hours after which concreting of the next pour may proceed.
- E. Expansion joints shall be constructed at the locations, of the materials and to the dimensions shown on the Drawings.
- F. The upper surface of lifts of concrete walls and columns shall be horizontal and if the formwork extends above the joint on the exposed face, it shall be cleaned of adhering concrete before the next lift is placed. The concrete placed immediately above a horizontal construction joint shall be a modified mix with the same properties as the regular mix but with a lower coarse aggregate content. It shall be thoroughly compacted and worked against the existing concrete.
- G. Where sections of the work are carried out in lifts the reinforcement projecting above the lift being cast shall be adequately supported to prevent movement of the bars during the casting and setting of the concrete.

#### **2.1.3.13 FORMWORK**

- A. Construction
  - 1. Formwork shall be in accordance with BS 5975 and shall include all temporary or permanent forms required for forming the concrete, together with all temporary constructions required for their support. The formwork and support system shall be of an Approved specialist designed to withstand the construction loading and climatic conditions. The design and work on Site shall be verified and Approved by an Approved independent third party before it is released for the next activity.
  - 2. All formwork shall be of such quality and strength as will ensure rigidity throughout the placing, ramming, vibration and setting of the concrete without visible deflection.
  - 3. All formwork shall be so constructed that there shall be no loss of material from the concrete. After setting, the concrete shall be in the position and of the shape and dimensions prescribed. The finished surface of exposed



concrete shall be of a quality specified on the Drawings and Approved by the Employer's Representative.

4. Unless otherwise provided on the Drawings or directed by the Employer's Representative, all exposed edges shall be bevelled by using dressed, mill-cut hardwood metal or plastic, triangular moulding, having twenty (20) millimetres sides. Details of the bevels are to be submitted to the Employer's Representative for approval prior to their use in the Works.
5. All curved surfaces shall be formed with Approved plywood or steel forms.
6. The Contractor shall in all cases request the approval of the formwork by the Employer's Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor's request for approval and his intention to commence concreting shall be not less than one clear normal working day and the Employer's Representative may require a longer period if, in his opinion, the formwork is of such complexity as to require it.
7. Where internal metal ties are permitted, they or their removable parts shall be extracted without damage to the concrete and the remaining holes fully filled with a low shrink mortar Approved by the Employer's Representative. No permanently embedded metal part shall have less than 40 mm cover to the finished concrete surface or the specified cover to the reinforcement whichever is the greater.
8. The Contractor shall submit to the Employer's Representative for his approval strength and deflection calculations and Drawings of the formwork he proposes to use. The Contractor shall ensure that adequate time is given to enable the Employer's Representative to examine the calculations and Drawings and also to inspect the formwork before concrete is placed within it.
9. Approval shall not absolve the Contractor of his responsibilities under the Contract.

**B. Falsework and Shoring**

1. Detailed Drawings for falsework shall be prepared by the Contractor and submitted to the Employer's Representative for approval. The Drawings must be Approved by the Employer's Representative before the work is started. The falsework and shoring shall be of an Approved specialist designed to withstand the construction loading and climatic conditions. The design and work on Site shall be verified and Approved by a competent Approved third party before it is released for the next activity.
2. The Contractor shall submit to the Employer's Representative for approval at least one (1) month before commencing work, complete and full details of his proposed system of falsework, including detailed Drawings and calculations. Falsework shall be capable of accommodating temperature changes without causing damage to the concrete.
3. Falsework shall be designed and constructed in accordance with the provisions of BS 5975. The falsework shall provide the necessary rigidity to support all loads placed upon it without appreciable settlement or deformation. Falsework columns shall be supported on wood or metal bases to support all falsework that cannot be founded on rock, shale or thick deposits of other compact material in their natural beds. Falsework shall not be supported on any part of the structure, except the footings,

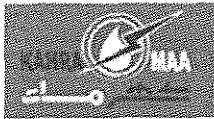


**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

without the written permission of the Employer's Representative. The number and spacing of falsework columns, the adequacy of sills, caps and stringers and the amount of bracing in the falsework framing shall be subject to approval of the Employer's Representative.

4. All timber shall be of sound wood, in good condition and free from defects that might impair its strength. If the vertical members are of insufficient length to cap at the desired elevation for the horizontal members, they shall preferably be capped and frames constructed to the proper elevation. Ends of the vertical members shall be cut square for full bearing to preclude the use of wedges. If vertical splices are necessary, the abutting members shall be of the same approximate size, the ends shall be cut square for full bearing, and the splices shall be scabbled in a manner Approved by the Employer's Representative.
5. All steel members shall be in good condition, free from damage, kinks, corrosion or any other defect that might impair their strength.
6. The Contractor shall make allowance for any deflection that is likely to arise during construction, so that the hardened concrete conforms to the specified line and level and is in accordance with the following requirements:
  - a. All slabs and beams more than 5 metres in span shall be laid to a camber. The Contractor shall be responsible for determining the magnitude of the camber. The following formula may be used subject to the Contractor verifying its applicability: Camber =  $(\text{Span})^2/(7200 \times \text{depth})$  (values in mm)
  - b. The Contractor's shop Drawings shall clearly identify the camber applied to the formwork of each element.
  - c. The Employer's Representative will check and approve the Contractor's computations.
7. Long, tapered hardwood wedges or screw jacks shall be used in all falsework construction and shall be so placed that they can be adjusted to give proper form alignment. The Contractor shall, if required by the Employer's Representative, provide means for adjusting forms to offset any excessive settlement, if screw jacks are used, they shall be adequately braced and secured in such a manner that will prevent tipping of the jacks in any direction. Anchoring of the falsework to the Permanent Works shall only be allowed by prior approval of the Employer's Representative.
8. The Contractor shall provide means for accurately measuring settlement in falsework during placement of concrete, and shall provide a competent observer to observe and correct the settlement.
9. In designing forms and centring, concrete shall be regarded as a liquid. In computing vertical loads, a weight of two thousand six hundred and fifty (2,650) kilograms per cubic metre shall be assumed, and horizontal forces shall be calculated in accordance with CIRIA report R108.

The imposed loading from supported materials and construction activities shall be in accordance with BS 5975.
10. The Employer's Representative may refuse permission to proceed with other phases of the work if he deems the falsework unsafe or inadequate to support properly the loads to which it will be subjected.



11. The review or approval of falsework Drawings by the Employer's Representative or permission to proceed with the work shall not relieve the Contractor of the responsibility for successful erection or satisfactory results.

**C. Preparation of Formwork before Concreting**

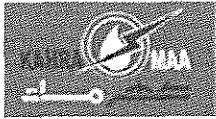
1. The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Employer's Representative, be coated with a release agent Approved by the Employer's Representative. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement. Different release agents shall not be used in formwork to concrete that will be visible in the finished Works. A panel shall be constructed utilising the proposed release agent for the Employer's Representative approval. The surface of the panel shall not exhibit discoloration.

Data shall be supplied confirming that the release agent will not stain the concrete surfaces and will not adversely affect the bond of subsequently applied finishes or any concrete ingredient.

2. Immediately before concreting all forms shall be thoroughly cleaned out, all formwork shall be inspected and Approved by the Employer's Representative before any concrete is placed in it but such approval shall not relieve the Contractor of his responsibilities for the safety, accuracy or efficiency of the work. The formwork shall be fitted with proper handrails and safety barriers as applicable, including the safety nets and screens where deemed necessary while working at heights.
3. Consideration will be given to the use of controlled permeability formwork to assist in achieving the durability requirements.
4. The formwork and supporting structure installed on Site shall be inspected by the designer and Approved prior to the concreting works.

**D. Removal of Formwork**

1. The Employer's Representative shall be informed in advance when the Contractor intends to strike any formwork. At the time of striking any formwork, the concrete shall be of sufficient age and strength for it to withstand the effects of striking, including the effect of thermal shock or the loss of surface durability upon premature exposure, and to be able to withstand the resulting stresses without adverse effects.
2. Where accurate determination of the striking time is required then temperature matched curing of test cubes shall be used.
3. The Contractor to ensure that the concrete is capable of supporting its own weight and subsequent applied construction loads. Horizontal formwork is to be maintained in place until concrete members are capable of supporting their own weight and all construction loads without deflection exceeding span/360. Non-destructive pullout devices are to be used to verify concrete strength prior to formwork removal.
4. When formwork is removed during the curing period the provision of Approved curing methods shall immediately follow the removal of the formwork.
5. The time at which the formwork is struck shall be the Contractor's responsibility but the minimum periods between completion of placing



concrete in a section of the Works and the removal of forms shall be as follows:

- a. Vertical sides of beams, walls and columns 24 hours
- b. Soffits of slabs (props left in) 4 days
- c. Removal of props to slabs 11 days
- d. Soffits of beams (props left in) 10 days
- e. Removal of props to beams 15 days
- 6. Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms and, if props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.
- 7. Formwork shall be removed without damage to the concrete.
- 8. Where it is intended to re-use formwork it shall be thoroughly cleaned and made good to the satisfaction of the Engineer. Damaged or unfit formwork shall be immediately replaced.

#### **2.1.3.14 CLASSES OF FINISHES**

##### **A. Formed Surfaces**

- 1. Type A - Rough finish for buried or rendered work. This finish is obtained by the use of properly designed formwork or moulds of closely jointed saw or wrought boards or other suitable material. The surfaces will be imprinted with the grain of the boards and their joints. In addition, small blemishes caused by entrapped air or water may be expected, but the surface should be free from voids, honeycombing or other large blemishes. The holes left for formwork bolts shall be filled. Fins and irregularities projecting more than 3mm shall be cleaned off.
- 2. Type B - Normal finish for exposed work. This finish is obtained by the use of properly designed forms of closely jointed wrought boards, plastic, steel or other suitable material, provided that the surfaces shall be free from the imprint of the forms. Very minor blemishes caused by entrapped air or water may be expected, but the surface should be free from voids, honeycombing or other large blemishes. The holes left for formwork bolts shall be filled. Fins and other projections shall be removed and all blemishes filled with a cement and fine aggregate paste. Care shall be taken in the choice of any release agent used, to ensure that the finished concrete surface is not permanently stained or discoloured.
- 3. Type C - Superior finish for exposed work. This finish can only be achieved by the use of high quality concrete and by using properly designed forms having a hard, smooth surface. The concrete surfaces should be smooth with true, clean arises. Only very minor surfaces blemishes should occur and there should be no staining or discoloration from the mould oil or curing agent. The surface shall be free from the imprint of wood grain. Unfaced wrought boarding or standard panels shall not be used. The material for the form shall be a proprietary re-usable system and shall be provided in large sheets arranged in an Approved uniform pattern. Joints between sheets shall be arranged to coincide with architectural features, sills or heads of windows or changes in direction of the surface; all joints between sheets shall be accurately aligned in the plane of the sheets. Boltholes are not allowed.



4. Other types of finish. These shall include any finish different from A, B and C that requires the use of special forms or linings, the use of a different concrete mix near the surface, grinding, bush hammering or other treatment. If any of these special finishes is required it shall be as specified on the Drawings. The Contractor shall make trial samples for inspection and approval by the Employer's Representative.
  5. Whichever method the Contractor uses for obtaining each finish, the same method shall be used for the remainder of the work.
  6. Remedial treatment to the finish of the concrete, additional to that specified above, requires the approval of the Employer's Representative. The Contractor may prepare a mock-up as part of permanent work using the proposed formwork system to ensure that the quality of concrete finishes complies with the specification requirements.
- B. Unformed Surfaces
1. The finish of unformed surfaces shall be tamped, floated, trowelled or brushed as defined below and shown on the Drawings.
  2. TF: Tamped surfaces shall be formed by levelling and tamping the concrete to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction. It is also the first stage of the following finishes.
  3. FF: Flated shall be uniform surface that has been worked no more than is necessary to remove screed marks by hand with a wood or steel float of a type Approved by the Employer's Representative. The surface shall not be floated until the concrete has hardened sufficiently.
  4. ST: Steel trowelled shall be a hard, smooth finish free from trowel marks formed with a steel trowel under firm pressure. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. If laitance is brought to the surface it shall be removed.
  5. BR: Brushed shall be formed by first producing a floated finish and then, before the concrete has hardened, by Drawing a wire broom over the concrete surface at right angles to the traffic flow to give an average texture depth of 1mm.
  6. PF: Power Float shall be a uniform surface that has been worked no more than is necessary to remove screed marks with a power float of a type Approved by the Employer's Representative. The surface shall not be floated until the concrete has hardened sufficiently.

#### **2.1.3.15 SURFACE FINISHES**

- A. Refer to Architectural Specifications. The concrete faces inside lift and MEP shafts shall be coated with an Approved anti-carbonation paint unless specified otherwise.

#### **2.1.3.16 TOLERANCES**

- A. The concrete work shall be constructed to an accuracy that shall permit the proper assembly of components and installations and shall be compatible with the finish. The accuracy of the work shall be within the tolerances stated on the



Drawings or specified elsewhere and in the absence of any other requirements, shall comply with the following:

All setting out dimensions		±5mm
Sections of concrete members		±5mm
Foundations		
Surface against ground (underside)		±10mm
Top surfaces of bases and piers	+	5/-10mm
Slabs		
Surface level (5m straight edge)		±5mm
Surface level to datum		±10mm
Position of slab edges		±5mm
Columns and walls		
Plumb in storey height (3.3m typical)		±3mm
Plumb in any 20m height		±10mm
Plumb in any height greater than 20m	1:2000 but <	±50mm
Cross diagonal distortion in storey height (3.3m typical) between adjacent columns or walls		±7mm
Dimensions and position of openings		±5mm
Holding down bolt assemblies		±5mm
Position of embedded items		±5mm
Building vertical alignment (foundation to roof)	1:2000 but <	±50mm
Cover to reinforcement		
Members up to 500mm thick		±5mm
Members between 500mm and 1m thick		-5/+10mm
Members between 1m and 2m thick	-	5/+15mm
Members greater than 2m thick		-5/+20mm

Notes:

1. The thickness of a slab shall not be less than 95% of the nominal thickness specified.
2. Where stated on the Drawings, slabs shall be laid to the specified falls.
3. Gaps and slots for sealants shall satisfy the requirements the Specification for Joints and Sealants.
4. Positions of slab edges, openings and embedded items are relative to a local grid established at a particular level. All other tolerances relate to main setting out lines.

## **2.2 PRE-CAST STRUCTURAL CONCRETE**

### **2.2.1 GENERAL**

#### **2.2.1.1 SUMMARY**

- A. Qatar Construction Specification (QCS) form the basis of the specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) Section 5.



- B. Precast Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed in accordance with the details shown on the Drawings and these Specifications.
- C. Precast Concrete shall generally follow the provisions of clause 2.1 Cast-in-Place Concrete and shall be manufactured off-site in a facility adequate for the purpose.
- D. Related Sections: Sub section 2.1 - Cast-in-Place Concrete

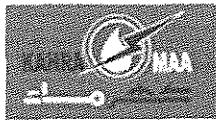
### **2.2.1.2 REFERENCES**

#### **Standards**

- 1. References as Sub section 2.1 - Cast-in-Place Concrete.
- 2. Note on particular material, finishing, tolerance and manufacturing requirements of Architectural Specifications. The requirements of Architectural Specifications take precedence over this specification for precast cladding panels.

### **2.2.1.3 SUBMITTALS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prior to starting work on the contract the Contractor shall submit for approval details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the Specification.
- C. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials or fabrication plant are used.
- D. Before manufacturing precast concrete components, the Contractor shall provide shop drawings for the approval of the Employer's Representative. Shop drawings shall clearly indicate information including, but not limited the following:
  - a. Location of each unit in the completed structure.
  - b. Dimensions of each unit including holes, irregularities and thickness of facing unit.
  - c. Reinforcing details, including grade of reinforcement.
  - d. Details of the Concrete and details of any admixture proposed.
  - e. Joint clearances and clearances between units and structural building framework.
  - f. Connection and insert details including materials, size and length of welds, etc.
  - g. Identification mark, finish designation number and location of each precast unit.
  - h. Location and details of lifting and handling points.
  - i. Erection sequence and any special handling instructions or bracing required.
  - j. Joint sealant details.



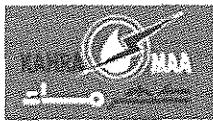
- k. Special precautions to be taken by other trades affecting work of this Section
- E. Copies of each document shall be submitted to the Employer's Representative for his approval and fabrication shall not be commenced until such approval has been given in writing. The drawings shall be submitted in related batches sufficiently in advance of the scheduled manufacturing date to ensure that the Employer's Representative has sufficient time and information to give full consideration to the proposals on the documents and for any changes to be incorporated and re-submitted for approval. Unless otherwise specified or agreed in writing, a period of at least 21 days shall be allowed from receipt of the documents by the Employer's Representative to their return. These approval copies shall be additional to the number of copies of final drawings to be supplied.
- F. All documents submitted for approval shall have already been checked by the Precast Concrete Manufacturer and certified accordingly.
- G. Approval of the documents by the Employer's Representative shall not relieve the Contractor of his obligations. The Contractor shall be entirely responsible for his drawings including their accuracy (relative to the Employer's Representative's drawings) the correctness of detail and the proper design of connections and joints and shall be responsible for any additional work required as a result of defects in his drawings.
- H. The Contractor shall submit a method statement covering transportation, handling and on site erection. The delivery of material shall not commence until approval is received from the Employer's Representative.

#### **2.2.1.4 QUALITY ASSURANCE**

- A. Comply with pertinent provisions of QCS 2010.
- B. Materials and components shall be obtained from suppliers operating quality systems in accordance with either ISO 9001 or an in-house system approved by the Employer's Representative.

#### **2.2.1.5 DELIVERY, STORAGE & HANDLING**

- A. Comply with pertinent provisions of QCS 2010.
- B. Precast concrete components are to be manufactured, delivered, handled and stored in strict compliance with the manufacturer's quality procedures and method statements.
- C. When components are stored, either in the place of manufacture or on site, they shall be supported at such bearing positions as will ensure that any stresses induced in the elements are always less than the permissible design stresses.
- D. Avoid bearing on elements which will be exposed to prevent discolouration of exposed surfaces.
- E. Components to be adequately restrained during transit to prevent damage.
- F. Components are to be handled safely and carefully with suitable lift equipment and supports. Components shall be handled or supported only at the points described in the working drawings and shall be handled and placed without impact.



- G. Any precast concrete component that is damaged during manufacturer, delivery or construction shall be removed from site and replaced at the expense of the Contractor. The Employer's Representative shall be afforded an opportunity to inspect all precast concrete units before the application of finishes that may hide defects.
- H. Separate stacked members with suitable battens and bracing.
- I. Structural precast units shall be stored free of the ground and protected from wind or rain.
- J. The units shall be covered and protected from dust, dirt or staining materials.

## **2.2.2 PRODUCTS**

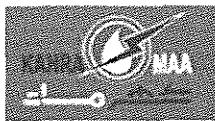
### **2.2.2.1 GENERAL**

- A. Concrete
  - 1. Concrete generally shall be in accordance with Subsection 2.1.
- B. Material
  - 1. For exposed faces, constituent materials must be carefully controlled to ensure consistency of colour and appearance.
  - 2. Aggregates must comply with the relevant parts of clause 2.1 "Cast in Place Concrete" and must be free from absorbent materials or other particles such as coal or iron sulphide which may cause unsightly staining. Refer to Architectural Specifications for particular aggregate specification for Architectural precast panels.
- C. Cast-in items, fixings, restraints
  - 1. All cast in items for handling and lifting, and all fixings and restraints shall be grade 316 (marine grade) stainless steel. Measures shall be undertaken to prevent bi-metallic reaction between stainless and mild steel.
  - 2. Upon request by the Employer's Representative, the contractor shall provide product data sheets and installation instructions. Precast unit dimensions and safe working loads shall be clearly stated.
- D. Cover spacers
  - 1. Cover spacers may not be used on exposed faces with specialised finishes (exposed aggregate, polished, etc.).

## **2.2.3 EXECUTION**

### **2.2.3.1 GENERAL**

- A. Design
  - 1. The Contract Drawings indicate the location, sizes and structural requirements of the precast elements. The Contractor will design the elements for all permanent and temporary loads and submit calculations and shop drawings for the Employer's Representative approval, as detailed in the submission sub-section of this specification.
  - 2. All lifting devices shall be designed for all loads caused by lifting and placing plus an additional allowance for impact of 100%.



**B. Mould Construction**

1. Moulds shall be constructed from materials which shall ensure a consistency of appearance on all exposed surfaces. Casting surfaces and profiles for features shall be checked and replaced whenever necessary. The proposed construction of moulds and number of uses shall be submitted for the Employer's Representative approval.

**2.2.3.2 WORKMANSHIP**

**A. Construction Joints**

1. Construction joints will not normally be allowed on a precast element. Where the element cannot be cast in one operation, the Contractor shall submit details of construction joints for the Employer's Representative approval.

**B. Surfaces Finishes**

1. Refer to relevant Architect's drawings for details of surface finishes.

**C. Dimensional Tolerances in casting**

1. Comply with pertinent provisions of the following specification sections:

Section 2.1- Cast-in-Place Concrete

**D. Curing**

1. Curing by high pressure steam, steam vapour or other accepted processes may be used to accelerate hardening or striking times with the Employer's Representative approval. Curing of exposed precast concrete work to be in compliance with the Architectural Specification.

**E. Cutting**

1. No element shall be cut, drilled or chased without the Employer's Representative approval.

**F. Protection**

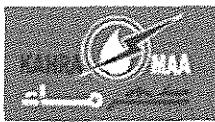
1. The precast elements shall be protected at all stages of manufacture, handling and storage and also during and after erection on site.

**G. Marking**

1. Units shall be indelibly marked during manufacture in a place which will not show on finished elevations as follows:
  - a. Location or identification mark shown on Contractor's working drawings.
  - b. Date of casting.
  - c. The way up for handling, transportation and building into the Works
  - d. Lifting points.

**H. Repairs**

1. Repairs will not be permitted without the Employer's Representative prior approval, either at the point of manufacture or on site.



### **2.2.3.3 INSPECTION AND TESTING**

#### **A. Inspection**

1. The Employer's Representative shall be afforded the facility to inspect the materials and workmanship at any time during the manufacture or installation of precast elements and shall have the right to reject any unit for reasons including (but not limited to) any of the following:
  - a. Broken edges, whether the reinforcement is exposed or not.
  - b. Cracks, other than hair cracks (hair cracks defined as less than 0.1 mm wide).
  - c. Unauthorised repairs.
  - d. Inadequate or no cover to reinforcement.
  - e. Failure to comply with Architect's requirements for finishes.
2. Rejected units will be clearly and indelibly marked, removed and replaced at the Contractor's expense.

#### **B. Testing**

1. Comply with pertinent provisions of Subsection 2.1 - Cast-in-Place Concrete
2. The Employer's Representative may instruct the Contractor to carry out tests on completed precast elements.

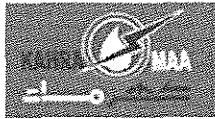
### **2.2.3.4 ERECTION**

#### **A. General**

1. The precast elements shall be erected to the lines and levels shown on the drawings. Where elements are bedded in mortar or where in-situ joints are made after installation, such work shall be carried out to details shown on the Contractor's working drawings.
2. The elements shall be lifted and supported in the final position both temporarily and permanently, in such a way that they shall be stressed only in the manner for which they have been designed.
3. The units shall be adequately braced and supported during erection to ensure correct alignment and safety and such bracing and support shall be maintained until adequate permanent connections have been made.

#### **B. Dimensional Tolerances in Erection**

1. Unless specified otherwise, the precast elements shall be erected or located such that each surface edge or corner of a unit shall be not more than the following distance from its true intended position in space:
  - a. 8 mm for units more than 1m overall in any direction.
  - b. 10 mm for units more than 1m but not more than 6m overall in any direction.
  - c. 15 mm for units more than 6m in any direction.



2. In addition to the above, each surface edge or corner shall not be more than 5 mm from its true position in space relative to the corresponding surface, edge or corner of the adjacent units or units.
3. Any or all the above requirements may be varied by the consultant if the accuracy of the position of the units is not suitable for structural reasons, for reasons of appearance or for the proper assembly of the unit or other adjacent units or components.

C. Erection Mock-up

1. Where units are to be erected together to form a larger unit the contractor shall arrange a trial assembly to verify the suitability of erection methods and tolerances.

## 2.3 POST TENSIONED CONCRETE

### 2.3.1 GENERAL

#### 2.3.1.1 SUMMARY

- A. Qatar Construction Specification (QCS) form the basis of the specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010).
  - B. Provide post-tensioned prestressed concrete as specified on the Drawings, specified herein, and needed for a complete and proper installation
  - C. Related sections – Documents affecting the work of this section include, but are not necessarily limited to the following:
    1. Subsection 2.1: Cast-in-Place Concrete
    2. Subsection 2.4: Grout

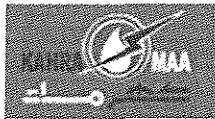
#### 2.3.1.2 REFERENCES

- A. The British Standards referred to below, together with all appropriate references listed within those Standards, shall be used within this Specification. The edition to be used shall be that current at the date of this Specification, except that the latest editions of standards may be used where no reduction in quality will result. Any differences between their requirements and this Specification shall be submitted to the Employer's Representative for his ruling.
  - B. Where a Standard has been specified and equivalent internationally recognised Standard, such as ASTM or DIN, may be used subject to the Employer's Representative approval.
  - C. British Standards

All Standards as noted in Subsection 2.1 Cast-in-Place Concrete plus the following additional:

BS 4447 Specification for the performance of prestressing anchorages for post tensioned construction

BS 4486 Specification for hot rolled and hot rolled and processed high tensile alloy steel bars for the prestressing of concrete



BS 5896 Specification for high tensile steel wire and strand for the prestressing of concrete

BS 8110 Structural use of concrete

Part 1. Code of practice for design and construction

Part 2. Code of practice for special circumstances

BS EN 445 Grout for prestressing tendons – Test methods

BS EN 446 Grout for prestressing tendons – Grouting procedures

BS EN 447 Grout for prestressing tendons – Specification for common grout quality control. BS EN 934 Part 4. Admixtures for concrete, mortar and grout. Admixtures for prestressing tendons. Definitions, requirements, conformity, marking and labelling.

BS EN 15630 Steel for the reinforcing and prestressing of concrete. Test methods

Part 1. Reinforcing bars, wire rod and wires

Part 2. Welded fabric

Part 3. Prestressing steel

#### **2.3.1.3 SUBMITTALS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prior to starting work on the contract the Contractor shall submit for approval details of all proposed prestressing equipment and materials, together with full documentary evidence that the materials and manufacture will comply with the specification. A method statement giving full details of prestressing operations and quality Control procedures including HSE measures shall be submitted for approval.
- C. Approval to commence will not be given until equipment certificates and the like information have been furnished and reviewed.

#### **2.3.1.4 QUALITY ASSURANCE**

- A. The constituent materials and prestressing equipment shall be obtained from suppliers operating quality systems in accordance with ISO 9000 series or an in-house system Approved by the Employer's Representative.
- B. The works shall be closely supervised and monitored by qualified personnel. A foreman experienced in prestressed work who shall be present, at all times throughout the various stages of sheathing, stranding, anchorages, grouting and jacking operations as hereinafter specified.
- C. The prestressing and grouting materials shall be tested as required for technical compliance.



### **2.3.1.5 HEALTH AND SAFETY**

- A. The Contractor shall take every care to ensure the safety of the workforce and general public during tensioning of tendons (as they contain considerable energy and, if they should be released, serious injury and damage would result). Areas behind anchorages shall be screened off and kept clear until 24 hours after grouting. Warning signs shall be erected and shall be clearly displayed.
- B. The Contractor shall adhere to the Site DM safety requirements. The Contractor shall submit the HSE measures and risk assessment associated with the prestressing operations for the Employer's Representative review. The work shall be supervised by qualified safety personnel.

### **2.3.1.6 CERTIFICATE OF COMPLIANCE**

- A. Obtain from the manufacturer and furnish a certificate of compliance with the relevant British Standard for each delivery of prestressing steel and each delivery of anchorage components. The Employer's Representative is to review certificates prior to installing strands.

### **2.3.1.7 DELIVERY HANDLING AND STORAGE**

- A. Deliver materials to the job Site properly marked to identify the location for which they are intended.
- B. Handle tendons and wires with care to prevent damage or deformity. Handle concrete and grout constituents in accordance with Subsections 2.1 and 2.4 of the Specification.
- C. Prestressing steel shall be stored on palettes at least 300 mm above ground, and be protected from contamination by windblown sand or rain.
- D. Prestressing steel shall be in coils of sufficiently large diameter to ensure that the strand pays off straight.

## **2.3.2 PRODUCTS**

### **2.3.2.1 PRESTRESSING EQUIPMENT**

- A. Prestressing gauges to conform to British Standards indicated in references.
- B. Maximum error in pressure indication to be 1% of the maximum scale value
- C. Calibration of gauges and dynamometers to be carried out at intervals not exceeding 6 months.
- D. Friction losses in prestressing jacks to be calibrated and measured at least once a year, or after re-sealing. The Contractor shall provide the Employer's Representative with jack calibration records for the intended jacks to be used on Site prior to stressing.



#### **2.3.2.2 PRESTRESSING DUCTS**

- A. Comply with pertinent provisions of QCS 2010.
- B. All prestress tendon ducts, duct formers, sheathing and the like shall confirm to British Standards indicated in the references.
- C. Where ducts are formed with sheaths, provide sheathing material strong enough to transfer the tendon stresses into the body of the concrete.

#### **2.3.2.3 PRESTRESSING TENDONS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prestressing tendons to comply with BS 5896, BS EN 15630 and any other relevant references into his specification. All tendons to be protected from excessive temperatures, welding sparks, ground currents and the like.
- C. The Contractor shall obtain from the manufacturer and furnish a certificate of compliance with the relevant standard's requirements for tensile strength and load extension.
- D. Tendons types and sizes shall be as noted on the Drawings.
- E. All high tensile steel shall be stress relieved in the manufacturing mill by thermal and mechanical means. No other heat treatment shall be permitted after leaving the shop.
- F. Tendons shall be clean, free from rust, scale, pitting and any lubricant or oil that would affect their bond with cement grout or corrosion.
- G. It is the Contractor's responsibility to ensure that all tendons are adequately protected against corrosion throughout construction. The tendons shall be stored above the ground on racks and protected with tarpaulins or other Approved methods until used. Tenders may be inspected by Hyder Consulting prior to installation. Any tendons with signs of corrosion shall be rejected.
- H. Tendons shall not be subject to heat, welding or ground currents. No welding shall be conducted within the vicinity of tendons. Superfluous extension of tendons 150 mm beyond anchorages or jack grips shall be cut in accordance with manufacturer's instructions.

#### **2.3.2.4 PRESTRESSING ANCHORAGES**

- A. Comply with pertinent provisions of QCS 2010.
- B. All anchorages and couplings shall comply with BS 4447 and other references in this Specification.
- C. All anchorage devices shall be capable of withstanding a static force corresponding to the specified minimum ultimate tensile strength of the tendon being anchored, when such force is applied in a manner similar to the one in which the tendon imposes load on the anchorage in practice. All anchorages proposed must comply with BS 4447.

#### **2.3.2.5 TENSILE REINFORCEMENT AT ANCHORAGE**

- A. Comply with pertinent provisions of QCS 2010.
- B. The term anchorages used in this clause shall be taken to mean all anchorages whether wholly or partly embedded in concrete and all anchorages formed from



embedded tendons or other device. The maximum force at working load to be developed at the anchorage shall be taken to be that force corresponding to the minimum specified ultimate strength of the tendon.

### **2.3.3 EXECUTION**

#### **2.3.3.1 PRESTRESSING RECORDS**

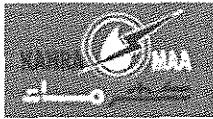
- A. Comprehensive records shall be taken by the Contractor to monitor compliance with this Specification. The following data shall be recorded:
  - 1. Concrete mix and quality
  - 2. Concrete strength, details of placing and curing including dates
  - 3. Date of prestressing operation
  - 4. Name of operator
  - 5. Type and identification numbers of equipment used
  - 6. Calculated tendon extension at each stressing stage
  - 7. Initial force or pressure for measurement of elongations
  - 8. Final force or pressure and elongation on completion of tensioning
  - 9. Elongation remaining after release of jacks
  - 10. Tendon breakage
  - 11. Ramming pressure, if applicable
  - 12. 'As Built' showing exact location of cables

#### **2.3.3.2 STRESSING OPERATIONS**

- A. Stressing operations to be designed and implemented in strict compliance with the British standards listed in the reference section of this Specification.
- B. Do not commence stressing until the concrete has attained the required transfer strength. Obtain approval from the Employer's Representative before commencing initial or incremental stressing. The sequence of stressing shall be as shown on the Drawings or as Approved.
- C. Form supports shall not be removed until sufficient prestressing has been applied to support the dead load, formwork and anticipated construction loads. Also refer to structural Drawings for additional propping requirements.
- D. Measurement discrepancies: For any jack pressure, if the measured value of tendon elongation differs by more than 5% from the calculated value, ascertain the cause to Employer's Representative satisfaction before proceeding with the stressing.
- E. Do not cut tendons until approval is given. No tendons are to be cut until the grout has achieved required strength. Flame cutting is not permitted. Abrasive cutting disc not to come within 25 mm of any part of anchorage without approval.
- F. The minimum cover over the cut tendons shall not be less than the minimum cover to reinforcement as defined in Subsection 2.1 to provide adequate protection and maintain durability. This shall be considered when the recesses are concreted and all tendons are grouted.

#### **2.3.3.3 STRESSING PROCEDURE**

- A. The Contractor shall give 24 hours' notice of all stressing operations. No member shall be stressed until the concrete has attained the strength specified. The



stressing operation shall be performed only by personnel trained and experienced in this type of work.

- B. Special care shall be taken to apply the tensioning force smoothly and evenly. The stressing operation shall be performed in accordance with the best practice applicable to the particular system Approved.
- C. To minimise uneven distribution of forces and to avoid tensile cracking, the stressing sequence shall ensure that the forces applied are kept as symmetrical as possible about the centroid of the tendons.
- D. No member shall be left partly stressed except as specified on Drawings for stage stressings.
- E. The jacks shall be set accurately in the line of the tendons. The force which is applied initially to take up the slack of the tendon shall be sufficient to set the jack firmly, but shall not exceed the amount normally associated with the particular method of prestressing.
- F. In the case of a tendon breaking or slipping after tensioning, so that the allowable tolerances are exceeded, the tendon shall be released, replaced if deemed necessary by the Employer's Representative and re-stressed. Under no circumstances shall the maximum jacking force exceed the rated capacity of the jacking equipment used, or 85% or the specified minimum ultimate strength of the tendon, whichever is the lesser.

#### **2.3.3.4 TENSIONING DATA TO BE RECORDED**

- A. The following data, where applicable, shall be recorded.
  - 1. Identification number of each dynamometer, gauge, pump and jack.
  - 2. Identification particulars of tendons.
  - 3. Age and strength of concrete.
  - 4. Date and time of stressing.
  - 5. Initial forces (or pressures) when tendons are marked for measurement or elongation.
  - 6. Final forces (or pressures) and elongations obtained on completion of tensioning.
  - 7. Elongations remaining after release of jacks.
- B. The fully completed forms shall be forwarded to the Employer's Representative before any tendon is grouted or cut off.
- C. The Contractor is to allow for any special fixings and additional measures required for fixing to prestressed concrete elements.

#### **2.3.3.5 DRAW-IN AT ANCHORAGE DEVICE**

- A. The normal 'draw-in' of tendon when anchoring the tendon in the anchorage device shall be taken into account.

#### **2.3.3.6 RELEASE OF STRESSED TENDONS AT ANCHORAGE**

- A. All anchorage devices fixed at stressing ends of tendons shall be capable of being fully released, if required, after the tendon has been anchored at a stressing load of 75% of the minimum specified ultimate load for the tendon.



### **2.3.3.7 DAMAGED ANCHORAGE DEVICES**

- A. Any anchorage or anchorage component which has been damaged in any way shall not be used.
- B. All steel parts shall be stored with care and protected from corrosion. All threaded parts and fittings shall be protected by greased wrappings or plugs until used. Anchorage devices shall at all times be kept free from dirt, mortar, rust, paint, or any deleterious matter.
- C. Anchorage services cast into the work shall be protected from corrosion. Anchorages holding stressed tendons and which are not immediately protected by concreting shall be protected from corrosion to the satisfaction of the Employer's Representative. Anchorages exposed for extended periods will be required to be positively protected by a suitable epoxy resin coating, greased or otherwise protected as instructed by the Employer's Representative.
- D. The Contractor is to obtain from the manufacturer and furnish certificates showing the results of the tests specified therein, namely:  
Test certificates and data shall include the following information:
  1. Description of wire by diameter and coil number and other means of identification where applicable.
  2. Date of tests on wire.
  3. Sufficient load elongation graphs representative of each parcel of wire such that the elongation of 70% of the ultimate load is accurate with  $\pm 4\%$  for all coils represented by the graph.
  4. Breaking load for wire under tensile test.
  5. Proof stress (or stress at 1.0% extension under load).
  6. Confirmation that the wire has performed satisfactorily under the reverse bend test.
  7. Elongation at fracture.
  8. Confirmation that the wire or strand shall be carried out in a NATA registered laboratory or under conditions which meet the requirements of NATA registration.

### **2.3.3.8 GROUTING DUCTS**

- A. Duct grouting to be carried out in strict compliance with the British Standards listed in the references.
- B. Manually operated grouting machines are not to be used. Pressure test the ducts at the grout pressure with water before grouting, and rectify leaks. Remove water from ducts with oil-free compressed air. Prevent damage to grout vents and fittings during grouting.
- C. Seal the duct on completion of grouting at a pressure of not less than 310 kPa. Fit pressure tap connections to each duct for this purpose.
- D. Grout to be in accordance with Subsection 2.4 of the Specification.
- E. For testing purposes take not less than 3 grout samples during each day's grouting and test for shrinkage and bleeding.
- F. Maximum shrinkage of grout to be 1% by volume after 24 hours.
- G. For each duct grouted, keep and furnish to the Employer's Representative a record identifying the duct and tendon, giving the stressing and grouting dates,



and showing the composition of the grout (cement type, water cement ratio, admixtures), grout density, and details of grouting (interruptions, topping up, etc).

- H. The concrete around grouted tendons shall be protected and maintained at a temperature of 5°C or higher for at least 3 days after grouting.

#### **2.3.3.9 PROTECTION IN HOT WEATHER**

- A. Where there is the likelihood of an ambient air temperature greater than 30°C during the placement of the concrete, then the reinforcement shall be adequately shaded or sprayed with water so as to prevent the temperature of the concrete alongside the bars rising above 30°C.

#### **2.3.3.10 INSPECTIONS**

The Contractor shall give sufficient notice, and in any case not less than 48 hours, to the Employer's Representative of the completion of fixing of the reinforcement or tendons and shall allow a further sufficient time and not less than 2 working hours for the carrying out of the inspection. The inspection shall take place at a time so as to allow any defects to be rectified, prior to the pour.

### **2.4 GROUT**

#### **2.4.1 GENERAL**

##### **2.4.1.1 SUMMARY**

- A. Qatar Construction Specification (QCS) form the basis of the specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) Section 13.
- B. This Specification covers the requirements for materials, design, workmanship and testing for grouting, mortar packing and concrete packing under base, plates, filling bolt sleeves, seating precast concrete units and filling pockets. It includes cementitious grout, mortar and concrete. It does not cover resin grouting or the use of epoxy resin mortar.
- C. Related Sections - Documents affecting work of this Section include, but are not necessarily limited to:
1. Subsection 2.1 - Cast-in-Place Concrete
  2. Subsection 2.3 - Post Tensioned Concrete
  3. Subsection 2.6 - Structural Steel Framing
- D. The requirements of Subsection 2.1 shall apply except where varied by this Specification. The pertinent provisions of Subsection 2.1 are not repeated in this Section.

##### **2.4.1.2 REFERENCES**

###### **Standards**

ASTM C270	Standard Specification for Mortar for unit masonry
BS 12	Portland cement
BS 882	Aggregates from natural sources for concrete
BS 1881	Testing concrete



BS 3148	Methods of tests for water for making concrete
BS 4551	Methods of testing mortars, screeds and plasters
BS 5328	Part 1 Guide to specifying concrete
Part 2 Method for specifying concrete mixes	
Part 3 Specification for the procedures to be used in producing and transporting concrete	
Part 4 Specification for the procedures to be used in sampling, testing and assessing compliances of concrete	
BS EN 197	Cement. Compositions, specification and conformity criteria for common cements
BS EN 206	Concrete. Specification, performance, production and conformity
BS EN 934	Admixtures for concrete, mortar and grout. Admixtures for masonry mortar. Definitions, requirements, conformity and marking and labelling.
BS EN 1008	Mixing water for concrete ~ Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
BS EN 12390	Testing hardened concrete. Shape, dimensions and other requirements for specimens and moulds
BS EN 12620	Aggregates for concrete

#### Other References

QCS 2010: Qatar Construction Specification 2010

#### **2.4.1.3 SUBMITTALS**

- A. Comply with pertinent provisions of QCS 2010 and clause 2.1 "Cast in Place Concrete".

#### **2.4.1.4 QUALITY ASSURANCE**

- A. Comply with pertinent provisions of QCS 2010 and clause 2.1 "Cast in Place Concrete".
- B. Constituent materials shall be obtained from suppliers operating quality systems in accordance with either ISO 9000 series or an in-house system Approved by the Employer's Representative.

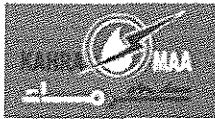
#### **2.4.1.5 DELIVERY, STORAGE & HANDLING**

- A. Comply with pertinent provisions of QCS 2010 and clause 2.1 "Cast in Place Concrete".

#### **2.4.2 PRODUCTS**

##### **2.4.2.1 CEMENT**

- A. Comply with pertinent provisions of Subsection 2.1.



#### **2.4.2.2 AGGREGATES**

- A. Comply with pertinent provisions of Subsection 2.1.
- B. Fine aggregate shall be within the limits of grading M of BS 882 and shall be such as to reduce bleeding to a minimum.
- C. Coarse aggregate shall be rounded and evenly graded and shall be 10 mm nominal size, except when pumping is to be employed when 6 mm rounded and evenly graded aggregate may be used. The percentage of material passing a No. 14 sieve shall not exceed 5 per cent.

#### **2.4.2.3 WATER FOR CONCRETE**

- A. Comply with pertinent provisions of Subsection 2.1.

#### **2.4.2.4 ADMIXTURES**

- A. Comply with pertinent provisions of Subsection 2.1.

#### **2.4.2.5 PROPRIETARY CEMENTITIOUS MATERIALS**

- A. Proprietary cementitious materials shall be supplied pre-packed in the correct proportions, ready for the addition of water only. The constituents shall be stored in sealed containers under cover and used in strict rotation. Each consignment shall bear a batch number, date of production and shelf life of the material. Materials containing calcium chloride or iron will not be Approved.
- B. Details of the mortar composition and mix proportions shall be submitted for the Employer's Representative prior approval, together with test data taken from tests carried out by an independent testing authority to confirm compliance with the test requirements contained in the "Field Quality Control" of this specification.
- C. The material shall be stored, handled, mixed and placed strictly in accordance with the manufacturer's instructions.
- D. Except where non-shrinking grout or dry packing is specified, all grout or packing shall be expansive.

### **2.4.3 EXECUTION**

#### **2.4.3.1 MIX SPECIFICATION**

- A. Comply with pertinent provisions of Subsection 2.1.
- B. Minimum Strength
  - 1. The compressive strength of the grout, mortar or concrete shall not be less than that of the concrete under the baseplate or unit.
  - 2. The testing methods and compliance requirements shall be in accordance with "Field Quality Control" section contained in this specification.
- C. Expanding grout for use in congested areas
  - 1. Expanding grout for filling areas where the least clear dimension is less than 50mm shall be of mix proportions (cement : fine aggregate) 1 : 2 by weight.



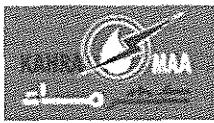
2. The water-cement ratio shall be kept to a minimum compatible with flowability. Flowability shall be measured using a flowmeter and the reading should be between 350mm and 650mm depending on grouting method used.
- D. Expanding concrete for use in uncongested areas
  1. Expanding concrete for filling uncongested areas where the least clear dimension is greater than 50 mm shall be of the mix proportions (cement : fine aggregate : coarse aggregate) 4 : 5 : 7 by weight.
  2. The workability of the fresh concrete shall be suitable for the conditions of handling and placing. Workability shall be assessed by means of a slump test in accordance with BS 1881 : Part 102, compacting factor test in accordance with BS 1881 : Part 103 or Vebe consistometer test, as appropriate.
  3. If slump is used to monitor workability it should be between 100mm and 200mm.
- E. Dry packing mortar or concrete
  1. Dry packing mortar or concrete may only be used where specified by the Employer's Representative or where its use has been Approved by the Employer's Representative.
  2. Sufficient water shall be added such that the slump does not exceed 5mm.
  3. For spaces with a least dimension less than 75mm, the mix proportions shall be 1 : 2 (cement : fine aggregate).
  4. For spaces with a least dimension greater than 75mm the mix proportions shall be 1 : 1 : 2 (cement : fine aggregate : single sized 10 mm coarse aggregate). The use of admixtures will not be permitted.
- F. Proprietary cementitious materials
  1. The optimum water content for each batch of material shall be determined prior to use by flow tests under steel plates under similar conditions to the actual application. Upon removal of the test plate, each quadrant of the upper surface of the mortar shall not contain more than 5% area of voids.

#### **2.4.3.2 MIXING GROUT**

- A. Comply with pertinent provisions of Subsection 2.1
- B. Hand mixing will not be permitted. Grout shall be mixed in an Approved colloidal type mixer.
- C. The grout, mortar or concrete shall be placed within 30 minutes of being mixed.

#### **2.4.3.3 WORKMANSHIP**

- A. Comply with pertinent provisions of Subsection 2.1.
- B. Method of placing
  1. Bedding material shall be poured into the formwork and worked into position by straps, rods, or other suitable means until the whole of the space is completely filled. Dry pack shall be rammed against firm formers to ensure full compaction.



2. In all cases the mortar, grout, or concrete shall be worked from one side and in one direction only, in a manner which will avoid the formation of air pockets and voids.
3. Except where it is specified that bolt sleeves are to be left unfilled, the bolt sleeves shall be filled to within 50 mm of the concrete foundation level prior to the grouting of the baseplate.
4. Expanding grout or concrete shall not be vibrated.
5. The Contractor shall submit method statement fully detailing the surface preparation, formwork, method of mixing and placing, curing etc.

C. Formwork

1. Edge formwork shall be fixed around each baseplate or unit as required to suit the placing method. It shall be sufficiently robust to allow the bedding material to be placed without leakage. Except where dimensions are specified on the Drawings, the horizontal clearance between the formwork and the baseplate or unit shall be as small as possible. The gap should not exceed 75 mm on the entry side and 50 mm elsewhere. A separate feeding hopper shall be used if necessary to maintain the 75 mm limit.
2. For wide baseplates or units where well and plunger is used, the formwork shall be well anchored down.
3. Where it is specified that the edge of the concrete, mortar or grout beyond the baseplate or unit is to be chamfered, bull nosed or trimmed, the excess bedding material shall be cut off whilst it is still green.
4. Formwork shall not be struck earlier than 24 hours after completion of filling.

**2.4.3.4 CURING**

- A. Comply with pertinent provisions of Subsection 2.1.

**2.4.3.5 FIELD QUALITY CONTROL**

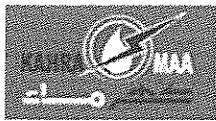
- A. Comply with pertinent provisions of Subsection 2.1.

1. Site trials shall be carried out to confirm the performance, workability, strength and durability of the proposed grout, prior to incorporation into permanent works. The material manufacturer's technical representative shall be present during the Site trials and for difficult and major grouting works as required at Site.

B. Specimens

1. Gang moulds suitable for preparing three of six specimens simultaneously shall be constructed in accordance with BS 4551 Clause 15. The moulds shall be constructed to produce specimens 100 mm x 100 mm x 25 mm with the 25 mm dimension uppermost.
2. The moulds shall be coated on all internal surfaces and joint faces with a release agent suitable to the type of bedding material being moulded. The moulds shall be filled following the procedure defined in BS 4551.

C. Sampling



1. Where a batch of bedding material has been selected by the Employer's Representative for sampling for the purpose of making test prisms, one prism shall be made from each of six samples.
  2. The sampling shall be carried out in accordance with BS 4551 and BS EN 1015. The test prisms shall be made at the Site of application of the mortar.
- D. Test procedure
1. The prisms shall be removed from the moulds after 24 hours and shall be cured under the same conditions as the bedding material to which they refer.
  2. Testing shall be in accordance with BS 1881: Part 116 (and BS EN 12390 Part 3). The compression testing machine shall comply with the requirements of BS 1881: Part 115 (and BS EN 12390 Part 3) and be maintained in an environment between 15° and 25°C. Three prisms shall be tested at 7 days and three at 28 days. The type of failure shall also be recorded.
  3. The specified compressive strength shall be deemed to have been achieved if:
    - a. None of the three prisms has a strength less than that specified.
    - b. The difference between the highest and lowest of the three strengths is not more than 20 per cent of the average strength.

#### **2.4.3.6 RECTIFICATION OF FAILURE**

- A. Comply with pertinent provisions of Subsection 2.1.
- B. All work which fails to comply with this Specification shall be rectified promptly. Work which cannot be rectified shall be broken out and reconstructed to the specified standard.

### **2.5 STRUCTURAL STEEL FRAMING**

#### **2.5.1 GENERAL**

##### **SUMMARY**

- A. Qatar Construction Specification (QCS) form the basis of the specification for the WORK. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) Section 16.
  - B. Provide structural steel as shown on the Drawings, specified herein, and including all secondary and tertiary needed for a complete and proper installation.
  - C. Related Sections
  - D. In addition to the General Conditions, the Contractor shall also refer to the following specifications:
    1. Subsection 2.1 - Cast-In-Place Concrete



### **2.5.1.2 REFERENCES**

- A. The Standards referred to below, together with all appropriate references listed within those Standards, shall be used with this Specification. The edition to be used shall be that current at the date of this Specification, except that the latest editions of Standards may be used when no reduction in quality will result. Any differences between their requirements and this Specification shall be submitted to the Employer's Representative for his ruling. Where a Standard has been specified an equivalent internationally recognised Standard, such as ASTM or DIN, may be used subject to the Employer's Representative approval.
- B. British Standards
- |         |   |
|---------|---|
| BS 4    | Structural steel sections   |
|         | Part 1: Specification for hot rolled sections   |
| BS 449  | The use of structural steel in buildings  |
|         | Part 2: Metric units  |
| BS 499  | Welding terms and symbols   |
|         | Part 2: Specification for symbols for welding   |
| BS 639  | Covered carbon and carbon-manganese steel electrodes for manual metal-arc welding.                |
| BS 1133 | Packaging Code  |
|         | Section 6 Temporary protection of metal surfaces against corrosion (during transport and storage) |
| BS 1449 | Steel plate sheet and strip.  |
|         | Part 1: Section 1.12: Tolerances on dimensions and shape for hot-rolled narrow strip.             |
| BS 1763 | Thin PVC Sheeting (calendered, flexible unsupported)  |
| BS 2600 | Method for radiographic examination of fusion welded butt joins in steel                          |
|         | Part 1: 2mm up to and including 50mm thick  |
|         | Part 2: Over 50mm up to and including 200mm thick   |
| BS 2853 | The design and testing of steel overhead runway beams   |
| BS 2910 | Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes  |
| BS 2994 | Specification for cold rolled steel sections  |
| BS 3643 | ISO Metric screw threads  |
|         | Part 1 Principles and basic data  |
|         | Part 2 Specification for selected limited of size   |
| BS 3692 | ISO Metric precision hexagon bolts, screws and nuts   |
| BS 3923 | Methods for ultrasonic examination of welds   |
|         | Part 1: Manual examination of fusion welds in ferritic steels                                     |
|         | Part 2: Automatic examination of fusion welded butt joints in ferritic steels                     |
| BS 4165 | Electrode wires and fluxes for the submerged arc welding of carbon steel and medium tensile steel |
| BS 4190 | ISO Metric black hexagon bolts, screws and nuts   |
| BS 4320 | Metal washers for general Engineering purposes  |
| BS 4360 | Weldable structural steels  |
| BS 4395 | High strength friction grip bolts and associated nuts and washers for structural Engineering      |
|         | Part 1: General grade   |
| BS 4604 | The use of high strength friction grip bolts in structural steelwork                              |
|         | Part 1: General grade   |
| BS 4848 | Hot rolled structural steel sections  |
|         | Part 2: Hollow sections   |



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

BS 4872	Approval testing of welders when welding procedure approval is not required
BS 4933	Part 1: Fusion welding of steel ISO Metric black cup and countersunk head bolts and screws with hexagon nuts
BS 5135	Arc welding of carbon and carbon manganese steels
BS 5289	Visual inspection of fusion welded joints
BS 5400	Steel, concrete and composite bridges
BS 5531	Part 10: Code of practice for fatigue Safety in erecting structural frames
BS 5950	Structural use of steelwork in buildings
BS 5996	Part 1: Code of practice for design in simple and continuous construction: hot-rolled sections. Part 2: Specification for materials, fabrication and erection: hot-rolled sections.
BS 6037	Specification for acceptance levels for internal imperfections in steel plate, strip and wide flats, based on ultrasonic testing.
BS 6072	Permanently installed suspended access equipment.
BS 6363	Method for magnetic particle flaw detection
BS 6443	Welded cold formed steel structural hollow sections
BS 6651	Method for penetrant flaw detection
BS 6722	Code of Practice for protection of structures against lightning.
BS 6780	Recommendations for dimensions of metallic materials
BS 7079	Through thickness reduction of area of steel plates and wide flats.
BS 7668	Preparation of steel substrates before application of paints and related products
BS EN 287	Weldable structural steels. Hot finished structural hollow sections in weather resistant steels.
BS EN 288	Approval testing of welders for fusion welding.
BS EN 970	Approval of welding procedures for metallic materials
BS EN 10021	Non-destructive examination, fusion welds - visual examination
BS EN 10025	General Technical delivery requirements for steel and iron products
BS EN 10029	Hot rolled products of non-alloy structural steels. Technical delivery conditions
BS EN 10034	Tolerances on dimensions, shape and mass for hot-rolled steel plates 3mm thick or above.
BS EN 10045	Structural steel I and H sections - Tolerances on shape and dimensions.
BS EN 10051	Charpy impact test on metallic materials
BS EN 10056	Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels - tolerances on dimensions and shape.
BS EN 1011-3	Structural steel equal and unequal leg angles
BS EN 10113	Recommendations for welding of metallic materials. Arc welding of stainless steels.
BS EN 10137	Structural steel fine grain structural steels
BS EN 10147	Plates and wide flats made of high yield strength structural steels in the quenched and tempered or precipitation hardened conditions.
BS EN 10155	Continuously hot-dip zinc coated plate and strip
BS EN 10164	Structural steels with improved atmospheric corrosion resistance. Technical delivery conditions
	Steel products with improved deformation properties perpendicular to the surface of the product. Technical delivery conditions



BS EN 10204 Metallic products. Types of inspection documents.  
BS EN 10210 Hot finished structural hollow sections in non-alloy and fine grain structural steels.

Part 1: Technical delivery requirements

Part 2: Dimensions, tolerances & sectional properties

**C. American National Standards**

AWS D1.1 Structural Welding Code

**2.5.1.3 SUBMITTALS – PRODUCT DATA**

- A. Comply with pertinent provisions of QCS 2010.
- B. Submit two copies to the Employer's Representative the manufacturers test certificates verifying that the materials comply with the relevant British Standards for all structural steel, bolting materials and welding consumables.

**2.5.1.4 SUBMITTALS – SHOP DRAWINGS AND DOCUMENTS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Shop Drawings and Documents
  1. The Employer's Representative will supply the Contractor with information necessary for the preparation of his Drawings and documents. If the Contractor discovers any contradiction or ambiguity in the information supplied by the Employer's Representative then written clarification shall be obtained from the Employer's Representative.
  2. The Contractor shall provide the following documents:
    - a. Marking plans and details for holding-down bolts, cast-in ferrules and other embedded items
    - b. Engineering and fabrication Drawings which are fully coordinated with all relevant trades
    - c. Details of all connections including details of the design approach and calculations justifying the connection design
    - d. Welding procedure details and welders qualification certificates
    - e. Fabrication method statement
    - f. Erection marking plans
    - g. Erection method statement including calculations deemed appropriate by the Employer's Representative.
    - h. Details of the Quality Assurance Plan for structural steelwork together with full details of the stage control and inspection documents, including third party testing and certifications.
    - i. As erected Drawings
  3. Copies of each document shall be submitted to the Employer's Representative for his approval and fabrication shall not be commenced until such approval has been given in writing. The Drawings shall be submitted in related batches sufficiently in advance of the scheduled fabrication date to ensure that the Employer's Representative has



sufficient time and information to give full consideration to the proposals on the documents and for any changes to be incorporated and re-submitted for approval. Unless otherwise specified or agreed in writing, an average period of 20 days shall be allowed from receipt of the documents by the Employer's Representative to their return. These approval copies shall be additional to the number of copies of final Drawings to be supplied to the Employer's Representative.

4. All documents submitted for approval shall have already been checked by the Contractor's Representative and certified accordingly.
5. The Employer's Representative will verify the correct interpretation of his requirements but is not responsible for verifying the dimensions or checking the strength or practicability of the details.
6. Approval of the documents by the Employer's Representative shall not relieve the Contractor of his contractual obligations. The Contractor shall be entirely responsible for his contractual Drawings including their accuracy (relative to the Contractor's Representative Drawings) the correctness of detail and the proper design of connections and joints and shall be responsible for any additional work required as a result of defects in his Drawings.
7. Where the steelwork connects to an existing structure, the Contractor shall verify on Site all dimensions that may affect fabrication and notify the Employer's Representative in writing of any discrepancies before fabrication commences.

#### C. Connections and Joints

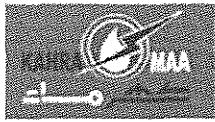
1. General
  - a. The Contractor shall design and detail all steel connections.
  - b. Where typical connections are shown on the Contractor's Representative Drawings the Contractor shall satisfy himself as to their practicability and he shall be at liberty to put forward alternative suggestions for their design.
  - c. All connections designed by the Contractor shall be submitted for the Contractor's Representative review. The Contractor shall provide calculations to demonstrate the adequacy of connections which he has designed. In addition to other loads, all connections shall be designed to resist construction loading.
  - d. Connections shall be designed taking account of the effects of any eccentricity on the component parts of the connection, including welds and bolts.
  - e. The Contractor shall not introduce eccentricity into the layout of the members nor into the arrangement of the connections except as agreed by the Contractor's Representative in writing.
  - f. Before commencing the workshop Drawings the Contractor shall prepare and submit for the Contractor's Representative approval Drawings showing typical details proposed for the connections.
  - g. The Contractor shall meet the Contractor's Representative approximately one week after these Drawings have been submitted, at a time and place agreed by the Contractor's Representative, to review these Drawings and co-ordinate the procedure for the approval of workshop Drawings.



- h. Simply supported end connections shall provide sufficient flexibility to accommodate the end rotation of the beam. This flexibility may be provided by movement of bolts in clearance holes or by flexure of cleats or endplates. Care must be taken to ensure that the welds and bolts are strong enough to resist the forces that can produce such movement or flexure.
  - i. In cleated end connections of beams the cleats shall project 2mm beyond the end of the member unless specified otherwise on the Drawings.
  - j. Load carrying connections shall have not less than two bolts of a size appropriate to the member or else welds giving a similar capacity.
2. Welded Connections
- a. In addition to meeting the requirements of BS 5950 Part 1, for the design of welds, the guidance given in Appendix A of BS 5135 shall be applied.
  - b. The dimensions of all welds shall be clearly specified on the working Drawings using symbols in accordance with BS 499, Part 2.
3. Bolted Connections
- a. Unless specified otherwise preloaded high strength "bearing type" bolts shall be used for all connections to main structural members and trusses.
  - b. Unless specified otherwise, ordinary bolts in clearance holes tightened to the "snug tight" condition will be acceptable for connections of such members as wind bracings, sheeting rails and purlins and for minor secondary members.
  - c. Nuts in connections subject to vibration shall be of the self-locking type or provided with lock-nuts, except where high strength friction grip fasteners are used.
  - d. Whenever bolted connections are used, the reduced sectional area of members shall be computed and the members shall be strengthened if required.
4. Connections of Runway Beams and Trolley Beams
- a. Connections of runway beams shall comply with BS 2853. Special attention is drawn to the provisions of Appendix G of BS 2853 - see Amendment No. 3 (PD 6225). Connections of trolley beams for window cleaning trolleys and the like shall be designed as for runway beams.
- D. In order to meet the requirements for erection tolerances under final dead load, and the criteria of BS 5950 for deflections due to live loads, it will be necessary to pre-camber those members or pre-set those elements that would not otherwise comply. The amount of camber or pre-setting necessary to meet the requirements of this Specification shall be agreed with the Employer's Representative and shall be shown on the shop Drawings.

#### **2.5.1.5    QUALITY ASSURANCE**

- A. The Contractor shall operate a Quality Assurance System for all stages of the work and all work shall be in accordance with that system. The Contractor shall have internationally acceptable accreditation to the approval of the Employer's



Representative. The Contractor shall engage an independent third party specialist for all inspection and tests and certification of the works.

#### **2.5.1.6 DELIVERY, STORAGE AND HANDLING**

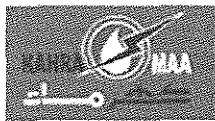
- A. Deliver materials to the job Site properly marked to identify the location for which they are intended.
- B. Use markings corresponding to markings shown on the Approved Shop Drawings.
- C. Store in a manner to maintain identification and to prevent damage. Each grade of steel shall be stored separately.
- D. Particular care shall be taken when transporting, handling or storing parts which have been metal sprayed, galvanised or painted. If the coating is damaged it shall be restored to comply with the relevant requirements of QCS 2010.
- E. Each type and grade of bolt and each type and grade of welding consumable shall be clearly identified and stored separately.
- F. Each type of welding consumable shall be stored in environmental conditions suited to that type.
- G. An assembly, which contains several loose parts, may be identified by a single tag or marking provided that the whole unit is put together before delivery in such a way that it will not accidentally fall apart.
- H. Holding down bolts shall be delivered to Site with the threads protected against corrosion with Type TP 4a Soft-film grease as specified in BS 1133: Section 6.
- I. Where specified metal sleeves shall be supplied in accordance with the Drawings.

#### **2.5.2 PRODUCTS**

##### **2.5.2.1 MATERIAL**

###### **A. Plates and Sections**

1. The dimensions of rolled steel sections shall comply with BS 4: Part 1 or BS 4848. Dimensional tolerances shall comply with BS EN 10034 or BS EN 10056 as appropriate. The dimensional tolerances for flats round and square bars shall be as specified in BS EN 10025 Clause 2.2. The tolerances for plate and strip produced on continuous mills shall comply with BS EN 10051 or BS1449 as appropriate. Tolerances for plates produced by non-continuous mills shall comply with BS EN 10029, and thickness class A tolerances shall apply. The tolerance over or under the nominal thickness shall be equal to half the total thickness tolerance.
2. All steel plates and sections shall comply with the Standards listed in Table 1 as appropriate, except that rimming steel shall not be used. Only new steel shall be used; the surface condition of steel shall be in accordance with subsection Fabrication - Surfaces.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

<b>Standard</b>	<b>Product Type</b>
BS EN 10025	Hot rolled products of non-alloy structural steels - Technical delivery conditions.
BS EN 10113 Parts 1, 2 & 3	Hot rolled products in weldable fine grain structural steels. Part 1 - General delivery conditions. Part 2 - Delivery conditions for normalised steels.
BS EN 10137	Hot rolled quenched and tempered weldable structural steel plates.
BS EN 10210 Parts 1 & 2	Hot finished structural hollow sections of non-alloy and fine grain structural steels Part 1 - Technical delivery requirements Part 2 - Dimensions, tolerances & sectional properties
BS EN 10155	Structural steels with improved atmospheric corrosion resistance. Technical delivery conditions.
BS 7668	Weldable structural steels. Hot finished structural hollow sections in weather resistant steels.

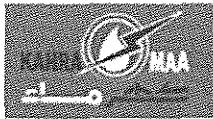
**Table 1 Standard Applicable to Various Products of Structural Steel.**

3. Except where noted or agreed otherwise, the particular grade of steel used shall be determined in accordance with BS 5950 Part 1 Section 2.4.4 adopting a value of K equal to one.
4. Steel supplied to BS EN 10025 shall have the following options invoked by the Contractor at the time of placing an order for the steel:
  - a. Option 3: The method of deoxidation shall be as given in table 2 of BS EN 10025.
  - b. Option 5: The carbon equivalent value shall not exceed the values given in table 4 of BS EN 10025.
  - c. Option 7: The carbon content of steels type S355JO, S355J2, and S355K2 shall not exceed 0.18% by ladle analysis.
  - d. Option 9: The impact properties of quality JR material shall be in accordance with table 6 of BS EN 10025 and shall be verified by test.
  - e. Option 10: When required by this Specification, or when noted on the Drawings, products with improved properties perpendicular to the surface shall be supplied in quality class Z35 to BS EN 10164.
  - f. Option 11: Where steel products are to be hot-dip galvanised or hot enamelled then the steel manufacturers shall be informed of the particular process in order that steel of a suitable condition is supplied.
  - g. Option 12: Specific inspection and testing shall be carried out for all steel products according to the requirements of clauses 8.2 to 8.9 of BS EN 10025. The inspection document shall comprise the inspection certificates as defined in BS EN 10021.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

- h. Option 14: The verification of the mechanical properties for quality JR steels shall be carried out by cast.
- i. Option 17: Flat products in grades S355JR and S355JO that are greater than 12.5mm thick shall be supplied in a normalised or equivalent condition. Any flat product that will be subject to hot working during fabrication or erection shall be supplied in a normalised or equivalent condition. Quality grades J2G4 and K2G4 shall not be supplied as an option unless specified by the Employer's Representative.
- j. Option 22: Any long product that will be subject to hot working during fabrication or erection shall be supplied in a normalised or equivalent condition.
- k. Option 24: Where sections are to be split during the fabrication process then the steel producer shall be made aware of this requirement in order that steel of a suitable condition is supplied.
5. Steel to BS EN 10113 Pt3 shall not be used unless specified by the Employer's Representative, in which case the options required for steel to Pts 1 & 2 shall be invoked. Steel to BS EN 10113 Pts 1 & 2 shall have to the following options invoked:
  - a. Option 2: The carbon equivalent value shall not exceed the values given in table 2 of BS EN 10113 part 2 or 3 as appropriate. Unless agreed otherwise with the Employer's Representative, prior to material ordering, the carbon equivalent value for steel grade S460 to Pt.2 shall be no greater than 0.51%.
  - b. Option 4: Only steel of designation NL shall be supplied unless otherwise specified by the Employer's Representative.
  - c. Option 6: When required by this Specification, or when noted on the Drawings, products with improved properties perpendicular to the surface shall be supplied in quality class Z35 to BS EN 10164.
  - d. Option 7: When steel products are to be hot-dip galvanised or hot enamelled then the steel manufacturer shall be informed of the particular process so that steel of a suitable condition is supplied.
  - e. Option 10: Hard stamping of steel shall not be allowed.
  - f. Options 13 & 16: All steel products shall be free from internal defects that would exclude them from being used for their intended purpose. When option 6 above applies options 13 and 16 shall also be invoked and ultrasonic testing shall be carried out to BS EN 10164 or Euronorm 186 as appropriate.
  - g. Option 15: Where sections are to be split during fabrication then the steel producer shall be made aware of this requirement so that steel of a suitable condition is supplied.
6. Steel supplied to BS EN 10137 shall have the following options invoked:
  - a. Option 2: The product analysis shall be performed to check compliance with Table 1 of BS EN 10137 - part 2.
  - b. Option 5: When required by this Specification or when noted on the Drawings, products with improved properties perpendicular to the surface shall be supplied in quality class Z35 to BS EN 10164.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

7. Steel supplied to BS EN 10210 Part 1 shall have the following options invoked:
    - a. Option 1.2 and 1.4: The carbon equivalent value shall not exceed the values given in tables A2 or B2 of BS EN 10210 Pt 1.
    - b. Option 1.6: The impact properties of quality JO and JR steel shall be verified by test and shall be in accordance with tables A3 or B3 of BS EN 10210 Part 1.
    - c. Option 1.7: Where steel products are to be hot dip galvanised then the steel manufacturer shall be informed of the particular process in order that steel of a suitable condition is supplied.
    - d. Option 1.9: Specific inspection and testing shall be carried out for all steel products in accordance with clauses 7.1 to 7.3 of BS EN 10210 Part 1. The inspection document shall include an inspection certificate of type 3.1B to BS 10204.
  8. Weathering steels supplied to BS EN 10155 shall have the following options invoked by the Contractor at the time of placing an order for the steel:
    - a. Option 4: The carbon equivalent value for grade S355 steel shall be limited to a maximum of 0.52% and for grade S235 steel the CEV limit shall be 0.44%.
    - b. Option 6: The impact properties of all steels shall be in accordance with table 6 of BS EN 10155 and shall be verified by test.
    - c. Option 7: Specific inspection and testing shall be carried out for all steel products according to the requirements of clauses 8.2 to 8.9 of BS EN 10155. The inspection document shall comprise of the certificates as defined in BS EN 10021.
  9. Steel supplied to BS 7668 shall have the following options invoked:
    - a. Option B4. The carbon equivalent value shall not exceed the value given in Table B1 of BS 7668.
- B. Cold rolled sections shall comply with BS 2994.
- C. Electrodes
- All electrodes shall have a yield strength, tensile strength, toughness and ductility not less than those specified for the grade of steel being welded.
1. Covered electrodes for manual metal-arc welding shall comply with the requirements of BS 639.
  2. When weathering steel is to be welded the welding electrodes shall be of matching composition to the parent material.
- D. Bolts, Nuts and Washers
1. Ordinary bolts and nuts shall comply with BS 3692, BS 4190 or BS 4395 Part 1 for hexagon headed bolts or BS 4933 for cup headed or countersunk bolts. Unless otherwise specified bolts and nuts shall be of grade 8.8. Only one grade of steel shall be used for each diameter of bolt.



2. Ordinary washers shall comply with BS 4320. Plain washers shall be made of steel and taper or other special shaped washers shall be of steel or malleable cast iron.
3. Bolting materials that have been sheradised or otherwise coated shall be manufactured and coated to give a satisfactory fit between the finished bolt and its nut.
4. High strength friction grip bolts, nuts and washers shall comply with BS 4395 Part 1.
5. Galvanising, sherardizing, or electroplating of nuts, bolts and washers shall be carried out only by the manufacturer of these items.

**E. Cast-in Holding Down Bolts**

1. For the purposes of this Specification the length of a holding down bolt shall be taken as the overall length excluding the head (or clear of the bottom nut in the case of a fabricated bolt) i.e., the sum of the embedded length, the projecting length and the thickness of the anchor plate.
2. Manufactured Bolts
  - a. Bolts obtained from bolt manufacturers shall comply with the requirements of BS 3692 or BS 4190 as appropriate.
  - b. Nuts shall comply with the requirements of BS 3692 or BS 4190 as appropriate and shall be of at least the recommended strength grade corresponding to the strength grade of the bolts. Nuts shall be of normal standard thickness; thin nuts shall only be used as locknuts.
  - c. Unless specified otherwise bolts shall be of strength grade 4.6 with nuts of strength grade 4 or higher.
3. Fabricated Bolts
  - a. Where bolts are fabricated from plain round bar the threads shall be ISO metric, coarse pitch series, free fit as specified in BS 3643. Both ends shall be threaded and the nut at the bottom end shall be welded in place to prevent it from turning. The diameters used shall be those for standard bolts quoted in BS 3692 and BS 4190 as appropriate.
  - b. The weight of the bar shall be within plus or minus 2.5% of the weight appropriate to the true cross sectional area. The bolt shall be straight within a tolerance of 2mm per metre length of the bolt, with a minimum tolerance of 2mm. The overall length shall be accurate within a tolerance of plus or minus 3mm, the bottom nut being so positioned that the length shall be within a tolerance of minus zero and plus 5mm. The threaded length shall be accurate within a tolerance of minus zero and plus 20mm.
  - c. Nuts shall comply with the requirements of BS 3692 or BS 4190 as appropriate and shall be of a strength grade such that the specified proof load stress of the nut is not less than the specified minimum ultimate tensile strength of the bolt material, except that the nuts of strength grade 4 may be used with bolts of grade 43 steel to BS 4360. Nuts shall be of normal standard thickness; thin nuts shall only be used as locknuts.
  - d. Unless specified otherwise, bolts shall be of grade 43 steel to BS 4360 with nuts of strength grade 8.8 or higher.
4. Anchor Plates

Unless specified otherwise, anchor plates shall be fabricated from grade steel to BS 4360. Anchor plates shall be accurate in plan size within a



tolerance of minus zero and plus 10mm; the thickness of plate shall be within normal rolling margins as specified in BS 4360. Anchor plates shall be sufficiently flat and free from warping to prevent grout from entering at the bottom of the sleeve (if used). The positions of snugs welded to the underside of anchor plates shall be accurate within a tolerance of plus or minus 1.0mm.

**5. Sleeves**

Bolt sleeves shall be made from mild steel sheet and shall not allow the passage of cement grout into the tube. The gauge thickness of steel appropriate to the sleeve diameter will be shown on the bolt Schedules. The length of the sleeve shall be accurate within a tolerance of plus or minus 3mm and the diameter within plus or minus 5mm. The ends of a sleeve shall be square to its centre line.

**6. Washer Plates**

The washer plates which are welded to the heads (or bottom nuts) of smaller diameter bolts to prevent them from turning between the snugs on the anchor plate shall be grade steel to BS 4360 unless specified otherwise. Washer plates shall be accurate in plan size within a tolerance of plus 2mm and minus 3mm and the corners shall be square within a tolerance of plus or minus 2°. The thickness of plate shall be within normal rolling margins as specified in BS 4360. The plates shall be flat and free from warping.

**7. Washers**

Unless specified otherwise standard washers shall be normal diameter black mild steel washers to BS 4320. Where the holes in the baseplate are larger than normal clearance holes, special washers will be required to details shown on the Schedules; unless specified otherwise these special washers shall be fabricated from grade steel to BS 4360.

**2.5.2.2 FABRICATION**

- A. Any material identification marks which have been hard stamped into the material shall be cut off in the course of fabrication.
- B. All measurement shall be made by a steel tape related to a standard tape which has been certified to be correct at 20°C. The tape and the steel to be measured shall be at the same temperature and proper precautions shall be taken to tension the tape correctly.
- C. All plates, bars and sections shall be flat, straight and free from twist within the tolerances specified in the relevant British Standard, unless more stringent tolerances are specified on the Contractor's Representative Drawings. Any flattening or straightening required in achieving the required tolerances or to satisfy fit-up requirements shall be carried out before any other work is done on that item. The method adopted for such work shall be such as not to deface or weaken the material.
- D. Cutting and Machining
  1. Steel may be sawn, sheared, cropped or machine flame cut. Where it is impractical to use machine flame cutting, the use of hand flame cutting shall be subject to the approval of the Employer's Representative, who may require dressing or other treatment of the cut edges, depending on the details of the joint or member.



2. Where notches are necessary they shall have smooth radiused internal corners, produced by drilling holes not less than 20mm diameter before cutting the rest of the notch or by carefully controlled flame cutting.
3. All burrs left by sawing, cropping or shearing shall be removed before fabrication or assembly. All sharp arises shall be removed by light grinding.
4. The Contractor shall inform the Employer's Representative of members on which he will be using shearing or flame cutting and in cases where steel so cut is specified as being subject to dynamic or fatigue loading or liable to brittle fracture, the sheared or flame cut edges shall be machined to a depth to be agreed by the Employer's Representative.
5. The ends of compression members at splices, caps or bases, dependent on contact for the transmission of compressive stress, shall be prepared so that the butting faces are in contact over at least 50% of the bearing area except for small clearances not exceeding 0.25 mm. Over the remaining area the gap shall not exceed 0.50mm. Base and cap plates and other bearing surfaces shall also be prepared to the same standard.
6. Members shall be adequately supported in both the vertical and horizontal planes during cutting or machining to ensure that the prepared ends are square to the axis of the member.
7. All plates 25 mm thick and over which are to be connected using high strength friction grip (HSFG) or fully tensioned fasteners shall be checked for 'bowing' or 'ripples'; if these defects are present they shall be eliminated before despatch to Site.
8. In HSFG or fully tensioned connections all surfaces which have been machined shall be grit blasted in such a way as to provide a slip factor of not less than 0.45.

**E. Fitted Plates and Stiffeners**

The ends of fitted plates and stiffeners shall be accurately sawn or sheared and ground to fit tightly between the flanges or parts to be stiffened. The maximum gap shall not exceed 0.25 mm.

**F. Smithed Work**

All forging shall be performed in such a manner as not to impair the strength of the metal. The metal shall not be worked after it has fallen to a 'blue heat'.

**G. Holes**

1. Holing shall be in accordance with BS 5950 Part 2 (or BS 4604: Part 1 in the case of holes for friction grip bolts). All 'burrs' and 'rags' shall be removed.
2. Slotted holes shall either be punched in one operation or else formed by punching or drilling two round holes and completed by high quality flame cutting and dressing, to ensure that the bolt can travel the full length of the slot freely.
3. Circular holes for bolts shall not be flame cut.

**H. Composite Columns**

1. Ventilation holes shall be provided in the column walls to prevent dangerous build up of steam pressure inside the column in the event of a fire. Two 6mm diameter holes placed diametrically opposite each other both at the top and bottom of each storey height shall be provided. Care shall be taken to ensure that the holes are positioned outside the level of any floor slab or screed.



2. A drain hole shall also be provided at the base of a column to prevent water collecting if it is left standing on Site prior to filling. This hole may be one of the steam vent holes.

**I. Welding**

1. Welding shall comply with the requirements and recommendations of BS 5135 except as otherwise directed in this Specification and on the Contract Drawings.
2. The Contractor shall determine the welding procedure details to meet the requirements of this Specification, including the requirements of Inspection and Quality Control.
3. Unless otherwise specified, T-butt welds shall be reinforced by equal-leg fillet welds of leg length equal to a quarter of the thickness of the thinner plate joined, but not less than 3mm nor greater than 10mm.
4. Where the steelwork is to be blasted and metal sprayed or galvanised after fabrication, cleats and other solid attachments welded to the member shall be welded all round to seal the unprotected surface.
5. Welding procedure details for steels not complying with BS EN 10025, BS EN 10155, BS EN 10113, or BS EN 10210 - Grades S275 or S355 shall be agreed with the Employer's Representative before fabrication is started, on the basis of weld procedure tests in accordance with BS EN 288.
6. Except as otherwise specified, the fit up of elements before welding shall conform to the recommendations for manual welding given in the note in clause 11.1 of BS 5135.
7. The root edges or root faces of butt welds shall not be out of alignment by more than 15 percent of the thickness of the thinner material but not greater than 3mm.
8. The Contractor shall demonstrate to the satisfaction of the Employer's Representative that the proposed weld procedure details are derived from procedures which have already been Approved. Where weld procedure tests are required to be performed to demonstrate this, the tests shall be in accordance with BS EN 288.
9. All welders shall be suitably qualified and experienced for the work on which they are employed and shall have satisfied the relevant requirements of BS EN 287 or BS 4872: Part 1 or AWS D1.1 as appropriate. The Contractor shall keep records identifying the welder for each welded joint. Copies of welders' qualifications shall be submitted by the Contractor for the approval of Employer's representative.
10. Welded attachments for fabrication or erection purposes shall be subject to the Employer's Representative approval and shall be clearly shown on the fabrication Drawings.
11. Unless otherwise specified, all welds shall not be undersized. Butt welds shall have a uniform convexity up to a maximum of lesser of 3mm or 1/5 of weld size in mm. Concave fillet weld shall have a throat thickness not less than 0.7 times the specified leg length. Convex fillet welds shall have a throat thickness not more than 0.9 times the actual leg length. All welds shall have a smooth surface.
12. In addition to the above requirements, all welds on steelwork which is not clad shall be ground smooth.

**J. Shear Stud Welding**



1. Shear studs shall be welded in accordance with the manufacturer's recommendations for materials, procedures and equipment.
2. When requested by the Employer's Representative and before production welding of studs commences, procedure trials shall be carried out. The trials shall be made on samples of materials and studs representative of those to be used in the Works. The samples of materials and studs shall be subject to the approval of the Employer's Representative.

**K. Bolted Connections**

**1. Bolting up with Close Tolerance Bolts**

Holes for close tolerance bolts shall be drilled and reamed. Where the holes are not drilled through all thicknesses in one operation, the parts to be joined together shall be accurately lined up with parallel drifts of a diameter not greater than the nominal size of the hole and not smaller than 0.15 mm less than the nominal diameter and the holes then reamed. A close tolerance bolt shall be fitted in each hole reamed and tightened before the next hole is reamed. All bolts shall be re-tightened after the last bolt has been fitted.

**2. Bolted Movement Connections**

Slotted holes for movement connections shall be provided with shouldered bolts, spring washers and flat washers.

**3. Correcting hole alignments**

Drifting to align holes shall not enlarge the holes or distort the metal. Holes which cannot be aligned without distortion shall be a cause for rejection unless enlargement by reaming is specifically Approved by the Employer's Representative.

**4. Provision of washers**

- a. Washers shall be provided at slotted holes and elsewhere as specified. With metal sprayed steelwork a washer shall always be provided under both head and nut.
- b. Square taper washers shall be provided for all bolts where the bolt head or nut is bearing on a surface at an angle to the bolt axis greater than 93° or less than 87°.

**5. Bolting Metal Sprayed or Galvanised Steelwork**

Ordinary bolted connections on metal sprayed or galvanised steelwork shall be made using spun galvanised or sheradised bolts, nuts and washers except where connecting coated steelwork to black steelwork.

**L. Marking**

1. Each piece of steel shall be uniquely identified throughout the fabrication process.
2. Each piece of steelwork shall be distinctly marked before despatch in accordance with the marking Drawing prepared by the Steelwork Contractor. Where applicable it shall also be given other marks and symbols to assist erection at Site, by showing from which works it has come and to which crane or area it is to be delivered.
3. The location of marks on members shall be consistent and shall be such that the marks are clearly visible both before and after erection.
4. Painted marks shall be applied using a paint that is compatible both in colour and chemically with the final Site anti-corrosion treatment.



5. The method of marking steelwork which is to be supplied to Site fully painted shall, unless specified otherwise, be as agreed with the Employer's Representative.
6. The painting of the Contractor's name or other advertising matter on steelwork is not permitted. Any such advertisement must be in the form of labels which are to be removed after the steel arrives on Site.
7. The marking of Safe Working Load on runway beams shall comply with BS 2853.
8. Where high strength bolts and threaded rods are used, additional marking must be visible which will identify the strength of these. The manufacturers' standard markings will suffice provided that they can be easily read on Site before the bolts are fixed.

**M. Surfaces**

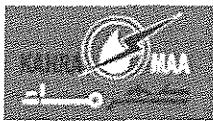
1. Steel surfaces shall not be more heavily pitted or rusted than Grade C of BS 7079 Part A1. Any major surface defects shall be reported to the Employer's Representative and his instructions followed.
2. Any minor surface defects such as surface laminations, blow holes and crevices exposed by blast cleaning shall, subject to the approval of the Employer's Representative, be made good as specified in BS EN 10025, BS EN 10113, BS EN 10155, BS 7613, BS EN 10210 or BS 7668 as appropriate.
3. Surfaces which become inaccessible after fabrication or assembly, such as the inside of structural hollow sections and other box sections, shall be sealed off from the outside atmosphere by continuous welds unless specified otherwise.
4. Hollow members which are to be galvanised shall have vent holes. These shall be large enough to ensure internal galvanising or if so specified shall be sealed after the member has been galvanised.
5. Contact surfaces, other than those where HSFG fasteners are to be used, shall be treated as required by Subsection 2.6 Corrosion Protection of Structural Steelwork.
6. Where specified on the Drawings machined surfaces shall receive an Approved coat of travel varnish within four hours of machining.

**N. Trial Assemblies**

1. Trial assemblies shall be carried out in general and for the large truss elements in particular.
2. The size of the assemblages shall be determined by the Contractor to the approval of the Employer's Representative and shall be sufficient to ensure that fit up and erection tolerances can be achieved on Site.

**2.5.2.3 SOURCE QUALITY CONTROL**

- A. Comply with pertinent provisions of the relevant British Standards and QCS 2010.
- B. Constituent materials shall be obtained from suppliers operating quality systems in accordance with either ISO 9001 or an in-house system Approved by the Employer's Representative.
- C. If it is found necessary to substitute alternative sections for any of the steel sections specified then the written approval of the Employer's Representative for the substitution and for the amendments to the detailed Drawing showing the substitution shall be obtained before fabrication is commenced.
- D. Lamination Testing

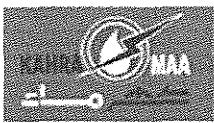


1. Except in the case of special plate with through thickness properties guaranteed by the manufacturer, all plates and sections 40mm or over in thickness shall be ultrasonically tested for laminations, and shall meet the acceptance criteria of level B6 to BS 5996.
  2. Other plates may be specified to be ultrasonically tested for laminations. Unless otherwise specified they shall meet the requirements of level B6 to BS 5996.
  3. Welded joints that cause high tensile through thickness strains to occur (as discussed in Appendix G of BS 5135), shall be fabricated from steel that meets the quality level Z35 of BS EN 10164.
  4. For all steel plates and sections which will be subject to through-thickness stresses, the Contractor shall carry out non-destructive testing on the steel to ensure that the affected zones are free from laminations and inclusions. Table 5, 18 and 19 of BS 5135 shall be used to determine acceptance levels for steel products.
- E. Welding shall meet the requirements stated in subsection Materials - Welding and shall be subject to the inspection and testing requirements stated in subsection Inspection and Quality Control.

### **2.5.3 EXECUTION**

#### **2.5.3.1 ERECTION**

- A. Method of Erection
  1. The Contractor shall submit a detailed Method Statement including logistics and the health and safety plan to the Employer's Representative for approval prior to erection. The Method Statement shall be in accordance with the method of erection, if any, specified in the Contractor's Representative Drawings. When necessary to amplify the information given in his Method Statement, the Contractor shall prepare Erection Drawings for approval by the Employer's Representative.
  2. Erection of the steelwork shall be carried out in a safe manner and the work shall be arranged in such a manner as to facilitate phased hand over of the steelwork for subsequent operations. The temporary supporting structures to enable permanent work installations shall be properly engineered and the design and details submitted to the Engineer for his approval.
- B. The Contractor shall supply adequate plant, tools, service bolts, drifts, bolt tightening devices and other equipment to ensure that the steelwork is correctly erected in accordance with the programme.
- C. Transport, Storage, Handling and Attachments
  1. Care shall be taken when transporting, storing, handling or erecting all material to ensure that no part is damaged. Damage to any part of the structure either before or during erection shall immediately be brought to the notice of the Employer's Representative. Damaged material shall be rectified or replaced. No part that has been damaged shall be assembled into the structure without the written approval of the Employer's Representative.
  2. Steelwork to be stored shall not be placed directly on the ground. It shall be stored in such a manner as to avoid water retention.



3. Particular care shall be taken when transporting, handling or storing parts which have been metal sprayed, galvanised or painted. If the coating is damaged it shall be restored to comply with the relevant requirements of QCS 2010 for Structural Steelwork.
  4. Lifting points shall be suitably wrapped and protected and steel slings shall not be allowed to come into direct contact with coated steelwork.
  5. Welded attachments shall not be employed unless they are clearly shown on the fabrication Drawings.
- D. Foundations / Cast in place Concrete works
1. All the necessary anchorage materials which are to be built into the foundations / Cast-in-place Concrete elements shall be supplied to Site in time to meet the agreed programme.
  2. Immediately the foundations are available the Contractor shall satisfy himself that the foundations / Cast-in-place Concrete elements have been correctly formed and that the holding down bolts has been accurately set and have the full amount of play shown on the Drawings and shall inform the Employer's Representative accordingly, in writing.
- E. Temperature Effect
1. In setting out and erecting continuous structures proper adjustments shall be made as Approved by the Employer's Representative to counteract dimensional discrepancies owing to temperature variations.
  2. Where stanchion bases are to be cast into pockets formed in concrete foundations, any horizontal steel members which tie the stanchions together shall be fixed first and the stanchions shall then be lined, levelled, plumbed and concreted in and the concrete in the pockets allowed to harden before fixing the rest of the steelwork to them.
  3. Except where specified otherwise, sliding joints shall be treated with molybdenum disulphide grease before erection.
  4. The Contractor shall limit the temperature effects during erection by adequately controlling the temperature of the element using thermal insulation or an alternative system Approved by the Employer's Representative. He shall demonstrate that the change in temperature of any element or elements shall not cause undue effects on the structure.
- F. Lining and Levelling
1. The permanent welding or bolting up of connections shall not be carried out until a sufficient portion of the structure has been erected and temporarily connected up, to ensure that there will be no straining of members during the erection and lining up of the remainder of the structure.
  2. Temporary bracing, as deemed acceptable by the Employer's Representative shall be provided and left in position until such time as the building is sufficiently far advanced for such bracing to be no longer required. The design and details of temporary supports shall be submitted for Engineer's approval.
  3. Packs for levelling up stanchions shall be shown on the Drawings submitted for the Employer's Representative approval. At least three sets of packs shall be used for each stanchion. The number of packs provided shall be 25% in excess of the theoretical requirement.



4. Packs shall not be larger than is necessary for their purpose, they shall be sawn and not sheared or flame cut. Packs shall not protrude unduly from the stanchion base; they shall be grouted in and the grout shall totally enclose them.

**G. Grouting up of Structures**

1. The Employer's Representative shall be informed when stanchions or other members have been lined, levelled and plumbed and no grouting or concreting-in shall be done until the Employer's Representative has Approved the alignment and plumbing.
2. Following such approval, the Contractor shall immediately grout the baseplates and concrete in the stanchions or other members, using materials Approved by the Employer's Representative.

**H. Composite Columns**

**1. Welding to Concrete Filled Columns**

Primary load bearing structural components shall be welded to the column before commencing to fill with concrete. Subject to the approval of the Employer's Representative, the welding of relatively small lugs and fittings after filling may be allowed.

**2. Column Welded Splices**

To allow welding to take place, the concrete filling shall be stopped at a level approximately 250mm below the top of the column. The next column length can then be spliced into place using a full penetration butt weld with a backing ring. Following this, concrete filling can be resumed.

**3. Bolted Flange Joints**

When a flanged connection is used, the flange shall be welded to the column before filling. When flanges are used at both ends of a column length at least one flange shall have to incorporate an aperture for filling. In order to ensure complete filling under this flange, the maximum size of any lip shall not exceed 15mm.

**4. Preparation for Concrete Placing**

- a. Surfaces to receive concrete shall conform to the requirements of QCS 2010.
- b. All loose material and debris shall be removed from the bottom of the column. Any free water which may have collected at the bottom shall also be removed.

**5. Placing and Compacting the Concrete in Composite Tube Columns**

- a. The Contractor shall submit a detailed Method Statement to the Employer's Representative for approval prior to construction.
- b. The Contractor shall conduct a full-scale test on Site to the satisfaction of the Employer's Representative to demonstrate the proposed method of filling, compaction and making good.
- c. Comply with pertinent provisions of Subsection 2.1 Cast-in Place Concrete.
- d. The columns shall be concrete filled by pumping concrete into the column through temporary ports in the base of the column. The



Contractor shall design, fabricate, install, remove and make good the opening and works associated with the temporary ports.

- e. The concrete filling method shall ensure compaction of the concrete during placing.
- f. Drain holes that are present in the column to prevent build up of water on Site and to allow escape of moisture in the event of fire shall be temporarily plugged whilst the concrete is being placed. The plugs shall be removed after the concrete has achieved its initial set.
- g. Polythene sheeting shall be placed over the top and tied or taped around the column to prevent early drying out of the concrete at the top surface.

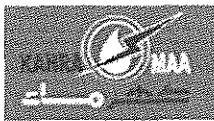
#### I. HSFG Bolted Connections

1. Care shall be taken to ensure that all HSFG bolts, nuts, washers etc. are maintained in good condition. Particular care shall be taken to ensure that the threads of bolts and nuts are free from damage, grit, corrosion or any condition necessitating excessive torque to obtain the required tension. The Employer's Representative approval shall be obtained before lubricating the threads should this be necessary. Care must be taken in applying lubricant to the threads as it is essential that no lubricant gets between the contacting surfaces of the steelwork. Plumber's Tallow is recommended for this purpose; oil shall not be used.
2. The faying surfaces shall be prepared to achieve a slip-factor of not less than 0.45. The Contractor shall demonstrate compliance with this requirement in accordance with the BS 4604 test method. Galvanised and metal sprayed surfaces shall always be lightly grit blasted. Painted surfaces shall be prepared in accordance with QCS 2010.
3. Assembly shall be in accordance with BS 4604: Part 1. The faying surfaces shall be kept completely dry for assembly.
4. General grade HSFG shall be tightened by the Part-Torque, Part-Turn method in accordance with the procedure described in System A below or by using load indicating washers in accordance with the procedure described in system B below.
5. System A - Part-torque, Part-turn Method of Tightening
  - a. After assembly all the bolts in the joint shall be tightened with the required bedding torque, to ensure that the parts of the joint are brought into good contact with each other, using a calibrated tightening device such as a break-back spanner or a torque controlled impact wrench.
  - b. The appropriate values of the bedding torque to be used in each case will depend on the actual conditions of the bolts and other factors and will be determined by the Employer's Representative in each case. It may be necessary to conduct trials on Site and facilities shall be made available by the Contractor for this purpose.
  - c. During the tightening of any one joint, the first few bolts tightened may relax and it may be necessary to tighten each bolt more than once until the bedding down torque is achieved.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

- d. After bedding down, the parts joined together must be in close contact over their full area, with no signs of distortion in any of the parts. This stage of tightening is not intended as a corrective for faulty workmanship in the assembled plies.
  - e. After bedding down the joint each nut and bolt shall be permanently marked with a cold chisel on one side of the nut and on the protruding thread of the bolt in one continuous line. This marking is to record their subsequent relative positions.
  - f. Before final tightening is carried out the Employer's Representative shall be informed so that he may check that the bolts have been correctly bedded down.
  - g. A tolerance of +20% on the specified bedding down torque will be permitted to allow for slight variations in the calibration of the devices used for tightening and checking.
  - h. When permission to proceed has been obtained from the Employer's Representative the bolts shall be further tightened so that the nut is turned relative to the bolt shank by the amount given in Table 3 of BS4604 Part 1.
  - i. After completion of the turn of the nut the Employer's Representative shall be informed so that he may check that the nut has been turned the correct amount relative to the bolt.
6. System B - Tightening using Load Indicating Washers
- a. The load indicating washers shall be used in conjunction with HSFG bolts manufactured in accordance with BS4395 Part 1.
  - b. The Contractor shall ensure that the load indicating washers do not jam on the shanks of the bolts. This can be checked before installation by placing the load indicating washer upside down on the bolt (i.e. with the protrusions away from the bolt head). If the washer does not turn freely on the shank right up to the underside of the bolt head, the washer or the bolt, whichever is at fault, shall be rejected.
  - c. The load indicating washer shall preferably be fitted with the protrusions bearing against the bolt head. If this is not possible, it may be fitted against a special nut face washer which is fitted against the nut.
  - d. Where a hardened taper washer is necessary the bolt shall preferably be fitted in such a way that the taper washer can be placed between the nut and the steelwork or, if this is not possible, the taper washer may be placed between the load indicating washer and the steelwork.
  - e. Where the load indicating washer is fitted under the head of the bolt care must be taken that the head of the bolt does not turn during tightening.
  - f. Where it is necessary to use the special nut face washers the manufacturers instructions on assembly shall be carefully followed to ensure proper functioning of the load indicating washer in this position.
  - g. No methods other than the above shall be used.



h. After assembly all the bolts in the joint shall be tightened to a "snug tight" condition, to ensure that the parts of the joint are brought into good contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using a spanner. Alternatively the bolts shall be tightened to a specified bedding torque as in System A, subsections a. and b.

i. During the tightening of any one joint, the first few bolts tightened may relax and it may be necessary to tighten each bolt more than once until the bedding down torque is achieved.

j. After bedding down, the parts joined together must be in close contact over their full area, with no signs of distortion in any of the parts. This stage of tightening is not intended as a corrective for faulty workmanship in the assembled plies.

k. Before final tightening is carried out the Employer's Representative shall be informed so that he may check that the bolts have been correctly bedded down.

l. When permission to proceed has been obtained from the Employer's Representative each bolt shall be further tightened so that the average gap is reduced to 0.40 mm maximum in normal assemblies or 0.25 mm maximum against a nut face washer. The gaps shall not be reduced to less than 0.10 mm.

m. After completion of the tightening the Employer's Representative shall be informed so that he can check that the gaps have been closed to within the limits.

n. The time, torque and amount of turn required to obtain the specified gap shall be observed and these should remain substantially constant for similar bolts.

o. Where excessive time or turn or unusual force is required to reduce the gap the reason for this shall be sought and rectified before proceeding with the work.

7. High Strength Bearing Type joints

a. For bearing type joints an applied finish on the contact finishes shall be permitted.

b. The procedure for tightening bearing type joints shall be the same as for HSFG bolts.

8. Tightening of Galvanised or Plated Nuts and Bolts

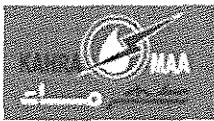
a. Care shall be taken to ensure that coating materials do not strip off and jam the threads as this will give a false indication of torque.

J. Site Bolting

1. All Site bolting shall meet the relevant requirements stated in this Specification.

2. Bolting up and final tightening of bolts shall be carried out progressively as the erection, alignment and grouting proceeds in order to release the steelwork and the area under it for subsequent operations.

3. Care shall be taken not to damage bolts by over-tightening.



**K. Site Welding**

1. Where Site welding is required the requirements stated in subsection Fabrication - Welding shall be met and the welding shall be subject to the inspection and testing requirements stated in subsection Inspection and Quality Control. Special attention shall be paid to the safety of welders working on Site. Hotwork permit shall be obtained from the concerned safety department prior to the works as applicable at Site.
2. Due precautions shall be taken against inclement weather. Welding shall not be carried out during rain except under cover and with adequate protection against ingress of water to the zone to be welded. Electrodes shall be kept dry and stored in an appropriate environment.
3. Gas shielded welding shall only be carried out with adequate protection from wind and draughts.

**L. Installation of Holding Down Bolts**

1. The Contractor shall provide such temporary or permanent supports as are necessary to ensure that all bolts are cast in position within the requirements of this Specification. All bolts shall be held rigidly in position at top and bottom. Permanent supports which project outside the finished concrete shall be cut away to the Employer's Representative approval. Steel templates with supports independent of the shuttering or reinforcement shall be used for bolts exceeding 48mm diameter and/or length exceeding 1 metre.
2. The Contractor shall provide plugs at the top of bolt sleeves to prevent ingress of debris into the sleeve and to prevent any washer of lesser diameter than the sleeve from falling into the sleeve.
3. The levels of the tops of all holding down bolts shall be accurate within a tolerance of minus zero and plus 12mm.
4. When the bolts have been cast in, the bolt threads and the nut shall either be coated with grease as specified in the subsection Delivery, Storage and Handling or then wrapped with a suitable thickness of flexible PVC sheeting to BS 1763, properly tied on, or else wrapped with two layers of Denso tape.
5. Once cast in position, bolts shall be protected by the Contractor against damage from any source until hand over. Where it is necessary for vehicles to run over areas where there are projecting bolts, the Employer's Representative may direct the Contractor to provide temporary mass concrete, timber sleepers, or other suitable Approved provisions to protect the bolts against damage.
6. **Bolts Rigidly Cast In**
  - a. Where holding down bolts are cast rigidly into concrete, unless a greater degree of accuracy is called for on the Drawings, the position of the centre of the bolt in plan at any level within the length of the bolts shall be accurate within a circle of 6mm diameter, the centre of which is on the intersection of the true ordinates of the bolt.
  - b. Unless a greater degree of accuracy is called for on the Drawings bolts shall not deviate from a plumb line by a slope greater than 1 in 150.



7. Bolts in Sleeves

- a. The position of the centre line of the bolt in plan at the top and bottom and at any level within the length of the bolt shall be accurate within the tolerances given in Table 2 or Table 3 as appropriate. After the bolts have been concreted in and the top has been pulled over to its true position, the slope specified in the appropriate table shall not be exceeded.
- b. Where tolerances to Table 3 are required, this will be indicated on the Contractor's Representative Drawings, otherwise Table 2 applies.
- c. The centre line of the bolt shall be free to move laterally at the top of the bolt within a circle of 30mm diameter, the centre of which is at the specified position of the bolt.

<b>Bolt Length in mm</b>	<b>Tolerance in mm</b>
300	$\pm 4$
450	$\pm 6$
600	$\pm 8$
750	$\pm 10$
900	$\pm 12$
1050	$\pm 14$
1200	$\pm 16$
1350	$\pm 18$
1500	$\pm 20$
1650	$\pm 22$
1800	$\pm 24$
1950	$\pm 26$
over 1950	$\pm 28$
<b>Final Slope:</b>	<b>1 in 75 (Maximum)</b>

**Table 2 Positional Tolerance for Holding Down Bolts in Sleeves for slab type base plates.**



Bolt Length in mm	Tolerance in mm
450	± 3
600	± 4
900	± 6
1200	± 8
1500	± 10
1800	± 12
2100	± 14
2400	± 16
2700	± 18
3000	± 20
over 3000	± 20
<b>Final Slope:</b> <b>1 in 50 (Maximum)</b>	

**Table 3 Positional Tolerance for Holding Down Bolts in Sleeves - for thick castings and for base plates where the bolts pass through holes at two levels.**

#### 8. Other Requirements

- The Contractor shall survey the holding down bolts and other encast elements and manufacture templates to ensure proper fit-up when the steelwork is erected. Oversize holes shall be provided in the bolt boxes to facilitate erection.
- Holding down bolts may be cast solidly into the concrete without sleeves. A bituminous coating may be applied to the bolts to facilitate pre-stressing by the Contractor. During pre-stressing, jacking shall be repeated until it has been demonstrated that relaxation of shear stresses within the bituminous coating has taken place.

#### M. Electrical Continuity for Lightning Protection

- All structural steel elements shall be electrically continuous and connected to the concrete reinforcement by means of a flexible copper earth bond.
- The system and its installation shall comply with BS 6651.

#### 2.5.3.2 ERECTION TOLERANCES

- The Contractor shall be responsible for the correct positioning and the correct levels of the structure.
- Unless otherwise specified the tolerances for position and level of the steelwork shall be:

All setting out dimensions	± 5mm
Position relative to main setting out lines	± 10mm
Position relative to a local grid established at a particular level	± 5mm
Level (5m straight edge)	± 5mm
Level relative to datum	± 10mm
Plumb or deviation from vertical alignment of any element	in 2000 but not more than ± 50mm
Overall vertical alignment (foundation to roof)	± 50mm



### **2.5.3.3 AS ERECTED DRAWINGS**

On completion of the Contract, the Contractor shall provide the Employer's Representative with CD ROM (AutoCad 2004 format) and a set of paper prints of "As Erected" Drawings comprising following:

1. General arrangement Drawings
2. Fabrication Drawings
3. Drawings made after fabrication revisions
4. The fabrication Drawing register

### **2.5.3.4 INSPECTION AND QUALITY CONTROL**

#### **A. General**

1. The Contractor shall be responsible for carrying out all inspection and testing in accordance with this Specification.
2. In the event that materials or workmanship fail to comply with the requirements of this Specification any further inspection and testing which is necessary to satisfy the Employer's Representative shall be the responsibility of the Contractor. Testing laboratories shall be accredited where appropriate.
3. Additional inspection and testing may be required by the Employer's Representative.
4. The Contractor shall demonstrate to the Employer's Representative that full records are maintained through all stages of the work and these records shall be freely available for inspection by the Employer's Representative or his representatives at any time.
5. The Contractor shall provide safe and easy access for all inspections.
6. The independent testing laboratory shall comply with pertinent provisions of QCS 2010-Quality Assurance.
7. The independent testing laboratory shall be qualified to undertake such tests be experienced with local construction conditions and hold approvals from all relevant statutory authorities.

#### **B. Inspection and Testing of Welding**

1. The Contractor shall carry out inspection and testing of welding to meet the requirements and recommendations of BS 5135, except as otherwise directed in this Specification and on the Contract Drawings. Welds shall be inspected and tested in accordance with Tables 4 and 5. Testing procedures shall be in accordance with BS 2600, BS 2910, BS 3923 or equivalent Approved.
2. All welds shall have 100 percent visual inspection to BS 5289 in addition to the requirements given in this Specification and Contract Drawings.
3. Inspection and testing by the Contractor shall be carried out by suitably qualified and experienced staff to the approval of the Employer's Representative and all in accordance with the relevant British Standards listed in this Specification. Testing shall be carried out by an independent testing laboratory.



4. Every facility shall be given to the Employer's Representative or such inspector or testing agencies Approved by the Employer's Representative as he may appoint to visit at all reasonable times all places where work is being carried out and to inspect and test the steelwork during all stages of preparation, fabrication and trial assembly.

<b>Quality Category</b>	<b>Location of Weld</b>
Class A	All connections of trusses, primary structural members.
Class B	All steel elements other than those shown in Class A.
Class C	Not used

**Table 4:** Requirements for Inspection & Testing Of Welds (& Steel Products at Zones Subject to Through Thickness Stresses) in accordance with BS 5135 Appendix H Tables 18 & 19

<b>Weld Category</b>	<b>Requirements</b>
Normal – All welds unless otherwise stated below	1. The weld shall not be undersize. 2. Butt welds shall have a uniform convexity up to a maximum of lesser of 3mm or 1/5 of weld size in mm. 3. Concave fillet welds shall have a throat thickness not less than 0.7 times the specified leg length. 4. Convex fillet welds shall have a throat thickness not more than 0.9 times the actual leg length. 5. All welds shall have a smooth surface.
Special - All welds on steelwork which is not clad	1. All above requirements apply. 2. In addition, all welds shall be ground smooth.

**Table 5:** Particular Requirements for Weld Profile & Surface Finish

5. When trial assembly is specified it shall be carried out in the Contractor's works to the extent required by the Employer's Representative to prove the accuracy of the workmanship.
6. When parts which have to fit together are manufactured in different works or for any reason cannot be matched before despatch to the Site, the Contractor shall make adequate provision to ensure a correct fit by providing checking jigs or other suitable means satisfactory to the Employer's Representative.
7. A minimum of 5 working days advance notice shall be given to the Employer's Representative of the Contractor's intention of making a trial assembly.
8. When random (less than 100 percent) volumetric non-destructive testing of welds is specified, it shall be ensured that the positions tested are fully representative of all aspects of the welding (a minimum of 15% of all welds shall be tested).



9. The particular method of non-destructive weld testing, Approved by the Employer's Representative, shall be sufficiently sensitive to allow the proper detection of defects and interpretation of results appropriate to the quality category.
10. When random (less than 100 percent) volumetric non-destructive testing of welds reveals unacceptable defects in a joint, all previously untested joints in the group represented shall be tested until it is established to the satisfaction of the Employer's Representative that the cause of the defects has been demonstrated and the defects eliminated. This may require 100 percent testing.
11. Any work which does not comply with the requirements of this Specification shall be rectified promptly to the satisfaction of the Employer's Representative including any further inspection and testing which is deemed to be required.
12. Inspection by the Employer's Representative shall not relieve the Contractor of
  - a. his responsibility to perform his own quality control operations to ensure that all work meets the Specification and
  - b. his responsibility to rectify all defects including any which appear or are found subsequently.
13. Copies of welding inspection reports shall be submitted by the Contractor for the approval of the Employer's Representative.

**C. Inspection and Testing of Shear Stud Welding**

1. All studs shall be visually inspected. They shall show a full 360° collar.
2. At locations agreed with the Employer's Representative a minimum of 5% of studs shall be subjected to bend test.
3. The bend test shall be made by striking the head of the stud with a 6 kg hammer until it is displaced laterally a distance of about one quarter the height of the stud. The stud weld shall not show any signs of cracking or lack of fusion.
4. Studs subjected to the bend test shall not be straightened.
5. Defective Studs
  - a. Studs with defective welding shall be removed by flame cutting or gouging at a point not less than 3 mm from the surface of the parent material.
  - b. The residual stud material shall be ground flush and the affected area visually inspected. When thickness of the parent material is greater than 20 mm it shall also be checked by magnetic particle inspection.
  - c. Acceptance criteria shall be in accordance with the Specification.
  - d. Studs shall not be removed by hammering.

**D. Testing Runway Beams, Trolley Beams and Supports for Permanently Installed Suspended Access Equipment**

1. The testing of runway beams shall be carried out in accordance with BS 2853 and all statutory requirements. The Contractor's Representative shall provide all labour, materials and equipment necessary for the test.



When the runway beams are ready for testing the Employer's Representative shall be informed and the tests shall be carried out in the presence of the Employer's Representative and all relevant approval bodies, including the Health and Safety Executive and Insurance Representatives.

2. Trolley beams for window cleaning trolleys and the like shall be tested as runway beams.
3. Supports for Permanently Installed Suspended Access Equipment shall be tested to meet the requirements of BS 6037.
4. All beams and supports shall be marked to show the safe working load where this is not clearly indicated on the lifting equipment itself.

## **2.6 CORROSION PROTECTION OF STRUCTURAL STEEL**

### **2.6.1 GENERAL**

#### **2.6.1.1 SUMMARY**

- A. Qatar Construction Specification (QCS) form the basis of the specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010).  
B. Metal coating work shall consist of furnishing all materials and application of coating as directed in accordance with the details shown on the Drawings and these Specifications.  
C. Related Sections

In addition to the General Conditions, the Contractor shall also refer to the following Specifications:

1. Subsection 2.5 – Structural Steel Framing

#### **2.6.1.2 REFERENCES**

- A. The Standards referred to below, together with all appropriate references listed within those Standards, shall be used with this Specification. The edition to be used shall be that current at the date of this Specification, except that the latest editions of Standards may be used when no reduction in quality will result. Any differences between their requirements and this Specification shall be submitted to the Employer's Representative for his ruling. Where a Standard has been specified an equivalent internationally recognised Standard, such as ASTM or DIN, may be used subject to the Employer's Representative approval.

- B. British Standards

BS 381C	Colours for specific purposes
BS 729	Hot dip galvanised coatings on iron and steel articles
BS 1134	Method for the assessment of surface texture
BS 1706	Method of specifying electroplated coating of zinc and cadmium on iron and steel
BS 2451	Chilled iron shot and grit
BS EN 22063	Metallic and other inorganic coatings; Thermal spraying; Zinc, aluminium and their alloys



BS 2989	Specification for continuously hot dip zinc coated and iron-zinc alloy coated steel wide strip, sheet/plate and slit wide strip
BS 3382	Electroplated coatings on threaded components
BS 3900	Method of test for paint
BS 4800	Paint colours for building purposes
BS 4921	Sherardised coatings on iron and steel
BS 5252	Framework for colour co-ordination for building purposes
BS 5378	Specification for safety colour and safety signs
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion
BS 7079	Preparation of steel substrates before application of paints and related products.

C. Other References

- |          |   |
|----------|---|
| CS 2010  | Qatar Construction Specification 2010                         |
| NFPA 101 | Code for Safety to Life from Fire in Buildings and Structures |

#### **2.6.1.3 SUBMITTALS**

- A. All submittals shall comply with the pertinent provisions of QCS 2010.
- B. Prior to starting work on the Contract the Contractor shall submit for approval details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the specification.
- C. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials or place of manufacture are used.

#### **2.6.1.4 QUALITY ASSURANCE**

- A. The Contractor shall comply with the pertinent provisions of QCS 2010.
- B. Where possible constituent materials shall be obtained from suppliers operating quality systems in accordance with ISO 9001.

#### **2.6.1.5 DELIVERY, STORAGE AND HANDLING**

- A. Comply with pertinent provisions of the British Standards and this Specification as appropriate.
- B. Care shall be taken when transporting, storing and handling all steelwork to ensure that no part is damaged.
- C. Particular care shall be taken when transporting, handling or storing parts which have been painted. If any coating is damaged it shall be restored to comply with the relevant requirements of this Specification.
- D. Lifting points shall be suitably wrapped and protected and steel slings shall not be allowed to come into direct contact with coated steelwork.
- E. Steelwork shall be stored in such a way as to avoid water retention. If necessary it shall be kept under well ventilated cover.
- F. Steelwork to be stored shall not be placed directly on the ground.



### **2.6.1.6 CORROSION PROTECTION SCHEDULE**

- A. The particular requirements under this Section are indicated in the Corrosion Protection Schedule below.
- B. Corrosion Protection Schedule includes the following:
  - 1. Painting systems including surface preparation, materials, thicknesses and other requirements.
  - 2. Galvanisation requirements.
  - 3. Sprayed metal coatings.
  - 4. Protection to nuts, bolts and washers.

### **2.6.2 PRODUCTS**

#### **2.6.2.1 MATERIALS**

- A. Reference shall be made to the Corrosion Protection Schedule below.
- B. Materials shall suit the intended purpose and shall comply with the requirements of the Contract.
- C. Painting

The Contractor shall provide technical data sheets for all materials giving the following information:

- 1. Scope of use
- 2. Type of product (Chemical and physical characteristics)
- 3. Chloride and Oxygen diffusion resistance
- 4. Vapour transmission resistance
- 5. Composition with % of solids
- 6. Mixing ratio for two-pack materials or more
- 7. Pot life
- 8. Method of application
- 9. Covering capacity
- 10. Thickness of dry and wet films
- 11. Drying time
- 12. Flash point
- 13. Colours
- 14. Packing
- 15. Solvent type
- 16. Change in appearance with time (gloss, matt, etc.)
- 17. Health and safety precautions
- 18. Storage conditions and shelf life
- 19. Spray application; nozzle characteristics (diameter and spray-angle), pressure



20. Minimum and maximum application temperatures
  21. Resistance to heat
  22. Adhesion characteristics.
- D. Galvanising: all materials used in galvanising process shall conform to the requirements of BS 729.
- E. Sprayed Metal Coatings: the composition and form of the coating metals shall conform to the requirements of BS EN 22063

### **2.6.3 EXECUTION**

#### **2.6.3.1 GENERAL**

##### **A. Painting**

1. The Contractor shall supply all labour, equipment, material, paint, thinners, and cleaning materials necessary to prepare and to paint surfaces in accordance with this Specification, together with the specified test equipment for quality control.
2. The Contractor shall at all times liaise with the paint manufacturers in order to ensure regularity of supply, compatibility between successive coats and colour matching of progressive batches of the same colour. Painting works shall be carried out by an Approved applicator, certified by the material manufacturer.
3. Where paints for any one system are being supplied by different manufacturers or from different manufacturing units, the Contractor shall ensure compatibility. Before using the materials the Contractor shall supply to the Employer's Representative written confirmation from each source of supply that the materials are compatible.
4. The Contractor shall ensure that during the course of the work accredited representatives of the paint manufacturers visit the place of application to ensure that the application of the paint is satisfactory and in accordance with the manufacturers' instructions. The number and frequency of these visits shall be agreed between the Contractor and the Employer's Representative at the commencement of the work. Copies of the manufacturers' reports on these visits shall be supplied to the Employer's Representative.
5. Notwithstanding any demarcation between shop and Site treatments specified in the Corrosion Protection Schedule, where items of steelwork are difficult to treat after erection or where the programme of erection work is such that the Contractor may prefer to apply the complete treatment prior to erection, the Employer's Representative will consider such proposals from the Contractor. Any approval given by the Employer's Representative will not relieve the Contractor of his responsibilities under the Contract for the quality of the completed treatment.
6. If standard prefabricated finished items are used by the Contractor, an alternative protection system will be considered by the Employer's Representative provided that it is not inferior to that specified and provided that colours of finishing coats match. The Contractor shall provide full details of the proposed system for approval to the Employer's Representative prior to the implementation of the system.



7. All paint products and thinners shall be delivered to the place of application in sealed containers (maximum capacity twenty litres), clearly labelled, identifying the manufacturer, formulation, colour, batch number, date of manufacture, shelf life, pot life, mixing instruction and method of use.
  8. Paints shall only be thinned in accordance with the manufacturer's instructions.
  9. All products shall be stored in properly ventilated and temperature controlled premises in accordance with the manufacturers' instructions.
  10. Products shall not be stored for longer than the shelf life recommended by the manufacturer. When the shelf life limit is reached the materials shall be removed from the place of application and discarded. Products shall be stored in such a manner that the material stored longest will be used first.
  11. Products which have livered, gelled or deteriorated in any way during storage shall not be used. Materials which can be restored to normal consistency by stirring will be accepted, provided that they have not exceeded the recommended shelf life.
  12. Immediately prior to application products shall be thoroughly stirred with a power mixer for a time sufficient to thoroughly remix the constituents, except where this would be contrary to the manufacturer's instructions, (for example with thixotropic paints).
  13. If the product is a two-pack system then the manufacturer's instructions shall be strictly adhered to in respect of mixing and the maximum length of time the material may be in the pot before application. Under no circumstances may material be used after the recommended pot life has elapsed.
  14. Products containing heavy or metallic pigments which have a tendency to settle shall have them kept in suspension in the pot during the period of application by the use of a mechanical stirrer.
  15. An adequate quantity of solvent and degreasing agent shall be available on Site prior to the commencement of on-site work.
- B. Galvanising
1. The items to be galvanised and the thickness of coating required shall be as specified in the Corrosion Protection Schedule in Appendix A.
  2. The Contractor shall supply all labour, equipment and material necessary to prepare the surfaces, to galvanise and to protect the finished surfaces in accordance with this Specification, together with the required equipment and materials for quality control.
  3. The work shall be carried out in accordance with BS 729 or BS 2989 as appropriate except as otherwise directed by this Section of the Specification.
  4. Attention is drawn to the possibility of embrittlement of steel through unsuitable combinations of material composition, degree of working and the galvanising process used as indicated in BS 729.
- C. Sprayed Metal Coating
1. The material and thickness of the sprayed metal coating shall be as specified in the Corrosion Protection Schedule in Appendix A.
  2. The Contractor shall supply all labour, equipment, and material necessary to prepare and coat the surfaces in accordance with this Specification, together with the required equipment and materials for quality control.

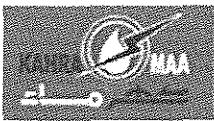


3. The work shall be carried out in accordance with the requirements of BS EN 22063.
- D. Protection to Nuts, Bolts and Washers
  1. The work shall be carried out in accordance with the following British Standards, as appropriate:

BS 729	Hot dip galvanised coatings on iron and steel articles
BS 3382	Electroplated coatings on threaded components
BS 4921	Standardised coatings in iron and steel
  2. Any coating which involves heating or any process which may affect the mechanical properties of the nuts, bolts and washers shall be carried out only by the manufacturer of these items, and with the approval of the Employer's Representative.

#### **2.6.3.2 SURFACE PREPARATION**

- A. General
  1. Prior to surface preparation all oil and grease patches on the surface of the steel shall be removed and any cleaning solvent then dried off.
  2. No contamination shall be permitted to occur between preparation and prime coating e.g. water, cutting oils, cutting dust or grease.
  3. Where fabrication is carried out after cleaning and priming, all damaged areas, new surfaces and weld runs shall be cleaned to the standard indicated in the Corrosion Protection Schedule. The Schedule may indicate that this primer is different from the general primer as the means of application demands.
- B. Surface Preparation by Blast Cleaning Techniques
  1. All surfaces to be coated shall be free of scale, rust, grease, oil, dust and other deleterious materials.
  2. The surface finish of cleaned steel shall be in accordance with BS 7079. The quality or standard at the time of painting shall be as specified in the Corrosion Protection Schedule.
  3. The surface roughness after blast cleaning shall be such that the value of Ra as defined in BS 1134 is from 45 to 65 microns for standard systems and 75 microns for ultra high build coatings.
  4. Generally dry abrasive blast cleaning techniques only shall be used. Wet blasting or other techniques shall only be used in cases where approval in writing has been obtained from the Employer's Representative.
  5. Abrasives shall be carefully stored in a dry atmosphere. They shall be clean and shall not be re-used unless properly recycled in equipment which has dedusting, screening and drying facilities. Abrasives shall be restricted to re-usable iron or steel (grit or shot) or copper slag.
  6. The type and grades of abrasive shall be selected in accordance with BS 2451 and BS 7079 or as Approved by the Employer's Representative.
  7. Sand blasting shall not be used.



8. Before the work commences, the Contractor shall make 150mm square check coupons of the same material as that to be blasted and prepare them by the method selected, using the same abrasives and equipment to be used for the work. These samples shall be coated with a transparent lacquer and retained for reference purposes.
  9. The blasting should be carried out in a dry atmosphere, because high humidity may result in agglomeration of dust and abrasive particles which may inhibit the cleaning process. Blast cleaning shall not be carried out when the temperatures of surfaces are less than 3°C above the dew point or when the relative humidity of the area is greater than 85%.
  10. The compressed air supply used for blasting shall be kept free of water and oil by the use of adequate separators, traps and filters, which shall be regularly emptied and/or changed.
  11. The discharge pressure at the nozzle should preferably be 0.70 N/mm<sup>2</sup>. It shall not be allowed to fall below 0.55 N/mm<sup>2</sup>.
  12. After blast cleaning and immediately prior to painting, all accumulated dust, residue and debris shall be removed by means of a hand-held or equivalent, vacuum cleaning method.
  13. Laminations, blow holes, crevices, pitting and other surface defects after blasting shall be brought to the attention of the Employer's Representative, who will direct what remedial action, if any, is to be taken.
  14. Welding flux and spatter remaining after blasting shall be removed by grinding or other suitable mechanical means.
  15. Sharp edges shall be removed by grinding to give a nominal 2 to 3 mm chamfer. Burrs caused by removal of temporary lugs shall be removed by grinding.
  16. Where extensive rectification has been necessary to areas greater than 0.10 m<sup>2</sup>, these shall be blasted to the original quality of surface preparation.
  17. Within four hours of completion of surface preparation, or as indicated in the Corrosion Protection Schedule, and before surface rusting reoccurs, a coating of primer shall be applied to avoid deterioration of the prepared surface.
- C. Surface Preparation by Manual Techniques
1. All surfaces to be coated shall be free of loose mill scale, rust, grease, oil, dust and other deleterious materials immediately prior to painting.
  2. The surface finish of cleaned steel shall be in accordance with BS 7079. The standard at the time of painting shall be as specified in the Corrosion Protection Schedule.
  3. The means of achieving the above standard of surface preparation shall be determined by the Contractor. Special attention shall be paid to the removal of all loose mill scale and to the cleaning of weld runs by the use of suitable tools.
  4. A coating of primer shall be applied to the surfaces as soon as possible after preparation and certainly on the same day.



### 2.6.3.3 PAINT APPLICATION

#### A. General

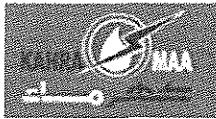
1. The surfaces to be over-coated shall be free of all defects (including runs, sags, pin holes, voids, bubbles or holidays) which may adversely affect the adequacy of the coating.
2. The application of all coatings shall be carried out in accordance with this Specification and the paint manufacturers' recommendations. In the case of conflict between this Specification and the manufacturer's recommendations such conflict shall be drawn to the attention of the Employer's Representative, who will give his ruling on the procedure to be followed.
3. The exposed surfaces of all nuts, bolts and washers shall be rendered clean and free from oil, grease or other deleterious metal before coating with paint. They shall receive all the specified coats including the appropriate primer.
4. No coating may be applied when the temperature of the atmosphere or of the surface to be coated is outside the limits recommended by the manufacturer.
5. No coating may be applied when the relative humidity of the atmosphere exceeds the limit recommended by the manufacturer or is such that condensation is present on the surface to be coated, nor when the temperature of the surface to be coated is less than 3°C above the dew-point.
6. The application of coating shall cease when there is a likelihood of weather conditions adversely affecting the application and/or drying of the coating or of wind-borne dirt or rust getting on the newly coated surface before it dries.
7. Each coating shall be allowed to dry for the time recommended by the manufacturer prior to the application of succeeding coats.
8. Work shall generally be progressed with minimum delay between the application of successive coats consistent with the above clause. If however delay occurs and the surfaces become unclean and unsuitable to receive the next coat they shall be cleaned with Approved solvents or other necessary means before proceeding further.

#### B. Experienced Operatives

1. Paint operatives shall be skilled and experienced with the material and equipment being used. Where necessary, the Contractor shall provide adequate training in association with the manufacturers.
2. Adequate supervision shall be provided at all times and all supervisors shall be skilled in each of the methods of application under his control.

#### C. Spray Application

1. The equipment to be used, together with the diameter and spray angle of nozzles and air pressures shall be in accordance with the paint manufacturer's recommendations for each coating material.
2. The air used shall be completely dry and free from oil.



3. Air pressure shall be controlled both at the pressure-pot level and at the spray level.
4. Paint should be applied to narrow surfaces in parallel passes overlapping by approximately 50%.
5. Paint should be applied to large surfaces in transverse passes. Each coat shall be evenly and completely applied to the entire surface area.
6. Any runs shall be brushed out immediately.
7. The Contractor shall have available at the place of application a sufficient quantity of nozzles of various diameters and angles, together with all accessories to enable the products to be properly applied.
8. The equipment shall be thoroughly cleaned before re-use.
9. Lines and pots shall be thoroughly cleaned before the addition of new materials and after use.

**D. Brush-application**

1. The shape and quality of the brushes used shall be suitable for the work carried out.
2. Round or oval brushes shall be used on irregular surfaces. Wide flat brushes may be used on large flat areas, but shall not exceed 125 mm in width.
3. Extension handles to brushes shall not be used.

**E. Making-good**

1. Damage surfaces including previous coats of paint and damage caused by on-site welding shall be made good in accordance with the "Surface Preparation" section of this specification along with the following clause.
2. Where remedial work needs to be carried out the surfaces shall be cleaned to the same standard as the original preparation. Where the original preparation was by blast cleaning equipment, portable blast cleaning equipment shall be used for this re-preparation. This shall continue for a minimum of 25 mm into the adjoining coat surfaces, after which the bare metal shall be coated with the materials indicated in the Corrosion Protection Schedule.
3. Care shall be taken to ensure there is no abnormal thickness of coating in the areas which have been made good.

**F. Procedure Trials**

1. Before work commences, the Contractor shall carry out tests in the presence of the Employer's Representative. These trials shall demonstrate the adequacy of the methods and the equipment intended for actual application.
2. Steel sample coupons 150 mm square by 3 mm thick shall be prepared for the various stages of the protective treatment and for each of the decorative colours selected. They shall be coated in precisely the same way and to the same shade as the paint to be applied to the steelwork. After drying, these samples shall be retained as reference pieces for any inspection carried out during the execution of work.

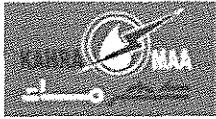
**G. Nominal and Minimum Film Thicknesses**



1. The film thicknesses specified in the Corrosion Protection Schedule are nominal thicknesses. Except where the minimum thickness is also specified in the Corrosion Protection Schedule, the minimum thickness shall be taken as 75% of the nominal thickness.
2. Coatings will be acceptable only if measured film thicknesses are not less than the minimum and the average of measured thicknesses is not less than the nominal thickness.
3. The minimum number of readings shall be:
  - a. Flat plate - 5 readings per m<sup>2</sup>.
  - b. Webs - 4 readings per metre length.
  - c. Flanges - 2 readings per metre length.

H. Surfaces Requiring Special Treatment

1. Connections using ordinary bolts
  - a. Contact surfaces shall be prepared and painted with the atmosphere coats as specified for the adjacent steelwork. In the case of Site connections any damaged areas shall be made good in accordance with the "Making-good" section of this specification.
  - b. Where indicated in the Corrosion Protection Schedule contact surfaces shall be given a further coat of the specified primer, and the surfaces shall be brought together whilst this paint is still wet.
2. Connections using high strength friction grip bolts
  - a. Immediately prior to making the joint the faying surfaces shall be in accordance with the requirements indicated in the Corrosion Protection Schedule. If these surfaces are inadvertently painted, further instructions shall be obtained from the Employer's Representative.
  - b. If necessary, vacuum-blasting immediately prior to making the connection shall be used to achieve the required surface condition.
3. Box members
  - a. Where practicable box members and penetrations into box members will be hermetically sealed, and in these cases the inside surface need not be painted.
  - b. Where box members are of such a size as to require inspection openings, the inside shall be painted. Except where indicated otherwise in the Corrosion Protection Schedule this shall be painted with any specified prefabrication primer and the specified post-fabrication primer only. Care shall be taken to ensure adequate ventilation during such painting, especially if the operatives have to work inside the box.
4. Structural steelwork components in contact with or encased in concrete
  - a. Steelwork to be encased in concrete and other surfaces in contact with concrete shall be cleaned to remove oil, grease



and chemicals which may be adhering to the surface. The surface shall then be blast cleaned or wire brushed to remove loose mill scale, rust and dust particles. No subsequent treatment shall be applied to these surfaces prior to placement of concrete.

- b. Where components are partially encased in concrete the protective system, excluding cosmetic coats, shall continue for 50 mm into the concrete, except where otherwise indicated on the Drawings.
- I. The Contractor shall be responsible for and shall protect all equipment, structures and any other items required to be protected by the Employer's Representative from mechanical damage, damage from paint droppings, or overspray. Examples of items to be protected are: fittings, machinery, cables, pipe-work, gratings and any areas of the structure not being painted at the particular time.
- J. Colours
  - 1. The finishing coats to all steel shall be in accordance with the Colour Schedule with reference to BS 381C, BS 4800, BS 5252 and BS 5378.
  - 2. The shades of successive coats shall differ so as to facilitate inspection and to assist the applicator in covering previous coats.
  - 3. The shades of primers and undercoats shall be submitted to the Employer's Representative for approval before commencing work.

#### **2.6.3.4 GALVANISING**

##### **A. Preparation and Coating**

- 1. The method of surface preparation shall be determined by the galvaniser. However if the Contractor wishes to depart from the following outline of anticipated preparation requirements this shall be discussed and agreed with the Employer's Representative before signature of Contract.
- 2. It is expected that before pickling the steel should be free of dirt, oil, grease, or any material which reduces the efficiency of the pickling process. It is anticipated that the method will include pickling in either hydrochloric or sulphuric acid with the inclusion of suitable inhibitors followed by fluxing. If thought advantageous prior shot or grit blasting may be included.
- 3. The minimum average coating weight measured over any area of one square metre shall be not less than that specified in BS 729 Table I.
- 4. The weight of applied coating may be determined by measuring the thickness of the coating and assuming a density of coating such that 1.0 g/m<sup>2</sup> is equivalent to 0.14 microns of thickness.

- B. Any small areas of damage to the coating shall be renovated by the use of zinc alloy repair rods and not by the use of any paint or similar material.

##### **C. Transport, Storage And Handling**



1. Care shall be taken when transporting, storing and handling all steelwork to ensure that no part is damaged.
2. Particular care shall be taken when transporting, handling or storing parts which have been galvanised. If any coating is damaged it shall be restored to comply with the relevant requirements of this Specification.
3. Lifting points shall be suitably wrapped and protected and steel slings shall not be allowed to come into direct contact with coated steelwork.
4. Steelwork shall be stored in such a way as to avoid water retention. If necessary it shall be kept under well ventilated cover.
5. Galvanised surfaces shall be kept apart during transportation and storage.
6. Galvanised steelwork transported overseas by ship shall be dipped in a 10-18 per cent solution of chromic acid to give a protective coating of 12 microns thickness. This coating must be removed by abrasive means, to be Approved by the Employer's Representative before any subsequent overcoating is carried out.

#### **2.6.3.5 SPRAYED METAL COATINGS**

##### **A. Preparation And Coating**

1. The standard of surface preparation shall be in accordance with the requirements of BS EN 22063. The method of preparing the surface shall be determined by the Contractor.
2. The sprayed metal coating shall be applied as soon as possible after surface preparation, before visible deterioration of the surface is noted, and certainly within four hours.
3. Where indicated in the Metal Spraying Schedule the sprayed metal coating shall be primed and sealed immediately after spraying, using the materials and method specified in the Metal Spraying Schedule.

##### **B. Transport, Storage And Handling**

1. Care shall be taken when transporting, storing and handling all steelwork to ensure that no part is damaged.
2. Particular care shall be taken when transporting, handling or storing parts which have been metal sprayed. If any coating is damaged, it shall be restored to comply with the relevant requirements of this Specification.
3. Lifting points shall be suitably wrapped and protected and steel slings shall not be allowed to come into direct contact with coated steelwork.

#### **2.6.3.6 INSPECTION AND QUALITY CONTROL**

- A. All the work and materials covered by this section shall be subject to inspection by the Employer's Representative. Any work or materials so inspected and



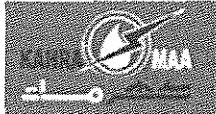
found to be defective or not conforming to this Specification shall be rectified by the Contractor at no additional cost and in a manner Approved by the Employer's Representative.

- B. Unless other special arrangements have been agreed with the Employer's Representative at least one week's notice shall be given to the Employer's Representative prior to the start of any work covered by this Specification. Whilst work is in progress access shall be given to the Employer's Representative at all times and all equipment necessary for the quality control shall be made available by the Contractor to the Employer's Representative.
- C. Blast cleaning control shall be by means of visual comparison with the Swedish Standards SIS 055900 standard plates specified in the Corrosion Protection Schedule complemented by the check coupons described in the "surface preparation" section of this Specification.
- D. Further inspection may be made using a reflectro-meter.
- E. The surface roughness shall be checked either by means of a profile gauge or a roughness gauge.
- F. The results shall be recorded and retained for reference.
- G. Wet and dry film thicknesses shall be checked as necessary.
- H. An adequate number of wet film thickness gauges shall always be made available by the Contractor at the place of application for use by inspection staff. The final check shall be by dry film measurement using suitable test equipment.
- I. During application the Contractor shall as required provide samples of the paint being used for analysis in a laboratory for composition and physical characteristics. The cost of these tests shall be borne by the Contractor. Test shall be carried out at a rate of one test per 1000 litres of paint.
- J. The Employer's Representative may call for tests of thickness and adhesion of the coatings. These shall follow the methods outlined in BS EN 22063.
- K. Any remedial work consequent upon lack of adhesion or too thin a coating shall follow the requirements of BS EN 22063.

## **2.6.4 CORROSION PROTECTION SCHEDULE**

### **2.6.4.1 PERFORMANCE SPECIFICATION**

- A. The Contractor shall provide corrosion protection to the steelwork which has the following durability and maintenance characteristics:
  - 1. Fully compliant to all provisions of BS 5493.
  - 2. Time to first maintenance for the purpose of BS 5493 shall be "Long Life", with 10 to 20 years as a minimum for all categories of systems defined below.
  - 3. A Contractor/Paint Manufacturer guarantee shall be provided for a period of 10 years. A proforma for the guarantee is included below.



4. After inspection and repair at the end of the Contractual maintenance period, an inspection and minor touch up as necessary will be carried out at 10 years, with an inspection and major recoating for cosmetic reasons after 20 years.

#### B. EXPOSURE CATEGORIES

Corrosion protection systems are required for the following project nominated exposure categories:

<b>Exposure Category</b>	<b>Exposure Conditions</b>	<b>Typical Applications (indicative)</b>
A	External - Directly exposed to the environment	BMU support frame
B	External - Concealed beneath cladding	Perimeter columns (to be confirmed)
C	Internal - Exposed	Exposed internal columns and other steelwork.
D	Internal - Concealed	Roof members in the location of false ceiling, cladded columns
E	Internal - With intumescent paint coating	N.A.
F	Internal - Concrete encased	N.A.

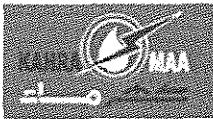
All steelwork will have a period of external exposure during transportation and construction.

#### C. ENVIRONMENT

The project environment is typical of the Middle East, i.e. a severe coastal environment with a hot, humid, salt/dust laden and polluted atmosphere.

#### D. CORROSION PROTECTION SYSTEMS

1. The Contractor is responsible to the Employer's Representative for demonstrating that the proposed corrosion protection systems satisfy the nominated performance Specification.
2. Some indicative corrosion protection systems are specified below for each project exposure category. The Bidder should present prices for the indicative systems of this Specification, together with detailed Specifications and prices for their proposed corrosion protection systems.
3. Exposure Category A: External - Directly exposed to the Environment



**Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)**

Preparation	Grit blast clean to BS 7079 Part A1 Sa2 <sup>1/2</sup> .
Primer	2 pack epoxy zinc rich to BS 5493 Type DF to 50 microns Dry Film Thickness (DFT).
Build and Finish coats	2 pack high build epoxy to BS 5493 Table 4K Part 3/4. Stripe coat plus 2 coats at 200 microns DFT each.
Total nominal DFT = 450 microns	

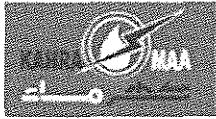
4. The Contractor shall allow for inclusion of a stripe coat where sharp corners could lead to premature breakdown of the system or where future access for maintenance is prevented by the close proximity of the cladding system. The stripe coat shall be applied immediately after the primer.
5. Consideration shall also be given to a single build/finish coat if quality and thickness can be substantiated by the Contractor.
6. Exposure Category B: External - Concealed beneath cladding

Preparation	Grit blast clean to BS 7079 Part A1 Sa2 <sup>1/2</sup> .
Primer	2 pack epoxy zinc rich to BS 5493 Type DF to 50 microns Dry Film Thickness (DFT).
Build and Finish coats	2 pack high build epoxy to BS 5493 Table 4K Part 3/4. Stripe coat plus 2 coats at 175 microns DFT each.
Total nominal DFT = 400 microns	

7. Exposure Category C: Internal - Exposed

Preparation	Grit blast clean to BS 7079 Part A1 Sa2 <sup>1/2</sup> .
Holding Primer	2 pack epoxy zinc phosphate to BS 5493 Table 4K Type KP1A. 75 microns DFT.
Build coat	2 pack epoxy MIO to BS 5493 Table 4K Part 3/4. 125 microns DFT.
Finish coat	2 pack polyurethane to BS5493 Table 4K Part 4, or acrylic urethane. 1 or 2 coats as necessary to provide a high quality finish. Gloss and colour to be advised by Kahramaa. Minimum 50 microns DFT.
Total nominal DFT = 250 microns	

8. Exposure Category E: Internal - With intumescent paint coating



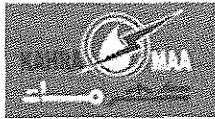
Preparation	Grit blast clean to BS 7079 Part A1 Sa <sub>2</sub> <sup>1/2</sup> .
Holding Primer	2 pack epoxy zinc phosphate to BS 5493 Table 4K Type KP1A. 75 microns DFT.
Intumescent coating with a sealer coat to satisfy fire resistance. Gloss and colour to be advised and Approved by the Employer's Representative.	

9. Exposure Category F: Internal - Concrete encased

Preparation	Free from oil, grease, dirt, sand, loose rust and mill scale.
Holding Primer	Unpainted

E. GENERAL NOTES APPLICABLE TO ALL SYSTEMS

1. The dry film thicknesses (DFT) noted above are NOMINAL thicknesses, i.e. the average of a set of readings over any square metre of painted area should equal or exceed the NOMINAL DFT. In no case shall any reading be less than 75% of the nominal thickness, i.e. MINIMUM DFT = 75% OF NOMINAL DFT (see also above note relating to aluminium metal spray systems).
2. The above systems shall be applied by airless spray in general.
3. The Contractor shall confirm with his tender those coats which are intended to be Site applied. The suitability of any finish coat for brush application shall be confirmed if this is intended. Damage repair by application of brush coat(s) on Site may be accepted if satisfactory evidence of adequate appearance and performance can be demonstrated.
4. All bolts, nuts and washers in the steelwork superstructure shall be protected from corrosion. Bolts shall be supplied with the following coating as a minimum:
  - Sheradising to BS 4921 Class 1
  - Galvanising to BS 729, subject to precautions with higher grade bolts concerning embrittlement, is also acceptable.
  - The bolts shall be etch primed (T wash or equal) and coated with the build coat and finish coat(s) appropriate on the steelwork they connect. Where aluminium metal spray system is adopted, the bolts and surrounding area shall be coated with a 2 pack epoxy MIO and a polyurethane or acrylic urethane finish coat to a nominal 150 microns DFT.
5. The Contractor shall provide full details of the paint supplier and paint systems proposed with the return of his tender.



6. At the request of the Employer's Representative, samples shall be provided for each system. Note that the final visual appearance of the exposed structure is as specified. All painted areas are to be subject to the Employer's Representative approval. Samples of adequate and agreed sizes are to be submitted for Employer's Representative approval. Some adjustment of the colour and gloss of the paint finish may be required to match the external cladding of the building. Approved samples will form the basis of all other subsequent approvals for colour match.
7. The Contractor shall confirm at tender stage that the systems offered are capable of satisfying the nominated performance Specification.

## **2.6.5 PROFORMA FOR CORROSION PROTECTION SYSTEMS GUARANTEE**

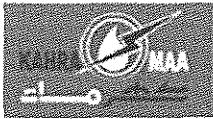
1. A ten years guarantee shall be provided for the corrosion protection systems.
2. The ten years guarantee is based on the Re criteria, i.e. the European Scale of Degree of Rusting for Anti-Corrosive Paint.
3. The Contractor shall repair Defective Areas of the coated surfaces during the guarantee period, at his own expense, including the provision of any necessary access.
4. Defective Areas may be general or local and may show full through thickness coating breakdown or limited breakdown of the coating down to the primer.
5. A General Defective Area shall be taken as an area of 10m<sup>2</sup> or one element of the structure (e.g. a beam or column), whichever is lesser, showing a breakdown of Re 3, or greater than 1% of surface area of coating breakdown.
6. A Local Defective Area of the structure shall be taken as an area not greater than 0.01m<sup>2</sup> showing a breakdown of Re 5, or greater than 8% of area of coating breakdown. There shall be no more than two Local Defective Areas within each General Defective Area.
7. Repair materials and application methods shall be subject to the approval of the Employer's Representative.
8. Under the guarantee, the Contractor shall provide a back to back guarantee from the paint manufacturer, warranting the Kahramaa against local or general defects in the coating systems.

## **2.7 SUBSTRUCTURE WATERPROOFING**

### **2.7.1 GENERAL**

#### **2.7.1.1 SUMMARY**

- A. Qatar Construction Specification (QCS) forms the basis of the specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010).
- B. This Specification covers the materials, workmanship, testing, design life and guarantee requirements for substructure waterproofing, including membranes, joint



fillers, joint sealant and water-stops, as necessary to keep water out of the building and substructure elements, as shown on the Drawings.

- C. Appendix A2.7.2 forms part of this Specification.
- D. In addition to the general conditions of contract, the Contractor shall also refer to the following specifications:
  1. Subsection 2.1: Cast-in-Place Concrete
  2. Subsection 2.10: Bored Piles

#### **2.7.1.2 REFERENCES**

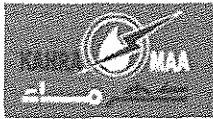
- A. Except where otherwise specified, work shall be in accordance with the British Standards relevant to this Specification. The latest editions shall be used, including all current amendments and additions.
- B. Any differences between the British Standard requirements and this Specification shall be submitted to the Engineer for his ruling.
- C. Standards

BS 8000 1989              Part 4: Workmanship on building Sites. Code of practice for waterproofing

BS 8102 1990:              Code of practice for the protection of structures from water in the ground

#### **2.7.1.3 SUBMITTALS**

- A. Prior to starting work on the Contract the Contractor shall submit for approval, details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the Specification.
- B. Details shall include, but not be limited to, manufacturer's printed specifications and membrane installation instruction, including procedures and materials for terminations, penetrations, flashing, protection, compatibility, jointing, bonding, repair and testing.
- C. Further submissions shall be made for any change of material, quality or source and the Engineer approval obtained before the new materials or place of manufacture are used.
- D. During installation, the waterproofing manufacturer's technical representative shall prepare and submit daily reports to the Engineer. The reports shall fully detail installation activities, observations, defects and corrective actions taken. Waterproofing details and Drawings for all applicable structural elements shall be submitted for engineers review and approval prior to proceeding with the installation works.
- E. To certify the installation of the waterproofing system, the Contractor shall submit manufacturer's certification stating materials ordered and supplied are compatible with each other, suited for locations and purpose intended, and shipped in sufficient quantity to ensure proper and timely installation. A certificate signed by the manufacturer of the materials specified shall also be submitted, which states



materials installed on the Works meet manufacturer's published performance standards, installation instructions and the requirements of this Specification.

#### **2.7.1.4 QUALITY ASSURANCE**

- A. All substructure waterproofing systems shall be manufactured and supplied by a company certified to conform to the requirements of the quality standard ISO 9002.
- B. The manufacturer shall supply specific instructions and a quality Plan to the Contractor to form a clear and unambiguous scope of works. The Contractor shall work in strict accordance with the manufacturer's instructions at all times.
- C. The Contractor shall operate an Approved quality system for all stages of the work and all work shall be in accordance with that system.
- D. The labour force shall be adequately trained and supervised to ensure that the quality system is adhered to during all stages of the work.
- E. Special consideration shall be given to prevent any damage of the waterproof system by plant, labour or other means. Particular attention should be paid to construction operations carried out in the vicinity of the waterproofing.
- F. Where required, the Contractor shall ensure that the ground dewatering system is working sufficiently to ensure no hydrostatic pressure is exerted on the waterproof membranes and to ensure concrete substrates are sufficiently dry for lasting bond of the waterproof membrane.
- G. The manufacturer is to have a technical representative present during the performance of the work as necessary to ensure the proper preparation and installation of waterproofing.
- H. The representative of the manufacturer is to approve the conditions of the substrates prior to the application of the waterproofing. If necessary, the Contractor shall rectify conditions as necessary to obtain the manufacturer's representative's approval.

#### **2.7.1.5 DELIVERY, STORAGE & HANDLING**

- A. Delivery to Site, storage and handling of all materials shall be clearly controlled in strict compliance with the manufacturer's instructions and fully documented by the Contractor. All documentation shall be open to inspection by the Engineer. The following information shall be shown for each delivery of each material:
  1. Name of Manufacturer and product (M)
  2. Batch reference (M)
  3. Date of manufacture (M)
  4. Shelf-life and conditions of storage (M)
  5. Date of usage and location in the Works



Information shown (M) shall be clearly marked on the material itself when it is delivered and the Contractor shall impose this requirement upon the manufacturer.

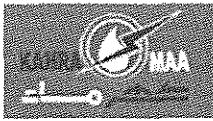
### **2.7.1.6 WARRANTY**

- A. The Contractor shall furnish a written warranty of all waterproof materials and workmanship for water tightness extended to include, but not limited to, seams, membranes, pile heads, penetrations, construction joints and movement joints.
- B. The warranty shall be a back-to-back warranty to insure against material defects and installation defects. The Contractor and manufacturer shall accept joint responsibility for the performance of the waterproof system.
- C. The warranty shall be signed by the product manufacturer agreeing to repair or replace defects in materials and workmanship, and failure of waterproofing to prevent water from entering into the building and building components for a period of twenty years from date of the Taking-Over-Certificate. Under warranty, the membrane manufacturer shall be responsible for all costs of removal and replacement of overburden, such as floors and walls as necessary to obtain access to the waterproofing.
- D. Warranty shall include the waterproofing of substructure components, including the raft foundations, to ensure that water ingress does not occur over the design life of the membrane. Special quality measures should be adopted during construction to guarantee zero defects to the raft foundation membranes.

## **2.7.2 PRODUCTS**

### **2.7.2.1 MATERIALS**

- A. Specification
  1. A range of waterproofing options is available to the Contractor. The Contractor shall specify a waterproofing system that is fully compatible with the structural form, the proposed construction methodology and all other interfaces, to provide a waterproof basement that satisfies all the requirements of this Specification, for the duration of the required warranty.
  2. The Drawings provides details of waterproofing systems that are considered to be appropriate for use in this project. This information is provided for guidance only and does not relieve the responsibility of the Contractor and the waterproofing manufacturer to provide an appropriate waterproof system and achieve the required waterproof basement.
  3. The materials shall be in accordance with the British Standards mentioned in this Specification.
  4. All materials shall be approved in accordance with the Quality Assurance procedures in this Specification in conjunction with the following requirements.
- B. Requirements of all materials
  1. All components and elements, which are needed to make the structure watertight, shall be proven to work together. There shall be a single source of responsibility and performance of the products.



**Qatar General Electricity & Water Corporation**  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
(Packages A, B, C, D & E)

2. The waterproof system provided shall be installed without damage and protected against construction operations. The Contractor to provide all necessary temporary protection at all stages of Waterproofing installed at Site.
3. The waterproof system shall be designed to be fully effective over the design life of the structure.
4. The waterproof system shall be designed to resist the maximum water head of water to be imposed on the structure.
5. Waterproofing material shall be specially formulated to allow application in the hot climatic conditions encountered in the Middle East and it should not be adversely affected by temporary heat gain whilst exposed during construction.
6. Materials shall be compatible with other materials against which they abut. Particular attention shall be paid to the compatibility of interfaces and junctions with adjacent buildings.
7. Under normal service conditions a factor of safety of at least two shall be provided against failure of any kind, including but not limited to the following:
  - a. Pressures from solids, liquids or gases
  - b. Abrasion and other effects of traffic or flow of materials over joints
  - c. Chemical and biological attack
  - d. Fire
  - e. Degradation from UV light, thermal effects and other natural phenomena
  - f. Degradation by ageing (e.g. ultra-violet) or fatigue (e.g. vibration)
  - g. Damage caused by chemicals in the ground
  - h. Damage during construction
  - i. Damage caused by cracking of the sub-strate up to 0.5mm crack width
8. Materials shall be properly formulated for their intended use and shall be within their movement and fatigue capability, taking account of construction tolerance.
9. Materials shall be physically and chemically stable at handover and not liable to subsequently release of toxic agents.
10. Materials to be mixed on Site shall have adequate pot-life to allow proper installation by the operators, taking into account the size of container and the conditions under which the operators are working.
11. Materials that will be in contact with potable water shall be Approved under the Water Research Centre's Testing Scheme.
12. Materials that will be exposed to food products or used in a food preparation or food handling or food storage environment, shall be fully cured at handover and shall, after curing, be inert, non-toxic, odourless, non-tainting, mould resistant and waterproof.
13. Materials that will be in any way exposed when the work is completed shall be resistant to attack by vermin (rodents, insects, etc).
14. Materials that will normally be open to view once the works are completed shall present a neat appearance. Solvents shall not bleed and stain adjacent work.



15. Installation shall be strictly in accordance with the manufacturer's requirements, by specially trained and experienced operators.

**C. Additional requirements for waterproof barriers**

1. Penetrations through the waterproof barrier by services, etc. shall be sealed with a compatible waterproof system as recommended by the waterproofing manufacturer.
2. Penetrations by services, etc. shall incorporate a hydro-expansive water-stop to prevent tracking of water into the structure if the sealed waterproof system fails.
3. Where the waterproof barrier is required to interface with a system of basement waterproofing that has been installed and warranted by others, the Contractor and Waterproofing Manufacturer shall extend the warranty on this waterproof system to fully guarantee the interface detail.

**D. Additional requirements for primers**

1. Where the membrane Manufacturer recommends the provision of a primer, it shall be provided fully in accordance with his requirements.

**E. Additional requirements for water-stops in construction joints**

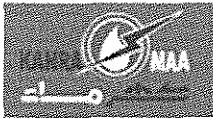
1. Construction joints in water retaining concrete elements are to be protected to prevent water ingress. An external water-bar is to be provided together with a hydro-expansive cast-in waterstop. Water stops in construction joints are defined in Appendix A2.7.1.
2. The Contractor shall provide details of all proposed construction joint locations prior to pouring concrete. The Contractor shall inform the Engineer without delay if the need for any additional joints arises. The as-built Drawings for construction joints, as provided at Site, including their locations and details shall be submitted to the Engineer for approval.

**F. Additional requirements for water-stops in movement joints**

1. Water-stops shall be provided at all movement joints to prevent water seepage. Movement joints are to be provided only as shown on the construction Drawings.
2. Water-stops in movement joints shall be specifically designed to withstand the following: differential movement, rotation and translation without degradation and failure or loss of water tightness. The Contractor shall submit full details for the Engineers review and approval.
  - a. +/- 50mm Horizontal movement
  - b. +/- 40mm Vertical movement
  - c. +/- 20mm Translation.

**G. Fillers and Sealant to Expansion Joints**

1. All materials used to fill expansion joints shall be such that they will accommodate the calculated movements of the joints without extrusion and shall not shrink away from either surface of the joints. Backing strips and fillers acceptable to the Engineer shall be used in accordance with the manufacturer's recommendations.
2. Where joints shall be filled with polysulphide or polyurethane sealant acceptable to the Engineer, the material shall comply with BS EN ISO 11600 or BS 5212.



3. The appropriate sealant grades shall be used for horizontal and vertical joints, and the joints shall be thoroughly cleaned and primed with the appropriate primer before applying the sealant. The sealant shall be of a colour to match as nearly as possible the colour of the adjoining surfaces where it is to be permanently exposed.

**H. Additional requirements for pile head waterproofing**

1. All permanent work pile heads shall be made watertight to prevent the transport of water through the concrete matrix by capillary action. Pile head waterproofing is defined in Appendix A2.7.1.

**I. Initial meetings and approvals**

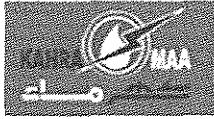
1. At the start of the Contract the Contractor shall meet with the Engineer to review the requirements of the job. Where additional information is necessary for the design of the waterproofing system and joints, it is the responsibility of the Contractor to request this information from the Engineer.
2. The Contractor shall then submit to the Engineer, for approval, his proposals for the supply of materials and for their installation into the works. If required by the Engineer, technical representatives of the Manufacturers and of any proposed application Subcontractors shall attend a meeting to review the proposals. If requested by the Engineer, site-trials shall be carried out using mock-ups to demonstrate the system proposed.

**J. Approval of materials and their method of application**

1. The Contractor shall submit samples and full technical details for approval by the Engineer. Samples shall include 300 x 300mm of membranes and 300mm of strip products, as appropriate. Technical details shall include:
  - a. Full material analysis and properties (both initial and long-term).
  - b. Shelf-life and pot-life.
  - c. Instructions for handling, mixing, installing, finishing, curing and protecting (including Health and Safety and COSSH).
  - d. Requirements for preparation and condition, backing, de-bonding and priming.
  - e. Behaviour under imposed movements, cross-joint pressure and fatigue.
  - f. Special instructions for jointing, interfaces, etc.
2. Colours of materials that will be visible when the works are completed shall be to the Engineer approval.

**K. Manufacturer's Requirements and Expertise**

1. The Contractor shall submit to the Engineer for each material two copies of the Manufacturer's Specifications and recommendations and a letter from the Manufacturer certifying that the material complies with the requirements of this Specification and is suitable for the intended application.
2. The requirements of the material Manufacturer shall be met by the Contractor. A technical representative of each company supplying materials shall visit the Site at the commencement of the relevant part of the works and shall advise on the use of the materials. Installation shall then proceed strictly in accordance with the Manufacturer's recommendations. If required by the Engineer, the



same technical representative shall make further visits to the Site during the execution of the works.

**L. Operators' Expertise**

1. The Contractor must demonstrate to the satisfaction of the Engineer that the operators are adequately experienced and that they fully understand the requirements of the particular job being undertaken. New operators shall at no time be employed on the work without being Approved by the Engineer. The waterproofing works shall be carried out by a specialist contractor qualified for installation of that particular system and also Approved by the material manufacturer.

**2.7.3 EXECUTION**

**2.7.3.1 WORKMANSHIP**

**A. Trials**

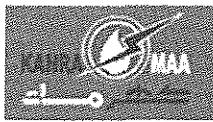
1. At the start of the work the Contractor shall carry out trials which may at the discretion of the Engineer be incorporated in the final works. The quality of the work shall be to the approval of the Engineer. Once a satisfactory standard of work has been reached, the trials shall be used as a standard for the approval of the work as a whole.

**B. Preparation for application of membrane**

1. Surfaces to receive waterproofing shall be prepared in strict compliance with the requirements of the manufacturer. All contaminants such as dust, loose particles, moisture, oils or greases shall be removed from the surface. If necessary, rough or other unsuitable surfaces shall be improved to satisfy the manufacturer's recommendations for the product to be applied.
2. A technical representative of the manufacturer shall be present on Site, as defined in the Quality Assurance section of this Specification section. The representative is to approve the conditions of the sub-strates prior to the application of the waterproofing. If necessary, the Contractor shall rectify conditions as necessary to obtain the manufacturer's representative's approval.
3. The waterproofing manufacturer's representative shall verify that the installation complies with the waterproofing manufacturer's requirements and shall prevent entry of water into the building and structural components so that the installation can be warrantied. The Contractor shall provide remedial work as necessary to obtain the waterproof manufacturer's technical representative's verification.

**C. Installation**

1. Membranes, tanking, pile head waterproofing and penetrations are to be installed in strict compliance with the manufacturer's requirements and as described in Appendix A2.7.1 of this Specification.
2. All water-stops shall be installed in strict compliance with the manufacturer's installation instructions and as described in Appendix A2.7.1 of this report. The works shall be carried out by trained and experienced workers only.



3. Sub-standard work, which is not in accordance with this Specification, shall be completely removed and remade.

### **2.7.3.2 INSPECTION AND TESTING**

#### **A. Testing**

1. The Contractor shall be responsible for all testing required by the waterproofing manufacturer, to give the required warranties. The Engineer shall be permitted access to witness any tests. Two copies of all test results shall be submitted promptly to the Engineer.

#### **B. Approval of the Engineer**

1. Wherever the Contractor is required to obtain the approval of the Engineer, this must be requested in writing and written approval obtained before the work concerned is put in hand.

#### **C. Approval of materials**

1. The Manufacturer shall provide full test data for all materials. If required by the Engineer, tests shall be repeated and further tests carried out.

#### **D. Site Inspection**

1. The Contractor shall provide full supervision of all operators and their work shall be thoroughly inspected on a regular basis to maintain standards.

#### **E. Site testing**

1. If required by the Engineer, samples of materials shall be removed from the works and tested at the expense of the Contractor.
2. Joints exposed to the weather shall be water-jet tested in the presence of the Engineer. The jet shall be from a 19mm hose under minimum 2 kN/mm<sup>2</sup> pressure held 600mm from the joint and moved along the joint at 600mm/minute. The joints shall be considered to pass the test if they do not show any sign of water ingress.
3. Joints required to resist water or other pressure shall be tested for compliance with this Specification as directed by the Engineer. Other tests deemed necessary to prove the adequacy of the installed waterproofing shall be carried out without additional cost.

#### **F. Rectification**

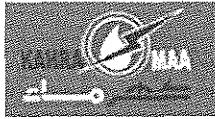
1. All work which fails to comply with this Specification either during construction or during the guarantee period shall be rectified promptly, by the Contractor at his own expense.

### **2.7.3.3 APPENDIX A2.7.1 – WATER PROOFING SYSTEMS**

A range of waterproofing options is available to the Contractor. The Contractor shall specify a waterproofing system that is fully compatible with the structural form, the proposed construction methodology and all other interfaces, to provide a waterproof basement that satisfies all the requirements of this Specification, for the duration of the required warranty.

The systems noted below are provided for guidance purposes only.

Each system shall be obtained from a single manufacturer who shall supervise the installation on Site, in accordance with this Specification.



The Contractor may propose alternative systems provided that the requirements of this Specification are satisfied.

#### A.1 WATERPROOFING BARRIERS

##### A.1.1 General

The waterproof barrier shall fully comply with this Specification and the drawings.

All elements which are in contact with soil and/or ground water level shall be protected with a waterproofing membrane.

A 75mm blinding concrete shall be required underneath all waterproofing membranes.

The waterproofing system shall be one of the proposed systems as below.

##### A.1.2 Type 1: Bonded synthetic membrane

All elements that are part of any underground structures which are in contact to the soil or/and ground water shall be externally protected with a fully bonded waterproofing membrane. This bonded system could be either chemically or physically bonded.

These elements include the base slabs, external walls of the reservoirs, pumping stations, underground structures of the MV and generator basement and bulk storage fuel foundation.

The membrane is to be a single ply, HDPE or blended polyethylene/ polypropylene membrane with adhesive bonding agent. The minimum membrane thickness is to be 1.2mm.

The membrane shall be laid on regular, smooth, formwork or a blinded surface, free from projections, with no gap or voids greater than 10mm.

The membrane shall be installed to achieve full bonding of all plies, joints and corners, to the concrete substrate, to achieve a single bonded waterproof barrier. All seams are to be fully bonded by overlapping, taping or jointing in strict accordance with the manufacturer's recommendations.

The manufacturer's representative and the Contractor shall both carry out a full inspection of the substrate preparation and waterproof system and confirm in writing that the installation, including joints and corners, is satisfactory and achieves the requirements of the warranty.

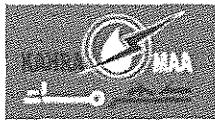
The bonding agent shall form a continuous bond between the concrete substrate and waterproof barrier and shall prevent migration of water if any leakage occurs. The manufacturer shall confirm in writing that the bonding agent can resist the maximum water pressure to be exerted on the structure, to ensure de-bonding of the membrane under pressure cannot occur.

The bonding agent shall be protected in strict accordance with the manufacturer's instruction and remain free of dirt, dust, grease and other intrusions to ensure concrete is poured onto an effective bond surface.

All defects shall be made good before pouring of concrete.

No protection screed shall be required on top of the bonded waterproofing membrane.

##### A.1.3 Type 2: Un-bonded synthetic membrane



All slabs on grade, pad and strip shall be protected with un-bonded waterproofing membrane.

The membrane is to be a single ply, loose laid, plasticised PVC membrane manufactured by extrusion. The minimum membrane thickness is to be 2.0mm.

The membrane shall be laid on regular, smooth, formwork or a blinded surface, free from projections.

The membrane shall be installed with overlaps to allow full fusion of sheets at all joints and corners to achieve a single homogeneous waterproof barrier. All seams to be fused by automated machine heating, in strict accordance with the manufacturer's instructions.

The manufacturer's representative and the Contractor shall both carry out a full inspection of the substrate preparation and the waterproof system and confirm in writing that the installation, including joints and corners, is satisfactory and achieves the requirements of the warranty.

A system of full compartmentalisation shall confine water travel if a leak occurs in the membrane. Compartments shall be achieved by fusing the membrane to external water-bars that shall be cast into the concrete structure. Water bars shall be fully compatible with the membrane to allow fusing of the joint.

Compartments shall be limited to maximum 200m<sup>2</sup> in Plan area. Compartments shall be of regular shape to allow free flow of repair between the membrane and concrete structure if repair is necessary. The Contractors proposed compartment arrangement is to be submitted to the Engineer for approval prior to installation.

A single resin injection hose shall be installed in each compartment. The hoses shall allow the two-way flow of liquid to test for leakage of the membrane and to provide an inlet for injection of repair resin between the loose membrane and the concrete structure, should a leak occur during the design life of the structure.

Once installed, rot proof protection boards, thermal insulation or a sand and cement-blinding layer, as appropriate, shall permanently protect the inspected membrane.

All defects during construction shall be made good prior to protection of the membrane.

A 50mm protection screed shall be required on top of the un-bonded waterproofing membrane.

## A.2 WATERPROOF ANCILLARIES

### A.2.2 WATER-STOPS

#### A.2.2.1 External Water-bars

External water-bars shall be compatible with the waterproof membrane barrier to allow fully watertight jointing between water-bar and membrane.

External water-bars shall be profiled to provide a keyed interface with the concrete structure to prevent water tracking between the water-bar and the structural element.

External water-bars shall allow cyclic building movements over the full design life without loss of integrity, deterioration, fracture or failure of any kind.

Minimum width of the external water-bars shall be 300mm.



The Contractor shall prepare shop drawings that show the layout of the waterstops, specials and joints.

#### A.2.2.2 Internal Water-bars

Internal water-bars shall be profiled to provide a keyed interface with the concrete structure to prevent water tracking between the water-bar and the structural element.

Minimum width of the internal water-bars shall be 250mm.

The Contractor shall prepare shop drawings that show the layout of the waterstops, specials and joints

#### 3 Hydro-expansive cast-in waterstops

Hydro-expansive water-stops are to be a conformable, swellable polymer / butyl rubber water-stop strip that expands when in contact with water. The size and number of layers shall suit the structural section to be waterproofed.

Hydro-expansive water-stops shall be fully encapsulated by poured concrete and shall form a seal to resist the applied water pressures.

#### A.2.3 PENETRATIONS

##### A.2.3.1 Waterproofing compounds

Epoxy grout waterproofing shall waterproof pile heads.

A high strength, non-shrink, flowable epoxy grout shall be applied to the finished pile head in strict accordance with the manufacturers instructions.

The waterproof grout shall be of minimum thickness 10mm, or greater if required under the conditions of the warranty.

The pile head shall be prepared in strict accordance with the manufacturer's instruction to ensure and effective aggregate interlock between the pile head and epoxy grout.

The grout shall be fully compatible with the waterproof system to ensure the waterproof barrier is continuous across the pile head.

##### A.2.3.2 Liquid applied membrane system

The use of liquid applied membranes shall be limited to jointing between pile head epoxy grout or service penetrations and the primary waterproof barriers, and only if direct bonding is not achievable.

Liquid applied elastomeric membrane to form a tough, rubber-like, seamless waterproof barrier, applied in strict accordance with the manufacturer's instructions.

Liquid applied membranes shall be cold applied.

Liquid applied membranes shall be fully compatible with the waterproof barrier, the pile head epoxy grout or the service penetration sleeve to ensure the barrier is continuous.



## **2.8 PROTECTION OF INTERNAL SURFACES OF WATER HOLDING STRUCTURES**

### **2.8.1 Reservoirs and Potable Water Holding Structures**

No internal coating is required to the internal wall, column, underside of the roof and top of the raft slab. The internal surface of the reservoir shall be fair face finish free from honeycombing and excessive air holes, fines and projection arising from defective mixing and placing of formwork. The finish shall be integral with the body of the concrete and shall not be obtained by means of applied rendering.

For the valve chambers attached to the reservoir consisting of the inlet, outlet scouring, and other associated valve chambers the internal finishing coating shall be waterproofing non-toxic paint based on cementitious material which also has the property of sealing voids and protecting concrete from any corrosive action.

### **2.8.2 Structures in contact with sewage**

Internal surfaces of manholes and structures in contact with sewage or sewer gases shall be coated in accordance with QCS Section 5 Part 14 clause 14.5.4.

### **2.8.3 Structures in contact with surface water, land drainage and leak detection**

Internal surface of chambers in contact with surface water, land drainage and leak detection shall be coated with one coat of bituminous emulsion and two coats of bitumen paint

### **2.8.4 Structures in contact with irrigation and fire fighting**

The internal finishing coating of the chambers shall be waterproofing non-toxic paint based on cementitious material which also has the property of sealing voids and protecting concrete from any corrosive action.

## **2.9 EARTHWORKS**

### **2.9.1 GENERAL**

#### **2.9.1.1 SUMMARY**

- A. Qatar Construction Specifications (QCS) forms the basis of the Specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) section 12.
  1. Construction of foundations
  2. Reinforced concrete pits and trenches
  3. Ground bearing slabs
  4. Pipeline trenches
- B. Excavate, backfill, compact and grade the Site to the elevations shown on the Drawings, as specified herein and as needed to meet the requirements of the construction shown in the Contract Documents, including, but not limited to, the following:
  1. Construction of foundations
  2. Reinforced concrete pits and trenches
  3. Ground bearing slabs
  4. Pipeline trenches



### C. Related Sections

In addition to the general conditions of contract, the Contractor shall also refer to the following Specifications:

1. Clause 2.1 .-Subsection- Cast-in-place Concrete
2. Subsection 2.10 – Bored Piles
3. Subsection 2.7 – Substructure Water Proofing

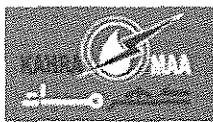
### 2.9.1.2 REFERENCES

#### A. General

1. Except where otherwise specified, work shall be in accordance with the British Standards relevant to this Specification. The latest editions shall be used, including all current amendments and additions.
2. Any differences between the Contractor requirements and this Specification shall be submitted to the Employer's Representative for his ruling.

#### B. British Standards

BS 812	Testing Aggregates	
	Part 1	Methods for determination of particle size and shape
	Part 2	Methods for determination of physical properties
	Part 102	Methods of sampling
	Part 103	Methods for determination of particle size distribution
	Section 103.1	Sieve tests
	Section 103.2	Sedimentation test
	Part 105	Methods for determination of particle shape
	Section 105.1	Flakiness index
	Section 105.2	Elongation index of coarse aggregate
	Part 106	Method for determination of shell content in coarse aggregate
	Part 109	Methods for determination of moisture contents.
	Part 110	Methods for determination of Aggregate Crushing Value (ACV)
	Part 111	Methods for determination of Ten percent Fines Value (TFV)
	Part 112	Method for determination of Aggregate Impact Value (AIV)
	Part 117	Method for determination of water-soluble chloride salts
	Part 118	Method for determination of sulphate content
	Part 119	Method for determination of acid-soluble material in fine aggregate
	Part 120	Method for testing and classifying drying shrinkage of aggregates in concrete
	Part 121:1989	Method of determination of soundness
BS 882	Aggregates from natural sources for concrete.	



BS 1047	Specification for air-cooled blast furnace slag aggregate for use in construction.
BS 1377	Soils for civil engineering purposes. Part1                   General requirements and sample preparation Part 2               Classification tests Part 3               Chemical and electro-chemical tests Part 4               Compaction related tests Part 5               Compressibility, permeability and durability tests Part 6               Consolidation and permeability tests in hydraulic cells and with pore pressure measurements Part 7               Shear strength tests (total stress) Part 8               Shear strength tests (effective stress) Part 9               In-situ tests
BS 1485	Specification for zinc coated hexagonal steel wire netting.
BS 3882	Specifications for top soil.
BS 4897	Coated macadam for roads and other paved areas. Part 1               Specification for constituent materials and for mixtures Part 2               Specification for transport, laying and compaction
BS 5837	Code of practice for trees in relation to construction.
BS 5930	Code of practice for Site investigation.
BS 6031	Code of practice for earthworks.
BS 6164	Code of practice for safety in tunnelling in the construction industry.
BS 8004	Code of practice for foundations.
BS 8110	Structural use of concrete

### **2.9.1.3 OTHER REFERENCES**

- Specification for highway works: part 2. DTp.  
Notes for guidance on the Specification for highway works: part 2 DTp.  
Irvine, D.J. and Smith, R.J.H. Trenching practice. CIRIA Report 97.  
Mackay, E.B. Proprietary trench support systems. CIRIA Technical Note 95.  
Parsons, A.W. and Boden, J.B. The moisture condition test and its potential application in earthworks. TRRL Supplementary Report 522. DTp.  
Young, O.C. The structural design and laying of small underground drains of rigid materials. TRRL Supplementary Report 303. DTp.  
The CIRIA Guide to Concrete Construction in the Middle East

Note:

- CIRIA      Construction Industry Research and Information Association  
TRRL       Transport and Road Research Laboratory  
DTp         Department of Transport



#### **2.9.1.4 SUBMITTALS**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prior to starting work on the contract the Contractor shall submit for approval details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the Specification.
- C. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials or place of manufacture are used.

#### **2.9.1.5 QUALITY ASSURANCE**

- A. Comply with pertinent provisions of QCS 2010.
- B. Prior to starting work on the contract the Contractor shall submit for approval details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the Specification.
- C. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials or place of manufacture are used.
- D. Material shall be obtained from suppliers operating quality systems in accordance with either ISO 9001 or an in-house system Approved by the Employer's Representative.

#### **2.9.1.6 DELIVERY, STORAGE AND HANDLING**

- A. Materials shall be stored in a manner that will ensure preservation of their specified quality and fitness for the work. They shall be placed on hard, clean surfaces and, when required by the Employer's Representative they shall be placed under cover. Stored materials shall be located in such a manner to facilitate prompt inspection and control.

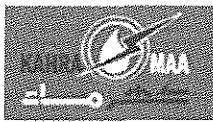
#### **2.9.2 PRODUCTS**

##### **2.9.2.1 GENERAL**

- A. Approval of materials

All materials, suppliers and sources must be approved in writing by the Employer's Representative prior to their use in the works. Prior to approval being given all or any of the following must be complied with, as required by the Employer's Representative:

1. Provision of a material to Site and subsequent testing of the sample for compliance with the Specification and standards. Refer "testing requirements" section contained in this Specification.
2. Site inspection at up to three locations where the material has been used over the previous 5 years.
3. Provision of test data for material produced at the supplier's source over the previous 6 months.



4. Works inspection.

#### **2.9.2.2 CLASSIFICATION OF MATERIALS**

##### **A. Approval of Materials**

1. Material which gives support to other parts of the works and which has to meet specific requirements for strength and stability.
2. Material for this purpose shall be of Suitable Material as described below.
  - a. Material which is acceptable for retention in formation, use in fill and/or re-use after excavation, and which excludes unsuitable material as described in the "Unsuitable Material" clause contained on the following page.
  - b. Material which is granular (such as sands, gravels and crushed rock) and meets the following requirements:
    - Less than 5% passing 63 micron sieve
    - Maximum rock particle size 37.5 mm
    - Liquid limit not exceeding 30% when determined by the methods of BS 1377 Part 2 Test 5:1990:MO
    - Less than 2% of organic material when measured by the method of BS 1377 Part 3 Test 3
    - minimum soaked CBR of 15% when compacted to 95% of maximum dry density, using the following methods: CBR to BS 1377; Part 4:1990 Method 7; MDD/OMC to BS 1377 Part 4:1990: Method 3

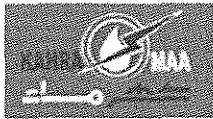
##### **B. Approval of Materials**

1. Materials for all other purposes as shown on the Drawings or otherwise specified.
2. Material for this purpose shall be of Structural Fill except the size limitation for granular material may be increased with the Employer's Representative approval.

#### **2.9.2.3 UNSUITABLE MATERIALS**

Material which is unsuitable for use in fill or retention in excavation as part of the formation and for re-use after excavation and is as described below:

- A. materials from swamps, marshes or bogs
- B. organic soils including topsoil
- C. peat, stumps or perishable materials
- D. materials susceptible to spontaneous combustion
- E. soil of liquid limit exceeding 30% and plasticity index exceeding 6%
- F. material which is not well graded and with uniformity coefficient < 3
- G. materials having hazardous and/or unacceptable chemical and/or physical properties



- H. Other prescribed material described in the Contract or as defined by the Employer's Representative.
- I. sabkha soils
- J. material having a total water-soluble chloride content > 2%
- K. material having a soluble sulphate content exceeding 1.9 g/l as SO<sub>3</sub> in a 2:1 water to soil extract

#### **2.9.2.4 SELECTED BACKFILL MATERIAL FOR STRUCTURES, FOUNDATION PITS, TRENCHES AND RETAINING WALLS**

- A. Material shall comply with the requirements of structural fill where it supports the works above, and non-structural fill elsewhere.
- B. Any fill material used within 1.0 metres of concrete structures or cement-bound materials shall not have a water-soluble sulphate content exceeding 1.9 g/l as SO<sub>3</sub> in a 2:1 water to soil extract, nor shall it contain any chemical in sufficient concentration that it would have a deleterious effect on concrete or cement-bound material, in the opinion of the Employer's Representative.

#### **2.9.2.5 GRANULAR FILL**

Granular fill shall be a free-draining material complying with the following:

- A. Material shall be granular crushed rock with maximum size of less than 37.5 mm.
- B. Material passing 425 micron shall be non-plastic according to BS 1377.
- C. Aggregate crushing value shall not exceed 30% in accordance with BS 812 part 110.
- D. Material shall not have a soluble sulphate content exceeding 1.9 g/l as SO<sub>3</sub> in 2:1 water to soil extract.
- E. Material on wet sieving, in accordance with BS 1377, shall comply with the requirements shown in Table 1 below.

<b>BS Sieve Size</b>	<b>Percentage by Mass Passing</b>
37.5 mm	100
10 mm	45 – 100
5 mm	30 - 85
600 micron	0 – 35
150 micron	0 – 5
75 micron	0 – 2

**Table 1: Particle Size Distribution for Granular Fill**

#### **2.9.2.6 ROCKFILL**

Rock fill shall consist of hard durable inert natural material of suitable size for deposition and compaction. The maximum size of such materials shall not exceed two-thirds of the thickness of the compacted layer and shall be graded so that when the layer compacted is uniformly dense and the surface is closed.

#### **2.9.2.7 FILL MATERIAL FOR DEPOSITION BELOW STANDING WATER**

Fill material for deposition below standing water shall be granular material with a 10% fines value of not less than 50 kN as tested in accordance with BS 812 : part 103 (method 8), except that samples shall be soaked in water at room temperature for 48



hours prior to testing without having been previously oven-dried. The material shall have a maximum particle size not greater than 400 mm and shall have a particle distribution size in the smaller fractions as shown in Table 2.

BS Sieve Size	Percentage by Mass Passing
37.5 mm	0 - 100
6.3 mm	0 - 100
3.35 mm	0 - 35
2.36 mm	0 - 10
600 micron	0 - 2

Table 2 Particle Size Distribution for Fill material for Deposition below Standing Water

#### **2.9.2.8 FILL MATERIAL FOR DEPOSITION ON SOFT GROUND**

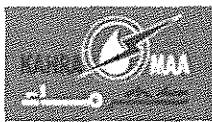
- A. Fill material for deposition on soft ground shall be granular material with a 10% fines value of not less than 50 kN as tested in accordance with BS 812 : part 103 (method 8), except that samples shall be soaked in water at room temperature for 48 hours prior to testing without having been previously oven-dried.
- B. The material shall consist of granular material graded from 400 mm to 150 mm, except that not more than 10% shall be less than 150 mm size. For treatment of small areas of soft ground, the Employer's Representative may require the size range to be reduced to such sizes as the Employer's Representative may direct.

#### **2.9.2.9 SOLID ROCK**

- A. Solid rock shall mean rock found in ledges or masses, greater than 0.3 m<sup>3</sup> in volume in its original position, which has to be loosened either by blasting, by hydraulic breaker, by pneumatic tools or, if excavated by hand, by wedges and sledge hammers.
- B. Descriptions of soils and rocks shall comply with the requirements of BS 5930 when included or otherwise agreed with the Employer's Representative. The criteria which are to be used to distinguish between the various types of soil, soft rock and hard rock will be agreed between the Contractor and the Employer's Representative on Site.

#### **2.9.2.10 IMPROVED SUBGRADE MATERIAL**

- A. Material for Improved Subgrade layer shall meet the following requirements:
  1. Not more than 20% by weight passing mesh no. 200 in accordance with BS 1377: Part 2: 1990 (Clause 9.2)
  2. Soaked CBR value at 95% maximum dry density (soaked) BS 1377 Part 4 (method 3.5) not less than 30% when tested according to BS 1377 Part 4 (method 7)
- B. A chemical analysis of the proposed material shall be carried out to satisfy the following requirements:
  1. The material shall be shown to have an acid-soluble sulphate content of 2% or less and chloride content in the form of acid soluble chloride of 2% or less by dry weight.
  2. The applicable Test methods should be in accordance with BS 1377 Part 3 (method 5) and BS 1377 Part 3 (method 7) respectively.



- C. When Approved by the Employer's Representative a sulphate content greater than that specified in section 2.10.2 may be acceptable when the carbonate content is in the region of 40-50% (BS 1377 Part 3 (method 6)).
- D. Higher chloride contents may be tolerated provided that the ratio of (carbonate + sulphate) to chloride contents is maintained at approximately 15:1
- E. The moisture content of the compacted material shall not vary by more than □ 3% of the optimum moisture content when tested in accordance with BS 1377: Part 2 Test 3.2.
- F. The material shall possess satisfactory binding characteristics to enable it to be compacted to give a smooth well-knit surface as judged by the Employer's Representative.

#### **2.9.2.11 GEOTEXTILES**

Geotextile fabrics where required below fill on soft ground, on fill below standing water and where required by the Employer's Representative shall meet the following minimum requirements:

- A. Geotextile fabric suitable for placing over fine sand
- B. Non-woven fabric consisting only of long-chain polymeric filaments or yarns formed into a stable network such that filaments or yarns retain their relative position to each other
- C. Stabilised against ultra-violet light
- D. Resistant to chemical attack from ground and water-borne salts
- E. Weight of 135 g/m<sup>2</sup>
- F. Thickness under load of 2 kN/m<sup>2</sup> > 0.7 mm
- G. Tensile strength of 200 mm width to ASTM D1682 > 1.6 kN
- H. Puncture resilience to DIN 54307 > 1.5 kN
- I. Permeability > 50 l/m<sup>2</sup>/s/m(H<sub>2</sub>O)/layer

#### **2.9.2.12 FILLING OF VOIDS**

Unless otherwise agreed with Kahramaa, all fill required to compensate for over-excavation under structures shall be sulphate resisting concrete grade 20.

### **2.9.3 EXECUTION**

#### **2.9.3.1 GENERAL**

- A. Levels, Reference Points and Setting Out
  - 1 The works are to be set out from primary datum level(s) and setting-out point(s) indicated on the Drawings or from information provided by the Employer's Representative.
  - 2 The Contractor shall submit his proposals, for setting out and controlling the alignment of the Works, to the Employer's Representative and obtains his approval prior to the start of construction. The Contractor shall supply the



details of the level and location of all temporary benchmarks and established reference points to the Employer's Representative.

- 3 Should the Contractor dispute the original ground levels shown on the Drawings he shall agree these with the Employer's Representative before disturbing the original ground.

**B. Method of Construction**

1. Prior to the commencement of work, the Contractor shall submit to the Employer's Representative the detailed proposals for methods of construction (including temporary works and construction plant) for all earthworks. The detailed proposals shall include but not be limited to the numbers and types of plant, routings and expected outputs, locations of spoil heaps, installation and removal of Temporary Works, attendance and supervision, protection of existing services and controls to ensure quality assurance and safety.

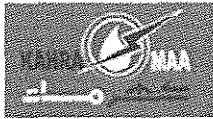
**C. Existing Buried Services**

1. The Contractor is to ascertain the position of all existing services within the area of the construction Works.
2. All existing services must be maintained and protected during the progress of the Works. The Contractor shall be responsible for any damage caused to the underground services and/or any delays arising from such damage.
3. The location of all existing services is to be documented and details submitted to the Employer's Representative.

**2.9.3.2 TESTING**

**A. Testing Laboratory**

1. An on-site testing laboratory shall not be required. The Contractor shall be required to provide the services of an independent testing laboratory Approved by the Employer's Representative for the purposes of carrying out the testing, all as prescribed in the Specification.
2. Test equipment shall include for carrying out the following tests:
  - a. Mechanical analysis (particle size distribution) including fine analysis using sedimentation and full pre-treatment, all in accordance with BS1377: Part 2:1990 Method 9.
  - b. Moisture determination in accordance with BS 1377: Part 2:1990 Method 3.
  - c. Liquid limit to BS 1377 Part 2 Test 4:1990:MO
  - d. Plasticity Index to BS 1377 Part 2 Test 5:1990:MO
  - e. Dry density/moisture content relationship in accordance with BS 1377: Part 4:1990 Method 3.



- f. Field Density of compacted soil to BS 1377 Part 9:1990 Method 2 (use of a properly calibrated nuclear density gauge would be an acceptable alternative).
- g. Shear strength by hand vane apparatus to BS 1377 Part 7:1990.
- h. All other tests as required in the Specification and British Standards, including:
- i. CBR to BS 1377 Part 4:1990 Method 7; Chlorides content to BS 1377 Part 3:1990:Section 7; Sulphates content to BS 1377 Part 3:1990 Section 5; Alkali, carbonates & bicarbonates to BS 1377 Part 3:1990 Section 6; pH value to BS 1377 Part 3: 1990 Section 9.
3. Where it is agreed with the Employer's Representative, and the extent of earthworks is small an independent laboratory may be used to carry out all necessary testing. This QCS terms and clauses regarding independent laboratories are obligatory and considered to be part of the contract conditions.
4. The Contractor shall follow and comply with regular Circulars regarding testing and laboratories, Quality forms, Safety forms etc. which are issued from the Employer or relevant authorities.
5. The Contractor shall only engage independent laboratories from the latest Approved laboratory list issued by the Employer or Employer's Representative or relevant authorities for Quality Control purposes.
6. The Contractor shall provide all necessary containers, plant, transport and labour for obtaining and handling of samples.
7. The Contractor shall provide all necessary staff for testing including a suitably qualified laboratory supervisor who will be subject to the Employer's Representative written approval.
8. The frequency of testing which is to be carried out shall be as specified by the Employer's Representative but not less than one set of tests a day or part thereof, when the relevant works are in progress. The Employer's Representative shall be notified when tests are to be undertaken. The Contractor shall supply the Employer's Representative with full reports (two copies) and two copies of test results together with laboratory test worksheets within 24 hours of carrying out such tests.

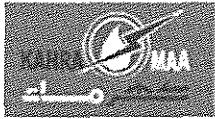
#### **2.9.3.3 WORKMANSHIP**

- A. In the setting-out and construction of excavations and filled areas the Contractor shall allow for settlement, heave and lateral spreading of embankments whether caused by consolidation of fill, settlement of foundation, heave in excavations or change in volume of materials after excavation or any other cause.
- B. The tolerance limits for the permanent finished earthworks shall be as follows:
  1. Horizontal dimensions shall be only +75 mm of the dimensions shown on the Drawings.
  2. For slopes to embankments or cuttings the horizontal deviation between the top and the bottom of the slope shall be within □ 5 per cent of the horizontal



component of the slopes shown on or calculated from the Drawings, but shall not exceed the values in section 3.3.1.

3. Formation levels shall be within zero and -25 mm of the levels shown on the Drawings.
  4. Other earthworks levels shall be within zero and -75 mm of the levels shown on the Drawings.
  5. All finished surfaces shall have the correct cambers and/or falls for drainage.
- C. The moisture content and acceptability of material arising within the Site shall be determined in its unexcavated state.
- D. The Contractor shall employ plant and methods of working which maintain acceptable material in a suitable condition for use and or reuse in the Works.
- E. Should for any reason whatsoever the ground becomes unstable the Contractor shall inform the Employer's Representative immediately and shall submit for the Employer's Representative approval proposals for dealing with the unstable ground. If necessary the Contractor shall proceed with the work by day and night without intermission and to the extent required by the Employer's Representative. Records of all labour, plant and material involved, including pumping, shall be agreed with the Employer's Representative as work proceeds.
- F. Adverse Conditions
1. The Contractor shall not carry out any excavation or placing of fill materials when conditions are such that the Works or other Works would be adversely affected. Once any operation has been stopped, owing to adverse weather or other conditions, it shall not be re-started without the approval of the Employer's Representative.
  2. The Contractor shall plan his operations so as to take account of the season and to take full advantage of favourable climatic conditions. Additionally, the Contractor's temporary drainage of the Works shall take these factors into account.
  3. The Contractor shall seek the Employer's Representative approval to any changes in his method of working that are necessary to ensure full compliance with this requirement before the changes are implemented.
- G. Temporary Earthworks: Stockpiles and Subsoil Heaps
1. The Contractor shall make his own arrangements for stockpiles and for provision of storage areas for soil but shall submit proposals for these, and other temporary earthworks, for the approval of the Employer's Representative.
  2. Such Works shall be stable under all conditions and shall not impede the natural drainage of the area in which they may be situated. The Contractor shall satisfy the Employer's Representative by testing and calculation as appropriate as to their stability.
  3. Fill materials shall not be stockpiled in the vicinity of excavations nor shall they be stockpiled on embankments.
- H. Earthworks to be Kept Free of Water (Dewatering)
1. The Contractor shall arrange for the rapid disposal of water, from whatever source, from all earthworks, excavations, stockpiles or completed formations of all types during construction and, where practicable, the water shall be discharged into the permanent drainage system. Adequate means for



trapping silt, oil or other deleterious matter shall be provided on temporary systems discharging into permanent drainage systems. In depressions, pumping shall be used as necessary to keep them free of water.

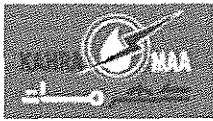
2. The Contractor shall provide temporary water courses, ditches, drains, wellpoints, pumping or other means of maintaining the earthworks free from water. Such provisions shall include carrying out the work of forming cuttings and embankments in such a manner that their surfaces are sufficiently even and have at all times sufficient minimum crossfalls, cambers and longitudinal gradients to enable them to shed water rapidly and prevent ponding. Excavations for foundations, pits and trenches shall be dewatered such that groundwater level is kept at 300 mm below the underside of any structure.
3. All temporary water courses, ditches, drains etc. shall be filled in or removed and the ground reinstated prior to completion of the Works. Buried pipes may, subject to the approval of the Employer's Representative, be left in position but in that case shall be completely filled with grout.

**I. Work alongside Adjoining Property**

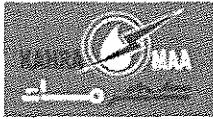
1. Before carrying out excavations or associated Works, including pumping or groundwater lowering, alongside adjacent properties the Contractor shall survey such properties and record their levels and structural condition, take particular note of any cracks, other damage or deformations. The survey shall include a photographic record and a means of monitoring the movement of any adjacent structures during excavations and Site operations.
2. The Contractor shall supply the Employer's Representative with a copy of all such survey records (including photographs). All such records shall be adequately referenced as to location, direction of view, date, etc.
3. Before commencing work alongside adjoining property the Contractor shall submit to the Employer's Representative his detailed proposals for carrying out the work including diagrams of his proposed methods of support together with his calculations and estimates of vertical and lateral movements, and his means for keeping the Works free of water.

**J. Change of Groundwater Levels Due To Pumping/Dewatering**

1. In pumping out excavations or in any other operation, such as groundwater lowering/dewatering which could vary the groundwater levels or affect in any way the Permanent Works and/or nearby properties, the Contractor shall ensure the stability and, in particular, prevent or minimise the settlement of such Permanent Works and/or nearby properties.
  2. The Contractor shall submit his proposals to the Employer's Representative for his approval before starting such operations. The proposals shall include the Contractor's assessment of likely settlement together with calculations and conditions assumed.
  3. The Contractor shall take all necessary precautions to prevent any adjacent ground from being adversely affected by loss of fines through any de-watering process.
- K. Protection of all earthworks covered by this Specification shall be provided by the Contractor, by methods Approved by the Employer's Representative, until the Works are certified complete by the Employer's Representative.



- L. The Contractor shall notify the Employer's Representative immediately of any landslips, and shall then deal with these without delay and as the Employer's Representative may direct. If any slip or fall disturbs or weakens any foundation, support or potential support the Contractor shall execute such additional work immediately as the Employer's Representative may direct.
- M. Contaminated, Disturbed or Man-Made Ground: Health and Safety
  - 1. The Contractor's attention is drawn to the possibility of contamination of ground and/or of disturbed or man-made ground masses and he shall pay additional attention to the potential problems that can be posed in working in such conditions. The Contractor shall ensure that full reference is made to any existing reports or other relevant information on ground conditions, particularly with respect to possible physical or chemical hazards for workers, whether in solid, liquid or gaseous forms. Suitable precautions shall be taken to protect the workforce and the neighbourhood from environmental hazards that might result from the Contractor's operations. Such hazards could relate to dust, flammability, explosiveness, skin contact, inhalation or ingestion. The Employer's Representative shall advise the Contractor at the tender stage of any facts or well-founded suspicions that may exist regarding the potential hazards.
  - 2. If the Contractor has knowledge of or encounters material and conditions in the ground mass, which may constitute an environmental hazard, or suspects they will constitute an environmental hazard, he shall promptly advise the Employer's Representative and request instructions from the Employer's Representative. The Contractor shall not carry out any further work until satisfactory clearances have been received from the Employer's Representative and the local authorities if required.
- N. Disposal of Materials off Site
  - 1. Contaminated and waste materials shall be removed from Site in accordance with the requirements of the Local Authorities. The Contractor shall satisfy the Employer's Representative that all waste materials are taken only to a disposal Site/treatment plant which is licensed to accept waste of that nature.
  - 2. No excavated acceptable or temporarily unacceptable material or topsoil other than that agreed by the Employer's Representative to be surplus to the requirements of the Contract shall be removed from the Site except on the instruction of the Employer's Representative.
  - 3. All unacceptable material shall, unless the Employer's Representative permits or instructs otherwise, be removed from the Site and run to either tips provided by the Contractor or otherwise disposed of by the Contractor. Public roads may only be used for haulage if arrangements acceptable to the Employer's Representative and the Approving Authority are agreed beforehand.
- O. Open ditches, culverts and outfalls for drainage purposes shall be maintained by the Contractor. New ditches, culverts and outfalls shall be constructed before cuttings are opened or embankments or filling begun. The sides shall be dressed fair throughout and the bottoms accurately graded so as to carry off water to the outlet.
- P. Running Layers and Access Routes (Haul Roads)
  - 1. Where the Contractors proposals include running over the location of the permanent Works he shall provide, above the formation levels shown on the Drawings, a suitable running layer of 300 mm minimum depth above



formation levels for the movement and operation of plant, materials and labour associated with his Works so that material at formation and below is not adversely affected.

2. Prior to commencement of work, the Contractor shall submit his proposals to the Employer's Representative for his approval for haul roads.
3. During the execution of the Works, the Contractor shall maintain the running layer to the satisfaction of the Employer's Representative.
4. The running layer shall be removed in a manner which does not adversely disturb the previous construction or interfere with subsequent operations for the Permanent Works.

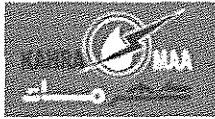
#### **2.9.3.4 EXCAVATION**

##### **A. General**

1. The Contractor shall record the strata through which he excavates together with their locations and depths. He shall provide a copy of the records to the Employer's Representative as the work proceeds. Where excavation produces a combination of acceptable and unacceptable materials, the Contractor shall carry out the excavation in such a manner that acceptable materials are excavated separately for use in the Works without contamination by unacceptable materials which shall be removed off Site. Where excavation produces a combination of acceptable materials with different characteristics, these materials shall be excavated and stored separately.
2. Any old foundations, tree roots, buried refuse or obstructions encountered during the course of excavation shall be taken out and removed from the Site excluding combustible materials which shall either, with the Employer's Representative and local authority approval, be burnt under controlled conditions or removed from the Site. Care shall be taken to ensure that roots to existing trees to be retained are not disturbed. Should an unforeseen services be encountered the Employer's Representative shall be notified immediately and no action taken pending his instructions. When instructed by the Employer's Representative disused drains shall be traced and either sealed with Grade C10 concrete or filled using a pfa to OPC 15:1 grout or other Approved material as directed by the Employer's Representative.
3. When rock is encountered, the Employer's Representative shall be notified immediately and it shall then be removed only to the net extent to permit the Works to be properly executed. The Contractor shall free the faces and bottoms of the excavations of loose material which can be moved with a crowbar. For excavations in which concrete is to be placed, the resulting cavities and any large fissures shall be filled with grade C10 concrete. For trenches filling shall be as shown on the Drawings and as directed by the Employer's Representative. The quantities of material shall be measured and agreed with the Employer's Representative as work proceeds and prior to removal. Rock projections, boulders or other hard spots in excavations shall be removed to a depth not less than 100 mm below formation level and as directed by the Employer's Representative and a new formation prepared, and the excavation filled as specified. The quantities of these materials shall be measured and agreed with the Employer's Representative as work proceeds and prior to removal.



4. The Contractor shall carry out his operations in such a manner as to ensure that damage to or deterioration of the formation or final surface of the excavation and the ground below is not caused. The natural moisture content of the ground below the formation shall be preserved. Excavation in error or for any other reason by the Contractor to a greater extent than is indicated on the Drawings shall be made good with a material Approved by the Employer's Representative deposited and compacted as specified or, if instructed by the Employer's Representative, with grade C10 concrete.
5. If the Contractor encounters ground in the formation which he considers unacceptable, the Employer's Representative shall be informed immediately.
6. On completion of the excavation the formation shall be neatly finished leaving no extraneous material. The permanent work shall be placed immediately or the formation sealed to the approval of the Employer's Representative after the formation has been inspected and Approved by the Employer's Representative. The Contractor shall give adequate notice to enable this to be done.
7. Excavations shall be kept free from noxious or explosive gases, whether generated in strata by blasting or otherwise. The Contractor shall satisfy himself that each excavation is safe before allowing entry of personnel. The Contractor shall carry out tests for the presence of noxious or explosive gases, or to detect a lack of oxygen before allowing personnel to enter any confined space or excavation, and he shall then monitor conditions continuously during the period of work. He shall take such measures (e.g. ventilation, the provision of breathing apparatus, and back-up personnel and equipment) as will avoid any risk of injury to personnel. The Employer's Representative may order the withdrawal of personnel if dissatisfied with the Contractor's arrangements.
8. The Contractor shall establish a sequenced system of excavation and dewatering, including acceptable excavation retention wall system, as required, along the entire perimeter of the site which shall also be fully coordinated with all adjacent existing or proposed new construction, utilities etc. The design, installation and maintenance of all excavation systems and dewatering system elements, including removal of any excavation retention system shall be the complete and sole responsibility of the Contractor. Any damage to new or existing construction, inside or outside the project limits caused by construction techniques or movement of the soil retention system is the sole responsibility of the Contractor.
9. The soil retention system and all dewatering systems shall be designed and installed by the Contractor to suit site requirements.
10. The Contractor shall coordinate all elements of the dewatering system and soil retention systems with all elements of permanent building systems.
11. The Contractor shall provide positive protection (mat/ sheet coverings), for all excavation slopes, to protect slopes from instability and deterioration due to wind or rain.
12. All excavation below the slab level required for pits shall be retained by localized soil retention systems.



13. The Contractor shall provide surface drainage channels, sumps, and sump pumps to protect all excavations from flooding.
14. The site shall be dewatered, as required, before (or as) the excavation proceeds. The Contractor shall provide all construction and equipment for the dewatering system including, but not limited to, trenches, sumps, dewatering wells, well points, observation wells, pumping system, disposal location, settling basins, maintenance and emergency back-up equipment. At all times the dewatering system shall maintain a water level a minimum of 1000mm below the deepest foundation subgrade. The dewatering system shall be removed only after written confirmation from the Engineer.

**B. Forming of Cuttings**

1. Cuttings shall be excavated to the lines and levels shown on the Drawings or as directed by the Employer's Representative.
2. Toes to the slopes of cuttings shall only be undercut where Permanent Works necessitate excavation(s). Such excavations shall be restricted in extent and shall remain open only for the minimum period necessary. The Contractor shall submit to the Employer's Representative for approval a method statement giving his procedure for carrying out such work.
3. Where for reasons of programme the excavation cannot immediately be completed, sealed and the Permanent Works placed, excavation shall be restricted such that at least 300 mm of material is left above formation level as a protective layer; the extent of further protection to be provided in each case shall be dependant on the situation and material involved. Trafficking shall only be allowed by approval of the Employer's Representative.

**C. Dressing of Formation and Side Slopes of Rock Encountered in Cuttings**

1. Where rock is encountered in cuttings, the side slopes shall be cut to the lines, levels and slopes shown on the Drawings or as directed by the Employer's Representative.
2. Surface irregularities remaining on the base of an excavation after completion of the rock excavation shall be corrected to formation level by filling with a granular material Approved by the Employer's Representative. Such material shall have a maximum size not greater than one third the thickness to be compacted and not exceeding one third the maximum allowable compacted layer thickness, whichever is the less. The formation so constructed shall be formed to lines and levels shown on the Drawings.
3. The sloping sides of all permanent cuttings shall be scaled of all rock fragments which are loose or can be prised with a crowbar.

**D. Excavations for Structures and Foundations**

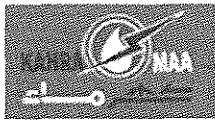
1. Excavations shall be to the lines and levels shown on the Drawings.
2. The sides of excavations for structures such as basements and foundations shall be adequately supported at all times and, except where required as shown on the Drawings or allowed by the Employer's Representative, shall not be battered. The Contractor shall submit to the Employer's Representative proposals for his Temporary Works to ensure stability of the excavation, temporary and Permanent Works, and these proposals shall include detailed Drawings and calculations, methods of installation and withdrawal and his means of keeping the Works free of water.



3. The Contractor's attention is drawn to the possibility of bottom heave occurring in deep excavations. And in his proposals, the stability of the excavation against bottom heave shall be considered.
4. For excavation in soils such as over consolidated clays which are likely to heave and swell, the Contractor shall submit to the Employer's Representative for his prior approval a detailed method statement giving his procedure and proposed arrangements for minimising the effects of heave and swelling.
5. Where for reasons of programme the excavation cannot immediately be completed, sealed and the Permanent Works placed, excavation shall be restricted such that at least 300 mm of material is left above formation level as a protective layer; the extent of further protection to be provided in each case shall be dependant on the situation and material involved. Trafficking shall only be allowed by approval of the Employer's Representative and subject to clause 3.3.16.
6. When constructing structures and laying adjacent services, the construction or services requiring the deepest excavation shall be excavated first and construction brought to a safe level before starting further excavation. When this is impracticable, the Contractor shall obtain the approval of the Employer's Representative to his proposals for maintaining undisturbed the ground supporting the higher construction while excavating, constructing and filling around and/or over the lower one.
7. Where blinding concrete is placed in the bottom of an excavation no trimming of side faces shall be carried out until a period of 24 hours has elapsed.
8. Should ground be excavated in error or otherwise disturbed wider or deeper than is required all disturbed material shall be removed, and the excess excavation shall be made good with a material Approved by the Employer's Representative deposited and compacted as specified or, if instructed by the Employer's Representative, with grade C10 concrete.

**E. Proving Formation in Excavation and Dealing with Soft or Unsound Spots**

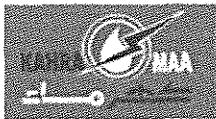
1. Formation in excavation shall be proof rolled or compacted by 1 pass of a smooth wheeled roller having a mass of a metre width of roll not less than 2100 kg unless otherwise specified by the Employer's Representative.
2. Any soft or unsound spots as may be found, by inspection, testing, proof rolling or compaction or otherwise as may be specified, in the formation or under areas to be filled, shall be excavated as required by the Specification and instructed by the Employer's Representative. The resultant excavation shall be backfilled with Approved material deposited and compacted as specified for the forming of filled areas or, if instructed by the Employer's Representative, with grade C10 concrete.
3. However, the Contractor's attention is drawn to the possibility that instability or an apparent soft spot may be due to a pore pressure rise as a result of compaction forces. In such circumstances the Employer's Representative shall be informed and in agreement with the Employer's Representative the pore pressure may be allowed to dissipate before deciding on the removal or otherwise of such an area.



4. An alternative method treatment using Approved rock fill material may be permitted or required by the Employer's Representative. If so it shall be placed directly on the naturally occurring soft soil and compacted to such total depth that on completion of compaction negligible deflection of the surface occurs by the passage of vehicles hauling in the rock. The rock fill material shall be deposited and compacted as specified above.
5. Where the formation in excavation is of essentially granular material it shall, following inspection, testing and/or proof rolling or compaction be compacted in accordance with the "Compaction of Earthworks" section of this Specification unless otherwise specified. Where the formation is of a cohesive nature compaction or otherwise shall be related to its nature and natural condition, and following inspection and testing the Contractor shall submit his proposals for treatment for the Employer's Representative.

#### **2.9.3.5 FILLING**

1. Forming of Embankments and Other Areas of Fill
  1. Embankments and other areas of fill shall be formed of acceptable material as shown on the Drawings, and/or as specified by the Employer's Representative.
  2. Haulage of material to areas of filling shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.
  3. Areas to be filled shall be clear of sweet soil, rubbish, scrap material and standing water (unless shown otherwise on the Drawings) when fill is placed. No filling shall be placed on areas or formation or already laid material or on a surface that has been damaged or not cleaned of debris or mud and without the approval of the Employer's Representative.
  4. All earthworks placed in or below embankments and other areas of fill such as backfill to trenches, pits and structures such as retaining walls and basements, or elsewhere in the Works, shall be deposited and compacted, as soon as practicable after excavation, in layers of thickness appropriate to the compaction plant used, but not exceeding 250 mm compacted thickness, unless otherwise permitted in the appropriate clause or otherwise specified, or otherwise agreed by the Employer's Representative.
  5. If there is a deficit in the 'cut-fill' balance of acceptable materials from excavations the deficiency shall be made good by importation of acceptable material. In this case the Contractor shall propose a source or sources of such material for the Employer's Representative approval (refer to Part 2 - Products).
  6. Where materials of different characteristics are available those of relatively higher bearing capacity shall be placed in the topmost 600 mm below formation level.
  7. Where non-cohesive material, on excavation, is too wet or too dry for satisfactory compaction the Contractor shall raise or lower the moisture content until satisfactory compaction is achieved and Approved by the Employer's Representative.
  8. Where for any reason the moisture content of acceptable material changes to a value unacceptable for compaction, the Contractor shall raise or lower the moisture content until satisfactory compaction is achieved and Approved by the Employer's Representative.



9. Areas of general fill and embankments shall be built up evenly over the full width, and with side slopes not greater at any time than shown on the Drawings or directed by the Employer's Representative. Areas of fill shall be kept free of water in compliance with the "Workmanship" section of this Specification. During construction of areas of general fill and embankments the Contractor shall control and direct construction traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor.
  10. In carrying embankments up to or over culverts, piped drains or other services, and where required in the Contract, up to or over bridges; the Contractor shall bring the embankments up equally on both sides. Where special forms of compaction, adjacent to structures are described in the Contract, filling may proceed over widths less than the full width of the embankment and in steps not exceeding the depth of one layer above the adjoining area of fill.
  11. If the Contractor wishes to continue to use the surface of embankments for constructional plant before trimming to formation level the requirements of Section 3.3.16 shall continue to apply. Additionally, the Contractor shall bring up and maintain the area between the extremities of any carriageway, including any central reserve and hard shoulder to a level not less than 150 mm above the formation level. The extent of the protection to be provided in each case shall be adjusted to suit the situation and materials involved whereupon constructional plant will be allowed to use the surface so formed but any damage to the sub-formation or subgrade caused by the use of such surface shall be made good by the Contractor. On compaction of sub-formation to formation level, the movement and use of constructional plant shall be only as permitted by the Employer's Representative.
  12. Material used for haul roads or running layers shall not be re-used without the permission of the Employer's Representative.
  13. The layers of fill shall be graded, levelled, pulverised and mixed, with water added as necessary, to ensure homogeneous conditions throughout the full depth of the uncompacted layer.
2. Backfilling of Trenches and Pits
1. The first 300 mm of main backfill shall be placed in layers not exceeding 100 mm uncompacted thickness with each layer being thoroughly compacted before placing the next layer. Only light compaction equipment subject to the approval of the Employer's Representative shall be used. Otherwise mechanical rammers, rollers and the like shall not be used to compact the fill until there is a minimum 600 mm of fill above the top of the pipes.
  2. The main backfill shall then be built up in layers not exceeding 150 mm in compacted thickness. Compaction shall be according to clause 3.6.
  3. As filling proceeds all trenches or pit supports shall be removed in a safe manner and in accordance with the Approved method of working.
  4. Particularly under roads or existing works such as pipes, the fill shall be compacted to a minimum relative compaction of 95% or bring it as nearly as possible to the same condition of density and moisture content as that of the undisturbed soil in the trench or pit sides provided the fill is of a similar nature; otherwise a selected material Approved by the Employer's Representative shall be used.

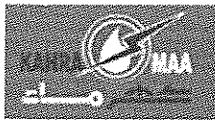


5. Unless otherwise specified, filling around manholes shall be as for trenches and shall be carried out as part of the same operation. The fill shall be raised equally all round the manhole shaft.
6. Any settlement that occurs shall be made good by the Contractor with the surface construction also being maintained in an acceptable condition.
3. **Filling Against Structures**
  1. Fill to structures shall be selected material as shown on the Drawings or Approved by the Employer's Representative.
  2. Fill shall be placed and compacted in accordance with the "Filling" and "Compaction of Earthworks" sections of this Specification excepting as otherwise specified in this sub-clause.
  3. Where fill to structures is required to a similar level on more than one side of a structural element, it shall be so placed that the difference in level of compacted filling against adjacent or opposite sides does not exceed 250 mm, unless otherwise permitted by the Employer's Representative.
  4. Do not backfill against basement walls until horizontal bracing slabs are in place where necessary and the concrete has attained the full design strength.
  5. Compaction plant used on fill within 2 m of a structure shall be restricted to:
    - a. Vibratory roller with mass a metre width of roll not exceeding 1300 kg with a total mass not exceeding 1000 kg.
    - b. Vibrating plate compactor having a mass not exceeding 1000 kg or Vibro-tamper having a mass not exceeding 75 kg.
  6. Fill within this zone shall not differ in level during construction from the level of the remainder of the adjoining fill to the structure by more than 250 mm.

#### **2.9.3.6 COMPACTION OF EARTHWORKS**

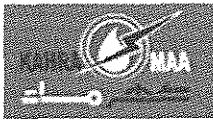
##### **A. Structural Fill**

1. All filling material shall be compacted to a minimum relative compaction of 95% based on BS 1377 and CML 12-97.
2. Before filling and compaction works are commenced, and further as may be necessary during the progress of the Works, the Contractor should have carried out classification tests, including natural moisture content and compaction tests in accordance with BS 1377 Part 4:1990 Method 3, as appropriate, on the main types of materials originating from the Site and any proposed to be imported to determine acceptability and optimum compaction requirements.
3. For materials which are non-plastic according to BS 1377 and have not more than 10 per cent passing 75 microns the compaction test shall be in accordance with test 14 of BS 1377 Part 4 unless otherwise specified by the Employer's Representative.
4. The Employer's Representative shall be advised of when the tests are to be undertaken. Two copies of all test results shall be forwarded to him for his approval prior to the commencement of work and thereafter as the occasion arises (refer to the "Testing" section of this Specification).



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

5. The Contractor shall submit to the Employer's Representative his proposals giving the maximum compacted depth of each layer, the type(s) of plant and the number of passes for compaction of each type of material. The Contractor shall demonstrate to the Employer's Representative satisfaction that he can achieve the requirements regarding compaction before the Works commence by carrying out compaction trials.
6. Where compaction is required the Contractor shall submit his method of compaction for each material to the Employer's Representative for approval.
7. Earth-moving plant will not be accepted as compaction equipment under this clause nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account in assessing the amount of compaction required for any layer.
8. Where side slopes to fills are shown on the Drawings the Contractor shall submit for the Employer's Representative approval his method for obtaining compaction, as specified, to the lines and levels shown on the Drawings.
9. The frequency of testing the compacted fill shall be sufficient in relation to the volume of particular works, the rate of placing and its purpose, and shall be as agreed with the Employer's Representative in accordance with the "Testing" section of this Specification.
10. In case the method of compaction is specified by the Employer's Representative the Contractor will be required to carry out tests in accordance with the above and when instructed by the Employer's Representative or carry out comparative field density tests determined in accordance with BS 1377 Part 9:1990 Method 2, or by using a nuclear density gauge (complying with ASTM D922 and ASTM D3017 Specifications for nuclear density - moisture gauges), which shall be calibrated on material similar to that which is being tested for field density.
11. If the test results, when compared with the results of similar tests on adjacent Approved work, in similar materials, carried out in accordance with the Specification, show the state of compaction to be inadequate the Contractor shall carry out such further work as the Employer's Representative may decide is required to achieve adequate compaction.
12. Works on the compaction of material shall proceed as soon as practicable after excavation and/or placing. Compaction requirements where not fully stated within this clause or given on the Drawings shall be as instructed by the Employer's Representative.
13. Work shall be continued until a state of compaction is reached throughout filled areas, including slopes of embankments, such that dry density tests from the compacted material in accordance with BS 1377 Part 9 Method 2 or ASTM D1556 has a dry density not less than that stated below.
14. For non-cohesive materials, within the limits of the "Structural Fill" section of this Specification and for materials with a plasticity index not exceeding 6 per cent, the state of compaction shall be such that the compacted material has a dry density not less than 95 per cent of maximum dry density and a moisture content within the range of 1 per cent above and 2 per cent below optimum percentage as determined in accordance with test 14 of BS 1377, unless otherwise specified by the Employer's Representative.
15. For intermediate materials the state of compaction shall be such that the compacted material has a dry density not less than the specified percentage of maximum dry density and a moisture content within the specified range



related to optimum percentage as determined in accordance with BS 1377 Part 4 Method 3, unless otherwise specified by the Employer's Representative.

16. Where fill materials have particle sizes exceeding the maximum size allowable in the relevant Test to BS 1377 Part 4 Method 3 or BS 1377 part 4 Test 14, the procedures for comparing test values with field values shall be agreed with the Employer's Representative prior to such fill materials being used.

**B. Non-Structural Fill**

1. Before filling, spreading and compacting operations are commenced; materials shall be classified by the Contractor for acceptability in accordance with sub-clauses the "structural fill" and "Unsuitable Materials" section of this Specification, and agreed by the Employer's Representative.
2. Fill shall be spread in layers not exceeding 300 mm in thickness unless otherwise specified by the Employer's Representative. Spreading shall not be done when the ground or the fill is excessively wet or otherwise in a condition detrimental to the work nor shall it be done during heavy rain.
3. Compaction shall be as specified on the Drawings or elsewhere in the Contract.

**C. Benching**

1. Where filling is to be placed on sloping ground (steeper than one vertical to six horizontal) the surface of the ground shall be benched in steps, or as shown on the Drawings, to enable melding of the fill with the existing slope, and may include, as necessary, under-draining for dealing with water.
2. Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the vertical steps of the benching.
3. Placing and compacting of fill material on a lower bench shall continue to a level one compacted layer thickness above an adjacent higher bench before material is placed upon the latter bench.
4. Four additional passes of the Approved compaction plant shall be made over a width of two metres each side of each vertical face immediately following the compaction of the first layer of material on each bench.

**D. Rock fill: spreading and compaction**

1. Rock fill shall be as specified in the "Classification of Materials" section of this Specification.
2. Material used in rockfill shall, except for any specified cover to slopes or near bottom of capping layer or formation level, be of such size that it can be deposited in horizontal layers each not exceeding 450 mm loose depth and extending over the full width of the area or of the embankment. Material shall be spread and levelled by a crawler tractor having a mass of not less than 15 tonnes and compacted. The top surface and side slopes of embankments as formed shall be thoroughly blinded with Approved fine graded material to seal the surface and give a compacted stable surface. Such fine graded material may on side slopes and verges be topsoil except where the final surface may be such as paving or otherwise shown on the Drawings.
3. Each layer in rock fill shall be compacted by at least 12 passes of a towed vibratory roller with a static mass a metre width of roll of at least 1800 kg or a



grid roller with a mass per meter width of roll of at least 8000 kg or other Approved plant.

4. Where rock is used as general fill and has the properties of rock fill it shall be spread and compacted as for rock fill.

**E. Improved Subgrade Material**

1. The compacted density of the fill shall be equal to or greater than 95% of the maximum dry density as determined by BS 1377: Part 4. Samples for soil classification, moisture and CBR tests shall be taken prior to incorporating the material in the works. For every completed layer of material, three field density tests shall be performed on an area of approximately 1500m<sup>2</sup> of prepared area.

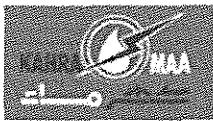
**F. Preparation and Surface Treatment of Exposed Subgrade for Building Foundations**

1. Preparation and surface treatment of the subgrade shall be carried out only after completion of any subgrade drainage or dewatering and, unless otherwise agreed by the Employer's Representative, immediately prior to blinding with concrete or the construction of the Works.
2. The sequence of operation shall be as follows:
  - a. The surface shall, after reinstatement of any soft areas, be well cleaned and free from mud and slurry.
  - b. The surface shall be compacted by a minimum of 6 passes of a smooth-drum vibrating roller having a minimum dead weight of 10 tonnes.
  - c. The surface shall be regulated and trimmed within a tolerance of ±20 mm.
  - d. Where the surface is too high it shall be retrimmed and recompacted in accordance with this Specification. If the surface is too low the deficiency shall be corrected by the addition of suitable material of the same classification and moisture content or other Approved material laid and compacted to Specification.
3. If the Contractor allows the moisture content of accepted compacted material to reach a value above the maximum permitted in this Specification for the material for compaction, the Contractor shall allow the material to revert to an acceptable moisture content and, if directed by the Employer's Representative, make good the surface by recompaction before laying the capping layer or other pavement layer. Alternatively, the Employer's Representative may allow or require the affected material or layer to be removed and replaced with acceptable material.

**2.9.3.7 REINSTATEMENT**

**1. General**

1. These clauses cover the reinstatement of surfaces which existed before the Works have commenced, which have been disturbed in the course of the Works and which are not finished as part of other works.
2. Where reinstatement involves such as public utilities or services, or public highways, roads, footpaths and bridlepaths or such privately owned facility, the Contractor shall ascertain the requirements of the relevant authority or owner, and carry out reinstatement to the requirements of the relevant authority or owner where superior to the requirements in this Specification.



2. Reinstatement of Surfaces over Trenches
  1. Those parts of the Site and any areas outside the Site disturbed by excavation for service trenches shall be reinstated to the same standard as existed before the Works commenced unless otherwise shown on the Drawings or instructed by the Employer's Representative.
  2. Backfilling shall be properly carried out in accordance with the "Backfilling of Trenches and Pits" section of this Specification.
  3. Any settlement that occurs shall be made good by the Contractor together with the surface condition being maintained in its former condition as defined in sub-clause 1 above.
3. Public and Private Highways, Roads and Footpaths
  1. Where these have been disturbed by excavation for trenches the material to be used for backfilling shall be a material Approved by the Employer's Representative and be such that thoroughly compacted it shall have negligible consolidation characteristics. The backfilling shall be carried out in accordance with the "Backfilling of Trenches and Pits" section of this Specification.
  2. Paved and hard surfaces shall be temporarily reinstated by the Contractor immediately following backfilling and before reopening the disturbed areas to traffic. The materials used shall be appropriate to the adjacent construction. Verges shall be temporarily reinstated to match nearly as possible the adjacent areas.
  3. Unless shown on the Drawings or instructed otherwise by the Employer's Representative the surfaces over disturbed areas shall be permanently reinstated by the Contractor, within 2 months of the temporary reinstatement, in materials and construction similar to the adjoining surfaces and in a manner specified by the Employer's Representative to obtain proper integration between these adjoining surfaces. To ensure satisfactory integration between the new and existing construction each layer is to be stepped back beyond the edges of excavation and underlying layers.
  4. Throughout the duration of the Works, the Contractor shall ensure that all vehicle wheels are thoroughly cleaned prior to leaving the site approaches and re-entering public roads. The Contractor shall ensure that points of entry from and exit to public roads are kept clean.

## **2.10 BORED PILES**

### **2.10.1 GENERAL**

#### **2.10.1.1 SUMMARY**

1. Qatar Construction Specifications (QCS) form the basis of the Specification for the work. The following clauses are to be added and or supplemented to those of Qatar Construction Specifications (QCS 2010) Section 4.
2. Piles shall be bored cast-in-place concrete piles and be in compliance with this Specification and the ICE Specification for Piling and Embedded Retaining Walls (1996). If there is any conflict between this Specification and the ICE Specification, this Specification shall prevail. The piles are to be designed by the Contractor's Representative.
3. Related Sections



In addition to the General Conditions, the Contractor shall also refer to the following specifications:

1. Clause 2.1 - Cast-In-Place Concrete
2. Clause 2.9 - Earthworks
4. PARTIES AND PERSONS

**Kahramaa** – the person named as the employer in the Contract Agreement and the legal successors in title to this person.

**Contractor** -The person(s) named as the contractor in the Contract Agreement and the legal successors in title to this person(s). [Includes sub-contractors and consultants (Contractor's Representative) appointed by the Contractor to undertake the works]

**Employer's Representative** – the person named by the Kahramaa in the Contract or appointed from time to time by the Kahramaa, who acts on behalf of the Kahramaa (Checking Engineers, Commissioning Agent, and Project Managers).

#### **2.10.1.2 REFERENCES**

ASTM D1143	Piles Under Axial Compressive Load
ASTM D3689 :19	Piles Under Axial Tensile Loads
BS EN 197 :2000	Cement. Composition, specifications and conformity criteria for common cements
BS EN 480	Admixtures for concrete, mortar and grout. Test methods.
BS EN 934	Admixtures for concrete, mortar and grout. Concrete admixtures
BS EN 1008 :2002	Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
BS EN 1011	Welding. Recommendations for welding of metallic materials
BS EN 10238 :1997	Automatically blast cleaned and automatically primed structural steel products
BS EN 12620	Aggregates for concrete
BS 12	Specification for Portland cement
BS 146 :2002	Specification for blast furnace cements with strength properties outside the scope of BS EN 197-1
BS 1305	Specification for batch type concrete mixers
BS 1370 :1979	Specification for low heat Portland cement
BS 1881	Testing concrete



BS 3963 :1974	Method for testing the mixing performance of concrete mixers
BS 7079	Preparation of steel substrates before application of paints and related products
BS 5328 :1981	Methods for specifying concrete, including ready-mixed concrete
BS 8008:1996	Safety precautions and procedures for the construction and descent of machine-bored shafts for piling and other purposes
BS 5930 :1999	Code of Practice for Site investigations
BS 8004 :1986	Code of Practice for foundations
BS 8110	Structural use of concrete

#### **2.10.1.3 OTHER REFERENCES**

1. Building Research Establishment Special Report 1 (2001) - Concrete in sulphate-bearing soils and ground waters BRE Special Digest 1: Concrete in aggressive ground

Construction Industry Research and Information Association:

1. Report PG7 - Pile load testing procedures.
2. Report CP28 - The role of integrity and other non-destructive testing in the evaluation of piled foundations

Engineering Equipment and Materials Users Association - EEMUA 163 Drilling Fluid Materials.

The Institution of Civil Engineers: Specification for Piling and Embedded Retaining Walls (1996)

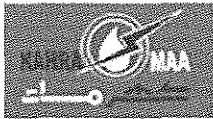
2. The Standards referred to in this Section of the Specification, together with any other references specified shall be the latest editions including all current amendments and additions. Any differences between their requirements and this Specification shall be submitted to the Employer's Representative for his ruling.

#### **2.10.1.4 SUBMITTALS**

1. Comply with pertinent provisions of QCS 2010.
2. Prior to starting work on the Contract, the Contractor shall submit for approval details of the proposed sources of all materials, and place of manufacture, together with full documentary evidence that the materials and manufacture will comply with the specification.
3. Further submissions shall be made for any change of material quality or source and the Employer's Representative approval obtained before the new materials or place of manufacture are used.
4. Piling Method and Programme



1. The Contractor shall submit a comprehensive Method Statement for the Works for review and approval by the Employer's Representative. It shall include: the QA/QC system to be used during the execution of the Works; all relevant details of the method of piling; and, the Plant proposed to be used. Any alternative method to that specified shall be subject to Employer's Representative approval and shall require additional testing at the Contractor's expense. Submittals shall be made in accordance with QCS 2010.
2. The Contractor shall submit to the Employer's Representative his proposed sequence and timing for boring piles, having regard to the avoidance of damage to adjacent piles.
3. The Contractor shall inform the Employer's Representative each day of the intended programmed of piling and shall give adequate notice of his intention to work outside normal hours and Public Holidays.
4. Any proposal by the Contractor for ground treatment of any nature or for temporary lowering of the water table by well pointing or any other method shall be subject to the approval of the Employer's Representative. The Contractor shall however remain fully responsible for any effects of such ground treatment or control of the level of water tables upon the existing roads, building and structures in the vicinity of the Works.
5. Dewatering of the Site to lower and maintain the ground water to below the formation level is the responsibility of the Contractor's Representative, ground water level will be maintained at a level shown on the Drawings during piling. If the water level is not maintained at the required levels contact the Contractor and Employer's Representative to investigate and provide action plan.
5. **Piling Records**
  1. The Contractor shall keep records as follows for the installation of each pile and shall submit two signed copies of these records to the Employer's Representative not later than noon of the next working day after the pile was installed. The signed records will form a record of the work.
  2. Any unexpected conditions shall be noted in the records or before forming shall be notified.
  3. The form of record shall be Approved by the Employer's Representative.
6. **Data to be recorded**
  1. Contract.
  2. Pile reference number.
  3. Pile type.
  4. Nominal cross-sectional dimensions or diameter of pile.
  5. Nominal diameter of under-ream/base.
  6. Standing groundwater level from direct observation and given Site investigation data.
  7. Date and time of boring.
  8. Date and time of concreting.
  9. Ground level expressed in terms of QNDH at pile position at commencement of installation of pile (commencing surface).



10. Working level expressed in terms of QNDH on which piling base machine stands.
11. Depth from ground level at pile position to pile toe.
12. Toe level expressed in terms of QNDH.
13. Pile head level as constructed expressed in terms of QNDH.
14. Pile Cut-off level expressed in terms of QNDH.
15. Length of temporary casing.
16. Length of permanent casing.
17. Soil samples taken and in-situ tests carried out during pile formation or adjacent to pile position and record of ground conditions along pile length.
18. Length and details of reinforcement.
19. Concrete mix.
20. Volume of concrete supplied to pile.
21. All information regarding obstruction delays and other interruptions to the sequence of work.
22. The coordinates of each pile installed.
23. Details of tremie pipe used to place concrete.
24. Details of Plant used to form pile including Plant reference number.
25. Verticality of bore.
26. Calliper logging.
27. Concrete records, slump, plot of actual v/s theoretical volumes etc.
28. Names of gangers, operators, etc.
29. Copy of the related Drawings.

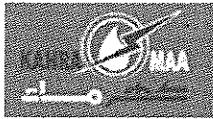
The Contractor shall report to the Employer's Representative the details of any piles that are installed out of tolerance not later than noon of the next working day and shall obtain the Employer's Representative approval for any remedial work that is required.

#### **2.10.1.5 QUALITY ASSURANCE**

- A. Material shall be obtained from suppliers operating quality systems in accordance with either ISO 9001 or an in-house system Approved by the Employer's Representative.

#### **2.10.1.6 SITE CONDITIONS**

- A. Factual information and reports on Site investigation for the Works will be provided to Tenderers. However, in the event that a full report is given, including interpretations, opinions or conclusions, no responsibility is accepted by the Client.
- B. The Contractor shall report immediately to the Employer's Representative any circumstances, which indicates that in the Contractor's opinion the ground conditions differ from those reported in or which could have been inferred from the Site investigation reports or trial pile results.



- C. The Contractor is to satisfy himself and confirm to the Employer's Representative that the soils data contain sufficient information for the execution of all work.
- D. Prior to commencing work, records of drains, cables, mains and other services shall be obtained and made by the Contractor to ensure that his Works will not cause damage to these services shall be Approved by the Employer's Representative.

#### **2.10.1.7 DELIVERY, STORAGE AND HANDLING**

- A. Materials shall be stored in a manner that will ensure preservation of their specified quality and fitness for the work. They shall be placed on hard, clean surfaces and, when required by the Employer's Representative they shall be placed under cover. Stored materials shall be located in such a manner to facilitate prompt inspection and control.

#### **2.10.2 PRODUCTS**

##### **2.10.2.1 SUMMARY**

- A. The materials for the manufacture of reinforced concrete shall be in accordance with Specification for clause 2.1 – Cast-in-Place Concrete.
- B. Temporary steel casings and permanent casings or liners shall be cylindrical, of the diameter indicated on the Drawings and shall be of sufficient strength to maintain shape and location during boring and placement of concrete. The casings shall be sufficiently watertight to exclude ground water during placing of concrete.
- C. Bentonite, as supplied to the Site and prior to mixing shall be in accordance with Engineering Equipment and Material Users Association - EEMUA 163 Drilling Fluid Materials.
- D. The sources of supply shall not be changed without prior approval of the Employer's Representative.
- E. Certificates relating to the quality of materials, showing the properties of each consignment delivered, shall be made available to the Employer's Representative at all times and copies shall be supplied to the Employer's Representative when requested.
- F. Rejected materials shall be removed promptly from the Site.

##### **2.10.2.2 TOLERANCES**

- A. Setting out of the main grid lines shall be carried out by the Contractor. The installation of piles at positions as required by the Employer's Representative shall be accurate to 75 mm as measured at cut-off level, in any direction. This tolerance shall ensure that pile heads are cast to a level above the specified cut-off so that, after trimming, a sound concrete connection with the pile can be made in accordance with the specified strength and durability characteristics as stated in Specification clause 2.1 – Cast-in-Place Concrete.
- B. At the commencement of installation, the equipment governing the alignment of the bored pile shall be made vertical to a tolerance of within 1 in 100. The maximum permitted deviation of the finished pile from the vertical is 1 in 75, as measured at cut off level.



- C. Forcible corrections to concrete piles to overcome errors of position or alignment shall not be made.

## **2.10.3 EXECUTION**

### **2.10.3.1 DAMAGE TO SERVICES AND STRUCTURES**

- A. If damage will be, or is likely to be, caused to mains, services or adjacent structures, the Contractor shall submit to the Employer's Representative his proposals for making surveys, monitoring movements or vibrations, and minimising or avoiding such damage.
- B. The Contractor shall carry out the work in such a manner and at such times so as to minimise noise and disturbance.

### **2.10.3.2 CONCRETE FOR PILES**

- A. Concrete for piles shall be as shown on the Drawings and shall be in accordance with Specification clause 2.1 – Cast-in-Place Concrete and the following requirements.
- B. The Contractor shall be responsible for selecting the mix proportions to achieve the required strength, workability, minimum cement content and any other properties required to ensure durability as specified in clause 2.1-Cast-in-Place Concrete.
- C. The Concrete shall have sufficient workability to enable it to be placed and compacted by the methods used in forming the piles.
- D. For piles exposed to potentially aggressive ground or groundwater, Employer's Representative Approved measures shall be taken to ensure durability. Reference should be made to Building Research Establishment Digest 360 relating to Sulphate Attack coupled with the CIRIA Special Publication 31, Guide to Concrete Construction in the Gulf Region, to Safeguard against Chloride Attack.
- E. All concrete aggregates, cement and water shall be sampled and tested as frequently as deemed necessary by the Employer's Representative as detailed under the relevant clauses in Specification clause 2.1 – Cast-in-Place Concrete. All test samples shall be supplied by the Contractor at his own expense.
- F. Trial mixes shall be prepared for concrete in accordance with Specification clause 2.1 – Cast-in-Place Concrete, showing that the proposed mix proportions will produce a concrete of the strength and quality required, having adequate workability for compaction by the method to be used in placing.
- G. The Contractor shall keep a detailed record summary of the results of all tests on concrete and concrete materials (strength and durability) and provide a statistical analysis that demonstrates the average, maximum, minimum and standard deviation of the results. Each test shall be clearly identified with the piles to which it relates and demonstrate that the sampling regime has been in accordance with the criteria set in Specification clause 2.1 - Cast-in-Place Concrete.

### **2.10.3.3 REINFORCEMENT FOR PILES**

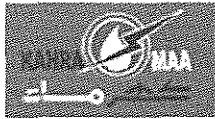
- A. The reinforcement for the piles shall conform to the requirements of Specification clause 2.1 - Cast-in-Place Concrete.



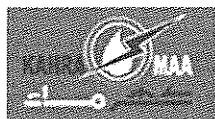
- B. Reinforcement in the form of a cage shall be assembled with additional support necessary to form a cage, which must be lifted and placed without permanent distortion. Inner support links shall not be placed within 750 mm of the pile cut-off level, or where the density of reinforcement is so high as to possibly result in the poor flow of concrete. Intersecting bars shall be fixed together by Approved means. Hoops, links or helical reinforcement shall fit closely around the main longitudinal bars and be bound to them by an Employers Representative Approved wire, the ends of which shall be turned into the interior of the pile. Alternate methods of cage fabrication will be considered. Reinforcement shall be placed and maintained in position to provide the specified projection of reinforcement above the final cut-off level.
- C. The cover to all reinforcement in cast-in-place piles shall be not less than 75mm unless otherwise Approved or proposed by the Employer's Representative. Spacers shall be designed and manufactured using durable materials and fixed to the reinforcement cage at not more than 1.5m centre to centre spacing with the number per level being dependant on the pile diameter, but less than 3m, in order to ensure that corrosion of the reinforcement or spalling of the concrete cover does not occur.  
  
Clip on spacers will not be considered acceptable on their own. The spacer (Approved by the Employer's Representative) is to be tied to the main bar using either tie wire or zip ties.  
  
Where concrete spacers are to be used, the Contractor is to provide test results demonstrating that the spacer is formed from equivalent strength concrete as is to be used for the pile construction.
- D. The number of laps in longitudinal steel bars shall be kept to a minimum. Joints in reinforcement shall be such that the full strength of the smaller of the bars being lapped is effective across the joint and shall be made so that there is no detrimental displacement of the reinforcement during the construction of the pile.  
  
Mechanical couplers will be considered on the basis of satisfactory test results Approved by the Employer's Representative.
- E. Reinforcement cages shall be placed under their own weight and not by the application of force. The means of inserting the reinforcement cages shall not cause buckling or lateral displacement of the cages, and shall be to the approval of the Employer's Representative.
- F. Welded joints and joint welding procedures shall be in accordance with BS EN1011, ASTM A706 and QCS 2010. Any structural welds are to be undertaken by persons carrying current, accredited welder's certificates only.

#### **2.10.3.4 BORING FOR PILES**

- A. Prior to boring the Contractor shall check the casing position for each pile during and immediately after placing the casing, and agree it with the Employer's Representative. All piles shall be constructed having the pile diameter not less than the minimum specified diameter.
- B. The Contractor shall ensure that the bore remains stable at all times. Temporary casing, bentonite suspension or alternate drilling medium may be used to support the wall of the bore prior to concreting.
- C. Piles shall not be bored so close to other piles which have been cast within 24 hrs and which contain workable or unset concrete that a flow of concrete could be



- induced from or damage caused to any of the piles. This may be maintained by adopting a minimum centre to centre distance of 3 times the larger pile diameter.
- D. The Contractor shall carry out the work in such a manner and at such times as to minimise noise and disturbance.
  - E. Any proposals by the Contractor for underpinning, needling, shoring or similar works in the vicinity of the Works shall be carefully designed by the Contractor and be subject to the review by the Employer's Representative and accepted as decreed necessary.
  - F. Temporary casings shall be clean and free from significant distortion. They shall be of uniform cross-section throughout each continuous length. They shall be free from internal projections and encrusted concrete, which might adversely affect the proper formation of piles.
  - G. Where piles are bored under water or drilling medium in an unlined state, the insertion of a full-length loosely fitting casing to the bottom of the bore prior to placing concrete will not be permitted.
  - H. Where boring takes place through unstable water-bearing strata, the process of excavation (refer to clause 2.9 - Earthworks Specification) and the depth of temporary casing employed shall be such that soil from outside the area of the pile is not drawn into the pile section and cavities are not created outside the temporary casing as it is advanced.
  - I. Stability of Bore
    - 1. Where the use of drilling fluid is Approved for maintaining the stability of a bore by the Employer's Representative, an adequate temporary casing shall be used in conjunction with the method so as to ensure stability of the strata near ground level until concrete has been placed. During construction the level of drilling fluid in the pile excavation shall be maintained within the cased or stable bore so that it is not less than 1.0m above the level of external standing groundwater at all times.
    - 2. In the event of rapid loss of drilling fluid from a pile excavation, the bore shall be backfilled without delay and the instruction of the Employer's Representative shall be obtained before boring at that location is resumed.
    - 3. Approval of the Employer's Representative shall be obtained before water is used to assist boring.
    - 4. Adequate precautions shall be taken at all times to prevent surface water or groundwater seepage entering the pile bore.
  - J. Pumping from pile bores shall not be permitted unless the bore has been sealed against further water entry by casing or unless the soil is stable and will allow pumping to take place without ground disturbance below or around the pile.
  - K. Piles shall be bored and concrete shall be placed without such delay as would lead to significant impairment of the soil strength. No unlined bores shall be left un-concreted for periods in excess of 24 hours from the commencement of drilling operations.
  - L. Each pile bore which does not contain standing water or drilling fluid shall be inspected directly or indirectly prior to concrete being placed in it. This inspection shall be carried out from the ground surface in the case of piles of less than 750mm diameter. Torches or other Approved means of lighting, measuring tapes, and means of measuring verticality shall be provided by the Contractor. For piles of 750mm diameter or larger, equipment shall, if instructed by the Employer's



Representative, be provided by the Contractor to enable him and the Employer's Representative to descend into the bore for the purpose of inspection. Any method of descent and the equipment used shall comply with the requirements of BS 8008.

- M. If bentonite is used as a drilling fluid, the Contractor shall submit proposals to the Employer's Representative for minimising the effects of the potential bentonite "cake" on the concrete/soil interface, for example, by scoring the face of the pile while with Drawing the auger.
- N. On completion of boring, the Contractor shall remove loose disturbed or softened soil from the bore. Where pile bores contain water or drilling fluid, a cleaning process shall be employed before concrete is placed. Large debris or accumulated sediment shall be removed using appropriate Approved methods, which shall be designed to clean while at the same time minimising ground disturbance below the pile bases. Water or drilling fluid shall be maintained at such levels, throughout and following the cleaning operation, that stability of the bore is preserved.

#### **2.10.3.5 DRILLING FLUID**

- A. Bentonite, as supplied to the Site and prior to mixing, shall be in accordance with Specification Engineering Equipment and Material Users Association - EEMUA 163 Drilling Fluid Materials. Alternate drilling fluids will be considered subject to Employer's Representative approval.
- B. A certificate shall be obtained by the Contractor from the manufacturer of the bentonite powder or drilling medium, showing the properties of each consignment delivered to the Site. This Certificate shall be made available and Approved by the Employer's Representative.
- C. Bentonite shall be mixed thoroughly with clean fresh water to make a suspension, which will maintain the stability of the pile bore for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the bentonite suspension, and of the suspension when supplied to the borehole, shall be not lower than 5 °C.
- D. Where saline or chemically contaminated groundwater occurs, special precautions shall be taken to modify the bentonite suspension or prehydrate the bentonite in fresh water so as to render it suitable in all respects for the construction of piles.
- E. The frequency of testing of the drilling fluid and the method and procedure of sampling shall be proposed by the Contractor for approval of the Employer's Representative prior to the commencement of the work. The frequency may subsequently be varied as required, depending on the consistency of the results obtained, subject to Employer's Representative approval.
- F. Control tests shall be carried out on the bentonite suspension, using suitable apparatus. The density of freshly mixed bentonite suspension shall be measured daily as a check on the quality of suspension being formed. The measuring device shall be calibrated to read to within 5g/L. Tests to determine viscosity, gel strength, density, sand content, fluid loss and pH value shall be carried out on bentonite supplied to the pile bore during drilling and from the pile bore immediately prior to concreting. The results of these tests shall comply with Table

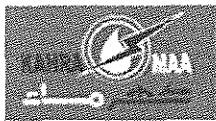


Property	Method	Supplied to Pile Bore During Drilling		Sampled immediately from Pile Bore Prior to concreting
Bentonite Content	-	4-5%	5-8%	4% min
Plastic viscosity	Fann Viscometer*	3-10	7-20	20 max
10 min gel strength (Pa)	Fann Viscometer*	2-20	10-40	7.5 – 40
Density (g/ml)	Mud balance	1.02-1.07	1.03-1.10	1.02-1.10
API sand content (% vol)	API test	3 max	3 max	6 max
Fluid loss in 30 min (ml)	API Test	40 max	40 max	60 max
pH	PH meter or indicator strips	8 - 11	8 - 11	8 - 11

\*Note: Where the Fann Viscometer is specified, the fluid sample should be screened by a number 52 sieve (300  $\mu\text{m}$ ) prior to testing.

**Table 1: Bentonite Tests**

- G. The tests shall be carried out until consistent working pattern has been established, account being taken of the mixing process, any blending of freshly mixed bentonite suspension and previously used bentonite suspension, and any process which may be used to removed impurities from previously used bentonite suspension. Tests being undertaken at the start of the day on the bentonite to be used and then during construction of each pile with 1 number suit of tests during boring then a final set post flushing. When the results show consistent behaviour, the tests for gel strength and pH value may be discontinued, and tests to determine density and viscosity shall be carried out as agreed with the Employer's Representative. In the event of a change in the established working pattern, tests for gel strength and pH value shall be reintroduced for a period if required.
- H. The movement of drilling tools up and down the pile bore produces local suction piston effects, by-pass currents, and variations in the level of the bentonite suspension due to the displacement volume of the drilling tool and Kelly bar. These effects may create scouring and over break of the excavation and the Contractor shall control the lifting speed of the drilling equipment to ensure that no adverse effects occur.
- I. All reasonable steps shall be taken to prevent the spillage of bentonite suspension, either clean or contaminated, onto the ground of the Site. Discarded bentonite shall be removed from the Site without undue delay. Any disposal of the bentonite shall comply with the regulations provided in the QCS 2010. Under no circumstances shall any suspension be allowed to discharge into any drainage system.



#### **2.10.3.6 PLACING CONCRETE**

- A. The method of placing and workability of the concrete shall be such that a continuous monolithic concrete shaft of the full cross-section is formed.
- B. The concrete shall be placed without such interruption as would allow the previously placed batch to have hardened. The method of placing shall be subject to the approval of the Employer's Representative.
- C. The Contractor shall take all precautions in the design of the mix and placing of concrete to avoid arching of the concrete in temporary casing. No soil, liquid or other foreign matter which would adversely affect the performance of the piles shall be permitted to contaminate the concrete.
- D. The concrete shall be of the workability Approved under cl. 3.2.2 when in its final position and shall remain sufficiently workable for all pile construction procedures to be safely completed.
- E. Internal vibrators may be used to compact concrete, with the approval of the Employer's Representative obtained in advance for each specific use.
- F. Before placing concrete in dry borings, Approved measures shall be taken to ensure that the structural strength of concrete placed in all piles is not impaired through grout loss, segregation or bleeding. Concrete shall be directed vertically into the centre of each vertical pile so that grout is not lost from the initial discharge. Concrete shall be placed using a full-length chute or tremie, which is first lubricated with grout.
- G. Before placing concrete under water or drilling fluid, measures shall be taken to ensure that there is no accumulation of silt or other material at the base of the boring, and the Contractor shall ensure that heavily contaminated bentonite suspension, which could impair the free flow of concrete from the tremie pipe, has not accumulated in the bottom of the hole.
- H. Concrete to be placed under water or drilling fluid shall be placed by tremie attached to a concrete pump and shall not be discharged freely into the water or drilling fluid.
- I. A sample of the bentonite suspension shall be taken from the base of the boring just prior to concreting, using an Approved sampling device. If the properties of the suspension are not within the values in Table 1 then the placing of concrete shall not proceed. In this event the Contractor shall modify or replace the bentonite to meet this Specification.
- J. The concrete shall be a rich coherent mix of high workability and shall be placed in such a manner that segregation does not occur.
- K. The concrete shall be placed by means of a concrete pump attached to a tremie pipe. The pipe of the tremie shall be clean and watertight throughout. The pipe shall extend to the base of the bore and a sliding plug or barrier shall be placed in the pipe to prevent direct contact between the first charge of concrete in the tremie and the water or drilling fluid. The pipe shall at all times penetrate the concrete by a minimum of 3m, which has previously been placed and shall not be withdrawn from the concrete until completion of concreting. A sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from it exceeds that from the water drilling fluid. The internal diameter of the pipe of the tremie shall be not less than 150 mm for concrete made with 20mm aggregate. It shall be so designed that external projections are minimised, allowing the tremie to pass within reinforcing cages without causing damage. The internal face of the pipe of the tremie shall be free from projections.



- L. Piles shall be concreted as soon as practicable after completion of drilling, cleaning of pile shaft and base, and recycling of drilling fluids as required in accordance with Specification clause 2.1 – Cast-in place concrete. Excavations left open for more than 12 hours may need to be re-cleaned and have the bentonite recycled to the satisfaction of the Employer's Representative.
- M. Pile bores left open for more than 24 hours from commencement of drilling operations will not be acceptable for incorporation into the Works. Approved replacement piles shall be constructed at the Contractor's expense.

#### **2.10.3.7 EXTRATION OF CASING**

- A. Temporary casings shall be extracted while the concrete within them remains sufficiently workable to ensure that the concrete is not lifted. During extraction the motion of the casing shall be maintained in an axial direction relative to the pile.
- B. When the casing is being extracted, a sufficient quantity of concrete shall be maintained within it to ensure that pressure from external water, drilling fluid or soil is exceeded and that the pile is neither reduced in section nor contaminated.
- C. The concrete level within a temporary casing shall be topped up where necessary during the course of casing extraction in such a way that the base of the casing is always below the concrete surface until the casting of the pile has been completed.
- D. Adequate precautions shall be taken in all cases where excess heads of water or drilling fluid could occur as the casing is withdrawn because of the displacement of water or fluid by the concrete as it flows into its final position against the walls of the pile bore. Where two or more discontinuous lengths of casing (double casing) are used in the construction the proposed method of working shall be Approved by the Employer's Representative.

For piles cast in dry bores using temporary casing and without the use of a permanent lining, pile heads shall be cast to a level above the specified cut-off so that, after trimming, a sound concrete connection with the pile can be made in accordance with the specified strength and durability characteristics.

For piles cast in dry bores within the permanent lining tubes or permanent casings, or where their cut-off levels are in stable ground below the base of any casing used, pile heads shall be cast to a level above the specified cut-off so that, after trimming, a sound concrete connection with the pile can be made in accordance with the specified strength and durability characteristics.

For piles cast under water or drilling fluid, the pile heads shall be cast to a level above the specified cut-off so that, after trimming to remove all debris and contaminated concrete, a sound concrete connection with the pile can be made in accordance with the specified strength and durability characteristics. Cut-off levels may be specified below the standing groundwater level, and where this condition applies the borehole fluid level shall not be reduced below the standing groundwater level until the concrete has set. No pile shall be cast with its head below standing water level unless Approved measures are taken to prevent inflow of water causing segregation of the concrete as temporary casing is extracted; and where applicable, the standing water level for each pile shall be agreed with the Employer's Representative, and this level is to be treated as the cut-off level for the purpose of calculating casting level.

- E. During extraction of temporary casings, where circumstances are such that newly placed unset concrete is brought into contact with external groundwater,



precautions shall be taken to ensure that the internal concrete pressure at all levels within the pile exceeds the external groundwater pressure.

- F. Excavation around temporary casing to assist in their extraction will not be permitted.

#### **2.10.3.8 TEMPORARY BACKFILLING**

- A. Excavation around temporary lining tubes to assist in their extraction will not be permitted. After each pile has been cast, any empty bore remaining shall be protected and shall be carefully backfilled as soon as possible with Approved materials.

#### **2.10.3.9 DISPOSAL OF EXCAVATED MATERIAL**

- A. Disposal of excavated material shall be carried out by the Contractor as necessary to facilitate the Works and to the satisfaction of the Employer's Representative.

#### **2.10.3.10 CUTTING OFF PILE HEADS**

- A. When cutting off and trimming piles to the specified cut-off level, the Contractor shall take care to avoid shattering or otherwise damaging the permanent section of the pile. Any cracked or defective concrete shall be cut away and the pile repaired in an Approved manner to provide a full and sound section at the cut-off level.

#### **2.10.3.11 FIELD QUALITY CONTROL**

Refer to the following:

1. 2.10.4 for field-testing of working piles.
2. 2.10.5 for preliminary pile testing.
3. 2.10.6 for dynamic pile testing.

#### **2.10.3.12 RECTIFICATION OF FAILURE**

- A. The action to be taken in the event of a pile being defective shall be determined by the Employer's Representative. This may range from qualified acceptance to rejection and removal of all or part of the affected Works. Should removal be impractical, then the Employer's Representative shall order the replacement of defective piles with new piles in positions to be advised by the Employer's Representative.
- B. The Contractor shall advise the Employer's Representative of any defective piles. Defective piles shall include, but are not limited to, those piles which:
1. Contain materials, which are not in accordance with Specification clause 2.1 - Cast-in-Place Concrete.
  2. Fail a load test – typically a pile will be deemed to have failed a load test if total head settlements/deflections are in excess of 20mm when tested to 150% of the safe working load. However final acceptance of the performance of the test shall be to the approval and satisfaction of the Employer's Representative who will confirm as to whether the load test has passed or failed.



3. Fail an integrity test or cross hole sonic test.
  4. Are not constructed in accordance with this Specification.
  5. Are not constructed in accordance with the Approved method statement, for example, practices which could lead to the formation of a bentonite "cake" on the concrete/soil interface.
  6. As determined by the Employer's Representative.
- C. Should piles be defective, then the Employer's Representative may instruct the following:
1. A change in the Contractor's method of piling and/or Plant used to manufacture the piles.
  2. Additional pile testing including static load tests.
  3. Removal of all or part of the affected work.
  4. Installation of additional piles.
  5. Additional structural works to overcome the deficiency.
- D. The cost of all additional work under the above clauses due to faulty materials, installation or workmanship, including the installation of new piles and associated structural modifications, shall be at the Contractor's expense.

#### **2.10.3.13 CLEARANCE OF WORKS**

- A. Upon the completion of the Works the Contractor shall clear away and remove from the Site all constructional Plant, equipment, surplus materials, rubbish, etc. and leave the whole of the Site and Works clean and in a good condition to the satisfaction of the Employer's Representative.

#### **2.10.4 WORKING PILE TESTING AND ACCEPTANCE CRITERIA**

##### **2.10.4.1 BENTONITE**

- A. Sampling and testing of bentonite shall be carried out in accordance with Subsection, Drilling Fluid.

##### **2.10.4.2 CONCRETE**

- A. Sampling and testing of concrete shall be carried out in accordance with Subsection, Concrete for Piles.

##### **2.10.4.3 CALLIPER LOGGING OF PILE BORE**

- A. Calliper logging of the entire length shall be carried out on piles as detailed below prior to concreting:
  1. 30 % of the main structural piles under the building;
  2. 15% of piles under the Thermal Energy Storage (TES) Tank area;
  3. Minimum of 1 per rig per week for piles under the Building and TES Tank area.



A mechanical calliper having a minimum of three arms shall be used to carry out the logging in accordance with ASTM. The caliper to be used shall be calibrated not more than 3 months prior to its use for this project and shall have a resolution not less than 2mm of the measured bore diameter.

The equipment used must be able to present results in real time on the Site.

- B. The Contractor shall submit a draft hard copy of the log to the Employer's Representative within 24 hours of the measurement having taken place.
- C. The bore shall be considered unacceptable if any part of the pile bore has a diameter less than the minimum specified diameter of the pile.

#### **2.10.4.4 PILE INTEGRITY TEST**

- A. Non-destructive pile Integrity testing shall be carried out on every pile constructed. The Contractor shall engage an independent, experienced Subcontractor Approved by the Employer for this testing. Sonic integrity testing and interpretation is to be carried out in accordance with Section 9.1 of the Institution of Civil Engineers' - Specification for Piling and Embedded Retaining Walls (1996) and CIRIA Report CP28 - The role of integrity and other non-destructive testing in the evaluation of piled foundations.
- B. All piles shall be tested by the sonic echo method. The age of the piles shall be not less than seven days at the time of testing.

In addition, cross-hole sonic logging shall be carried out on a minimum of 15% of the total number of piles, with a minimum of 50% of the building piles being tested. The age of the piles should not be less than seven days at the time of testing. The piles to be tested shall be to the approval of the Employer's Representative. Upon satisfactory receipt of results the sonic tubes are to be backfilled with an equivalent strength grout to that of the concrete.

- C. The Contractor shall submit to the Employer's Representative the preliminary result of each test with an initial assessment of the pile integrity within 24 hours of the testing. Final test results and interpretation of the pile integrity shall be submitted to the Employer's Representative within 7 days of the completion of each phase of testing.

#### **2.10.4.5 STATIC LOAD TESTS**

- A. Testing Standards
  - 1. Unless otherwise specified, pile load testing is to be carried out in accordance with ASTM D1143 for compression piles.
  - 2. Alternative Procedures: This Specification calls for conventional static load tests using Kentledge blocks, reaction piles and/or ground anchors. The Contractor's Representative may consider alternative procedures for this part of the works but it is essential that the testing system nominated by the Contractor does not interfere with adjacent piles or subsequent works and provides direct measurements of the pile head settlements and deflections.

Load tests in excess of 20,000 kN will generally not be permitted to be undertaken using Kentledge. For load tests exceeding 20,000 kN, the Contractor can consider using steel plates or ground anchors as the reaction



load or adopting other alternative method of testing like bi-directional load test. Prior approval from the Employer's Representative shall be required before adopting any alternative load test methods.

**B. Testing**

1. Scope of Works: The Contractor is to statically test a minimum of 1% of all the working piles.

The distribution of tests shall be determined by the Employer's Representative on Site, post construction of the piles, and shall include the following:

- a. no. of Tension pile, and
- b. 1 no. of Compression pile.

The Contractor will allow a provisional sum for 4 further piles to be tested in either compression or tension.

Any pile undergoing static load testing shall be included as part of the cross-hole sonic testing regime. The sonic tubes are to be grouted upon completion of testing with an equivalent strength grout to that of the concrete, to the approval of the Employer's Representative.

2. Additional pile lengths shall be provided above the ground level to suit the Contractor's testing arrangement.

The Contractor shall take all reasonable steps to negate the effects of skin friction between the formation and pile cut-off level to the satisfaction and approval of the Employer's Representative.

3. A.5.2.3 Compression and Tension test piles are to be instrumented by dial gauges and displacement transducers at the pile head and remote survey techniques.

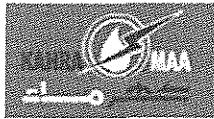
All working static test piles are to undergo calliper logging.

4. The Contractor shall be responsible for:

- a. Supply and installation of all instrumentation and test equipment.
- b. Conducting the tests with all monitoring specified.
- c. Preparation and submission of a complete test report to the approval of the Employer's Representative, the number of submissions being in accordance with the General Terms and Conditions of Contract.

5. Load Increments: Maintained Loading Tests (MLT): The load shall be sustained at a constant magnitude until the rate of movement of the pile head is less than the lesser of:

- a. 0.25mm per 10 minutes.
- b. 1 percent of the total pile movement per 10 minutes.



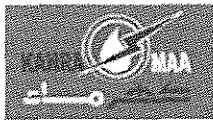
- c. 0.25mm per hour measured over 1 hour at the peak load of each cycle
- 6. The peak load shall not be maintained for more than 12 hours.
- 7. The following loading sequence is to be adopted for compression and tension tests:

<b>Percentage of Serviceability Load (%)</b>	<b>Minimum Holding Time</b>
25	10 min
50	10 min
75	10 min
100	6 hrs
50	10 min
25	10 min
0	1 hr
25	10 min
50	10 min
100	10 min
125	10 min
150	2 hr
100	10 min
50	10 min
0	1 hr

- 8. Instrumentation: Each test pile is to be provided with the following instrumentation as a minimum:

<b>Type of Instrumentation</b>	<b>Location</b>	<b>No. of Gauges</b>	<b>Deployment of Gauges</b>
Displacement transducers & Dial Gauges	Pile head	4	60° apart

- 9. The test rig and reaction piles also need to be instrumented to check their effect on the measured settlement of the test pile to the satisfaction of the Employer's Representative.



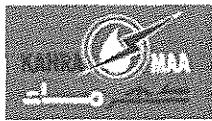
10. An integrated, computerized monitoring system, to the approval of the Employer's Representative, shall be used to show (in real time) and record the readings from the displacement transducers and load cells.

**C. Reaction System (For Conventional Static Pile Load Tests)**

1. The reaction system shall be such that:
  - a. Its safe working load is not less than the maximum required load specified in Clause A.5.2.7.
  - b. The resultant applied force is coaxial with the test pile.
  - c. If anchor piles are used, these shall be designed as follows:
    - i. With a geotechnical factor of safety of not less than 2.0 on ultimate pullout.
    - ii. For structural capacity with a factor of safety of not less than 1.5 on tension reinforcement.
    - iii. The resultant applied force is coaxial with the test pile.
2. Anchorages: Where ground anchors are used to provide a test reaction, no part of the anchor bond length shall be closer to the test pile than three times the shaft diameter of the test pile.
3. Kentledge: Where kentledge is used to provide a test reaction:
  - a. It shall be supported on cribwork disposed around the pile head.
  - b. The bearing pressure under the supporting cribs shall be such as to ensure the stability of the kentledge stack.
  - c. The distance from the centre of the test pile to the nearest part of the supporting cribwork shall be not less than 4.5m.
4. Reaction Piles: Where reaction piles are used to provide a test reaction, the centre-to-centre spacing between vertical reaction piles and the test pile shall be not less than 4.5m.

**D. Equipment for Loading and Load measurement (Conventional Static Pile Load Tests)**

1. Equipment for applying the test load shall:
  - a. Be arranged in conjunction with the reaction system to deliver the loads to the appropriate axis of the test pile.
  - b. Have a load capacity not less than the maximum required load specified in Clause A.5.2.7.
  - c. Be capable of accommodating a maximum pile movement of 75mm plus the displacement of the reaction system that occurs during loading.



- d. Be capable of applying a smooth increase or decrease of load and maintenance of the specified load increments in a stable manner.
2. Bearing Plate: A steel bearing plate shall be provided and shall be:
  1. Firmly bedded onto the top of the pile or pile cap.
  2. At right angles to the pile axis.
  3. Of sufficient strength to distribute the test load onto the head of the pile.
3. Load Measurement: The test load shall be measured through the use of load cells. The use of a dial gauge attached to the pump on its own will not be considered acceptable. The load-measuring device shall be:
  - a. Accurate to within 2 percent of the indicated load and of stable construction.
  - b. Calibrated prior to commencement of the test.
  - c. Re-calibrated when deemed appropriate by the Employer's Representative.

**E. Measurement of Pile Movement**

1. The movement at the pile head shall be measured to an accuracy of 0.05mm. The measurement apparatus used shall be capable of detecting a rate of pile-head movement of 0.1mm per 20 minute sufficient measurements shall be made to determine whether the pile head tilts under the test load.
2. Level and Staff (or Fixed Scales): A level and staff (or fixed scales) are to be used:
  - a. A reference datum shall be established on a permanent object or other well-founded structure or deep datum point situated so that only one setting up of the level is required.
  - b. The datum referred to in (1) shall be so located that it is not affected by either the test loading or other Site operations.
3. Reference Wires: Where reference wires are used they shall:
  - a. Be held under constant tension.
  - b. Be supported from points at a distance not less than 4.5m from the test pile and any part of the reaction system.
  - c. Pass across the faces of mirror-backed scales attached to the pile head.
4. Reference Beams: Where reference beams are used they shall:
  - a. Be simply supported.



- b. Either be supported from points at a distance not less than 4.5m from the test pile or any part of the reaction system or be checked for movement by levelling at appropriate times during the test.

#### **F. Test Procedures**

1. **Supervision:** The installation of the entire testing system, testing and monitoring, are to be carried out under the full-time supervision of the Contractor's Representative experienced in pile installation and testing.
2. **Delay between Installation and Testing:** Load testing of piles shall not commence until the strengths of materials in the pile and pile cap are adequate to sustain the maximum required test load specified in Clause A.5.2.7.
3. **A.5.6.3 Load Application:** Upon loading of each test pile to the maximum test load in accordance with Clause A.5.2.7 the load shall be removed smoothly and the residual settlement recorded.

The Contractor is to ensure that a constant load is maintained at any given load increment through the use of an electrical pressure gauge linked directly to the compressor. Manual means of ensuring a constant load as indicated on the load cells will not be considered acceptable.

4. **A.5.6.4 Recording during Loading Stages:** For Maintained Loading Tests (MLT), the load, settlement and time shall be recorded immediately upon reaching the load increment and at 10 minutes intervals for the period specified in Clause A5.2.5 to A5.2.7. Should it not be possible to achieve the load increment, readings should be taken as directed by the Employer's Representative.

#### **G. Reports**

Reports on the pile load tests shall be prepared and submitted to the Employer's Representative for approval. The reports shall include the following:

1. **Pile Construction and Installation:** This section of the report shall include piling records as described in Subsection, Submittals, of this Specification.
2. **Test Layout and Equipment:** This section of the report shall include the following:
  - a. Sketches and photographs showing: location and size of reaction and loading equipment, deflection measuring equipment, test pile and cap and position of reference level marks.
  - b. An assessment of the accuracy of the deflection measurement with particular reference to the movement of the supports of reference beams and wires due to variations in loading or temperature.
  - c. The results of calibrations of the load measuring apparatus.
3. **Test Procedure and Results:** This section of the report shall include the following for axial load tests:



- a. A tabulation of the readings during loading and unloading of the pile, together with relevant times. It shall be clearly indicated whether the results are uncorrected readings or readings after corrections for calibration, movement of datum points and other influences.
- b. A graphic representation of the test results in the form of either a load-settlement curve or a time settlement curve if sustained loading increments are made.
- c. An assessment of the effect of the reaction system on the deflections; and the ultimate bearing capacity, where appropriate.

**H. Information to be supplied**

1. **Tender Information:** The tenderer shall submit the following information with this tender:
  - a. Relevant experience.
  - b. Pile construction procedure, reinforcement and concrete strength.
  - c. Pile load reaction system to be adopted.
  - d. Details of instrumentation to be used.
  - e. Full details of any non-conformance and alternatives proposed.
  - f. Proforma test records.
  - g. Typical report showing how the information to be provided would be presented.
  - h. Name and CV of full-time supervising engineer for the testing.
2. **Quality Plan:** The successful tenderer(s) will be required to submit a quality plan for the testing regime for the Employer's Representative approval within 2 weeks of the instruction to proceed.

**I. Failure Criteria**

1. Typically a pile will be deemed to have failed a load test if total head settlements/deflections are in excess of 20mm when tested to 150% of the safe working load. However final acceptance of the performance of the test shall be to the approval and satisfaction of the Employer's Representative who will provide confirmation as to whether the load test has passed or failed.

## **2.10.5 PRELIMINARY PILE TESTING AND ACCEPTANCE CRITERIA**

### **2.10.5.1 BENTONITE**

- A. Sample and testing of bentonite shall be carried out in accordance with Subsection – Drilling Fluid.



#### **2.10.5.2 CONCRETE**

- A. Sampling and testing of concrete shall be carried out in accordance with Subsection – Concrete for Piles.

#### **2.10.5.3 CALLIPER LOGGING OF PILE BORE**

- A. Calliper logging of the entire length shall be carried out for all of the preliminary test piles prior to concreting. A mechanical calliper having a minimum of three arms shall be used to carry out the logging in accordance with ASTM D6167. The calliper to be used shall be calibrated not more than 3 months prior to its use for this project and shall have a resolution not less than 2mm of the measured bore diameter.
- B. The Contractor shall submit a hard copy of the log alongside a copy of the calibration certificate to the Employer's Representative within 24 hours of the measurement having taking place.
- C. The bore shall be considered unacceptable if any part of the pile bore has a diameter less than the specified diameter of the pile.

#### **2.10.5.4 PILE INTEGRITY TESTING**

- A. Non-destructive Integrity testing shall be carried out on every preliminary test pile constructed, prior to and post undertaking the load test. Where dynamic load testing is to be undertaken on a pile prior to static load testing an integrity test is to be carried out on that pile before and after the dynamic load test, and then a further one after the pile has been statically loaded. The Contractor shall engage an independent, experienced Contractor Representative for this testing. Sonic integrity testing and interpretation is to be carried out in accordance with Section 9.1 of the Institution of Civil Engineers' - Specification for Piling and Embedded Retaining Walls (1996) and CIRIA Report CP28 - The role of integrity and other non-destructive testing in the evaluation of piled foundations.
- B. All piles shall be tested by the sonic echo method. The age of the piles shall be not less than seven days at the time of testing.

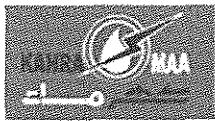
In addition, cross-hole sonic logging shall be carried out on all test piles. The age of the piles should not be less than seven days at the time of testing.

Upon satisfactory receipt of results and approval from the Employer's Representative, the sonic tubes are to be backfilled with an equivalent strength grout to that of the concrete.

- C. The Contractor shall submit to the Employer's Representative the preliminary result of each test with a preliminary assessment of the pile integrity within 24 hours of the testing. Final test results and interpretation of the pile integrity shall be submitted to the Employer's Representative within 7 days of the completion of each test.

#### **2.10.5.5 STATIC LOAD TESTS**

- A. Executive Summary



The intent of this portion of the piling package is to derive skin friction values for discrete stratigraphic layers over the pile socket length for input into final foundation design.

For the preliminary pile testing regime the Contractor is to allow for all works being undertaken from the current ground level due to program constraints.

**1. Testing Standards**

- a. Unless otherwise specified, pile load testing is to be carried out in accordance with ASTM D1143 for compression piles.
- b. Alternative Procedures: This Specification calls for conventional static load tests using reaction piles and/or ground anchors. The Employer's Representative will consider alternative procedures for this part of the works for the compression tests only, it is essential that the testing system nominated by the Contractor does not interfere with adjacent piles or subsequent works. When considering an appropriate testing methodology the Contractor's proposal should make allowance for negating the effects of skin friction from the current ground level up to the intended pile cut-off level.

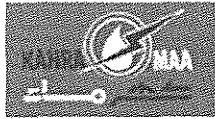
**2. Testing**

**a. Scope of Works:**

The Contractor is to statically test the capacity of preliminary piles (compression and tension) not to exceed the minimum load requirement to achieve geotechnical failure. The minimum load capacity of the piles shall be confirmed by the Geotechnical Engineer.

The Contractor will allow a provisional sum for 2 further piles to be tested in compression or tension similar to the above piles. These are to be dependent upon the outcome of the tests undertaken and as directed by the Employer's Representative.

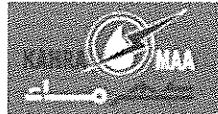
- b. Additional pile lengths shall be provided above the ground level to suit the Contractor's testing arrangement. The Contractor shall take all reasonable steps to negate the effects of skin friction between formation and pile cut-off level to the satisfaction and approval of the Employer's Representative.
- c. Compression test piles are to be instrumented by dial gauges and displacement transducers at the pile head and remote survey techniques. All test piles are also to be instrumented with strain gauges as described in clause B.5.2.8 below.
- d. The Contractor shall be responsible for:
  - i. Supply and installation of all instrumentation and test equipment.
  - ii. Conducting the tests with all monitoring specified.
  - iii. Preparation and submission of five copies of a test report.
- e. Load Increments: Maintained Loading Tests (MLT) - For compression and tension tests, the load shall be sustained at a constant magnitude until the rate of movement of the pile head is less than the lesser of:
  - i. 0.25mm per 10 min, and
  - ii. 1 percent of the total pile movement per 10 min.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

- iii. 0.25mm per hour measured over 1 hour at the peak load of each cycle.
- f. B.5.2.6 The peak load shall not be maintained for more than 12 hours.
- g. B.5.2.7 The following loading sequence is to be adopted for compression and tension tests:

<b>Percentage of Serviceability Load</b>	<b>Minimum Holding Time</b>
25	10min
50	10min
75	10min
100	6hr
50	10min
0	1hr
50	10min
100	10min
125	10min
150	2hr
100	10min
50	10min
0	1hr
50	10 min
100	10 min
150	10min
175	10min
200	1hr
150	10min
100	10min
50	10min
0	1hr
50	10 min
100	10 min
150	10 min
200	10min
225	10min
250	1hr
200	10min
150	10min



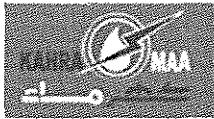
Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSSs  
(Packages A, B, C, D & E)

100	10min
50	10min
0	1hr
50	10 min
100	10 min
150	10 min
200	10min
250	10min
275	10min
300	2hr
200	10min
150	10min
100	10min
50	10min
0	1hr

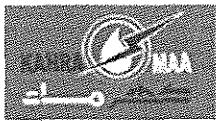
Cyclical loading elements may be added as required at and around 100% of the working load.

- h. Instrumentation: Each preliminary test pile is to be provided with the following instrumentation as a minimum:

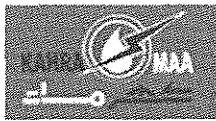
Type of Instrumentation	Typical Location	No. of Gauges	Deployment of Gauges
Displacement transducers and dial gauges	Pile head	4	60° apart
Strain gauge array 1	Pile head	3	120° apart
Strain gauge array 2	Cut Off Level	3	120° apart
Strain gauge array 3	One-third depth	3	120° apart
Strain gauge array 3	Two-thirds depth	3	120° apart
Strain gauge array 4	500mm above pile base	3	120° apart



- i. The test rig and reaction piles also need to be instrumented to check their effect on the measured settlement of test pile. Strain gauges should be accurate to within a tolerance of  $1 \mu$  strain.
  - j. An integrated, computerized monitoring system, subject to the approval of the Employer's Representative, shall be used to show (in real time) and record the readings from the displacement transducers and load cells.
3. Reaction System (For Conventional Static Pile Load Tests)
    - a. The reaction system shall be such that:
      - i. Safe working load is not less than the maximum required load specified in Clause B.5.2.7.
      - ii. If anchor piles are used, these shall be designed as follows:
        - With a geotechnical factor of safety of not less than 2.0 on ultimate pullout.
        - For structural capacity with a factor of safety of not less than 1.5 on tension reinforcement.
        - The resultant applied force is coaxial with the test pile.
    - b. Anchorages: Where ground anchors are used to provide a test reaction, no part of the anchor bond length shall be closer to the test pile than three times the shaft diameter of the test pile.
    - c. Kentledge: Where kentledge is used to provide a test reaction:
      - i. It shall be supported on cribwork disposed around the pile head.
      - ii. The bearing pressure under the supporting cribs shall be such as to ensure the stability of the kentledge stack.
      - iii. The distance from the centre of the test pile to the nearest part of the supporting cribwork shall be not less than 4.5m.
      - iv. For test loads in excess of 20,000kN kentledge will not be considered acceptable as safe means of providing a test reaction.
    - d. Reaction Piles: Where reaction piles are used to provide a test reaction, the centre-to-centre spacing between vertical reaction piles and the compression or tension test pile shall be not less than 4.5m.
  4. Equipment for Loading and Load measurement (Conventional Static Pile Load Tests)
    - a. Equipment for applying the test load shall:
      - i. Be arranged in conjunction with the reaction system to deliver the loads to the appropriate axis of the test pile.
      - ii. Have a load capacity not less than the maximum required load specified in Clause B.5.2.7.



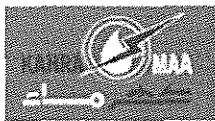
- iii. Be capable of accommodating a maximum pile movement of 75mm plus the displacement of the reaction system that occurs during loading.
  - iv. Be capable of applying a smooth increase or decrease of load and the maintenance of the specified load increment in a stable manner.
  - b. Bearing Plate: A steel bearing plate shall be provided and shall be:
    - i. Firmly bedded onto the top of the pile or pile cap.
    - ii. At right angles to the pile axis,
    - iii. Of sufficient thickness and size to distribute the test load onto the head of the pile.
  - c. Load Measurement: The test load shall be measured by the use of load cells. The use of a dial gauge attached to the pump on its own will not be considered acceptable.
    - i. Accurate to within 2 percent of the indicated load and of stable construction.
    - ii. Calibrated prior to commencement of the test.
    - iii. Re-calibrated when deemed appropriate by the Employer's Representative.
    - iv. Devices provided whereby the shaft and base loads can be evaluated separately as described in clause B.5.2.8.
5. Measurement of Pile Movement
- a. The movement at the pile head shall be measured to an accuracy of 0.05mm. The measurement apparatus used shall be capable of detecting a rate of pile-head movement of 0.1mm per 20 min. sufficient measurements shall be made to determine whether the pile head tilts under the test load.
  - b. Level and Staff: Where a level and staff (or fixed scales) are used:
    - i. A reference datum shall be established on a permanent object or other well-founded structure or deep datum point situated so that only one setting up of the level is required.
    - ii. The datum referred to in (1) shall be so located that it is not affected by either the test loading or the other Site operations.
  - c. Reference Wires: Where reference wires are used they shall:
    - i. Be held under constant tension.
    - ii. Be supported from points at a distance not less than 4.5m from the test pile and any part of the reaction system,



- iii. Pass across the faces of mirror-backed scales attached to the pile head.
  - d. Reference Beams: Where reference beams are used they shall:
    - i. Be simply supported,
    - ii. Either be supported from points at a distance not less than 4.5m from the test pile or any part of the reaction system or be checked for movement by levelling at appropriate times during the test.
6. Test Procedures
- a. Supervision: The installation of the entire testing system, testing and monitoring, are to be carried out in the full-time supervision of the Contractors Representative experienced in pile installation and testing.
  - b. Delay between Installation and Testing: Loading testing of piles shall not commence until the strengths of materials in the pile and pile cap are adequate to sustain the maximum required test load specified in Clause B.5.2.7.
  - c. Load Application: Upon loading of each test pile to the maximum test load in accordance with Clause B.5.2.7 the load shall be removed smoothly and the residual settlement recorded.
  - d. Recording during Loading Stages: For Maintained Loading Tests (MLT), the load, settlement and time shall be recorded immediately upon reaching the load increment and at 10 minute intervals for the period specified in Clauses B.5.2.5 to B.5.2.9. Should it not be possible to achieve the load increment, readings should be taken as directed by the Employer's Representative.
  - e. When the distance from cut off level to piling platform level is greater than 2m a double casing system shall be used to ensure no load is taken by the pile between these points. (an air gap is required between the casings to achieve this.)
  - f. Where a sacrificial cell alternative is adopted instrumentation is required as detailed above together with instrumentation to monitor movement above and below (where appropriate) the sacrificial cell.
  - g. The sacrificial cell shall be made ready for installation under specialist supervision and in the presence of the Employer's Representative.
  - h. During the tests no works or vehicle movements shall take place within 30m of the test pile. If the test apparatus shows Site activities outside this range are interfering with the test the activities shall cease.
  - i. The load test shall be carried out and reported by a qualified geotechnical Sub-Contractor. If a sacrificial cell is used the Sub-Contractor shall have experience of at least ten tests using this technique.



- j. The load test shall be carried out in general in accordance with ASTM D1143. The load stages shall be agreed with the Employer's Representative taking note of clause B.5.2.7.
7. Report: A report on the pile load test shall be prepared and shall include:
  - a. Pile Construction and Installation: This section of the report shall include piling records as described in Part I of this Specification.
  - b. Test Layout and Equipment: This section of the report shall include the following:
    - i. Sketches and photographs showing: the location and size of reaction and loading equipment; deflection measuring equipment; strain gauges; test pile and cap; and position of reference level marks.
    - ii. An assessment of the accuracy of the deflection measurement with particular reference to the movement of the supports of reference beams and wires due to variations in loading or temperature.
    - iii. The results of calibrations of the load measuring apparatus.
  - c. Test Procedure and Results: This section of the report shall include the following for axial load tests:
    - i. A tabulation of the readings during loading and unloading of the pile, together with relevant times. It shall be clearly indicated whether the results are uncorrected readings or readings after corrections for calibration, movement of datum points and other influences.
    - ii. A graphic representation of the test results in the form of either a load-settlement curve or a time settlement curve if sustained loading increments are made.
    - iii. An assessment of the effect of the reaction system on the deflections; and the ultimate bearing capacity, where appropriate.
    - iv. An assessment of the strain gauge readings giving an indication of the distribution of load taken along the shaft and at the base of the pile. A graphic representation of the assessed load distribution should also be provided.
    - v. Copies of all results to be supplied in a recognized spreadsheet format such as Excel.
8. Information to be supplied
  - a. Tender Information: The tenderer is to submit the following information with this tender:
    - i. Relevant experience.



- ii. Pile construction procedure, reinforcement and concrete strength.
  - iii. Pile load reaction system to be adopted.
  - iv. Details of instrumentation to be used.
  - v. Full details of any non-conformance and alternatives proposed.
  - vi. Proforma test records.
  - vii. Typical report showing how the information to be provided would be presented.
  - viii. Name and CV of full-time supervising Engineer for the testing.
- b. Quality Plan: The successful tenderer will be required to submit a quality plan for the testing regime for approval prior to commencement of testing.

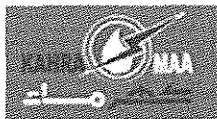
9. Failure Criteria

Final acceptance of the performance of the test shall be to the approval and satisfaction of the Employer's Representative who will provide confirmation as to whether the load test has been passed or failed.

## **2.10.6 DYNAMIC PILE TESTING AND ACCEPTANCE CRITERIA**

### **2.10.6.1 DYNAMIC PILE TESTING**

- A. Scope of Works
  - 1. The Contractor is to dynamically test 5% of the total number of working piles.
  - 2. Should a working pile be damaged whilst being dynamically tested then the Contractor shall install an identical replacement pile as directed by the Employer's Representative and at the Contractor's expense.
  - 3. The Contractor needs to ensure that there is adequate reinforcement in the pile so that the tensile stresses are not exceeded when trying to achieve 150% of the working load. The Contractor is to provide confirmation in this regard as part of the GRLWEAP analyses.
- B. The age of the piles shall be seven days or more have elapse after pile casting at the time of testing. The Contractor shall provide confirmation that the concrete in the pile under test has attained sufficient strength to be tested to the specified loads without damaging the pile.
- C. The permanent penetration per blow and temporary compression of the pile and soil system shall be measured independently of the instruments being used to record the dynamic test data from a fixed reference point unaffected by piling operations.
- D. Piles are to be integrity tested as per the procedure specified in section A.4, prior to and post dynamic load testing.
- E. The procedure adopted shall be in accordance with the guidance given in ASTM D4945. Analyses shall be according to the CASE Method and CAPWAP analysis.



#### 2.10.6.2 MEASURING INSTRUMENTS

- A. Strain transducers and accelerometers are to be mounted in pairs and diametrically opposite to each other on the original pile at a minimum distance of 1.5 times the pile diameter below the top.
- B. The pile driving analyzer along with the strain and accelerometer transducers must have current calibration certificates, copies shall be provided to the Employer's Representative prior to dynamic testing commencing.

#### 2.10.6.3 HAMMER

- A. C.3.1 The hammer and all other equipment used shall be capable of delivering an impact force sufficient to mobilize the equivalent specified dynamic test load without damaging the pile.
- B. The Contractor is to demonstrate and provide calculations to prove the hammer proposed has sufficient weight to mobilize the toe of the pile, the pile having to move 2.5mm per blow. Either a wave equation analysis based on the GRLWEAP program or drivability studies if it is not possible to prove by calculation.  
The Contractor is to use the GRLWEAP analyses to confirm that maximum allowable tensile and compressive stresses for the pile will not be exceeded.

#### 2.10.6.4 PREPARATION OF HEAD

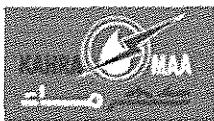
- A. The preparation of the pile head shall involve the trimming of the head, cleaning and building up the pile using materials the same as or giving equal performance characteristics of the concrete used to form the pile. The impact surface shall be flat and at right angles to the pile axis.
- B. Pile reinforcement is to be the full length of the pile, including where the pile head may have to be raised.

#### 2.10.6.5 INTERPRETATION OF TEST

- A. The interpretation of the tests shall be carried out by competent and experienced persons to be Approved by the Employer's Representative. The Contractor shall give all available details of the ground conditions, pile dimensions and construction method to the specialist firm in order to facilitate interpretation of the tests.

#### 2.10.6.6 RESULTS

- A. Initial results shall be provided to the Employer's Representative within 24 hours of completion of the test. These shall include:
  1. Maximum force applied to the pile head.
  2. Maximum pile head velocity.
  3. Maximum energy imparted to the pile
- B. 4 No copies of a full report shall be given to the Employer's Representative, within 7 days of completion of testing. The report shall include the following:
  1. Date of pile installation.
  2. Date of test.
  3. Pile identification number and location (the latter to be in Easting and Northings).



4. Length of pile below commencing surface.
  5. Total pile length, including projection above commencing surface at time of test.
  6. Length of pile from instrumentation position to toe.
  7. Hammer type, drop and other relevant details.
  8. Blow selected for analysis.
  9. Test load achieved.
  10. Pile head movement at equivalent Design Verification Load.
  11. Pile head movement at equivalent Design Verification Load plus 50% of Specified Working Load.
  12. Pile head movement at maximum applied test load.
  13. Permanent residual movement of pile head after each blow.
  14. Temporary compression.
  15. Integrity test results from tests undertaken prior to and post dynamic load testing.
- C. To be also included the report shall be the CASE Method and CAPWAP analysis of the pile and soil to provide the following information:
1. Magnitude and distribution of mobilized static soil resistance.
  2. Magnitude and distribution of soil stiffness damping.
  3. Deduced static load deflection behaviour of the pile at the head and toe.
  4. Assumptions made in the analysis.
  5. Limitations of method.
- D. For all piles tested, the following information shall be provided for typical blows:
1. Date of pile installation.
  2. Date of test.
  3. Pile identification number and location.
  4. Length of pile below commencing surface.
  5. Total pile length, including projection above commencing surface at time of test.
  6. Length of pile from instrumentation position to toe.
  7. Hammer type, drop and other relevant details.
  8. Permanent set per blow.
  9. Maximum force at pile head.
  10. Maximum downward energy imparted to the pile.
  11. Dynamic soil resistance mobilized during the blow.
  12. Static soil resistance mobilized during the blow assuming that the soil damping is proportional to pile velocity.
  13. Magnitude and location of possible pile damage.



## 2.11 DUCTILE IRON PIPEWORK

Ductile Iron pipes and fittings shall comply with BS EN 545 or ISO 2531 except where otherwise required herein.

Ductile iron spigot and socket pipework shall be Class K9.

Ductile iron flanged pipe shall be Class K12

Ductile iron fittings shall be Class K12 except for fittings with branches which shall be Class K14, capable of withstanding 18.75 Bar test pressure.

Pipes are to be appropriately lined inside and coated outside in accordance with all relevant specifications.

### 2.11.1 Joints

Spigot and Socket pipes and fittings shall be provided with approved integrally cast 'push-in' type joints, each joint being supplied with an approved jointing ring designed by the Manufacturer solely for the purpose of sealing the joint.

All flanged pipes and fittings shall be provided with raised face integrally cast flanges and shall be rated to PN16 as detailed in BSEN 545, and supplied with approved gaskets from the same Manufacturer.

The dimension and drilling of the flanges shall be to ISO 7005-2 or EN1092-2 and shall be supplied with complete gaskets, hot deep galvanised nuts, bolts and washers.

The nuts, bolts, washers shall be of mild steel having minimum tensile strength of 800 N/MM<sup>2</sup> hot deep galvanised. Nuts and bolts shall be to ISO 4014 and 4032, and washers to ISO 887.

Minimum deflections without leakage for Pipes and fittings with spigot and socket joints shall be capable of the following or as recommended by manufacturer:

Nominal Size (DN) (mm)	Deflection Limit (Degrees)
Up to and including 300	5
350 to 600	4
700 to 900	3
1000 to 1600	2

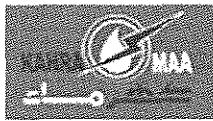
Rubber joint rings for spigot and socket joints and gaskets for flanged joints shall comply with the requirements of ISO 4633 and shall be manufactured from Ethylene Propylene rubber (EPDM) or Styrene Butadiene rubber (SBR) and shall be obtained from the Manufacturer of the pipes to be jointed.

Joint lubricants shall have no deleterious effects on either the joint rings or pipes and shall be unaffected by the liquid to be conveyed. Lubricants to be used for jointing water mains shall not impart to water taste, colour, or any effect known to be injurious to health and shall be resistant to bacterial growth.

### 2.11.2 Lengths of Pipes

All pipes shall be supplied in the standard lengths as stated in BSEN 545 except where otherwise specified.

Any deviation from the lengths specified shall be approved by the Engineer.



### **2.11.3    Markings**

All pipes and fittings shall be marked in accordance with BSEN 545.

**2.11.4** In addition all pipes shall be marked with white lettering, indicating the GTC contract number and shall have the nominal diameter of the pipe cast on.

### **2.11.5    Pipes for Cutting on Site**

Where short make-up lengths are required these shall be cut from pipes specially purchased for the purpose. The tolerance required on the external diameter to suit the joint shall apply for the full length of the barrel. The Contractor shall order a sufficient quantity of pipes for cutting on site which shall be clearly marked for that purpose. Cut surfaces shall be made good and protected to the approval of the Engineer.

## **2.12    COATINGS FOR DUCTILE IRON PIPES AND FITTINGS DURING MANUFACTURE**

### **2.12.1    General**

All materials used for the lining of ductile iron pipes and fittings shall conform to BSEN 545—"Effect of non-metallic materials on water quality".

All ductile iron pipes and fittings shall be internally lined with cement mortar in accordance with BSEN 545.

The method of lining, lining thickness, curing of lining, mortar cube strength and repair to lining, if any shall be carried out strictly in accordance with BSEN 545.

### **2.12.2    Lining Material**

The cement mortar lining to all ductile iron pipes and fittings shall be made using sulphate resisting cement according to EN 545 with a minimum compressive strength of 50 MPa. The internal lining shall have no seal coat. Fittings may alternatively be supplied with a 300micron thick epoxy coating.

The Contractor is to supply confirmation from the Manufacturer that the cement lining to be used is suitable for use with the range of chemical characteristics of water detailed in Appendix I.

The internal section of sockets to pipes and fittings shall not be cement lined and shall be suitably protected during the lining operation. The internal section of sockets of pipes and fittings shall be painted with a minimum 300-micron thick epoxy or bitumen coating. The coating shall be suitable for use in contact with potable water at 50 °C.

### **2.12.3    External Protection to Pipes and Fittings**

External coatings to pipes and fittings shall be as detailed in the Kahramaa General Specification of Main laying Materials for Waterworks. In addition to the requirements of this Clause the Contractor may, with the written approval of the Engineer, supply pipes which have a factory applied polyethylene or polyurethane coating, applied by extrusion methods.

## **2.13    CARBON STEEL PIPES**

Refer to Mechanical Specification Appendix A4.



## **2.14 VITRIFIED CLAY PIPES AND FITTINGS**

Vitrified clay pipes and fittings shall be in accordance of QCS 2010 section 8 part 3 clause 3.2

## **2.15 CONCRETE PIPES AND FITTINGS**

Concrete pipe and fittings shall be in accordance of QCS 2010 section 8 part 3 clause 3.3

## **2.16 PIPE BEDDING**

Imported granular material for pipe surround shall comprise of 14mm single size stone as approved by the Engineer's Representative compliant with Tables A.1 and A.2 and IGN 4-08-01. The stone shall be obtained from a source approved by the Engineer and shall not contain particles with sharp edges which could cause damage to the pipes. Local sand or sea sand shall not be used. The bedding shall be class S. for rigid pipe and class S1 for semi rigid and flexible pipes in accordance with BS EN 1295-1.

Granular material shall contain no excessive quantities of dust, soft or flaky particles, shells, congealed lumps, nodules of soft clay, alkali or other contaminations likely to affect adversely the compaction of the material or to attack the pipes.

The sulphate content (as SO<sub>3</sub>) of the material shall not exceed 0.40% by weight and the chlorides as (Cl) shall not exceed 0.10% by weight.

Prior to commencement and during progress of works the Contractor shall provide the Engineer with 8 samples of the granular material he proposes to use in the works along with their soil test results and shall obtain his written approval for its use. These samples will be retained by the Engineer for comparison with deliveries to the site during the works.

The 14mm single size stone shall be used as pipe bedding & surround in case of waterlogged areas only and areas other than water logged areas, the pipe bedding shall be as given in the KAHRAMAA General Specification for Main Laying Contract, Section 5, part 5.1 (v). Section 5.1 (vi) shall be modified to remove reference to No 22 mesh sieve.

The Stone used in water logged area for bedding shall be Gabbro unless otherwise agreed by Kahramaa, similarly for bedding and surround around the land drainage for all the PRPS's sites..

## **2.17 ANCHORAGE SYSTEMS**

Anchorage systems shall comprise lugs welded to the barrels of the pipes with steel tie bars bolted to connect the lugs in order to prevent pull out of the spigots. The anchorage system shall be pre-manufactured at the pipe manufacturer's facility and shall not be prepared on site. The anchorage system shall, as a minimum, have the same level of external corrosion protection as the pipe

Where anchorage systems are required they shall be fixed strictly in accordance with the manufacturer's instructions.



## **2.18 WRAPPING OF ALL BURIED PIPE JOINTS**

### **2.18.1 Flanges and Couplings**

All flanges and couplings outside of chambers are to be protected by either PVC Bituminous wrapping as defined in Kahramaa General Specification for Main Laying Contracts, section 8.2.iii, or by Heat Shrinkable Sleeves as defined below.

In addition the following clause shall be added. it should be noted wrapping tapes with self-adhesive bituminous resin on PVC backing layer shall be applied with 55% overlap on the pipes & Fittings regardless there is high water table or not.

### **2.18.2 Spigot and Socket Joints**

All spigot and socket joints shall be protected by Heat Shrinkable Sleeves as defined below.

### **2.18.3 Heat Shrinkable Sleeves**

Heat Shrinkable Sleeves shall consist of an irradiation cross linked thermally stabilized glass fibre reinforced, heat shrinkable woven polyolefin backing that is coated internally with a visco elastic sealant and bonds to , and provides a water proof seal between the sleeve and bare or pre coated pipes, flanges, adaptors, couplers and saddle straps. The glass fibre reinforced woven polyolefin gives to the heat shrinkable sleeve a high mechanical resistance and a high recovery capacity. An asphalt based adhesive shall not be allowed.

Heat Shrinkable Sleeves shall be suitable for use on ductile iron flanges, couplings adaptors, couplers and saddle straps in DI pipe systems. The sleeve shall be compatible with all standard main pipe coating including those specified for this project.

The installed sleeve shall have a peel strength of 10N/cm to steel at 23°C, and impact resistance at 23 °C of 8 Joules and a penetration resistance at 65 °C /24 hours of 0.6mm residual thickness. Sleeves shall be greater than 2.4mm thick as-supplied (backing and adhesive).

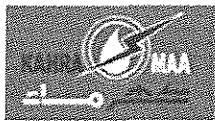
The installed sleeve shall be wide enough so as to overlap onto the adjacent main line coating by a minimum of 50mm.

To ensure that Heat Shrinkable Sleeves seal tightly, the sleeves shall have a minimum shrinkage of 50% in full unrestricted recovery. For small diameter pipes where the flange diameter to pipe diameter is large, shrinkage even higher than 50% may be required, It is the contractors responsibility to ensure that the sleeve has sufficient shrinkage to tightly fit.

Sleeves shall be installed in strict accordance with the manufacturers recommended procedure

## **2.19 VALVE CHAMBER NAME PLATES**

Name plates shall be provided at all sluice valve, air valve, washout and meter chambers. They shall indicate in both Arabic and English the type of chamber, and its reference in a format to be approved by the Engineer.



At buried chambers the name plate shall be fixed in an approved manner to the valve chamber marker post.

Where chambers are visible above ground the marker plate shall be plate shall be fixed to the edge of the chamber roof slab in a visible location near the access cover

## **2.20 FIBRE OPTIC CABLE DUCT**

### **2.20.1 HDPE Duct**

Ducts shall be used for installation of metal-free Fibre Optic (FO) cables and shall be provided with Polypropylene draw rope. The main raw material being used for the manufacture of ducts shall be High Density Polyethylene (HDPE) as per standards ISO-4437 or DIN-8074 and PE compounds shall be of designation PE100, i.e. for 10Mpa.

HDPE Ducts shall have outer diameter of 110mm and wall thickness shall be 5mm. HDPE Ducts shall have low frictional resistance of the inner conduit wall to facilitate cable insertion. HDPE Ducts shall be UV resistant and resistant to chemicals such as oil and other petroleum products, moisture and saline water. HDPE Ducts accessories (compression coupler and end cup) shall be of the same material as HDPE pipe.

Material submittal for HDPE Duct and duct coupler with samples shall be provided to Kahramaa for approval prior to installation.

### **2.20.2 Cable Route Markers**

Cable route markers shall be installed to mark the location and route of buried FO cables. Two types of cable route markers shall be used, standard cable route marker for unmade ground and cable route marker for paved areas.

Cable markers shall indicate cable trench route at every 50 m interval on straight runs of the cable route, at every change of direction, at both ends of road/pipelines crossings, at both sides of fence crossings and at bends, to vividly indicate buried cable underneath.

Cable route markers shall be manufactured from sulphate resisting cement. Marker plate shall be lead insert 95 mm x 70 mm with letter punching. Material submittal for Cable Route Marker with sample shall be provided to Kahramaa for approval prior to installation.

### **2.20.3 Cable Protection Tiles**

Alternative types of Cable Protection Tile in concrete or plastic will be acceptable but not a mixture of both types. Tiles must be in accordance with the requirements of BS 2484.

Recycled polyethylene cable tiles shall be of heavy duty, high impact, rot resistant and shall be chemical inert. PVC cable protecting tiles shall be 240 mm wide, 1000 mm long and 6 mm thick and tensile strength shall be a minimum of 10N/m<sup>2</sup>.



The printing in Arabic and English "FO CABLE" shall be provided on concrete cable protection tile and printing in Arabic and English " CAUTION – FIBRE OPTIC CABLE BELOW" shall be provided on PVC cable protection tile.

Material submittal for Cable Protection tile with sample shall be provided to Kahramaa for approval prior to installation.

#### **2.20.4 Warning Tape**

Cable warning tape shall be installed 300 mm above the cable protecting tiles during backfilling of the trench. The tape shall be manufactured from high grade PVC and shall be 150 mm wide with a minimum thickness of 0.1 mm. The tape shall be resistant to minerals and chemicals present in subsoil (water, oil, 10% NaCl, 8% Acetic Acid, 5% NaOH, Alcohol Mix).

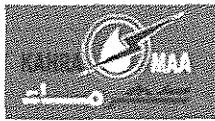
The tape shall be coloured fluorescent green with warning messages printed in black continuously along its length. The printing shall be minimum 20 mm high. The wording shall be in Arabic and English "CAUTION – FIBRE OPTIC CABLE BELOW...KAHRAMAA Tel No....." The text shall follow alternately with spacing of 6.5 inches between two warning displays. The printing shall be fully resistant to the deterioration effects of direct burial.

Material submittal for Warning Tape with sample shall be provided to Kahramaa for approval prior to installation.

#### **2.21 STAIRCASES, LADDERS, GRATINGS, OPEN MESH FLOORING AND HANDRAILING**

In addition to QCS 2010, the followings specification has been amended for the preferred metal works to be used on this project.

1. All metal works inside the reservoir comprising of handrail ladder, platforms and supports, safety chains, bolts and washers shall be stainless steel grade 316L.
2. The reservoir hatches shall be motorized with effective monitoring and control systems; such that an alarm shall be triggered in the control room should the covers be opened without authorization. In addition, the option for opening these covers by manual lock and master key shall be provided. These shall be made of anodized aluminium for class A pedestrian loading.
3. All metal works in other structures (with the exception of the reservoir, foul sewer, storm water manhole and metalwork associated with the chlorination processes,) comprising of handrail, ladder, platforms and supports, safety chains, grating covers and chequered plates, shall be anodized aluminium, marine grade 6082 T6 and shall be subject to Kahramaa review and approval.
4. All metal works for foul sewer and storm water manholes comprising of ladders, supports and handrails shall be GRP material and in accordance with QCS2010 section 8, Part 7.



## 2.22 MONITORING POINTS

Monitoring stations at the sampling points detailed on the drawings shall provide accurate and continuous water quality monitoring data. These shall include the following parameters as a minimum requirement:

- 1) pH
- 2) Electrical Conductivity (EC)
- 3) Temperature to
- 4) Turbidity
- 5) Free Chlorine
- 6) Total Chlorine
- 7) Mono-chloramines
- 8) Dissolved Oxygen
- 9) Pressure

The monitoring facility shall include a flanged tee on the pipeline with blank flange suitably adapted to take a sample line feeding to the quality monitoring instruments. The size of tee and location of sampling points are detailed on the drawings. The installed quality monitoring system shall be able to withstand operating pressure in the main line of up to 16bar and flow velocity of up to 2m/s.

The installed system shall be capable of transmitting data in real time and providing connection to SCADA, and shall be adequately equipped to provide opportunity for data logging and storage back up.

The system installed at remote locations shall be provided with the necessary backup power supply such as batteries, solar panels, etc.

## 2.23 RESERVOIR ACCESS COVERS

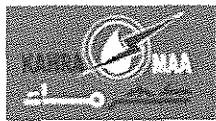
Reservoir access covers shall be aluminium, class A pedestrian loaded unless otherwise indicated on the Drawings. Top surface of the covers shall be patterned to provide slip resistance. Covers below 1 m<sup>2</sup> shall incorporate gas spring assisted opening and the lid shall lock in the open position with a safety hold-open stay to prevent accidental closure. A secondary safety grid shall be incorporated beneath the cover to guard against falling through the opening; covers above 1 m<sup>2</sup> shall be electrically operated. The access covers shall be designed to support uniformly distributed load of 7.5 KN/ m<sup>2</sup>

Covers shall incorporate a stainless steel slam action lock. This shall lock the cover but allow easy opening from the inside and tee key operation from the outside.

Cover frames shall incorporate double unbroken EPDM seals to prevent the ingress of dirt and moisture. Any water passing the seals shall be dispersed via an integral drainage channel.

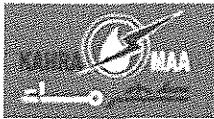
## 2.24 RESERVOIR AIR VENTS

Air vents at the roof reservoir shall be of GRP material to the sizes shown on the Drawings. Vents shall incorporate woven wire insect screen mesh in stainless steel SS304 grade.



## **2.25 FIXING METALWORK INSIDE THE RESERVOIR**

Bolts and nuts and all components of metal fixing in direct contact with water shall be stainless steel grade 316 and shall be fixed to the bracket support prior to concrete penetration without affecting the fair finish of the integrated concrete.



## Appendix A3 – Supplementary Note:

### General Equipment for the Laboratory – Specification of equipment

Below is the minimum list of basic equipment provided for water laboratory testing at each PRPS's site.  
KAHRAMAA reserve the right to add to this list at any stage of construction, commission and testing without any additional cost.

**Analytical Balance:** Minimum specifications: Precision 0.1 milligram, minimum scale readability 0.1 milligram. Electronic top loading balances are preferred. A desiccator is required for storage and drying. Laboratories that purchase all of their analytical reagents and standards from a reputable supplier in pre-calibrated form are not required to maintain an analytical balance.

**Refrigerator:** Refrigeration capable of operating at 2-10 C for storage and preservation of stock standard solutions. The refrigerator must be equipped with a thermometer with the bulb immersed in a stoppered liquid filled test tube or vial.

Tabletop or under counter refrigerators are acceptable as long as they can hold temperature and are of sufficient size. For sample and nonflammable reagent storage, a standard domestic model will be sufficient. For storing organics, flammables, or other volatile materials, a refrigerator suitable for flammable materials storage is necessary.

**Spectrophotometer** - Minimum specifications: Usable wavelength range from 400 to 880 nanometers. maximum setting accurate to 2.5 nanometers or less. Spectral band width of 15 nm or less.

**Turbid meters** Only those that have been evaluated by the Laboratory Certification Section shall be accepted.. Ratio only meters are not acceptable. Ratio/Non-ratio selectable meters must be calibrated with ratio on and used for samples and low level checks with ratio off.

**pH Meters** - Minimum specifications: Accuracy of 0.1 pH unit., expanded scale millivolt capability readable and accurate to 1 millivolt, or a direct reading concentration scale providing the equivalent or readability to 1 millivolt or better. Meters must be designed for a minimum of a two standard calibration and % slope or efficiency read-out. Digital display meters are required. Analog (needle) meters are not acceptable. Direct readout of concentration (activity), is recommended for fluoride determination by the electrode method. Automatic temperature compensation (ATC) probes are required for pH meters.

**ORP Meters** – Minimum specifications: Accuracy of  $\pm 5$  mV, 1 mV Resolution. ORP range shall be between -2,000 to +2,000 mV. ORP temperature range shall be from 0 to 50°C manual temperature compensation, with max RH 95%. Power Supply DC 9V battery (approximately 300 hours use in battery life). Meters must be designed for a minimum of a two standard calibration and % slope or efficiency read-out.

**Amperometric Titration Equipment** - Amperometric titrators must provide sufficient electrical range to allow the determination of both free and total chlorine.

**Magnetic Stirring Apparatus** - Units may be strictly for sample stirring or may contain a built -in light source for aiding in the detection of titrimetric endpoints.

**Colony Count** - capable of registering a maximum of 4 digits, i.e. 9999. Working temperature range from 5 to 50°C. Dish size diameter shall be from 50 to 90mm. The Max plate number to average 99.



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)

**CL and CLO<sub>2</sub> Photometer (Site test)** – Dual wavelength, direct-reading colorimeter. Test ranges for Chlorine (0.01 - 5 mg/l) and Chlorine Dioxide (0.02 - 10 mg/l). Temperature range shall be from 0 to 50°C.

**Desiccator** --Glass or plastic models may be approved depending on the application.

**Drying oven** - Must operate within 2.0 C of the target temperature.

**Heating block** -(Must operate within 2.0 C of the target temperature.

**Incubator** – shall be of double doors standard, Prevention of contamination and drops in temperature, and at the same time an optimum view of the sensitive load through wide-area interior glass doors. Temperature range up to 50 °C (temperature control/monitor device shall be used). The Incubator shall be selected to ensure that the working chamber is perfectly sealed off from the outside.

**Hot Plate** - Hot plates for use in digestion procedures must be large enough to handle all standards and samples simultaneously.

**Conductivity Meter** –Shall be used as EC and Resistivity Meter which is a combination bench meter that can measure conductivity in four different ranges and resistivity for testing. Direct reading and direct display.

**Water Bath** - Shall be capable of maintaining temperatures from ambient to 100 ±0.2 C.

**Glassware** - All glassware purchased for laboratory use shall be of borosilicate type glass for increased resistance to heat, chemicals, and abuse than regular flint glass.

**Microliter Pipette** - Adjustable volume microliter pipettes in appropriate ranges. Micropipettors should be of good quality and deliver 20-250 l or 50-200 l range.

**Burets** – Burets may be Class A, but this is not necessary as long as they are accurate. They must be self-leveling with a total volume that is sufficient to perform a titration without having to refill it during the titration. The tips must not be chipped. For chloride testing, amber burets are required, unless the buret is covered with aluminum foil or other light block.

**Autoclaves**-Autoclave shall be constructed to provide uniform temperatures within the chambers (up to and including the sterilizing temperature of 121°C); equipped with an accurate thermometer the bulb of which is located properly on the exhaust line so as to register minimum temperature within the sterilizing chambers (temperature-recording instrument is optional); equipped with pressure gauge and properly adjusted safety valves connected directly with saturated-steam supply lines equipped with appropriate filters to remove particulates and oil droplets or directly to a suitable special steam generator (do not use steam from a boiler treated with amines for corrosion control); and capable of reaching the desired temperature within 30 min.

1. Laboratory Equipment specifications, glass wares, Chemical and allied material:

A. List of Instruments required.

Serial No.	Quant	ITEM	Specifications
1	1	PH meter	Digital Display Auto buffer,(0-14 PH range)
2	1	Conductivity meter or pH-cum conductivity meter	Direct reading Digital display
3	1	Nephelo meter (Turbidity meter)	Direct reading Range:0-



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

			100& 100-1000
4	1	Monopan balance	Single pan Cap.200 gr. Taring device Accuracy-0.001
5	1	Spectrophotometer	Visible range
6	1	Refrigerator	400 Its. Cap.
7	1	Water still	Stainless steel Cap. 10 Its/hr
8	3	Voltage stabilizer	3 Nos.
9	2	Hot plate	Big size (2 Nos)
10	2	Heating mantle	Cap. 1 lt. ( 2 Nos)
11	1	Water bath	Big size Temp.0 to 55 C
12	1	Hot air oven	Menest type Inner chamber of aluminium. Big size4 shelves
13	2	Bacteriological Incubator	Temp. control device Range 0 to 55 C Medium size (2 Nos.)
14	1	Autoclave	Medium size steel cabinet
15	2	Magnetic stirrer	With speed control and Teflon paddle (2 Nos.)
16	1	Microscope	Binocular 10x 45 x
17	1	Vacuum pump	1 HP cap.
18	1	Ion Chromatographs (IC)	Metrohm 850 IC system
19	1	DPD	Photometer (At least three bench top instruments for measuring chlorine and chlorine dioxide).
20	1	Glass washing Machine (in the cleaning room)	60 cm - 90 cm wide compact machine. Performance/load: e.g. 37 narrow neck glasses, 96 pipettes (or as per specified by Kahramaa)
21	1	Membrane Filtration	Millipore MIAC 03P013

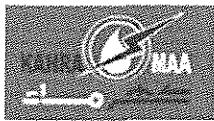
**B. List of Glasswares:**

Serial No.	ITEM	No
1	Conical flask Cap. 100 ml 250 ml	12 50
2	Beakers Cap. 100 ml	24



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

	250 ml 500 ml 1 lt. 2 lt	24 24 12 6
3	Pipetee (Ordinary) Cap. 5 ml 10 ml 25 ml 50 ml	12 12 12 6
4	Pipette (Graduated) Cap. 1 ml 2 ml 5 ml 20 ml 25 ml	12 12 12 12 6
5	Burette (Automatic) Cap. 10 ml 25 ml 50 ml 100 ml	6 12 12 6
6	Desiccators Small Big	6 3
7	Reagent Bottles Cap. 250 ml 500 ml 1 lit 2 lit	100 36 36 24
8	Sample bottles (Plastic) Cap. 250 ml 500 ml 1 lit 2 lit	50 50 24 24
9	Round bottom flask Cap. 250 ml	12
10	Measuring cylinders(graduated) Cap. 5 ml 25 ml 50ml 100 ml 250 ml 500 ml 1 lit 2 lit	6 6 6 6 6 6 3 3
11	Measuring flask Cap.10 ml 25 ml 50 ml 100 ml 250 ml 500 ml 1000 ml	24 24 12 12 12 12 6

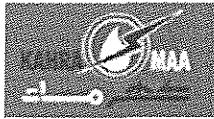


**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

12	Funnels 3" dia 4" dia 5 " dia	12 12 4
13	Porcelain dish Small size Medium size Big size	36 24 12
14	Crucibles	12
15	Distillation flask	6
16	Standard joints grouted Bends	24 12
17	Glass rods	5 kg
18	Glass bids	2 kg
19	Glass tubes	5 kg
20	Digital Thermometers 100 °C 250 °C	12 6
21	Wash bottle	12 Nos
22	Separating flask	18 Nos
23	Nesslar tubes Cap 25 ml 50 ml	12 12
24	Petri dishes	90 Nos

**C. List of Miscellaneous Stationary and other items:**

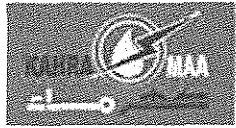
Serial No.	ITEM	Specifications
1	Filter paper	12 packs
2	Plastic carboys Cap. 1 lt Cap. 2 lts 5 lts 10 lts 20 lts 50 lts	25 50 25 12 6 3
3	Water sampler (steel) 2 lts 5 lts	3 Nos 3 Nos
4	Rubber tubing Plastic tubing Small dia Medium dia Big dia (2.5 cms)	50 mts 25 mts. 10 mts.
5	Forecep Medium Big	50 Nos
6	Burette Stand	6 Nos



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

7	Rubber cork Various sizes	50 Nos
8	Ice Box (Big) Iron (Medium) Thermocole	3 Nos 3 Nos
9	Cotton	
10	Test tube stand	12 Nos
11	Gas cylinder	2 Nos
12	Burners	6 Nos
13	Tripod Stand	12 Nos
14	Iron ring with clamp	12 Nos
15	Heating mentles (Loose)	6 Nos
16	Blotting papers	200 sheets
17	Physical balance with weight box	1 No
18	Wire guage	12 Nos
19	Asbestos sheets	6 Nos
20	Spatula	6 Nos
21	Wash bottle plastic one lit cap.	6 Nos
22	Stop watch	2 Nos
23	Glazed tiles ( 6 x 6" size)	6 Nos
24	Enamel tray Small ( 1'x 1') Big ( 2' x 2')	3 Nos 3 Nos
25	Plastic beakers Cap. 100 ml 250 ml 500 ml 1000 ml	12 12 12 6

Building/Room	Item	Quantity	Dimensions (LxWxH)	Description	Notes
Main Guard House	Guard Room	1	1 no. U-shape reception desk 2 nos. side tables (0.5mx0.5m)	4	2
	Lounge/Seating area	-	-	-	-
	Store Room	-	-	-	-
	Kitchen	-	-	-	-
TFS Guard House (Entrance)	Guard Room	1	1 no. U-shape reception desk	3	1
	Kitchen	-	-	-	-
TFS Guard House (Left)	Guard Room	1	1 no. U-shape reception desk	3	1
	Kitchen	-	-	-	-
Office	1 no. L-shape reception desk	1	-	-	-
Laboratory	6 nos. vibration reception desk (1.5mx0.5mx1m)	2	-	1	-
Water Treatment Facility	6 nos. wooden table w/drawers (1.25mx0.75m)	6 nos. chairs	6 nos. stools 2 nos. wooden bench	base cabinets 6 nos. racks with 2 shelves (1.5mx0.25mx0.5m)	base/overhead cabinets base/overhead cabinets base/overhead cabinets base cabinets 1 nos. file cabinet (1mx0.3mx0.2m) 6 nos. steel cup board 6 nos. glass door cup boards (for books and chemical storage)
Cold Room / Samples	-	-	-	-	-
Lab	-	-	-	-	-
Store Room	-	-	-	-	-
Record Room	7 nos. desks (1.2mx0.75m)	7	-	-	-
Training / Meeting Room	6 nos. desks (1.2mx0.75m)	-	-	2 (filling cabinets)	-
Cleaners' Staff Room	5 nos. desks (1.2mx0.75m)	-	-	3 (filling cabinets)	-
Maintenance Staff Room	6 nos. desks (1.2mx0.75m)	-	-	2 (filling cabinets)	-
Office	7 nos. desks (1.2mx0.75m)	4	-	6 (filling cabinets)	-
Sickening Canteen	5 nos. tables (4 seater)	20	-	2 (filling cabinets)	-
Store / Junior / Abduction	-	-	-	base cabinets	-
Male Changing Room	-	-	-	overhead cabinets	-
Store Room (3 nos)	-	-	-	7 (fitter cabinets)	-
Workshop (1, 2 and 3)	-	6	-	5 (locker cabinets)	-
Chemist Building	Operative's Room	1 no. desk (1.5mx0.75m)	3	1	-
	Offices (3 nos)	6 nos. desks (1.5mx0.75m)	12	1 (filling cabinet)	-
	Meeting Room	3 nos. conference table (1.2mx0.75m)	24	6 (filling cabinets)	-
	First Aid Room	1 desk (1.0mx0.75m)	2	1	-
	Print / Records	-	-	-	-
Main Pumping Station	Common Room	2 desks (4 seater each)	8	-	1 (single)
	Sewer Room	2 tables (4 seater each)	2	2	-
	Control Room	2 desks (1.2mx0.75m)	2	2	4 (single)
	Store Room	Special 1 tables	6	4	2 (filling cabinets)
	Female Changing Room	-	-	5 (locker cabinets)	-
	Male Changing Room	-	-	6 (locker cabinets)	-



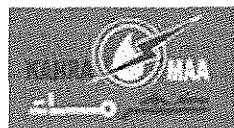
**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

## **STONE FAÇADE PERFORMANCE SPECIFICATIONS**



## TABLE OF CONTENTS

3.12. INTRODUCTION .....	472
3.12.1. PROJECT DESCRIPTION.....	472
3.12.2. FAÇADE CONTRACT DOCUMENTS.....	472
3.12.3. LANGUAGE.....	472
3.12.4. DESIGN RESPONSIBILITIES .....	472
3.12.5. BUILDING REGULATIONS AND STATUTORY REQUIREMENTS .....	473
3.12.6. REFERENCE STANDARDS.....	474
3.12.7. ATTENDANCE .....	474
3.12.8. DEFINITIONS AND INTERPRETATIONS .....	474
3.12.9. ACCOMPANYING DOCUMENTATION .....	475
3.12.10. SUBMISSION AT TENDER .....	476
3.12.11. GENERAL .....	476
3.12.12. TENDER SCOPE .....	476
3.12.13. TENDER SUBMISSION DRAWINGS .....	476
3.12.14. MATERIALS SOURCE INFORMATION.....	476
3.12.15. STONE SOURCE INFORMATION AND CERTIFICATES AT TENDER STAGE.....	476
3.12.16. STONE SOURCE INFORMATION .....	476
3.12.17. STONE SELECTION AND PROPERTIES .....	477
3.12.18. DETAILED SHOP DRAWINGS.....	477
3.12.19. STONE SHOP DRAWINGS .....	478
3.12.20. LOCAL AND STATUTORY AUTHORITY APPROVALS .....	478
3.12.21. STONE PROCUREMENT.....	478
3.12.22. VISUAL MOCK UP .....	478
3.12.23. SAMPLES AND MATERIAL SUBMISSIONS .....	478
3.12.24. METHOD STATEMENTS .....	479
3.12.25. GENERAL .....	479
3.12.26. SCOPE .....	479
3.12.27. QUALITY PLAN .....	479
3.12.28. QUALITY CONTROL PROCEDURES .....	480
3.12.29. SUBMISSIONS BEFORE PRACTICAL COMPLETION .....	480
3.12.30. OPERATION AND MAINTENANCE MANUAL .....	480
3.12.31. RECORD AND AS-BUILT DRAWINGS .....	482
3.12.32. SPARE MATERIALS .....	482
3.12.33. SCOPE OF CONTRACT WORKS .....	482
3.12.34. OVERALL CONTENT OF THE CONTRACT WORKS .....	482
3.12.35. ADDITIONAL STONE CHARACTERISTICS.....	483
3.12.36. SUITABILITY OF THE WORKS BY OTHERS.....	483
3.12.37. INTERFACES WITH OTHER CONTRACTORS .....	483
3.12.38. PART 2 - DURABILITY .....	484
3.12.39. DESIGN LIFE .....	484
3.12.40. GENERAL .....	484
3.12.41. SITE CONDITIONS .....	484
3.12.42. REFERENCE DOCUMENTS.....	484
3.12.43. DURABILITY.....	484
3.12.44. DURABILITY OF PRIMARY COMPONENTS .....	484
3.12.45. DURABILITY OF SECONDARY COMPONENTS .....	484
3.12.46. CORROSION.....	485
3.12.47. BIMETALLIC CORROSION .....	485
3.12.48. INFESTATIONS.....	485



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

3.12.49.	COMPATIBILITY .....	485
3.12.50.	WARRANTIES .....	485
3.12.51.	SEISMIC LOADS .....	486
3.12.52.	LOADING DURING MANUFACTURING AND INSTALLATION .....	486
3.12.53.	STABILITY .....	486
3.12.54.	ALUMINIUM OR STEEL FRAMING FOR CLADDING .....	486
3.12.55.	ALUMINIUM, MILD STEEL AND STAINLESS STEEL BRACKETS AND FIXING .....	486
3.12.56.	STONE PANEL DESIGN .....	486
3.12.57.	ACCOMMODATION OF MOVEMENTS .....	487
3.12.58.	GENERAL .....	487
3.12.59.	ACCOMMODATION OF THERMAL MOVEMENT .....	487
3.12.60.	ACCOMMODATION OF MOISTURE MOVEMENT .....	487
3.12.61.	MATERIALS AND COMPONENTS .....	488
3.12.62.	GENERAL TERMS .....	488
3.12.63.	STONE PROCUREMENT .....	488
3.12.64.	RANGE SAMPLES .....	488
3.12.65.	QUALITY TESTING DURING PROCESSING .....	489
3.12.66.	NOTIFICATION OF VARIATIONS DURING PROCESSING .....	489
3.12.67.	MARKING AND PACKAGING .....	489
3.12.68.	VISUAL APPEARANCE CRITERIA .....	490
3.12.69.	GENERAL .....	490
3.12.70.	CONSTRUCTED APPEARANCE .....	491
3.12.71.	STONE REPAIRS .....	492
3.12.72.	STONE FINISHES AND EDGES .....	492
3.12.73.	SEALANTS .....	492
3.12.74.	GENERAL .....	492
3.12.75.	INSTALLATION OF THE SEALANT .....	493
3.12.76.	ALUMINIUM EXTRUSIONS .....	494
3.12.77.	MILD STEEL .....	494
3.12.78.	GENERAL .....	494
3.12.79.	MILD STEEL PROTECTION .....	494
3.12.80.	GENERAL .....	494
3.12.81.	PREPARATION .....	495
3.12.82.	WORKMANSHIP .....	495
3.12.83.	SAMPLES .....	496
3.12.84.	APPLICATORS .....	496
3.12.85.	INACCESSIBLE SURFACES .....	496
3.12.86.	PROTECTION .....	496
3.12.87.	REMEDIAL WORK .....	496
3.12.88.	MILD STEEL FINISHES .....	496
3.12.89.	GENERAL .....	496
3.12.90.	STAINLESS STEEL .....	496
3.12.91.	GENERAL .....	496
3.12.92.	FABRICATION OF STAINLESS STEEL .....	496
3.12.93.	BRACKETS AND FIXING SUPPORTS .....	497
3.12.94.	GENERAL .....	497
3.12.95.	SAFETY FACTORS ON FIXINGS AND FASTENERS .....	498
3.12.96.	TORQUE SETTINGS .....	498
3.12.97.	BOLTS, NUTS AND WASHERS .....	498
3.12.98.	CONCRETE ANCHORS .....	499



3.12.99.	MASONRY ANCHORS.....	499
3.12.100.	GROUTING OF BASE PLATES .....	500
3.12.101.	SHIMMING.....	500
3.12.102.	FACADE ACCESSORIES AND ATTACHMENTS .....	500
3.12.103.	COPINGS AND FLASHINGS .....	500
3.12.104.	WORKMANSHIP AND FABRICATION.....	500
3.12.105.	WORKMANSHIP .....	500
3.12.106.	FABRICATION .....	501
3.12.107.	GENERAL.....	501
3.12.108.	CUTTING, SIZING AND THICKNESS OF STONE.....	501
3.12.109.	STONE CLADDING TOLERANCES.....	501
3.12.110.	REPLACEMENT AND REPAIRS .....	502
3.12.111.	FINAL CLEANING.....	502
3.12.112.	TESTING TO THE STONE FIXINGS PRIOR TO STONE PROCUREMENT.....	502
3.12.113.	ANCHOR LOAD TESTING.....	503
3.12.114.	VISUAL INSPECTION.....	503
3.12.115.	IMPACT TESTS .....	503
3.12.116.	QUALITY CONTROL PROCEDURES.....	503



## **Part 1 - GENERAL**

### **3.12. INTRODUCTION**

This document is prepared by Hyder Middle East.

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This Specification stipulates minimum requirements for the Project.

This Specification shall be read in conjunction with the Architectural Specifications. If any conflicts are found between the two documents, it shall be brought to the Engineer's attention for final decision.

#### **3.12.1. PROJECT DESCRIPTION**

The project sites are located in Qatar. The Stone Façade is located on the curved front façade of the Main Pump Building on each site.

The primary structure consists of concrete columns and concrete block infill.

#### **3.12.2. FAÇADE CONTRACT DOCUMENTS**

- A. The Contract Drawings and Specifications will form part of this Contract.
- B. This Performance Specification shall be read in conjunction with the Specifications and Design documents as provided by the Architect and Engineers.
- C. Should conflicting dimensions or details be identified, the matter shall be referred to the Engineer prior to production.
- D. Dimension Statement

Where dimensions are not given, the drawings must not be measured off the CAD drawing. The matter is to be referred to the Engineer for final clarification.

#### **3.12.3. LANGUAGE**

The language of the contract is English. All correspondences and documents submitted shall be in English. This includes any in-house documentation submitted for records or for review, such as factory QA/QC checklists, shipping labels, unit identification labels, etc.

#### **3.12.4. DESIGN RESPONSIBILITIES**

- A. The Specification and Contract Drawings define the scope, performance criteria, design intent and the required geometry of the visible surfaces, the location of joints and the finishes.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

- B. During the design process, the Façade Contractor shall provide all solutions for the works. The requirements stated herein are minimum requirements, unless indicated otherwise. The complete design of the stone façade works shall be the responsibility of the Façade Contractor. This includes providing samples; technical information and testing in order to justify the provided works are of the quality required in the Sub-contract Works Document and this Specification.
- C. The Façade Contractor takes the full responsibility for all structural calculations of the façade structure, components and fixings.
- D. The Façade Contractor may be permitted to provide alternative design proposal provided these proposals do not detract from the design intent and performance requirements as stipulated in the Contract Drawings. Approval must be obtained from the relevant Engineer prior to proceeding with alternative design and installation works.
- E. The Façade Contractor shall be responsible for providing all information relevant to their works. This includes carrying out the construction design and calculations to comply with the relevant codes as specified in the Technical Specifications.
- F. The Façade Contractor shall incorporate post breakage design provisions and testing verifications as required in order to have a safe failure mode of the system in the event of accidental failure.
- G. The Façade Contractor shall incorporate seismic design requirements as required in order to have a safe damage mode of the system in case of seismic event. No parts shall disengage and fall from the building during or after a seismic event.
- H. The Façade Contractor shall address any thermal movement, structural movement, alignment and flatness issues in detail.

### **3.12.5. BUILDING REGULATIONS AND STATUTORY REQUIREMENTS**

#### **A. Statutory Requirements**

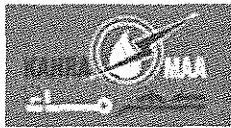
All local and International regulations shall be complied with.

The Façade Contractor's design and execution of the installation shall comply with Internation Stone Cladding Standards.

All materials, products, components and systems and the work executed with them are to comply with all applicable regulations and requirements. Where appropriate, works shall comply with requirements to Statutory Regulatory Inspectors / Engineer's satisfaction.

If not agreed otherwise or in the event of conflict or discrepancy the most stringent regulation, standard or guideline must be taken into account. The latest practicing code prevails.

#### **B. Authority Submissions**



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

The Façade Contractor shall be responsible for providing any drawings, information, test results, translations, and calculations necessary to obtain all Local and Statutory Authority approvals.

### **3.12.6. REFERENCE STANDARDS**

#### **A. Standard Compliance**

The system shall satisfy all the performance requirements of International Standards as outlined below.

Governing Codes and standards shall be stipulated in relevant sections of this Specification.

#### **B. Key Standards**

1. Qatar Construction Specifications 2010
2. American Society of Civil Engineering (ASCE7)
3. British European Standard or British Standard (BS or BS EN)
4. Australian / New Zealand Standard (AS NZ)
5. American Society for Testing and Materials (ASTM)
6. Curtain Wall and Cladding Technology Standards (CWCT)

C. If, in the opinion of the Façade Contractor, he considers that two current standards conflict or are in any way ambiguous he must notify the Engineer and confirm that he will comply with the higher of the available standards.

D. All updates and amendments of applicable Standards and Regulations current at the date of tender return are to be complied with. Where a standard or regulation is updated during the course of the works, the Façade Contractor shall notify the Engineer, formally in writing.

### **3.12.7. ATTENDANCE**

Where the Façade Contractor requires that the Engineer witness a test, attend a meeting or inspection, the Façade Contractor shall give a minimum of five working days written notice.

### **3.12.8. DEFINITIONS AND INTERPRETATIONS**

**Client:** The party who owns this Contract Work after it is handed over by the Contractor.

**Contractor:** The party responsible for managing the Sub-contract Works.

**Facade Contractor:** The party responsible for the design, supply, installation and execution of all the activities that comprise the Sub-contract Works.

**Sub-contract Works:** The works for which, the Façade Contractor undertakes the responsibility.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

<b>Warranty:</b>	Period over which the Façade Contractor is responsible to replace and/or repair free of charge any part/component of Contract Works should it malfunction or become unfit for intended use.
<b>Equivalent Products:</b>	Where the Specification permits substitution of a product of different manufacture to that specified. Equivalent product to be submitted to Engineer for review and approval.
<b>Negative Pressure:</b>	The external pressure on the plane of the wall, direction of pressure is away from cladding face.
<b>Positive Pressure:</b>	The external pressure on the plane of the wall. Direction of force is towards the cladding face.
<b>AAMA:</b>	American Architectural Manufacturer's Association
<b>AMD:</b>	Association of Millwork Distributors
<b>AS:</b>	Australian Standard
<b>ASCE:</b>	American Society of Civil Engineers
<b>ASTM:</b>	American Society for Testing and Material
<b>BMU:</b>	Building Maintenance Unit
<b>CP:</b>	Code of Practice
<b>Design Life:</b>	The period of intended use by the Client.
<b>Service Life:</b>	The actual period of term during which no excessive expenditure is required on operation maintenance or repair of a product or construction (as recorded in use).
<b>Contract Drawings:</b>	Shop Drawings.

### **3.12.9. ACCOMPANYING DOCUMENTATION**

This Performance Specification should be read in conjunction with the following information:

- Architecture – Information and drawings
- Structures – Information and drawings
- Services – Information and drawings
- Fire Strategy Information



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Project documentation listed above will be updated as required. The Main Contractor and Façade Contractor shall coordinate to ensure that design works reflect the updated information.

#### **3.12.10. SUBMISSION AT TENDER**

#### **3.12.11. GENERAL**

While tender options or alternatives submissions are permitted, these proposals shall meet the performance criteria as stipulated in this Performance Specification. The Performance Specification will still apply if the alternate proposals are approved.

- A. Any alternatives to the base tender shall be highlighted with supporting documentation and explanation for proposing substitution.
- B. Sketch proposal of alternative designs, if any.

#### **3.12.12. TENDER SCOPE**

The Tenderers shall clearly describe any work necessary for the proper completion of this Contract which has not been included in his tender and which he may require to be executed, and paid for by others. Any such work not specifically stated and described shall be deemed to have been included for in the tender.

#### **3.12.13. TENDER SUBMISSION DRAWINGS**

The Contract Drawings submitted shall show in detail the solutions to comply with the Design intent whilst maintaining the functional and technical requirements of this Specification.

As a minimum requirement, the Tenderers shall submit the following drawings for tender review purpose:

- A. Typical details of the proposed systems to be used.
- B. Submission drawings, based on the extent, arrangement, dimensions, shapes, finishes, structural conditions, Design and performance requirements as shown on the drawings in order to clearly demonstrate the construction and methods which are to be adopted.

Scale of the tender submission drawings: 1:50 for plans and elevations, 1:5 for details, submitted in A3 format.

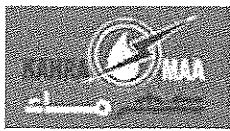
#### **3.12.14. MATERIALS SOURCE INFORMATION**

The Tenderers are required to provide a list of materials offered naming the proposed sources, material qualities and finishes. These shall be in compliance with the Performance Specification.

#### **3.12.15. STONE SOURCE INFORMATION AND CERTIFICATES AT TENDER STAGE**

#### **3.12.16. STONE SOURCE INFORMATION**

At tender stage, the Tenderer shall submit a description of the chosen stone and the times required for delivery of the stone.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Stone type for the Sub Contract works is to be sourced from a single actively working quarry possessing sufficient reserves under development to meet the combined Sub-Contract works requirement.

### **3.12.17. STONE SELECTION AND PROPERTIES**

The Tenderer is to confirm that the desired surface finish is achievable, the quantity and the quality of the material can be guaranteed considering the delivery time for the project. Any significant changes or deviations must be highlighted and discussed at Tender stage.

### **3.12.18. DETAILED SHOP DRAWINGS**

After this Contract has been awarded, the Façade Contractor shall submit to the relevant Engineer a preliminary set of façade system drawings depicting basic design principle for conceptual approval.

Once preliminary façade system drawings are approved in concept, full façade Shop Drawings shall be submitted for Engineer's review, including:

- Overall elevation, plans and sections with partial plans and section callouts.
- Partial plans, partial elevations, sections with all details cross-referenced to these partial drawings.
- Details of fabrication, assembly, installation and fixing anchorage for the cladding system and all interfaces.

These details shall show and describe thicknesses, construction, finishes, areas to be sealed, types and applications of sealants, gaskets, provision for thermal movement, fabrication and erection tolerances, etc.

Overall elevations shall be submitted with references to cladding system types, wind load zones, unit numbering system, setting out information, references of subsequent drawing packages, indication of interfaces in scope, movement and seismic joint locations (if any).

All detail drawing packages to be submitted with relevant supporting calculations signed and sealed by the qualified Professional Engineer responsible for their preparation. The Façade Contractor shall submit full, comprehensive packages. Packages with missing information will be stamped as "NOT APPROVED" and returned without review.

The Façade Contractor shall identify on the detailed working drawings, areas and issues of coordination with work by other Contractors.

When a drawing has been revised and is resubmitted for review each revision or alteration carried out on the drawing shall be highlighted to facilitate the identification of the revisions/alterations. All revisions must be clearly noted in the drawings; clouding and referencing the changes is required. References with description of the change shall be listed on the title block. Notes such as "modify to the Engineer's requirements" will not be acceptable. Failure to comply with this requirement may result in the rejection of the drawing.



### **3.12.19. STONE SHOP DRAWINGS**

- A. Submittals The Façade Contractor shall submit for approval sufficient sets of shop drawings, showing general layout, jointing, anchoring, stone thickness and other pertinent information. These drawings shall show all bedding, bonding, jointing and anchoring details along with the net piece dimensions of each stone unit.
- B. Cutting lists Each stone indicated on the setting drawings shall bear the corresponding number marked on an unexposed surface. Provision for the anchoring, in keeping with standard practices, and for the support of stone by shelf angles and loose steel, etc., when required, shall be clearly indicated on the shop drawings.

No fabrication of stone shall be started until such drawings have been prepared and approved.

The Façade Contractor shall be responsible for determining, making or verifying the design, structural, wind, seismic or other design loads, drawings or specification and the types, sizes or locations of anchors

### **3.12.20. LOCAL AND STATUTORY AUTHORITY APPROVALS**

The Façade Contractor shall be responsible for providing information and calculations where necessary in obtaining all Local and Statutory Authority approvals required in association with his works.

### **3.12.21. STONE PROCUREMENT**

Immediately after the award of the Sub Contract works, the Façade Contractor is to submit a feasibility plan describing the availability and suitability of the specified stone and the time for its preparation and delivery to site.

### **3.12.22. VISUAL MOCK UP**

The visual mock up is constructed to assist in finalizing the material and finishes selection.

The Façade Contractor shall construct a visual mock up. Location of visual mock-up to be specified by Engineer and Client.

The Façade Contractor shall submit drawings describing the entire mock-up which will include full size details showing profiles and thicknesses of all component parts.

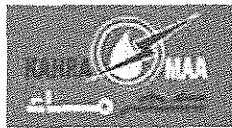
If fabrication is carried out without approval on the visual mock-up, that will be at the Façade Contractor's own risk and may result in abortive work.

### **3.12.23. SAMPLES AND MATERIAL SUBMISSIONS**

The Façade Contractor shall, when required, submit samples which shall be indicative of the type and quality of the material and these shall be reviewed and approved by the relevant Engineer and retained on-site to be used for the purpose of comparison when inspecting the works.

Samples requested shall be delivered to the relevant Engineer's offices free of charge.

Final approval of system drawings and detailed Shop Drawings may be withheld until satisfactory samples have been submitted and approved.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Approved samples shall be kept on site in a sample room until final handover. Samples cannot be incorporated in the Contract Works.

Fabrication and/or erection shall not proceed unless the relevant samples, prototypes or benchmarks have been approved by the relevant Engineer.

Prior to placing material order and to assist material selection and approval, provide the following samples:

- A. Bolts, anchors, screws, pins, rivets and other fixings with manufacturer's details, grade certificate and data sheets
- B. Two (2) visual samples of at least 600mm x 600mm of the stone cladding types. As far as is practically possible the samples shall display the likely range of: colour; figuring and normal features (e.g. shells, veining, spots etc.). Samples are to have the finish as specified by the Engineer with the required coatings applied to half the stone face and be clearly marked with the finish.
- C. Samples submission shall be accompanied with name of suppliers, product data sheets, performance data, test certificates.
- D. Further samples may be requested by the Engineer.

#### **3.12.24. METHOD STATEMENTS**

#### **3.12.25. GENERAL**

Upon award of contract and prior to the commencement of fabrication drawings the Façade Contractor shall submit a revised coordinated method statement for review. The Façade Contractor's method statement shall describe the activities and methods he proposes to use.

#### **3.12.26. SCOPE**

The Façade Contractor's method statement shall deal with all aspects of this Contract including site organization, temporary works, final cleaning and including such matters as:

- A. Design
- B. Methods of handling, and transportation including storage
- C. Construction and installation sequences
- D. Temporary works
- E. On-site quality control procedures
- F. Mock up, prototype
- G. Protection
- H. Testing and commissioning

#### **3.12.27. QUALITY PLAN**

The Façade Contractor shall produce a project specific Quality Plan. This plan shall follow the guidelines of BS EN ISO 9001 and must demonstrate exactly how the control mechanisms pertaining to quality, from the initiation of the contract through to completion, will be implemented.

The quality plan may make use of existing quality management documentation but is required to be project specific. It is essential that an active inspection regime is



implemented as part of the quality monitoring process. The Quality Plan specified shall form part of the Façade Contractor Inspection and test plan.

The quality plan shall be produced at the beginning of the Design phase and shall include the following:

- A. The name of the quality manager.
- B. Full schedule of inspection procedures.
- C. Examples of checklists.
- D. Hold points.
- E. Schedule of manufacturing procedures.
- F. List of product information.
- G. List of Sub-contractors (if any) and suppliers.
- H. Storage, handling, packaging, transport and protection requirements.
- I. Rejection and re-working procedures.
- J. Re-inspection procedures.
- K. Calibration records.
- L. Contractor and supplier quality plans.
- M. Certification of compliance with Specification.
- N. Checklist register.
- O. Procedure for tracking panels showing co-relationship between panel numbers and assembly stage tracking
- P. Panel numbering in elevation

It is essential that a full inspection record is available for all components, which are not visible in the assembled components.

Completed quality audit records shall accompany the components at all fabrication stages and form part of the delivery documents.

The Façade Contractor shall note that a very high standard of finish and alignment in terms of workmanship shall be required.

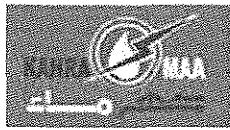
### **3.12.28. QUALITY CONTROL PROCEDURES**

The Façade Contractor shall submit a coordinated (between Façade Contractor and Main Contractor) Quality Control Procedure to the Engineer for approval. Quality control procedures for both in the factory and on site that will be undertaken by the Façade Contractor to ensure that the design integrity and performance of the installed system components are maintained.

### **3.12.29. SUBMISSIONS BEFORE PRACTICAL COMPLETION**

### **3.12.30. OPERATION AND MAINTENANCE MANUAL**

Eight weeks prior to the handover of this Contract Works, the Façade Contractor shall submit two copies of the draft operation and maintenance manual for approval.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Two (2) hard and soft copy (PDF) sets of the approved final version of the operation and maintenance manual shall be submitted to the Client and Engineer a month prior to handover.

The manual shall be A4 size and prepared in a format specified by the Engineer.

The operation and maintenance manual shall contain details of proper operation and maintenance of this Contract works. It shall clearly state the following:

- A. The name, address and telephone number of each firm and/or Sub-contractors involved in the supply of materials, components or assemblies used in the works.
- B. A clear and concise description of the construction method used to build the works.
- C. A thorough and complete explanation of the operation and maintenance principles.
- D. The recommended period to first and follow-up maintenance of all parts of the works.
- E. Cleaning materials and other consumables, and where and how they shall be used.
- F. Cleaning frequency recommended for overall façade and materials (such as coatings), as required, to ensure conformity with the requirements of the guarantee document.
- G. Identification of parts requiring operation and maintenance giving references to location of the item on drawings together with manufacturer's reference numbers, addresses and telephone numbers of firms from whom materials or parts can be obtained.
- H. A method statement covering the procedures for replacement of damaged or otherwise defective materials or components, and materials and components that have a Design life less than the Design life of the facade which will therefore require replacement during the life of the facade.
- I. Manufacturer's technical literature and spare parts manuals, where applicable.
- J. Copies of all test certificates and reports of materials and components as required by this document.
- K. The terms and conditions of guarantees.
- L. A Schedule shall also be provided to identify all finishes by application to facilitate remedial repairs to any subsequent damage. These repairs must be carried out in accordance to with the manufacturer's repair recommendations and method statement.
- M. The Façade Contractor's recommendations shall pay particular regard to safety in operation and maintenance and the requirement of relevant Safety and Health at Works regulations and international norms.

Following hand over of the maintenance manual after practical completion the Façade Contractor shall provide an experienced and qualified member of staff for the required time to familiarize a client's representative with the use of, and information contained within, the maintenance manual.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Record and As-Built Drawings to demonstrate the installations shall be provided.  
Refer to section below.

### **3.12.31. RECORD AND AS-BUILT DRAWINGS**

The Façade Contractor shall keep a full set of up to date detailed working drawings on the site for the exclusive use of recording any change or variation required in the installation.

The Facade Contractor shall prepare detailed, full and accurately dimensioned As-Built Drawings showing this Contract Works as finally supplied and installed.

The Facade Contractor shall prepare the As-Built Drawings for review by the Engineer prior to practical completion of the installation.

This Contract Works shall not be accepted as completed until the Facade Contractor shall have received an 'A' Status by the Engineer.

In addition to the above requirement, the Facade Contractor shall provide a copy of each detailed working/As-Built drawing electronically. All drawings shall be issued in PDF format.

The Facade Contractor shall incorporate all changes and modifications that was carried out to address the comments of the relevant Engineer during site inspections, field tests and final inspections. These shall be recorded in the Record Drawing set and issued in the As-Built Drawing set.

### **3.12.32. SPARE MATERIALS**

The following spare parts stock shall be delivered to site and stored as instructed by the Building Manager two weeks prior to date of practical completion. All parts shall be protected by approved wrapping and stored in crates. These parts shall not be used for replacement of glass and cladding damaged prior to official hand over of the works.

A. Stone: Provide minimum 2% replacement panels per each size, including all necessary fasteners and fixings to install. Submit proposed inventory and stone source information for approval.

Inventory shall be to be submitted for approval by the Engineer.

### **3.12.33. SCOPE OF CONTRACT WORKS**

#### **3.12.34. OVERALL CONTENT OF THE CONTRACT WORKS**

The Facade Contractor shall Design, procure, supply, deliver, test, manufacture and install a complete stone façade to the curved wall in front of the Main Pump Building, as described in accordance with the information outlined on the Contract Drawings and this Performance Specification.

The scope of works covered by this Contract includes, but is not limited to, the following principle elements of construction:



### **3.12.35. ADDITIONAL STONE CHARACTERISTICS**

Movement joints are only to be as shown on the contract drawings, subject to the Façade Contractor checking this provision against BS 8298:2004. The detailing of the support and restraint fixing methods are to allow for differential movement.

The cladding is to be supported on a substructure which is fixed via post-fixed brackets onto solid concrete blocks and slab edges, the design of which is to be fully coordinated and agreed.

Works which may involve site drilling must satisfy health and safety requirements and are subject to the approval of the Engineer.

### **3.12.36. SUITABILITY OF THE WORKS BY OTHERS**

The Façade Contractor shall undertake a survey of preceding Contractor's works including the details of points of attachments/interfacing for the primary brackets (such as position, dimensions and suitability of any work). The Façade Contractor shall coordinate with the Main Contractor if such work is wrongly dimensioned or in any other way not suitable for his installation. The Main Contractor and his Façade Contractor shall propose methods of rectification works where necessary to ensure timely delivery of installation. Deviations shall be recorded in the form of drawings (plans and elevations from datums that were provided by the Main Contractor).

The Main Contractor and the Façade Contractor shall coordinate to ensure all the necessary remedial actions are approved by the related Engineer and carried out so as not to delay the Contract programme.

Commencement of installation by the Façade Contractor shall indicate that the Façade Contractor has accepted condition of site and base structure as suitable for installation.

The Façade Contractor shall have no claim or right of action against the Client arising from work executed or to be executed by others.

### **3.12.37. INTERFACES WITH OTHER CONTRACTORS**

- A. The Façade Contractor shall ensure that staging of works and thorough interfacing coordination with the other packages are carried out during the design, fabrication, installation and commissioning of the Works.
- B. Coordination and interfacing will be required with the following and not limited to:
  - Lighting and electrical
  - Lightning protection
  - Facility management systems
  - Landscaping and paving



### **3.12.38. PART 2 - DURABILITY**

### **3.12.39. DESIGN LIFE**

#### **3.12.40. GENERAL**

The Design Life of the all the items and their component parts as per the scope of work shall be as follows, assuming routine maintenance is undertaken:

Building structure 60 years

Stone cladding 50 years

Design life expectancy starts from the practical completion date.

#### **3.12.41. SITE CONDITIONS**

Site exposure Arid desert Pollution rating Medium, with frequent dust storms UV-exposure Very high

#### **3.12.42. REFERENCE DOCUMENTS**

The terms used in this section are those defined in BS EN 7543.

#### **3.12.43. DURABILITY**

The Performance Criteria shall be satisfied for the full Design life of the external cladding.

#### **3.12.44. DURABILITY OF PRIMARY COMPONENTS**

The following shall be considered as primary components i.e. they are all components with a predicted service life not less than the design life of the external cladding without the need for maintenance, other than regular cleaning.

- All framing components, their fixings, and means of attachment to the structure.
- Cladding Panels and their fixings.

#### **3.12.45. DURABILITY OF SECONDARY COMPONENTS**

- The Façade Contractor shall state the predicted service life of all the secondary components and provide guidance on the required maintenance, replacement periods, and methods of replacement.
- Secondary components shall be capable of easy replacement without compromising the structural and weatherproof integrity of the external cladding.  Secondary components shall be capable of replacement without progressive dismantling of the external cladding.
- Secondary components are all components with a predicted service life of less than the Design life of the external cladding, assuming regular cleaning and maintenance in accordance with information to be provided by the Façade Contractor.



### **3.12.46. CORROSION**

Uniform corrosion to the exposed surface must be prevented. Design to be in accordance with BS EN 5250 and BS EN 6229 (risk of condensation).

The Façade Contractor shall design the façade system with the following considerations to minimize effects of corrosion:

- System design shall shed rather than trap water and allow complete drainage.
- Prevention of dirt build up by allowing rain-washing of exposed surfaces
- Prevention of condensation and ventilation or design that aids drying of condensation or penetrating water.
- On-site organic or metal coatings shall be prevented.

The Main Contractor and Façade Contractor shall inform the Engineer about any recorded site corrosion prior to any action in a monthly log during the construction stage of the project.

### **3.12.47. BIMETALLIC CORROSION**

At all locations where different metals are assembled together the Façade Contractor shall be responsible for ensuring that electrolytic corrosion will not occur.

Measures to prevent the effects of galvanic corrosion include, but are not limited to:

- Electrically isolate dissimilar metals from each other;
- Avoid an unfavorable anode-cathode surface area ratio by using an anode area as large as possible;
- Ensure moisture is unlikely to accumulate between dissimilar metals over long periods;
- If coupling of dissimilar metals is unavoidable, choose two that are close together in the galvanic series.
- Coating systems will not be considered as a form of bimetallic separation.

Cementitious Surfaces: All aluminium components in direct contact with cementitious surfaces shall be isolated. Refer to the recommendations made by CWCT TN 24.

### **3.12.48. INFESTATIONS**

Materials used in the manufacture of the external cladding, or its components, shall not be liable to infestation attack by micro-organisms, fungi or insects.

### **3.12.49. COMPATIBILITY**

Any material in contact with each other shall be compatibility tested to ensure that there is no staining, decrease in strength or change in material properties.

### **3.12.50. WARRANTIES**

The following warranties are to be provided as a minimum:

- General System Warranty 12 years



- Stone cladding 25 years
- Aluminium framing (including their brackets, fixings and means of attachment to the structure) 25 years
- Steel and stainless steel framing (including their brackets, fixings and means of attachment to the structure) 25 years
- Warranty date starts from the practical completion date.

#### **3.12.51. SEISMIC LOADS**

The Façade System shall be designed for seismic loading. It is assumed that movement due to seismic activity will be minimal. The cladding system shall account for the stated seismic movements. There are no seismic joints for this project that affect the facade system.

#### **3.12.52. LOADING DURING MANUFACTURING AND INSTALLATION**

All cladding types have to carry safely:

- Wind loading experienced as a temporary loading during construction phase.
- Additional access loads associated with construction to be coordinated with the Façade Contractor.
- Other loads arising from the temporary or partial support of the cladding components and assemblies during lifting. Cladding components shall not suffer from damaging deflections during lifting or transportation.

#### **3.12.53. STABILITY**

The Design and construction of the system shall be such that it remains rigid and free from undue play, and permanent deformation caused by its self-weight, wind loads, maintenance loads and impact loads or the normal use to which they will be subjected.

#### **3.12.54. ALUMINIUM OR STEEL FRAMING FOR CLADDING**

- Dead Loads + Live/Imposed/Impact Loads: The maximum in-plane deflection of any main framing member due to dead loads and Live/Imposed/Impact loads shall not exceed 1/500 of the span or 3mm whichever is the lesser.

#### **3.12.55. ALUMINIUM, MILD STEEL AND STAINLESS STEEL BRACKETS AND FIXING**

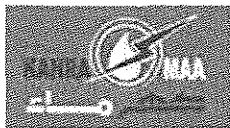
Design of aluminium elements shall be in accordance to BS EN 1999-1-1, -1-3 and -1-4. Design of mild steel, stainless steel and cold-formed steel shall be to BS EN 1993-1-1, 1-3, 1-4, 1-5, 1-8, 1-10 and BS EN 1090-2.

Deflection criteria for metal cladding shall be limited to L/90.

#### **3.12.56. STONE PANEL DESIGN**

- A. The minimum stone thickness shall be: 40mm -0mm + 2mm (stone thickness to be confirmed by the Façade Contractor based on stone selection)

The Façade Contractor must use the minimum expected flexural and compressive strength values recorded by the tests prior to the stone procurement. If the tests



during processing do not confirm the data recorded before the procurement, the stone thickness has to be increased accordingly. The possible increasing of the stone thickness and the implications of it are at the Facade Contractor's expenses.

- B. If based on satisfactory historical experience, the minimum stone thickness could exceed the requirement of the BS 8298:1994, section 3.9 if proved by adequate structural calculations and performance testing. The type and level of testing must be agreed with the Engineer and shall be at the Facade Contractor's expenses.

### **3.12.57. ACCOMMODATION OF MOVEMENTS**

#### **3.12.58. GENERAL**

The whole facade is to be capable of accommodating the following movements without any reduction in the specified performance:

- Due to deflection under design loads.
- Due to the effects of repeated wind loading.
- Due to changes in dimension and shape of components arising from building movements, including settlement, creep, twisting, and racking
- Due to seismic movements of the base structure and seismic racking of each panels
- Changes in service temperatures and from differential service temperatures between the inside and outside of the building.
- Thermal movement with no effect.
- Movement due to moisture content, either inside or outside the building.
- Due to maintenance loading

#### **3.12.59. ACCOMMODATION OF THERMAL MOVEMENT**

The whole facade is to be capable of accommodating changes in dimension and shape of its components resulting from changes in service temperatures and from differential service temperatures between the inside and outside of the building without any reduction in the specified performance.

Fabrication, assembly and erection shall therefore take into account the ambient temperature at the time of the respective operations from fabrication, assembly to its lifespan after installation.

Where necessary, carry out checks in respect of the influence of thermal movement on air permeability and water penetration performances of the installation.

The external cladding and all related components shall be designed so that any resultant thermal movements are achieved without any noise.

#### **3.12.60. ACCOMMODATION OF MOISTURE MOVEMENT**

If susceptible to moisture absorption, the façade components, including all joints between it and other works shall be capable of accommodating the following movements without any reduction in the specified performance:



- Due to changes in the moisture content of its components, resulting from variations in the moisture content of the air, either inside or outside the building.
- Due to the expansion of absorbed or retained moisture due to temperature change.

### **3.12.61. MATERIALS AND COMPONENTS**

#### **3.12.62. GENERAL TERMS**

All materials used in this Contract must be in accordance with all relevant statutory or local bylaw requirements and the recommendations of any relevant specified Standard or Code.

The Façade Contractor shall submit full details of all materials specified e.g. composition of materials, strengths and current BS EN / CP / AS / ASTM numbers where applicable. Compliance with other than these codes are not allowed unless separately approved.

The Façade Contractor shall make careful selection of materials to ensure that they are:

- In all respects eminently suitable for the purposes for which they are to be used.
- Totally compatible between each and every material used within the system and between the system and constructions supplied and fitted by others.

All materials and components used in this Contract must be new and obtained specifically for this Contract. The use of recycled or unused material or material content is not permitted.

Where proprietary materials are proposed they must be used in strict accordance with the manufacturer's printed instructions. Submit these for records.

The Façade Contractor is entirely responsible for the whole of the Contract Works finishes and shall ensure that all the finishes are executed by persons skilled in such work.

#### **3.12.63. STONE PROCUREMENT**

#### **3.12.64. RANGE SAMPLES**

- A. As soon as possible after award of Contract, the Facade Contractor shall arrange for 12 no. slabs of the thickness proposed for the Sub Contract works, to be cut from two or three randomly selected blocks taken from current workings at his elected quarry. These slabs shall then have the specified finish applied and shall be set up in the quarry with a neutral background and orientated facing east or west to enable viewing in shadow or sunlight. The slabs shall be at least 600 mm wide x 600 mm high.
- B. Six range samples shall be agreed. The samples shall then divided into two sets of three, namely "Upper Limit", "Benchmark", "Lower Limit". Each set of three shall indicate the agreed range. One set of three shall be set up in the Facade Contractor's fabrication yard/quarry and one set shall be kept on site, all to the satisfaction of the Client. Both sets are to be marked and signed by the Client and the Facade Contractor and photographed, with copies of the photographs to be retained by the Main Contractor. The slabs marked with unacceptable features shall be set up at the Facade Contractor's fabrication yard/quarry.



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)

- C. The Facade Contractor shall use these range samples to assess the visual quality of the stones processed during the fabrication and installation of the Works. He shall immediately notify the Main Contractor of any variations outside the agreed range.
- D. The Facade Contractor is to obtain approval of appearance before placing orders with suppliers or proceeding with production.

#### **3.12.65. QUALITY TESTING DURING PROCESSING**

- A. After passing the tests prior to the stone procurement, the Facade Contractor shall provide and test the sample/prototypes in order to demonstrate that the proposed stone will satisfy the properties expected by historical data and by the preliminary tests.
- B. The Facade Contractor shall provide sufficient samples of the required size to the Test Authority on request.

#### **3.12.66. NOTIFICATION OF VARIATIONS DURING PROCESSING**

- A. The Facade Contractor must inform the Client and the Engineer about any aesthetic or performance deviations during production.
- B. Should production begin falling outside of the expected stone appearance or performance properties, the Facade Contractor shall make arrangements for further inspections. Any remedial solutions to overcome the problem have to be agreed by the Engineer and they shall be at the Facade Contractor's own expenses.
- C. If there is a significant discrepancy between the production tests and the preliminary or historical test results, it is the discretion of the Engineer to conduct further testing of the stone to find the extent of the weakness and if appropriate, modify the specification accordingly before further production of the stones commences.
- D. The stone shall not exhibit any textural variation or bedding structure that will cause excessive differential weathering or cracks to develop.
- E. Each finished stone element shall be of sound quality and free from any defects as outlined under the visual appearance criteria that are liable to affect the physical properties, durability or appearance, other than those agreed as acceptable to the Client and Engineer from the range samples.

#### **3.12.67. MARKING AND PACKAGING**

- A. All in accordance with the Section 5 of BS EN 1469:2004.
- B. Marking and labeling is required for each stone piece. Marks and labels to refer the intended facade area of installation, size, thickness, stone type and proof of QA/QC check.



### **3.12.68. VISUAL APPEARANCE CRITERIA**

### **3.12.69. GENERAL**

- A. Generally stone must be free from any defects, including naturally occurring ones, which may adversely affect the strength and durability.
- B. Aesthetical imperfections not listed below and not reducing strength will be acceptable only if not noticeable when the slab viewed in vertical position from a distance of two meters by the Engineer and the Client.
- C. Edge damages and corner damages occurring during handling are only acceptable if not weakening the stone, not noticeable when viewed from 2 meters distance and are bow shaped. Triangular splits and damages, sharp defects are not permitted.
- D. Natural discoloration of the stone is only acceptable as marked on the control samples. The discoloration cannot exceed 10% of the area of the given stone slab.
- E. Definitions and permitted tolerances of naturally occurring geological features:

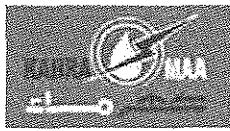


Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)

Naturally Occurring Geological Features	Definition	Permitted Tolerance
Vents	Fault in a stone that constitutes a weakness	Not permitted
Holes	Varying in diameter (5 – 25 mm) and filled with clay or sand deposits	Maximum size 5 mm diameter Maximum one number per unit Fill (off site) holes more than 5 mm in length, width or depth to maintain integrity and appearance as per agreed range samples. Do not fill fossil holes. Note: Holes shall be filled on site at discretion of the Engineer.
Cracks	Split penetrating to the other side	Not permitted
Fissures	Split which does not penetrate to the other side	Not permitted
Veins	Body of mineral usually impinges in a rock or fault	Veins lighter or darker than the general stone colour range – no restriction or limited to that evident in benchmark samples stones
Markings	Randomly shaped differences in colour	Limited to that evident in the benchmark sample stones
Fossils	Relic of once living plant or animal	No restriction
Pitting	Regular or irregular shaped indentations of less than 5 mm in diameter	Limited to that evident in the benchmark sample stones
Spalls	A relative thin, sharp edge fragments produced by exfoliation	Not permitted
Shell	A thin hard layer of rock	Not permitted
Staining		Not permitted

### 3.12.70. CONSTRUCTED APPEARANCE

- A. Generally, selected stone must be free from any defects, including naturally occurring ones, which may adversely affect the strength and durability.
- B. The Facade Contractor shall ensure there is a spread of the range through the various sections of the project to avoid group patching of like pieces and checkerboard patching.
- C. The Facade Contractor shall ensure that any similar character pieces are not installed adjacent to one another.
- D. Agreement on the degree of spread of range and adjacent similarity shall be obtained from the Client and Engineer as the works proceed.



### **3.12.71. STONE REPAIRS**

Stone repairs are not permitted.

### **3.12.72. STONE FINISHES AND EDGES**

- A. All panel edges and face surfaces shall be finished as selected by the Engineer.  
Back surface may be saw cut finish if minimum thickness is maintained at each point of the slab. If production quality does not seem to be even, honed back finish is required.
- B. Texturing and finish shall be in accordance with samples held by the Main Contractor, which can be viewed by appointment.

### **3.12.73. SEALANTS**

#### **3.12.74. GENERAL**

Pre-approved Sealant Suppliers are as follows:

- Dow Corning
- Momentive
- Sika
- Tremco

Other Sealant suppliers are not accepted. Only original Products are accepted.

The colour of all sealant materials to be used is to be agreed by the Engineer. The characteristics of the sealant have to be in compliance with this Specification and approved by the Engineer.

All sealants used in the construction and assembly of components shall be stored, applied and cured strictly in accordance with the manufacturer's printed instructions.

All sealants must be used only with the prior approval of their manufacturer for the intended application. The Façade Contractor shall be responsible for obtaining this approval and shall confirm to the Engineer that it has been obtained. Application of sealant materials shall not commence until the approval has been obtained from the manufacturer.

The certificate of approval shall indicate:

- The drawing number, the date and any revision thereto with regard to all the relevant design, performance and test criteria set out in this Specification to which the certificate applies.
- The sealant's adhesion and compatibility with all components to which it will come into contact and/or required to adhere to.  The life expectancy of the sealant materials detailed and specified.  Approval of joint design and dimension.  Approval that joint can accommodate the anticipated thermal movement of the components to which the sealant shall be applied.
- The value of the Movement Accommodation Factor (MAF) for each type of sealant as per BS EN 6093 and 6213. The MAF is defined as the total movement which a sealant is capable of tolerating throughout its working life expressed as a percentage of the minimum joint width.



**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

Oil or butyl based materials shall not be used under any circumstances.

Any failure of the sealants in any respect will be the Façade Contractor's responsibility and such faulty seals and caulk shall be promptly replaced at no additional cost to Client.

The primer for all sealants shall be as recommended by the sealant manufacturer and indicated in the Shop Drawings as required.

Sealant joints shall be completely filled with sealant supported by a suitable joint filler back up. The joint filler back up material and bond breaker shall be closed cell, polyethylene foam compacted when in place to approximately two-thirds its original width. It shall not emit entrapped gas at any time.

Sealants, primers and joint filler materials used shall not contain acids or ingredients which will stain concrete, masonry, terracotta or any other facing material or corrode metal or have injurious effects on organic or anodised finishes.

Sealant joints are to be a consistent width suitable to receive sealant and perform as intended.

The sealant joints shall be tooled to a clean, neat finish leaving no gaps or bubbles and no excess sealant on adjacent surfaces.

Particular attention shall be paid to the design of joints in runs of pressed metal assemblies such as parapets, sills and soffits. These joints shall have a minimum bearing surface of 12 mm for the sealant and be properly equipped with a bond breaker and secondary plate to provide support for the sealants and to allow a secondary seal to be introduced.

Assemblies with sealants forming air or water seals shall not be moved, twisted, racked or distorted until the sealants have cured and properly set.

Assemblies with sealants forming air or water seals shall not be moved, twisted, racked or distorted until the sealants have cured and properly set.

All sealants shall be in accordance with BS EN ISO 11600 and recommendations given by the CWCT Technical Note No.19 in order to comply with the requirements for such materials contained in this Specification.

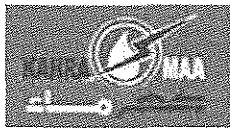
Fire rated sealants to be applied where fire rated assembly is required. Pre-approved suppliers include Hilti and Gluske. Fire rated sealant to be rated minimum category B1 as per DIN 4102.

Design of the sealant joint shall be in accordance with BS EN 6093, BS EN 6213, and recommendations given by the CWCT Technical Note No.20 and the CIRIA Report R 1988 in order to comply with the requirements for such materials contained in this Specification.

### **3.12.75. INSTALLATION OF THE SEALANT**

The Façade Contractor's attention is drawn to the high quality of workmanship required in the application of the sealant in order to meet the performance criteria set out herein. All sealants used in the construction and assembly of components must be applied strictly in accordance with the manufacturer's printed instructions.

The Façade Contractor shall ensure that sealants will not adversely affect the system or any of the building components.



Assemblies with sealants forming air or water seals must be kept clean, protected and not be moved, twisted, racked or distorted until the sealants have cured and properly set.

### **3.12.76. ALUMINIUM EXTRUSIONS**

- A. All extruded aluminium framing members shall be fabricated with heat treatable 6061 or 6063, temper T5 and T6 complying with BS EN 1999-1-1, -1-3 and -1-4, BS EN 12020 and BS EN 755 Parts 1 to 8, unless shown otherwise on the approved drawings. Brackets to be of grade 6061. Submit calculations to verify material selection. In addition, the alloy shall be selected to satisfy the requirements of the chosen finishing process.
- B. All extrusions shall be designed in accordance to BS EN 1999-1-1, -1-3 and -1-4. In any event aluminium extrusions shall be of adequate thickness and strength, not only to meet the structural requirements, but also to eliminate any risk of distortion in the finished surfaces. The thickness of extrusions shall be sufficient to ensure their complete rigidity in the lengths required in the final installation.
- C. The minimum wall thickness of the extrusions shall be as follows: Structural sections 3.0 mm Non-structural sections 2.0 mm
- D. Protection

All finished aluminium surfaces are to be carefully handled at works, on site and during transportation. All items shall be carefully packaged so as to avoid any damage whatsoever during the delivery and handling. Packing material shall not absorb and store moisture to avoid water mark damage of aluminium. Secure storage areas will be coordinated and provided by the Main Contractor. No damaged materials of any sort shall be fixed either in exposed or concealed positions.

The Façade Contractor will be responsible for the adequate protection of his work until completed and particular emphasis is placed upon the importance of avoiding any blemishes whatsoever on the finished aluminium faces.

### **3.12.77. MILD STEEL**

#### **3.12.78. GENERAL**

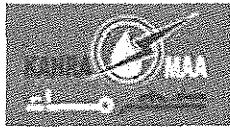
- A. Basis of Design: steelwork shall be designed to BS EN 1993-1-1, 1-5, 1-8, 1-10, BS EN 1090-2 and BS EN 1994-1-1.
- B. Grade: Structural steel to be S275 (Grade 43) or S355 (Grade 50). Wall thickness of structural components shall not be less than 5mm.

#### **3.12.79. MILD STEEL PROTECTION**

#### **3.12.80. GENERAL**

All mild steel is to be protected from corrosion with:

- Hot dip galvanisation to BS EN ISO 1461 by a member of the Galvanisers Association. Minimum average coating thickness: 140 microns for concealed exterior steel and 75 micrometers for concealed internal steel; OR.



- Electrodeposits of zinc coating Zn 12 as per BS EN ISO 2081 with chromate conversion to Class 2C or 2D. Electrodeposits of Zinc are not allowed for hollow sections.

### 3.12.81. PREPARATION

Preparation to be: blast cleaning to BS EN 7079 Part A1, preparation grade Sa2 using chilled iron grit grade G24 to give a coarse surface profile, followed by acid pickling.

Surface profile: Blast profile on steel shall be 40-60 microns in depth, and be of sharp, jagged nature as opposed to a "peen" pattern from shot blasting.

Defects in the steel: Remove all surface defects likely to be detrimental to the protective painting system, including:

- Defects in the steel, including cracking, surface laminations, shelling and deep pitting
- Defects resulting from fabrication, including fins and cuts, burrs, sharp edges and weld splatter.
- Rogue peaks remaining after blasting. Where extensive grinding is necessary to remedy defects, re-blast the dressed areas.

### 3.12.82. WORKMANSHIP

- A. Preparatory work: All cutting, welding and drilling to be completed beforehand. Provide all necessary vents and drain holes in approved locations and seal to approval after galvanising.
- B. Sequence: Except with the written approval, all hot dip galvanising shall be carried out subsequent to fabrication and welding. Where written permission has been granted for fabrication and welding subsequent to galvanising, any damaged or affected areas shall be cold galvanised to the approval, minimum thickness of 130 microns.
- C. Repairing work: The Façade Contractor shall be responsible for repairing by cold galvanising all damaged elements to approval. Repairs shall include the complete removal from the weld or area of breakdown of protection of all deleterious material including slab, scale, oil and paint, etc and preparation of the surface to ensure that the local protection is of a standard equivalent to the general protection.
- D. Fixings: After galvanising all nuts shall be tapped to prevent stripping of the galvanised coating on the bolt/threaded rod. Following tapping, the nuts shall be stored in a dry sealed bag until use.
- E. Storage: Ensure that all galvanised articles are not stored under damp or badly ventilated conditions; the Façade Contractor shall also take all other necessary measures to safeguard against white rust discolouration prior to the post treatment application.
- F. Repairs after installation: Subsequent to erection and the final tightening of all connections, the Façade Contractor shall repaint, to the specified general standard, any areas damaged or affected by wet storage staining (white rust).
- G. Mechanical properties: Avoid mechanical damage. Ensure that mechanical properties of the base metal do not change.
- H. Distortion and cracking: Not acceptable.



- I. Embritttlement: Take due care in processing steel that is susceptible to embrittlement.
- J. High strength friction grip bolting: Buff faying surfaces after galvanising.
- K. Surplus zinc on fastener threads: Remove.

#### **3.12.83. SAMPLES**

The quality of protection on an agreed sample to be approved before repetitive coating proceeds.

#### **3.12.84. APPLICATORS**

All operators are to be appropriately skilled and experienced in the use of specified materials and methods of application.

#### **3.12.85. INACCESSIBLE SURFACES**

The sequence of working must be such as to ensure that surfaces inaccessible after assembly receive the full specified treatment and coating system including, if necessary, local shop application of site coatings, or site applications of alternative approved systems at particular locations.

#### **3.12.86. PROTECTION**

All freshly applied surface coatings shall be adequately protected from damage. All surfaces adjacent to those being covered shall be adequately protected.

#### **3.12.87. REMEDIAL WORK**

Early degradation of coatings by blistering, peeling, flaking, cracking, lack of adhesion, etc. to be made good by complete removal, preparation and reapplication of all coats as instructed. Where tests show that the material is unsatisfactory, any work coated with such material shall be re-executed to approval.

#### **3.12.88. MILD STEEL FINISHES**

##### **3.12.89. GENERAL**

All exposed mild steel shall be coated by an approved multi-coat coating system, such as powder coating (see section below), or epoxy micaceous iron oxide barrier coat with polyurethane finish coat.

#### **3.12.90. STAINLESS STEEL**

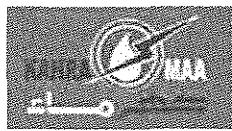
##### **3.12.91. GENERAL**

Stainless steel must be austenitic. Grade AISI 304 shall be used for internal (not visible) application and Grade AISI 316 shall be used for external applications and internal where visible.

All stainless steel cables and rods must be provided from a single supplier, and all Spiders must be provided from a single supplier.

#### **3.12.92. FABRICATION OF STAINLESS STEEL**

Fabrication aspects must be in accordance with BS EN 10088: (part 1, 2, 3) and SCI P291 "Structural Use of Stainless Steel", part 7.



Tolerances on dimensions must be in accordance with the BS EN 10029, BS EN 10048, BS EN 10051, and BS EN ISO 9445.

### **3.12.93. BRACKETS AND FIXING SUPPORTS**

All brackets, anchorages and supports must be fabricated and installed for full compliance with this Specification, including the accommodation of thermal, wind pressure and all other building dynamics.

All bracket construction and fixings must be fully protected to prevent corrosion and any bimetallic degradation that may occur due to dissimilar metals being in contact generally in accordance with the provisions of BS EN 6484.

The Façade Contractor must be responsible for supplying and fixing all necessary anchors and supports for the complete installation. The Façade Contractor shall allow for all necessary drilling to the structure and for the supply and fixing of stainless steel bolts and attachments.

"On site" rust proofing shall not be allowed.

Provide plastic shimming separators between stainless steel and galvanized mild steel.

### **3.12.94. GENERAL**

Fixings shall comply with the relevant Codes, Standards, and Manufacturer's Guidelines.

Fixings shall be designed so that the failure of any one fixing does not lead to progressive failure of adjacent fixings. All fixings for the façade have to be designed according to BS EN 1993-1-1, 1-5, 1-8, 1-10, BS

EN 1090-2 AND BS EN 1994-1-1. (Steel) and BS EN 1999-1-1, -1-3 and -1-4 (Aluminium). Fixings are any items used to attach the cladding to the structural frame and substrate, including,

but not necessarily limited to, brackets, plates, bolted connections, cast-in fixings and inserts, and all hardware required for stability. Fixings to be concealed in general. Where concealed fixings cannot be provided, pignose

fixings, countersunk bolts with capping, or other aesthetical fixing solutions to be provided, subject to Engineer's approval and calculations. Length of the fixings shall protrude past the thickness of nut by at least 3 threads.

All tested fixings or anchors shall not be used for installed facade works. Weld washers shall be used where required. Such washers shall be galvanized mild steel and shall not be less than 5mm thick.

Split washers shall be used with all weld washers. All screws shall be sealed with approved weatherseal. All post-installed anchors into concrete shall hold a valid European Technical Approval (ETA) or

ICC-ES report. Installation of post-installed anchors into concrete shall be as approved by the manufacturer.

If serrated washers will be used, the Façade Contractor must prove the structural suitability of the bracket design, especially with regards to the welds and the galvanization process of the serrated washers.



Reference is to be made to ETAG 001 for the design method for fixings into drilled holes in concrete.

### **3.12.95. SAFETY FACTORS ON FIXINGS AND FASTENERS**

All fixings and fasteners shall comply to testing requirements as stipulated in Clause 6.4.

### **3.12.96. TORQUE SETTINGS**

As part of the detailed material submission following the award of contract, torque settings must be supplied for all structural bolted or screwed fastenings.

### **3.12.97. BOLTS, NUTS AND WASHERS**

#### **A. Connection bolts**

Bolts and Nuts: Ordinary bolts and nuts shall comply with BS EN 3692, BS EN 4190, BS EN 14399 Parts 1-6 or BS EN 4933 as appropriate. Nuts shall be of at least the strength grade appropriate to the grade of bolt or threaded element with which they are used.

Washers: Plain washers for use with ordinary bolts and nuts shall comply with BS EN 4320. Where specified, the nuts used on connections subject to vibration shall be secured to prevent loosening.

Self-Locking Nuts: Self-locking nuts or a chemical product approved by the Engineer shall be used or else the nuts shall be secured by the use of locknuts. Where slotted holes are provided for movement connections the joint shall be free to move. Provide lock-nuts for vertical bolts in tension.

Angles: The angle between the axis of the bolt and bolt head shall be 90 degrees.

Load indicating washers: when placed under bolt head, shall prevent the bolt turning when tightening. When placed under the nut, nibs shall be protected with a hardened washer and prevent both washers from turning when tightening.

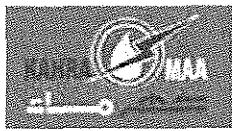
Re-tightening: Bolt assemblies that have been fully tightened and subsequently released are to be discarded.

#### **B. Finish to Bolt Assemblies:** All internal and not visible bolts, nuts and washers shall be spun galvanised, zinc plated sherardized or as otherwise approved. Prior to any work being undertaken the Façade Contractor shall confirm in writing that the finish is compatible with the steel finish and the environment. Nuts to be tapped after galvanising.

All external and visible bolts, screws and nuts, used for the curtain walling assemblies and for fixings to the structure, shall be of adequate strength for their design purpose and shall be austenitic stainless steel, type 316 S16 (PD 970).

#### **C. Sealed Hollow Sections:** All bolt holes to prevent access of moisture. The Façade Contractor is to submit the sealing proposal. No bolt holes are accepted for approval prior to manufacture in the external hollow sections.

#### **D. High Strength Friction (HSFG) Bolts:** Unless otherwise specified high strength friction grip bolts, nuts and washers shall comply with BS EN 14399. Where other types of high strength friction grip fasteners are used, they shall have mechanical properties similar



to bolts complying with BS EN14399 and be capable of being tightened to the minimum shanks tension specified in BS EN 1993-1-8.

- E. Faying surfaces for HSFG joints: The Façade Contractor shall check the faying surfaces in steel 25mm thick or more for deformities such as bowing, twist or rippling which may reduce the slip factor to below the design limit. Any remedial measures to be approved.
- F. Expanding Bolts and Nuts: The Façade Contractor shall submit the manufacture and type of expanding bolts and nuts for approval.
- G. Stud Bolts and Screws: Stud bolts and screws shall be pull tested to 2 times Design pullout load with no sign of fatigue to the fixing and base material. 10% of fixings shall be tested.
- H. Load indicating washers: When placed under bolt head, the Façade Contractor shall prevent bolt turning when tightening. When placed under nut, the Façade Contractor shall protect the nibs with a hardened washer and prevent both washers from turning when tightening.
- I. Spring Washers: Spring washers shall comply with BS EN 4464. All fixings shall be fixed off with spring washers.
- J. Weld Washers: Where oversized holes are provided in bracket or base-plate and restraint shall be provided, weld washers of minimum thickness of 5mm shall be provided. Full welding around the weld washers are required, spot welding is not acceptable.
- K. Tapered Washers: The Façade Contractor shall use suitably tapered washers under bolt heads and nuts which bear on sloping surfaces. These shall be prevented from turning when tightening. Where bearing faces are not parallel use tapered washers to compensate for lack of parallelism.
- L. Pins: The retention system to the head of pins shall to be designed to take a minimum of 2% of ultimate capacity of the pin.
- M. Testing: See Section 6.4 of this Specification.

#### **3.12.98. CONCRETE ANCHORS**

- A. Mechanical anchors for use in cracked and uncracked concrete shall have been tested and qualified for use in accordance with ACI 355.2 and ICC-ES AC193 or ETAG 001.
- B. Adhesive anchors for use in cracked and uncracked concrete shall be been tested and qualified in accordance with ICC-ES AC308 or ETAG 001.

#### **3.12.99. MASONRY ANCHORS**

- A. Mechanical and concrete screw anchors for use in solid-grouted concrete masonry shall have been tested and qualified for use in accordance with ICC-ES AC01 or AC106.
- B. Adhesive anchors for use in solid-grouted concrete masonry shall have been tested and qualified for use in accordance with ICC-ES AC106.



### **3.12.100. GROUTING OF BASE PLATES**

All grout to be dry mix non shrink cementitious grout with minimum compressive strength of 40 MPa. Grout shall entirely fill the gap underneath the base plate with no large voids.

### **3.12.101. SHIMMING**

Shimming limits shall not exceed  $4d/3$ , with  $d$  is diameter of bolt. Shimming limits to be stated on shop drawings and verified by calculations. Shimming beyond the limit must be verified by additional bolt bending check with additional checks per BS EN 1993-1-1, 1-5, 1-8, 1-10, BS EN 1090-2 AND BS EN 1994-1-1.

Shimming to be of solid aluminium, solid steel or hard plastic. Aluminium composite panel pieces or wood shims are not permitted.

Plastic or EPDM shimming shall only be used where only compression forces are transferred. The shim shall be one piece only and the shore hardness shall be minimum 80.

If lateral forces may transfer through the connection, aluminium or steel shims or grouting shall be used. The shimming shall be single piece or pieces welded together.

### **3.12.102. FAÇADE ACCESSORIES AND ATTACHMENTS**

### **3.12.103. COPINGS AND FLASHINGS**

All copings are to have two lines of defence against water penetration. All visible copings and sills are to have flush joints with sealed splice plates. The joints shall coincide with the cladding system joints. Joints in the flashing/membrane below copings and sills shall not coincide with the joints in the coping or sill. Flashings shall be formed from 1.2mm galvanized mild steel sheet and shall be bonded and fixed mechanically at their perimeter and to the adjacent constructions. Roofing membranes and backing components to form a continuous waterproofing membrane. Flashings shall be formed into shapes compatible with the building interfaces. Flashings shall be sealed at all joints and fixing penetrations and shall be fit for their purpose as the main weathering component for the life of the building. The Façade Contractor shall not be permitted to use adhesives alone to hold flashings in place. Thickness of flashing and coping shall be as stipulated in Section 4.6.2 Aluminium Sheeting.

### **3.12.104. WORKMANSHIP AND FABRICATION**

### **3.12.105. WORKMANSHIP**

The standard of workmanship for this Contract Works shall be established by the approved samples, mock up, and benchmark inspected sample works. All subsequent work will be of a quality which shall meet or exceed that of the said samples, mock up and benchmark works.

Workmanship not to the approved standard will be rejected by the Client or related Engineer, and shall be rectified or replaced by the Façade Contractor at his own expense. Works cannot be rectified by approved methods need to be replaced at the Façade Contractor's expense. If replacement involves moving or removing otherwise approved installed cladding components that also need to be done at the Façade Contractor's expense and then the reinstalled works need to be re-inspected.



**Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)**

No work shall be covered up or put out of view without the agreement of the Engineer, and the Engineer shall afford notice and full opportunity for the examination and measurement of any work which is about to be covered up or put out of view.

Nothing shall be fixed to or penetrate the cladding system without the specific approval of the Engineer. If such penetration is required, drawings shall be submitted for approval prior to commencing the works.

All works shall be carried out as per approved drawings and methods. If any changes are necessary, the variation works can only proceed after approval. All variation works prior to approval are carried out on the risk of the Façade Contractor. Shall these installation need to be removed or modified, this has to be carried out on the expense of the Façade Contractor.

**3.12.106. FABRICATION**

**3.12.107. GENERAL**

The Façade Contractor shall be entirely responsible for the whole of the facade fabrication and shall ensure that such work is executed by persons skilled in such fabrication, including all other components and elements to be used in the works.

All assemblies shall be fabricated in accordance with the approved working drawings and in full conformity with the standards specified.

**3.12.108. CUTTING, SIZING AND THICKNESS OF STONE**

A. Production generally shall meet the requirements of BS 8298, Section 4.

However, the quality of this façade requires the following additional stone tolerance requirements in production:

1. Length and width as per Table 2 of the BS EN 1469:2004
2. Thickness +2/-0mm
3. Bow and twist +/-1.0mm in 1200 mm
4. Flatness +2/-0 mm and 0.2% of the slab length

B. Cut stone so that the bedding is appropriate to its position in the building.

C. There shall be no cutting, drilling or working of the stone or the support substrate on site without the approval of the Client/ Engineer.

D. Interaction of tolerances between stone and the supporting system needs to be clarified by the Facade Contractor as soon as possible after award of Contract.

E. Texturing and finish shall be in accordance with samples held by the Client, which can be viewed by appointment.

F. Minimum thickness of stone to be in accordance with BS 8298, clause 3.9 and Table 4.

**3.12.109. STONE CLADDING TOLERANCES**

A. Approvals of Stone Appearance and Permitted Tolerances



Qatar General Electricity & Water Corporation  
Tender No. GTC 626/2014  
Construction of Mega Reservoir PRPSs  
(Packages A, B, C, D & E)

1. Arrange the setting out, erection, juxtaposition of components and application of finishes to ensure that there is satisfactory fit at junctions, that there are no practically or visually unacceptable changes in plane, line or level and that the finished work has a true and regular appearance as specified.
2. Whenever satisfactory accuracy, fit and/or appearance of the work are likely to be critical or difficult to achieve, obtain approval of proposals or of the appearance of the relevant aspect of the partially finished work as early as possible.
3. Without prejudice to the above, and unless specified otherwise, tolerances shall be not greater than those given in BS 5606, Tables 1 and 2.
4. Notwithstanding the requirements of BS 5606 the following stonework erection tolerances shall apply:

Vertically (up to 3m) +/- 4 mm

Straightness (in 5m horizontally) +/- 4 mm

Bed joint level (in 5m) +/- 4 mm

Length along wall (in 6m) +/- 4 mm The above cladding tolerances include the tolerances in the production of the materials (stone pieces, fixings, brackets, etc...), are measured on the final installation.

**B. Joint Width and Movement Joint**

1. Stone to stone joint width are to be 8 mm (+/- 2 mm) vertically and horizontally.
2. Movement joint is to be 15 mm (+/- 4 mm) and it has to comply the recommendations provided by the BS 8298, clause 3.11.4.3.

The installed cladding shall be capable of replacement without progressive dismantling of the external cladding.

**3.12.110. REPLACEMENT AND REPAIRS**

- A. Perform cleaning procedures, if necessary, according to manufacturer's written instructions. Prevent damage to surfaces and staining of adjacent materials.
- B. Cleaning is to be in accordance with the recommendations provided by the BS EN 8213.
- C. Contractor is to provide all access equipment necessary for the Façade cleaning during handover / inspections, all costs associated is to be borne by the contractor.
- D. During the time of Practical Completion, the Façade Contractor shall ensure façade is free from damage, dust, debris, cement, dirt and foreign material for handing over of Works. Handover works shall be accepted subjected to approval by the Engineer.

**3.12.111. FINAL CLEANING**

**3.12.112. TESTING TO THE STONE FIXINGS PRIOR TO STONE PROCUREMENT**

- A. The Façade Contractor shall forward to the Engineer / Client results of tests or design calculations to demonstrate that the fixing system is in accordance with the specification.



- B. The Facade Contractor shall allow for conducting pull-out tests for support and restraint fixings to the satisfaction of the authorities (if applicable), the Client and the Engineer.

#### **3.12.113. ANCHOR LOAD TESTING**

- A. Each anchor type to be used for fixing stone shall be tested.
- B. The following tests are required:
  - 1. ASTM C1354 Strength of Anchorage Anchorages for overhead stone
- C. Testing shall include tension testing, shear testing and testing of anchorages for eccentric loading based on the worst rift of the stone.
- D. In each case the following testing shall be carried out in the following increments of the specified design loading: 50%, 75%, 100%, 125%, 150%, 200% (these loads are to be held of 10 seconds).
- E. The acceptance criteria for anchors: Each sample to pass the 150% design loading test.
- F. All tests on anchorages shall be carried out on extra anchors that are not for project use over and above those required for the project.

#### **3.12.114. VISUAL INSPECTION**

The Facade Contractor shall make a standing arrangement for the Client and Engineer to inspect at regular intervals any stone element he chooses at the following stages:  After gang sawing and prior to further processing.  After initial processing and cutting to size.  After edge labours and surface finishing.

#### **3.12.115. IMPACT TESTS**

- A. Conduct soft body impact tests to Section 2 Part 7 of BS 8200: 1985 as follows:
  1. Test the prototype for stone.

#### **3.12.116. QUALITY CONTROL PROCEDURES**

##### **A. Inspections:**

Give sufficient notice so that inspections may be made of the following:

1. Required testing prototypes and first constructed examples/benchmarks constructed and ready for inspection or testing.
2. Commencement of any required testing, on or off site.
3. Test on site to sacrificial areas of each different fixing condition of stone cladding, with the stone and fixings to be replaced after testing and not incorporated into the permanent works. Cast-in channels / post fixed anchors and bracket plates are to be retained undamaged.

##### **B. Colour Consistency**

Acceptable range to be determined by the Engineer. Accepted and commented samples to be sent to the Engineer and kept as control samples until defects liability period finishes.



## APPENDIX 3B – IRONMONGERY SCHEDULES

### FINISH HARDWARE

#### 1. SCOPE OF WORK

This specification provides minimum requirements for the supply and installation of architectural hardware.

#### 2. GENERAL

All Hardware should be from one manufacturer and a combination of sources is not acceptable. Supplier should confirm in writing that proposed hardware is from a reputable branded manufacturer and supplier and must identify the source of production by presenting a documented letter from the manufacturer.

Hardware schedule provide convenience of use and maintenance of the building security against unauthorized access (and in some cases exit), escape from, protection against and prevention of fire, smoke spread of toxic atmospheres of other hazards and protection to doors and other surfaces. The Contractor shall ensure that hardware supplied meets with the Engineer's requirements, and if any item proposed or specified detracts there from the Engineer shall be informed. Unless stated, hardware to aluminum units shall be by the aluminum fabricator in accordance with this specification but with finishes to match his sections. Floor spring units, and cover plates, master keyed cylinders and access control hardware shall be by general hardware supplier.

- 2.1 The Contractor shall provide approved weatherproof storage facilities for all hardware delivered to the Worksite.
- 2.2 The Contractor shall check the hardware on installation for correct operation, maintain each item in accordance with the Manufacturer's instructions, protect it against damage by other trades and adjust, clean and lubricate it on completion of the Works.
- 2.3 The Contractor shall not fix hardware until background finishes are complete. Hardware previously fixed shall be removed before any finishing process.
- 2.4 Hardware shall be supplied complete with all mounting fixings.
- 2.5 European norms E.N set the minimum requirements. Unless more stringent standards are specified, all hardware shall comply with the following European Standards.

Standard	Title
EN179	Emergency Exit Devices
EN1125	Panic exit devices
EN1154	Door closing devices
EN1155	Electrically powered door holders
EN1158	Door co-coordinators
EN1303	Cylinders for locks
EN1527	Sliding door gear
EN1634-1	Fire testing
EN1670	Corrosion resistance

Qatar General Electricity & Water Corporation  
Tender NO. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



EN1906	Lever handles and knobs
EN1935	Single axis hinges
BSEN12209	Locks and latches for doors in buildings
BSEN12051	Door and window bolts
BSEN12320	Padlocks and padlock fittings
BS8424	Pull Handles

- 2.6. Hardware installed on fire rated doors must be CERTIFIRE approved and labeled hardware.

### **3. DESIGNS, MATERIALS AND FINISHES**

- 3.1 Regardless of other provisions, materials shall meet fire safety requirements and not be subject to bimetallic corrosion. Each item's design and finish shall reflect the nature and quality of the project. Every finished surface of one material, whether extruded, rolled, cast or stamped, shall match exactly in colour and texture all other items.
- 3.2 Ironmongery finish: Satin Stainless Steel Finish. Other Grade Stainless Steel material is not acceptable. Zinc alloy base material with a stainless steel plating surface or a brass base material with satin chrome plating is not acceptable.
- 3.3 Unless otherwise stated in the architectural hardware schedules, all hardware to be supplied is Eurolever Architectural Hardware from The Silver Shore Trading Co. P.O. Box 1881, Dubai U.A.E. Tel. No. +971 4 43516667, Fax No. +971 4 4351668, as per the approved items selected for design intent or alternative approved manufacturers subject to meeting design intent include FSB Germany, D Line Denmark only.

### **4. FIXING DEVICES**

- 4.1 Provide suitable, matching, metric, rust proofed fixing devices to suit the location and background, of Allen key, 'SUPADRIV', 'POSIDRIV' or equivalent positive locating drive types. Pull handle fixing shall be bolt through type, unless otherwise specifically required.

### **5. HINGES**

- 5.1 Hinges shall be suitable to match other items on the doors. Hinges shall be triple knuckle ball bearing type to minimize closing friction and prevent wear.  
Aluminium hinges are not acceptable.  
All hinges shall be independently tested to EN1935 Grade 13 and fire standard EN1634 -1. Acceptable hinges are Eurolever SS5 or equal and approved.  
Hinge size to be 4X3X3mm thickness.
- 5.5 Where indicated on the hardware schedule, supply 4.5mmX4.5mmX3.4mm thick, ANSI dimensioned hinges, ball bearing, fire rated to EN1634-1, minimum fire rating 120 minutes. Approved hinges are SS5, or equal and approved.
- 5.6 Independent test certificates indicating conformity with above mentioned indicated standards must be provided at the time of submittal as evidence that the hinges proposed conform to hardware industry certification, EN1935 Grade 13 and EN1634-1.
- 5.7 All hinges to be CERTIFIRE labeled and approved and CE marked.

Qatar General Electricity & Water Corporation  
Tender NO. GTC 626/2014  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



## 6. LOCK AND LATCHES

- 6.1 Lock suites for use on fire rated door assemblies shall be independently tested and certified as not compromising fire rating and shall not contain plastics, zinc or other low melting point components.
- 6.2 Mortise locks and latches shall conform to industry performance requirement BS EN 12209 and industry fire rating standard EN 1634-1, 60 minutes
- 6.3 Independent certificates indicating conformity with indicated standards must be provided.
- 6.4 Furthermore the proposed mortice lockcase should conform to:
  - a. Deadbolts incorporating anti-sawing hardened steel rollers, 16mm thick.
  - b. If for lever handles, special springing against progressive lever droop (levers with sprung roses are unacceptable due to potential for damage and corrosion.)

Facility for full reversal of hand, without opening the case.

Suitable forends, strike plates and rebate components if for rebated meeting styles, of non-corroding materials to match handles.

All locks to have backset of 60mm.

Approved Eurolever locks are: SS1.6, SS2.6, SS3.6 & 4.6.

All mortice lock and latches to be CERTIFIRE labeled and approved.

## 7. CYLINDERS

- 7.1 Cylinders shall be 6 pin, 61mm in length with practically infinite differs, finished to match handles and trim (includes coloured finishes), easily removable with the door open, without dismantling trim but not removable if closed. Three keys per cylinder required. The cylinder shall have Para centric keyways and TG pins to prevent picking and hardened steel drives pins and body insert to overcome drilling.
- 7.2 Cylinder to conform to performance standard EN1303 grade 3 & fire rating EN1634.
- 7.3 Independent test certificate indicating conformity with above mentioned standards must be provided at the time of submittal confirming cylinders proposed conform to hardware industry certification, EN1303 grade 3 and EN1634-1.
- 7.4 Include for master keying for all cylinders, details to be provided by architect.

## 8. LEVER HANDLES

- 8.1 Lever Handles shall be as per the design intent described below. All lever handles to be made from Satin stainless steel material. The levers shall be supplied complete with H.T. spindle suitable for door thickness between 35mm and 54mm.
- 8.2 Lever handles shall be as per the described lever handle model in the hardware specification schedule.

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



- 8.3 The lever handles should be solid body stainless steel unless stated otherwise in the hardware schedules. The lever handles should be on non-sprung unless stated otherwise in the hardware schedules.
- 8.4 In general lever edges and surfaces to be smooth and curved.
- 8.5 Approved lever handles is Eurolever Strasbourg Collection Model SS2002, both fitted on 50mm diameter, 4mm thick roses, as described and indicated in the hardware schedule and fitted with concealed ball bearing technology for frictionless movement.
- 8.6 All lever handles to be supplied on a 4mm thick, 50mm diameter roses, with polished edges, capable of being rigidly fixed to door.
- 8.7 Concealed fixing base for roses should be rigid and allow for bolt thru fixing.
- 8.8 Independent test certificate indicating conformity with Industry performance standard EN1906 to be provided at the time of submittal confirming proposed lever handles conform to this specific certification standard.

## **9. PULL HANDLES**

Pull handles should be as specified in the hardware schedule for all doors including but not limited to wardrobe doors, kitchen sliding doors and other doors.

They shall be supplied with bolt through fixings employing countersunk corrosion proofed bolts cup washers and locking patches. Approved pull handles are SS2300 as dimensions and other product details as described and indicated in the hardware schedule. All pull handles must be tested and comply with BS8424.

## **10. PUSH PLATES**

They shall be manufactured from the specified finish indicated in this document. All plates to be 1.6mm thick and shall be fixed with flush countersunk screws located 5mm from the edge corner. Eurolever Model Collection SS25315. The plates shall have square edges.

## **11. BOLTS**

To be fitted at top and bottom of non-active leaf of door pairs. Flush bolts to be provided having a 19mm throw and a 225mm body with a dovetail return ensuring no damage to the door.

Acceptable flush bolts as per Eurolever model SS1932, dimensions and other product details as described and indicated in the hardware schedule. Flush bolt must be tested to EN1634-1 fire rating, supply testing evidence conforming to performance standard EN12051.

Suitable easy clean dirt excluding spring type sockets to be provided as described in the hardware schedule. Acceptable easi-clean socket as per Eurolever model SS1934.

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



## **12. DOOR STOP**

All doorstops should be robust matching other ironmongery, concealed fixing. Approved doorstops are as per Eurolever model SS1927. Dimensions and other product details as described and indicated in the hardware schedule.

## **13. DOOR CLOSING DEVICES**

Door closer to be adjustable, hydraulic check types, incorporating following features:

- 13.1 Closing speed fully adjustable between two and thirty seconds (if delayed closing is specified the door, when opened to 90 degrees or beyond, shall stand motionless for a period adjustable up to 60 seconds, before starting to close).
- 13.2 Opening and closing from any angle up to 180 degrees with check adjustable to operate from any angle between 135 degrees and closed.
  - 13.3 Ten year guarantee in use of local ambient conditions, including positions of extreme exposure and, for back check closers, even if stops are not specified.
  - 13.4 They shall have plain, rectilinear bodies finished identically to other items on the door, suitable rust proof arms, fully concealed fixings and adjustment controls. All closers to meet EN1154a and be fire rated to EN1634-1 60 minute fire rating. Gray colour door closers are not acceptable unless specifically specified in the hardware schedules. Approved door closers are XX100. Dimensions and other product details as described and indicated in the hardware schedule.
  - 13.5 Upon submittal of proposed door closer for approval, submit independent fire test certificate indicating closer conforms to EN1634-1, 60 minutes fire resistant.
  - 13.6 Floor mounted closers shall be of suitable for single or double action, wood or metal doors by use of compatible fittings, with concealed fixing cover plates.
- 13.7 All door closers to be CERTIFIRE labeled and approved.

## **14. FIRE RATING REQUIREMENTS:**

- 14.1 For fire rated doors, supply CERTIFIRE Certificates and CE Certificates approved door hardware for the following hardware items; Mortice locks, mortice latches, hinges and door closers.

## **15. SUBMITAL PROCESS FOR APPROVAL:**

- 15.1 All hardware submittals must be accompanied by the following:  
Complete hardware sample board showing major components proposed.  
3 marked original copies of the product catalogue. Items proposed must be in the original product catalogue. Catalogue photocopies are not acceptable.

All items must be supplied thru the same manufacturer. Supply verification.

- 15.2 Submit valid product testing performance certificates verifying individual products are successfully tested as follows:
  - Hinges certified to EN1935 grade 13.
  - Mortice locks and & bathroom locks to BSEN12209.
  - Cylinders to EN1303 grade 3.
  - Lever handles and knobs to EN1906.

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



- Pull handles to BS8424.
  - 15.3 Submit valid fire testing certificates verifying products successfully certified to:
    - EN1634-1 fire rating and CERTIFIRE approved.
- 15.4 Where fire rating label requires fire certification longer than 60 minutes, submit separate fire certificate indicating 120 minute fire certification for the following items: mortice locks, cylinders and hinges in addition to CERTIFIRE approved certification.
- 15.5 The supplier must confirm in writing what custom design software program is available within his organization to assist in rapidly implementing changes to the hardware schedules as needed during the course of the project. Word, excel or similar commercial software programs are not acceptable.
- 15.6 The supplier shall offer full technical support and have qualified staff able to prepare or amend hardware schedules and advise on technical issues, while coordinating with the contractor & architect on all matters including master key systems, technical problems of specification, installation and operation.



## QUALIFICATION NOTES

Kindly Note the following:

1. Hardware Set Prefix Index:

- B(19-26): Buildings 19, 20, 21, 22, 23, 24, 25, 26
- AC: Air Compressor Building
- AP: Auxiliary Pump Station
- CB: Chlorination Building
- MC: Maintenance Cleaners Workshop
- MG: Main Guard House
- MP: Main Pump Station
- MVG: MV Generator Building
- RG: Remote Generator Building
- RS: Remote Substation Building
- TF: Tanker Filling Building
- TFS: TFS Guard House Building
- UP: Utility Pump Station
- WT: Water Testing Facility
- WQ: Water Quality Monitoring Building

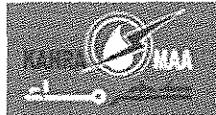
**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set Summary**

<b>Hardware Set Number</b>	<b>Doors-Qty</b>
AC-01	1
AC-02	3
AC-03	1
AP-01	1
AP-02	1
B(19-26)	8
CB-01	2
CB-02	7
CB-03	2
CB-04	1
CB-05	2
CB-06	1
CB-07	1
MC-01	3
MC-02	4
MC-03	4
MC-04	2
MC-05	10
MC-06	1
MC-07	1
MC-08	1
MC-09	1
MC-10	2
MC-11	1
MC-12	2
MC-13	3
MG-01	2
MG-02	3
MG-03	1
MG-04	2
MG-05	1
MP-01	22
MP-02	6
MP-03	22
MP-04	3
MP-05	1

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



MP-06	0
MP-07	15
MP-08	3
MP-09	5
MP-10	25
MP-11	7
MP-12	1
MP-13	1
MP-14	19
MP-15	6
MP-16	4

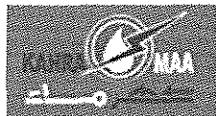
**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set Summary**

<b>Hardware Set Number</b>	<b>Doors-Qty</b>
MV-01	4
MV-02	6
MV-03	4
MV-04	1
MV-05	4
MV-06	1
RG-01	1
RG-02	1
RS-01	2
RS-02	1
RS-03	6
TF-01	1
TF-02	1
TFS-01	2
TFS-02	2
TFS-03	2
UP-01	3
UP-02	0
UP-03	1
WQ-01	1
WT-01	1
WT-02	10
WT-03	3
WT-04	1
WT-05	1
<b>Project Value Total:</b>	<b>275</b>

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: AC-01**

<b>Product Code Description</b>	<b>Quantity</b>
XX10020      Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10020K      Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10021      Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022      Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
XX100      Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105      Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
SC10.61M      Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS21150      Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0



**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-02

Switchgear RM

Air Compressor Building

**Door Listing:**

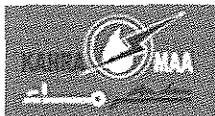
1.00

A C - G - 0 2 / 0 1

**Hardware Set: AC-02**

Product Code Description	Quantity
XX10020 Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022 Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105 Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire	3.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



approved. CE marked satin stainless steel finish.

SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
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**Total Number of doors:** **3**

**Remarks:** Single Door - HM

Type: D-03

Switchgear RM, Air Compressor RM

Air Compressor Building

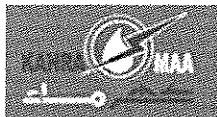
**Door Listing:**

100  
A C - G - 0 1 / 0 2      A C - G - 0 1 / 0 3      A C - G - 0 2 / 0 2

**Hardware Set: AC-03**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	1.0
SS1.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish.	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers, 19mm diameter, 135mm, on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Tested to EN1906. Complies with BS8300 standard.

XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-03

Air Compressor RM

Air Compressor Building

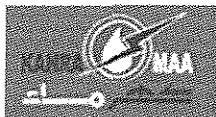
**Door Listing:**

1.00  
A C - G - 0 1 / 0 1

**Hardware Set: AP-01**

<b>Product Code</b>	<b>Description</b>	<b>Quantity</b>
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment comptable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0
SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-01

MCC Room

Auxiliary Pumping Station Building

**Door Listing:**

1.00

A P - G - 0 1 / 0 1

**Hardware Set: AP-02**

Product Code	Description	Quantity
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatible with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-02

MCC Room

Auxiliary Pumping Station Building

**Door Listing:**

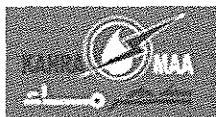
1.00

A P - G - 0 1 / 0 2

**Hardware Set: B(19-26)**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0
<b>Total Number of doors:</b>		<b>8</b>

**Remarks:** Entrance Door, Single Leaf

Set represents Buildings 19 through 26

Door type: D-01

**Door Listing:**

1.00

B 1 9 - G 0 0 1

B 2 0 - G 0 0 1

B 2 1 - G 0 0 1

B 2 2 - G 0 0 1

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



B 2 3 - G 0 0 1      B 2 4 - G 0 0 1      B 2 5 - G 0 0 1

B 2 6 - G 0 0 1

**Hardware Set: CB-01**

<b>Product Code</b>	<b>Description</b>	<b>Quantity</b>
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin	4.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



stainless steel finish.

**Total Number of doors:** 2

**Remarks:** Double Door - HM

Type: D-03

Chlorination Room, Electrical Room

Chlorination Building

**Door Listing:**

1.00  
C B - G - 0 6      C B - G - 0 8

**Hardware Set: CB-02**

Product Code	Description	Quantity
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



stainless steel finish.

**Total Number of doors:** 7

**Remarks:** Single Door - HM

Type: D-01A, D-02A

Vestibule, Chlorine Feed RM, Operator's RM

Chlorination Building

**Door Listing:**

1.00	C B - G - 0 2 / 0 1	C B - G - 0 2 / 0 2	C B - G - 0 2 / 0 3
	C B - G - 0 3	C B - G - 0 4	C B - G - 0 5
	C B - G - 0 9 / 0 1		

**Hardware Set: CB-03**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6 Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311 Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single Door - HM

Type: D-06

Operator's RM, Analyzer RM

Chlorination Building

**Door Listing:**

1.00  
C B - G - 0 9 / 0 2      C B - G - 1 2 / 0 2

**Hardware Set: CB-04**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6	Eurolever, mortice bathroom lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 78mm centres. Tested to EN12209 Satin stainless steel finish forend.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



standard.

XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS8036WC	Eurolever signage, 76mm diameter disc. Satin stainless steel, "WC" pictogram.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-04

Toilet

Chlorination Building

**Door Listing:**

1.00  
C B - G - 1 0 / 0 1

**Hardware Set: CB-05**

	<b>Product Code Description</b>	<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved. CE marked. Satin stainless steel finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single Door - HM

Type: D-04A, D-05A

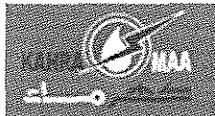
Janitor's RM, SHO.

Chlorination Building

**Door Listing:**

1.00  
C B - G - 1 0 / 0 2      C B - G - 1 1

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: CB-06**

<b>Product Code Description</b>	<b>Quantity</b>
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0

**Total Number of doors:** 1

**Remarks:** Single Door - AL

Type: D-08A

Analyzer RM

Balance Ironmongery by others

Chlorination Building

**Door Listing:**

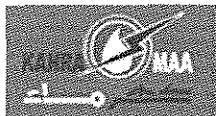
1.00

C B - G - 1 2 / 0 1

**Hardware Set: CB-07**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS1.6      Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SS2002      Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-03

FM-200

Chlorination Building

**Door Listing:**

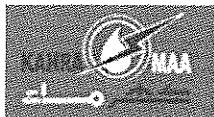
1.00

C B - G - 0 7

**Hardware Set: MC-01**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS1.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Total Number of doors:** 3

**Remarks:** Single Leaf, Fire rated

Electric Room, Staff, Janitor

Door type: D-05

Maintenance/Cleaners Workshop Building

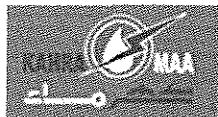
**Door Listing:**

1.00  
M C - G 0 0 2      M C - G 0 0 6      M C - G 0 1 5

**Hardware Set: MC-02**

<b>Product Code Description</b>	<b>Quantity</b>
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Satin nickel finish. .

**Total Number of doors:** 4

**Remarks:** Aluminum Doors and rolling shutters

Balance Ironmongery by others

Door type: D-12, D-13, D-09

**Door Listing:**

1.00	M C - G 0 0 1 M C - - G 0 1 4	M C - - G 0 0 4	M C - G - 0 0 7
------	----------------------------------	-----------------	-----------------

**Hardware Set: MC-03**

<b>Product Code Description</b>		<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved. CE marked. Satin stainless steel finish.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Total Number of doors:** 4

**Remarks:** Single Leaf

Non FR, Non lockable

Training Room, staff, prayer

Door type: D-06

Maintenance/Cleaners Workshop Building

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Door Listing:**

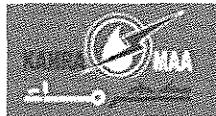
1.00

M C - G 0 1 6      M C - G 0 1 8      M C - G 0 1 9      M C - G 0 2 0

**Hardware Set: MC-04**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100      Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS4.6      Eurolever, dead lock, 60mm backset. Fitted with a europrofile cylinder hole operating an antisaw deadbolt. Satin stainless steel finish forend.	1.0
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311      Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS25315      Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS2300      Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS1927      Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS8036F	Eurolever signage, 76mm diameter disc, Satin stainless steel, female pictogram.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Male/female toilet entrance

single leaf

signage to be determined

Door type: D-03

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00  
M C - G 0 0 3 / 5      M C - G 0 1 7 / 7

**Hardware Set: MC-05**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS5.6	Eurolever, bathroom dead lock, 58mm backset. Fitted with a 8mm spindle hole operating a antisaw deadbolt. Satin stainless steel forend.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0
SS2300	Eurolever accessories 2000 Series Size 300mm, 19mm diameter, bolt thru fixing, pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS25315	Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Supplied with screws. Satin stainless steel finish

**Total Number of doors:** 10

**Remarks:** Single Door

Male/female cubicles

Door type: D-04

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00 M C - G 0 0 3 / 1 M C - G 0 0 3 / 4 M C - G 0 1 7 / 3	M C - G 0 0 3 / 2 M C - G 0 1 7 / 1	M C - G 0 0 3 / 3 M C - G 0 1 7 / 2
M C - G 0 1 7 / 4	M C - G 0 1 7 / 5	M C - G 0 1 7 / 6

**Hardware Set: MC-06**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105 Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6 Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.

SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** 1

**Remarks:** Double Door

Fire Rated, outward swing

Door type: D-11

Compressor room

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00

M C - G 0 0 8

**Hardware Set: MC-07**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



marked. Solid body with sliding cover. Supplied in a silver color finish.

XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	2.0

**Total Number of doors:** 1

**Remarks:** Double Door

Emergency exits

Door type: D-01

East corridor

Maintenance/Cleaners Workshop Building



**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

**Door Listing:**

1.00

M C - G 0 0 4 / 3

**Hardware Set: MC-08**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6 Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311 Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	1.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS21150 Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:**

1

**Remarks:** Single Leaf

Yard Exit

Door type: D-10

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00

M C - G 0 1 3

**Hardware Set: MC-09**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100    Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1.6    Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M    Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311    Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002    Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1932    Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



tested to EN1634-1. Satin stainless steel finish

SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	2.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** 1

**Remarks:** Double Door, fire rated

Corridor, to workshop

Door type: D-11

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00

M C - G 0 0 4 / / 2

**Hardware Set: MC-10**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single leaf, outward swing

Fire Rated, Emergency exit

Workshops

Door type: D-08, D-08A

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00  
M C - G 0 0 7 / 2      M C - G 0 1 4 / 2

**Hardware Set: MC-11**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS4.6	Eurolever, dead lock, 60mm backset. Fitted with a europrofile cylinder hole operating an antisaw	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



deadbolt. Satin stainless steel finish forend.

SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2300	Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS25315	Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Total Number of doors:** **1**

**Remarks:** Single Leaf

Kitchen, Fire rated

Door type: D-07

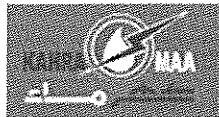
Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00

M C - G 0 0 1 / 2

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: MC-12**

**Product Code Description Quantity**

SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS25315	Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0
SS2300	Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0

**Total Number of doors:** 2

**Remarks:** Male/Female toilet lobby

Single leaf

Door type: D-02

Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00

M C - - G 0 0 3 / 6      M C - g 0 1 7 / 8

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: MC-13**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105 Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS4.6 Eurolever, dead lock, 60mm backset. Fitted with a europrofile cylinder hole operating an antisaw deadbolt. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS2300 Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS25315 Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS21150 Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:** 3

**Remarks:** Single Leaf

Outward swing

Store, Fire rated

Door type: D-05

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Maintenance/Cleaners Workshop Building

**Door Listing:**

1.00  
 M C - G 0 0 9      M C - G 0 1 1      M C - G 0 1 2

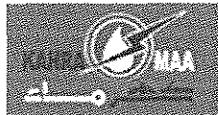
**Hardware Set: MG-01**

Product Code Description	Quantity
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6      Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311      Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002      Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100      Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0

**Total Number of doors:**

**2**

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Remarks:** Single Door - HM

Type: D-01, D-01A

Guard Room Pathway

Main Guard House

**Door Listing:**

1.00  
M G - G - 0 1 / 1      M G - G - 0 1 / 4

**Hardware Set: MG-02**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



a silver color finish.

XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
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**Total Number of doors:** **3**

**Remarks:** Single Door - HM

Type: D-01, D-01A, D-02

Guard Room Entrance

Main Guard House

**Door Listing:**

1.00

M G - G - 0 1 / 2      M G - G - 0 1 / 3      M G - G - 0 1 / 5

**Hardware Set: MG-03**

<b>Product Code Description</b>		<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6	Eurolever, mortice bathroom lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 78mm centres. Tested to EN12209 Satin stainless steel finish forend.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



marked. Solid body with sliding cover. Supplied in a silver color finish.

SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS8036WC	Eurolever signage, 76mm diameter disc. Satin stainless steel, "WC" pictogram.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-03

Toilet

Main Guard House

**Door Listing:**

1.00

M G - G - 0 2

**Hardware Set: MG-04**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61	Eurolever, two side cylinder key operation, 61mm length, nonsuited. Supplied with 3 keys. Satin Nickel finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single Door - HM

Type: D-02

Store Room, Electrical Room

Main Guard House

**Door Listing:**

1.00

M G - G - 0 4      M G - G - 0 5

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: MG-05**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6 Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved. CE marked. Satin stainless steel finish.	1.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927 Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150 Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** **1**

**Remarks:** Single Door - HM

Type: D-04

Kitchen

Main Guard House

**Door Listing:**

1.00

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



M G - G - 0 3

**Hardware Set: MP-01**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatible with europrofile cylinder hole to take single side cylinder to be supplied separately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

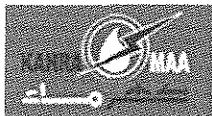
**Total Number of doors:** 22

**Remarks:** Single leaf door  
fire escape exit, inward swing  
door type: D-15, D-16

Main Pump Station

**Door Listing:**

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



1.00

M P - 0 1 0 / 5  
M P - B 0 0 7  
M P - B 0 1 4

M P - G 0 0 4 / 2  
M P - G 0 7 2 / 2  
M P - L 0 0 1

M P - L 0 0 6  
M P - M 0 0 1  
M P - M 0 0 9

M P - M 0 1 0

M P - B 0 0 1  
M P - B 0 0 9

M P - G 0 1 0 / 8  
M P - G 2 7 / 1

M P - L 0 0 9  
M P - M 0 0 6

M P - B 0 0 6  
M P - B 0 1 3

M P - G 0 2 3 / 2  
M P - G 4 2 / 2

M P - L 1 2  
M P - M 0 0 7

#### **Hardware Set: MP-02**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100    Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1932    Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934    Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
SS1.6     Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M   Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311    Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Satin stainless steel finish.

SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 6

**Remarks:** 1.5 leaf door + double door. Fire rated  
stair case lobby, Cable basement, elec room, server, control  
door type - D-26, D-20,  
Main Pump Station

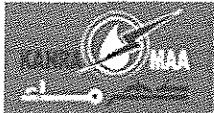
**Door Listing:**

1.00	M P - G 0 2 8 / 1	M P - G 0 3 0	M P - G 0 4 4
	M P - G 0 4 7	M P - G 0 5 0	M P - M 0 0 2

**Hardware Set: MP-03**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



length, master key suited. Supplied with 3 keys  
Satin nickel finish. .

SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:** 22

**Remarks:** Single Door

Cable basement, prayer, lobby, office, first aid

Door type: D-04, D-08

Main Pump Station

**Door Listing:**

1.00

M P - G 0 0 4 / 3  
M P - G 0 0 6  
M P - G 0 1 0 / 1

M P - G 0 1 0 / 6  
M P - G 0 1 4  
M P - G 0 2 8

M P - G 0 0 5  
M P - G 0 0 7

M P - G 0 1 1  
M P - G 0 1 5

M P - G 0 0 5 / 1  
M P - G 0 0 9 / 1

M P - G 0 1 3  
M P - G 0 1 7

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



M P - G 0 3 2  
M P - G 0 4 8  
M P - M 0 0 3  
M P - M 0 0 4 / 1

M P - G 0 3 6  
M P - G 0 5 1

M P - G 0 4 6  
M P - G 0 5 2

**Hardware Set: MP-04**

<b>Product Code Description</b>	<b>Quantity</b>
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0

**Total Number of doors:** **3**

**Remarks:** Ground Lobby, corridor rolling shutter  
Aluminum door  
Balance ironmongery by others  
Main Pump Station

**Door Listing:**

1.00	M P - G 0 0 2	M P - G 0 0 4	M P - G 0 2 7
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**Hardware Set: MP-05**

<b>Product Code Description</b>	<b>Quantity</b>
SS504      Eurolever closing device, floor spring, adjustable mechanism, supplied with a Satin Stainless Steel cover plate. straps to be specified separately	2.0
SS504D      Eurolever closing device, double action floor spring straps, floor spring series. Satin stainless steel finish.	2.0
SS25315      Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	4.0
SS21150      Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** **1**

**Remarks:** Double Door, Double Swing

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Entrance  
Door type: D-01  
Main Pump Station

**Door Listing:**

1.00

M P - G 0 0 0

**Hardware Set: MP-06**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	2.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



tested to EN1634-1. Satin stainless steel finish

SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
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**Total Number of doors:** **0**

**Remarks:** Double Door, Non fire rated

Door type: D-03

Meeting Room

Main Pump Station

**Door Listing:**

1.00

**Hardware Set: MP-07**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers, 19mm diameter, 135mm, on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:** **15**

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Remarks:** Single Door, non lockable

door type: D-06, D-16, D-13

Main Pump Station

**Door Listing:**

1.00

M P - G 0 0 5 / 2  
M P - G 0 1 0 / 3  
M P - G 0 4 9

M P - G 0 0 9 / 2  
M P - G 0 1 0 / 7

M P - G 0 1 0 / 2  
M P - G 0 2 7 / 2

M P - L 0 0 2  
M P - L 0 1 0  
M P - L 0 2 3

M P - L 0 0 3  
M P - L 0 1 3

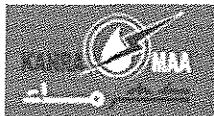
M P - L 0 0 7  
M P - L 0 1 5 / 2

M P - L 2 0

**Hardware Set: MP-08**

Product Code Description	Quantity
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS4.6 Eurolever, dead lock, 60mm backset. Fitted with a europrofile cylinder hole operating an antisaw deadbolt. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS25315 Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS2300 Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS1927 Eurolever accessory, floor door stop. Round	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.

SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS8036F	Eurolever signage, 76mm diameter disc, Satin stainless steel, female pictogram.	1.0

**Total Number of doors:** **3**

**Remarks:** Toilet entrance/changing room single leaf

signage to be determined

door type: D-09

Main Pump Station

**Door Listing:**

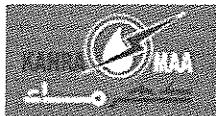
1.00

M P - G 0 0 3 / 1      M P - G 0 1 6 / 1      M P - G 0 1 9 / 1

**Hardware Set: MP-09**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS5.6	Eurolever, bathroom dead lock, 58mm backset. Fitted with a 8mm spindle hole operating a antisaw deadbolt. Satin stainless steel forend.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS2300	Eurolever accessories 2000 Series Size 300mm,19mm diameter, bolt thru fixing,pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	1.0
SS25315	Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** **5**

**Remarks:** Single door  
Male/female cubicle units  
Door type: D-10  
Main Pump Station

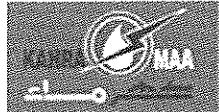
**Door Listing:**

1.00	M P - G 0 0 3 / 2	M P - G 0 1 6 / 2	M P - G 0 1 6 / 3
	M P - G 0 1 9 / 2	M P - G 0 1 9 / 3	

**Hardware Set: MP-10**

	<b>Product Code Description</b>	<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Certifire approved. CE marked. Satin stainless steel finish forend.

SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0

**Total Number of doors:** 25

**Remarks:** Double Door, Fire rated

outward swing

door type: D-13, D-21

Main Pump Station

**Door Listing:**

M P - G 0 2 1	M P - G 0 2 4	M P - G 0 2 5
M P - G 0 2 9 / 1	M P - G 0 2 9 / 2	M P - G 0 2 9 / 3
M P - G 0 3 1 / 1	M P - G 0 3 1 / 2	M P - G 0 3 1 / 3
M P - G 0 3 2 / 1	M P - G 0 3 2 / 2	M P - G 0 3 3 / 1
M P - G 0 3 3 / 2	M P - G 0 3 3 / 3	M P - G - 0 3 7
M P - G - 0 3 7 / 1	M P - G 0 3 7 / 2	M P - G 0 3 7 / 4
M P - G 0 3 9	M P - G - 0 4 1	M P - G 0 4 2
M P - G 0 4 5	M P - L 0 1 5 / 1	M P - L 0 1 5 / 3

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



M P - L 0 1 5 / 4

**Hardware Set: MP-11**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit. Supplied with 3 keys. Satin nickel finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:**

7

**Remarks:** Stair case door  
outward swing

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Door type: D-15

Main Pump Station

**Door Listing:**

1.00

M P - G 0 0 8  
M P - G 0 2 6  
M P - G 0 4 2 / 1

M P - G 0 1 0 / 9  
M P - G 0 3 4

M P - G 0 2 3  
M P - G 0 4 0

**Hardware Set: MP-12**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6	Eurolever, mortice bathroom lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 78mm centres. Tested to EN12209 Satin stainless steel finish forend.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers, 19mm diameter, 135mm, on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS21600	Eurolever accessories, 2100 series, size 600mm, 22mm diameter Satin stainless steel finish. bolt thru fixing pull handle. BS8424 compliant. Satisfies BS8300.	2.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



inner circular top, Satin stainless steel finish.

SS8036SN	Eurolever signage, 76mm diameter disc. Satin stainless steel, special needs pictogram	1.0
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**Total Number of doors:** 1

**Remarks:** Single leaf

SN- bathroom

21600 pull handle to be installed horizontally for support

Door type D-10

Main Pump Station

**Door Listing:**

1.00

M P - G 0 1 8

**Hardware Set: MP-13**

Product Code	Description	Quantity
SS504	Eurolever closing device, floor spring, adjustable mechanism, supplied with a Satin Stainless Steel cover plate. straps to be specified separately	2.0
SS504R	Eurolever closing device, right hand single action floor spring straps, 504 floor spring series. Satin stainless steel finish.	2.0
SS2300	Eurolever accessories 2000 Series Size 300mm, 19mm diameter, bolt thru fixing, pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	2.0
SS25315	Eurolever accessories, square edge push plates, 1.6mm thick, 315mm length, 152mm width. Supplied with screws. Satin stainless steel finish	2.0

**Total Number of doors:** 1

**Remarks:** Double door

non lockable

corridor door

Main Pump Station

**Door Listing:**

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



1.00

M P - g 0 0 4 / 5

**Hardware Set: MP-14**

<b>Product Code Description</b>	<b>Quantity</b>
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	10.0
SS1.6 Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311 Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS33/600MM 600*19mm Flush bolt Satin Chrome finish	2.0
SS1934 Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0

**Total Number of doors:** **19**

**Remarks:** Double doors

4500 mm length

louvers

Door type: D-18

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Main Pump Station**

**Door Listing:**

1.00

M P - G 0 5 3	M P - G 0 5 4	M P - G 0 5 5	M P - G 0 5 6
M P - G 0 5 7	M P - G 0 5 8	M P - G 0 5 9	M P - G 0 6 0
M P - G 0 6 1	M P - G 0 6 2	M P - G 0 6 3	M P - G 0 6 4
M P - G 0 6 5	M P - G 0 6 6	M P - G 0 6 7	M P - G 0 6 8
M P - G 0 6 9	M P - G 0 7 0	M P - G 0 7 1	

**Hardware Set: MP-15**

	<b>Product Code Description</b>	<b>Quantity</b>
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length,	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



master key suit, Supplied with 3 keys. Satin nickel finish.

SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
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**Total Number of doors:** 6

**Remarks:** Double Door

Fire exit

Door type: D-24

Main Pump Station

**Door Listing:**

1.00

M P - B 0 0 2	M P - G 0 1 2 / 3	M P - G 0 3 2 / 3
M P - G 0 7 2 / 3	M P - M 0 0 4 / 2	M P - M 0 0 5

**Hardware Set: MP-16**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS4.6	Eurolever, dead lock, 60mm backset. Fitted with a europrofile cylinder hole operating an antisaw deadbolt. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2300	Eurolever accessories 2000 Series Size 300mm, 19mm diameter, bolt thru fixing, pull handle. BS8424 compliant, Satisfies BS8300 Satin Stainless Steel finish	2.0
SS25315	Eurolever accessories, square edge push plates,	2.0

**Qatar General Electricity & Water Corporation**  
**Tender No. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



1.6mm thick, 315mm length, 152mm width.  
Supplied with screws. Satin stainless steel finish

SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	2.0
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**Total Number of doors:** 4

**Remarks:** Double Door

Non fire rated

roof

Door type: D-12A

Main Pump Station

**Door Listing:**

1.00	M P - L 0 1 7	M P - L 0 1 7 / 1	M P - L 0 1 7 / 2
	M P - L 0 1 7 / 3		

**Hardware Set: MV-01**

Product Code	Description	Quantity
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SC10.61M	Eurolever single side cylinder, 37.5mm length,	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



master key suit, Supplied with 3 keys. Satin nickel finish.

SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 4

**Remarks:** Single Door - HM

Type: D-08, D-10, D-03

Stair, Switchgear RM, FM200 RM

MV and Generator Building

**Door Listing:**

D 0 8 - M V - B - 0 2 M V - G - 0 9 / 0 1	D 0 3 - M V - G - 0 3 D 1 0 - M V - G - 1 0	D 1 0 -
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**Hardware Set: MV-02**

Product Code	Description	Quantity
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5.	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.

XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0

**Total Number of doors:** **6**

**Remarks:** Double Door - HM

Type: D-04, D-05, D-01

Lobby, Transformer RM, Switchgear LV, GMDB RM, GENSET RM  
MV and Generator Building

**Door Listing:**

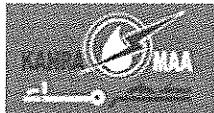
1.00	D 0 1 - M V - G - 0 1 / 0 2	D 0 4 - M V - G - 0 2 / 0 1	D 0 4 -
	M V - G - 0 4	D 0 4 - M V - G - 0 5 / 0 1	D 0 4 -
	M V - G - 0 6 / 0 1	D 0 5 - M V - G - 0 7 / 0 1	

**Hardware Set: MV-03**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	8.0

XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



120kg, EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.

SS21150 Eurolever accessories, square corner kick plates 4.0  
1.6mm thick, 800mm length, 150mm length.  
150mm high. Satin stainless steel finish.

XX10020K Eurolever , accessory silver finish steel metal box 1.0  
Keep for use with SS10020 panic latch where needed.  
Supplied complete with screws.

XX10020 Eurolever panic latch, suitable for door widths upto 1.0  
1200mm. Cut to size. Certified to EN1125, CE marked.  
Silver finish

XX10022 Eurolever panic device external attachment compatable 1.0  
with europrofile cylinder hole to take single side  
cylinder to be supplied separately. Silver finish.

XX9105 Eurolever figure 6 fixing bracket suitable for 2.0  
instalation with model 100 closer.

SC10.61M Eurolever, single side cylinder, 37.5mm length, 1.0  
master key suit, Supplied with 3 keys. Satin  
nickel finish.

**Total Number of doors:** 4

**Remarks:** Double Door - HM

Type: D-06, D-09

GENSET Control & Switchgear RM

MV and Generator Building

**Door Listing:**

1.00      D 0 6 - M V - G - 0 1 / 0 1      D 0 9 - M V - G - 0 8 / 0 1      D 0 6 -  
M V - G - 0 9 / 0 2      D 0 6 - M V - G - 0 9 / 0 3

**Hardware Set: MV-04**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire	3.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



approved. CE marked satin stainless steel finish.

SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved. CE marked. Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-08

Stair/ Switchgear RM

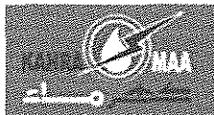
MV and Generator Building

**Door Listing:**

1.00

D 0 8 - M V - G - 0 9 / 0 4

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Hardware Set: MV-05**

Product Code Description	Quantity
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SS1.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS5	Eurolever, ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Total Number of doors:** 4

**Remarks:** Single Door - HM/Metal Louvre

Type: D-08, D-08A, D-02, D-02A

Switchroom LV, GDMB RM, GENSET RM

MV and Generator Building

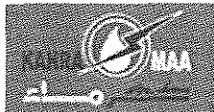
**Door Listing:**

1.00 D 0 2 - M V - G - 0 1 / 0 2 D 0 8 A - M V - G - 0 5 / 0 2	D 0 2 A - M V - G - 0 1 / 0 3 D 0 8 - M V - G - 0 7 / 0 2
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**Hardware Set: MV-06**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	8.0
SS2002    Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1311    Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1934    Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
SS1.6     Eurolever, mortice latch lockcase,heavily sprung	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.

SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish.	1.0
SC1932	Eurolever, accessory, flush bolt suitable for timber or steel door application. 225x19mm. Successfully tested to EN1634-1. Satin stainless steel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-09

GENSET Control & Switchgear RM

MV and Generator Building

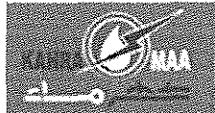
**Door Listing:**

1.00  
D 0 9 - M V - G - 0 8 / 0 2

**Hardware Set: RG-01**

Product Code Description	Quantity
XX10020K Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10020 Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10021 Eurolever bar latch, suitable for door widths upto	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.

XX10022	Eurolever panic device external attachment compatible with europrofile cylinder hole to take single side cylinder to be supplied separately. Silver finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights up to 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105	Eurolever figure 6 fixing bracket suitable for installation with model 100 closer.	2.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
SS5	Eurolever, ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-01

LV Room

Remote Generator Building

**Door Listing:**

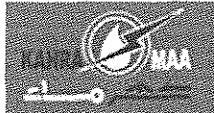
1.00

R G - G - 0 2

**Hardware Set: RG-02**

<b>Product Code Description</b>	<b>Quantity</b>
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**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-02

Remote Generator Room

Remote Generator Building

**Door Listing:**

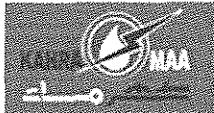
1.00

R G - G - 0 1

**Hardware Set: RS-01**

<b>Product Code Description</b>	<b>Quantity</b>
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**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved. CE marked. Satin stainless steel finish.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Total Number of doors:** 2

**Remarks:** Single Door, non lockable

Door type: D-06, D-16, D-13

Remote Substation Building

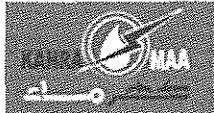
**Door Listing:**

1.00  
R S - G 0 0 1 / 3      R S - G 0 0 2 / 3

**Hardware Set: RS-02**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0

**Total Number of doors:** 1

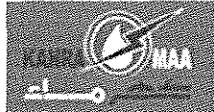
**Remarks:** Double Door

Outward swing

FR

Door type: D-02A

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



**Remote Substation Building**

**Door Listing:**

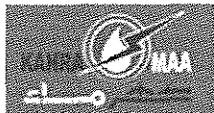
1.00

R S - G 0 0 4

**Hardware Set: RS-03**

<b>Product Code Description</b>		<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
XX10020K	Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10021	Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M	Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	4.0
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**Total Number of doors:** **6**

**Remarks:** Double Door

FR, ER exit

Door type: D-01

Remote Substation Building

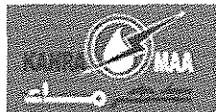
**Door Listing:**

1.00	R S - G 0 0 1 / 1	R S - G 0 0 1 / 2	R S - G 0 0 2 / 1
	R S - G 0 0 2 / 2	R S - G 0 0 3 / 1	R S - G 0 0 3 / 2

**Hardware Set: TF-01**

Product Code	Description	Quantity
SS5	Eurolever, ball bearing hinge, Size 100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS1.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers, 19mm diameter, 135mm, on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



standard.

SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934	Eurolever accessory, floor mounted easy clean socket Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Double Door, Non Fire rated

outward swing

entrance

door type: D-01

Tanker Filling Station Building

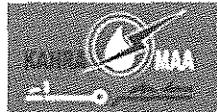
**Door Listing:**

1.00  
T F - G 0 0 1 / 1

**Hardware Set: TF-02**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Satin stainless steel finish.

SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Leaf

Entrance

Door type: D-02

Tanker Filling Station Building

**Door Listing:**

1.00

T F - G 0 0 1 / 2

**Hardware Set: TFS-01**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Tested to EN1906. Complies with BS8300 standard.

SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single Door- HM  
 Opening Outward - Type: D-01, D-01A  
 Guard RM Entrance  
 TFS Guard House Building - Entry+Exit

**Door Listing:**

1.00  
 G H - E N - G - 0 1      G H - E X - G 0 1

**Hardware Set: TFS-02**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2.6	Eurolever, mortice latch lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset. Tested to EN12209.Certifire approved.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



CE marked. Satin stainless steel finish.

SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 2

**Remarks:** Single Door - HM

Type: D-02A

Kitchen

TFS Guard House Building - Entry + Exit

**Door Listing:**

1.00  
G H - E N - G - 0 2      G H - E X - G - 0 2

**Hardware Set: TFS-03**

<b>Product Code Description</b>	<b>Quantity</b>
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6      Eurolever, mortice bathroom lockcase, heavily	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



sprung for lever handles. 8mm spindle hole.

60mm backset, 78mm centres. Tested to  
EN12209 Satin stainless steel finish forend.

SS3060	Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS8036WC	Eurolever signage, 76mm diameter disc. Satin stainless steel, "WC" pictogram.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0

**Total Number of doors:** 2

**Remarks:** Single Door - HM

Type: D-02A, D-02

T&B

TFS Guard House Building - Entry+Exit

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



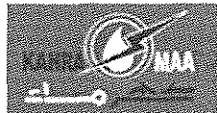
**Door Listing:**

1.00  
G H - E N - 0 3      G H - E X - 0 3

**Hardware Set: UP-01**

<b>Product Code Description</b>	<b>Quantity</b>
XX10020K    Eurolever, accessory silver finish steel metal box keep for use with SS10020 panic latch where needed. Supplied complete with screws	1.0
XX10020    Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10021    Eurolever bar latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022    Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0
SC10.61M    Eurolever, single side cylinder, 37,5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100    Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	2.0
XX9105    Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	2.0
SS5    Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
SS21150    Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



stainless steel finish.

**Total Number of doors:** 3  
**Remarks:** Double Door - HM  
**Type:** D-01, D-02  
**MCC RM, Potable/ Irrigation Water Pumping Station, Fire Water Utility Pumping Station**

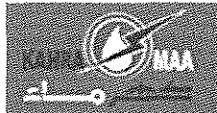
**Door Listing:**

1.00      U P - G - 0 1 / 0 1      U P - G - 0 2 / 0 1      U P - G - 0 3 / 0 1

**Hardware Set: UP-02**

<b>Product Code Description</b>	<b>Quantity</b>
SS1.6      Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M      Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
XX100      Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105      Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS5      Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS2002      Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Tested to EN1906. Complies with BS8300 standard.

SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:** 0

**Remarks:** Single Door - HM

Type: D-03

MCC RM, Potable/Irrigation Water Pumping Station

Utility Pumping Station

**Door Listing:** 1.00

**Hardware Set: UP-03**

	<b>Product Code Description</b>	<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	6.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



steel finish forend.

SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	2.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 1

**Remarks:** Double Door Entrance

Door type: D-02

Utility Pumping Station

**Door Listing:**

1.00

U P - G 0 0 1 / 2

**Hardware Set: WQ-01**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	4.0
XX100	Eurolever, door closer, adjustable power 2-5.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.

XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Door

FR

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Entrance  
Door type: D-01  
Water Quality Building

**Door Listing:**

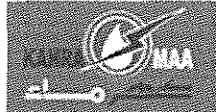
1.00

W Q - g 0 0 1

**Hardware Set: WT-01**

<b>Product Code Description</b>		<b>Quantity</b>
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	8.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0
SS1932	Eurolever accessory, flush bolt suitable for timber or steel door application. 225X19mm. Succesfully tested to EN1634-1. Satin stainless steel finish	2.0
SS1934	Eurolever accessory, floor mounted easy clean	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



socket Satin stainless steel finish.

XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0

**Total Number of doors:** 1

**Remarks:** Double Door - HM

Type: D-07

Gas Bottle Storage

Water Testing Facility Building

**Door Listing:**

1.00  
W T - G - 1 1 / 0 1

**Hardware Set: WT-02**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS1.6	Eurolever, mortice latch lockcase,heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 72mm centres. Tested to EN12209. Certifire approved. CE marked. Satin stainless steel finish forend.	1.0
SC11.61M	Eurolever, two side cylinder key operation, 61mm length, master key suited. Supplied with 3 keys Satin nickel finish. .	1.0
SS1311	Eurolever slim design concealed fixing europrofile cylinder escutcheon, 50mm diameter 4mm thick Satin stainless steel finish.	2.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	2.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 10

**Remarks:** Single Door - HM

Type: D-01, D-03, D-03A, D-03B, D-02, D-02A

Office, Laboratory 1 & 2, Autoclave RM, Elect. RM, Cold RM Samples, Cleaners  
Water Testing Facility Building

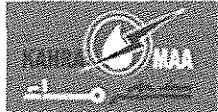
**Door Listing:**

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	W T - G - 0 5	W T - G - 0 6	W T - G - 0 7
	W T - G - 0 8	W T - G - 0 9 / 0 2	W T - G - 1 1 / 0 2
	W T - G - 1 2		

**Hardware Set: WT-03**

Product Code	Description	Quantity
XX10020	Eurolever panic latch, suitable for door widths upto 1200mm. Cut to size. Certified to EN1125, CE marked. Silver finish.	1.0
XX10022	Eurolever panic device external attachment compatable with europrofile cylinder hole to take single side cylinder to be supplied seperately. Silver finish.	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



SC10.61M	Eurolever, single side cylinder, 37.5mm length, master key suit, Supplied with 3 keys. Satin nickel finish.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
XX9105	Eurolever figure 6 fixing bracket suitable for instalation with model 100 closer.	1.0
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0

**Total Number of doors:** 3

**Remarks:** Single Door - HM

Type: D-05, D-05A

Entrance to Garage/Office/Store

Water Testing Facility Building

**Door Listing:**

1.00

W T - G - 0 1

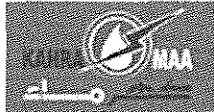
W T - G - 0 2 / 0 1

W T - G - 0 9 / 0 1

**Hardware Set: WT-04**

Product Code	Description	Quantity
SS5	Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6	Eurolever, mortice bathroom lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 78mm centres. Tested to EN12209 Satin stainless steel finish forend.	1.0
SS3060	Eurolever, slim design 50mm diameter 4mm thick	1.0

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



bathroom turn & Indicator 8mm spindle. Satin stainless finish

SS2002	Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100	Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927	Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS8036M	Eurolever signage, 76mm diameter disc. Satin stainless steel, male pictogram	1.0
SS21150	Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1942	Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-04

Male Toilet

Water Testing Facility Building

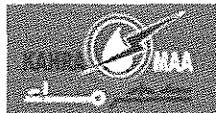
**Door Listing:**

1.00

W T - G - 1 3

**Hardware Set: WT-05**

**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



Product Code Description	Quantity
SS5 Eurolever,ball bearing hinge, Size100X75, 3mm thick. Tested to EN1935 grade 13. Certifire approved. CE marked satin stainless steel finish.	3.0
SS3.6 Eurolever, mortice bathroom lockcase, heavily sprung for lever handles. 8mm spindle hole. 60mm backset, 78mm centres. Tested to EN12209 Satin stainless steel finish forend.	1.0
SS3060 Eurolever, slim design 50mm diameter 4mm thick bathroom turn & Indicator 8mm spindle. Satin stainless finish	1.0
SS2002 Eurolever Strasbourg Collection, 1 pair grade 316 Satin stainless steel return levers ,19mm diameter, 135mm , on 50mm diameter 4mm thick rose. Fitted with Eurolever CONCEALED BEARING PERFORMANCE TECHNOLOGY. Tested to EN1906. Complies with BS8300 standard.	1.0
XX100 Eurolever, door closer, adjustable power 2-5. Adjustable speed. Suitable for door weights upto 120kg. EN1154 approved. Certifire approved. CE marked. Solid body with sliding cover. Supplied in a silver color finish.	1.0
SS1927 Eurolever accessory, floor door stop. Round shape, 38mm high, black circular buffer, 25mm inner circular top, Satin stainless steel finish.	1.0
SS8036F Eurolever signage, 76mm diameter disc, Satin stainless steel, female pictogram.	1.0
SS21150 Eurolever accessories, square corner kick plates 1.6mm thick, 800mm length, 150mm high. Satin stainless steel finish.	2.0
SS1942 Eurolever accessories, coat and hat hook. 88mm length, Satin stainless steel finish.	1.0



**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**

**Total Number of doors:** 1

**Remarks:** Single Door - HM

Type: D-04

Female Toilet

Water Testing Facility Building

**Door Listing:**

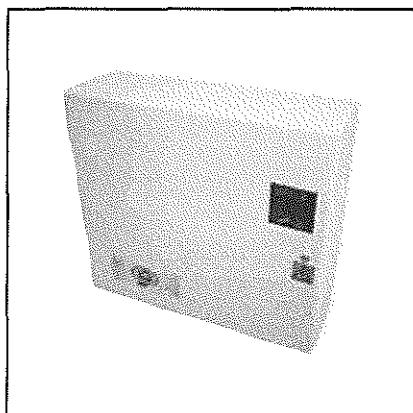
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W T - G - 0 4

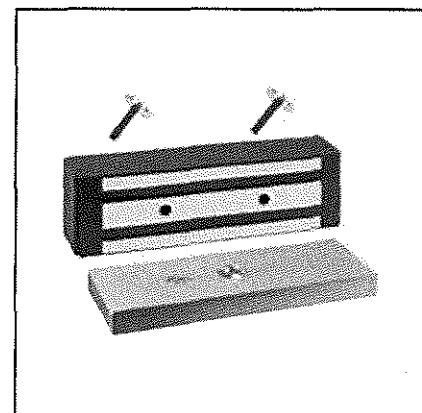
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**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



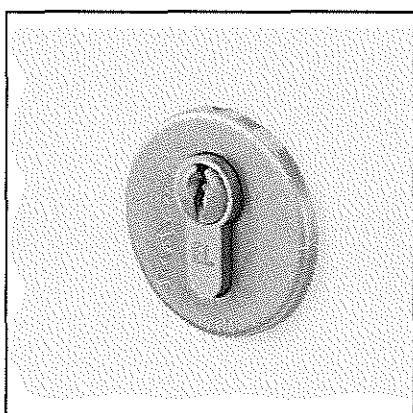
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AC9817



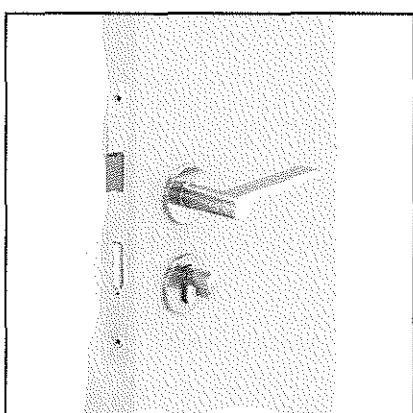
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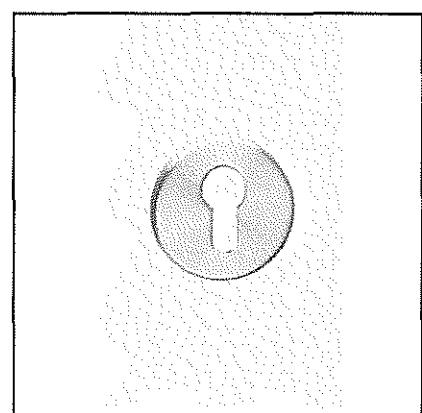
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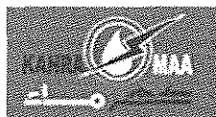
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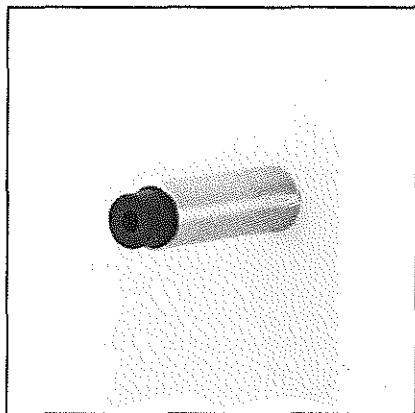
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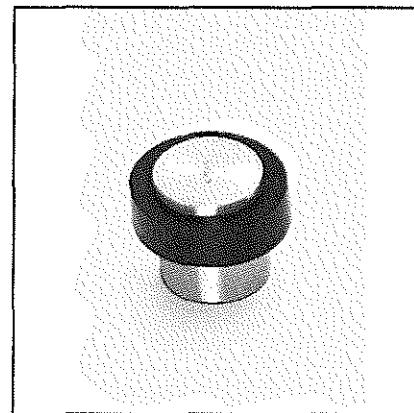
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**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



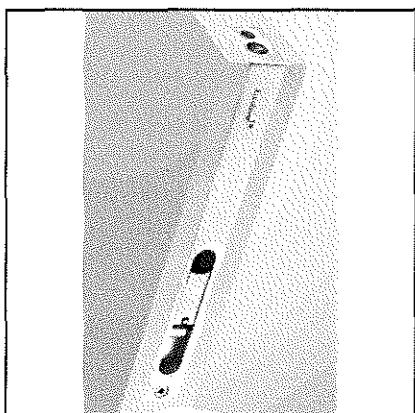
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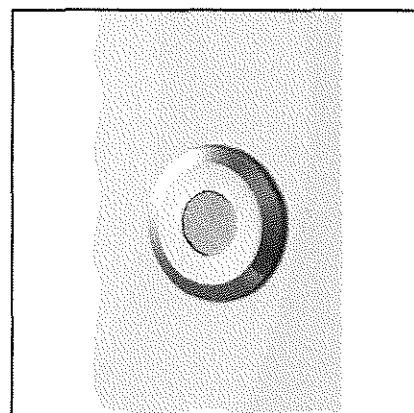
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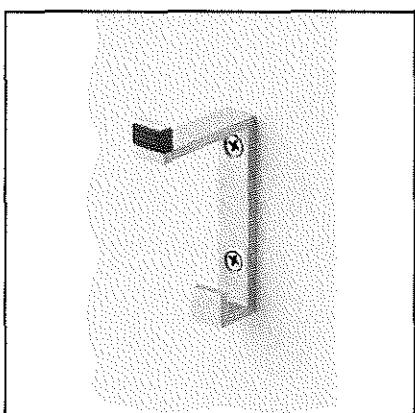
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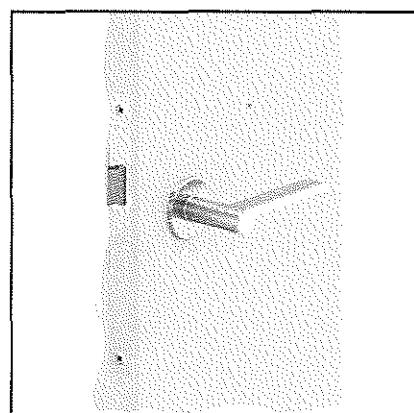
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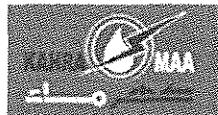
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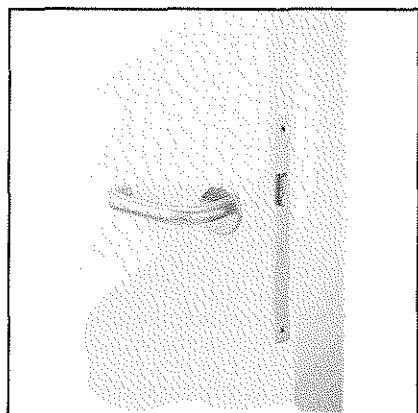
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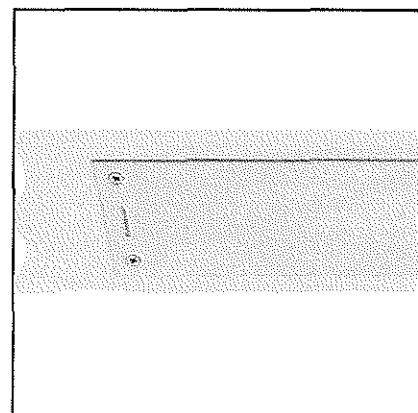
**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



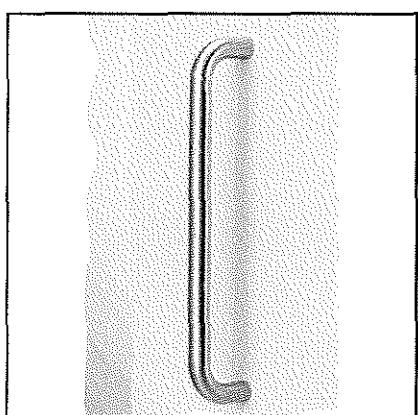
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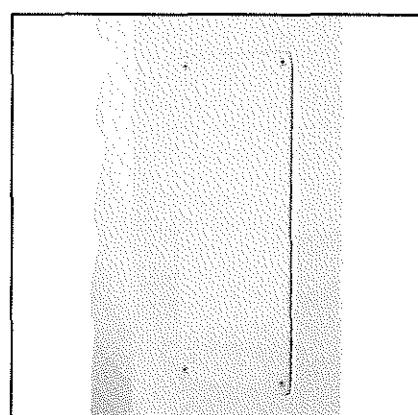
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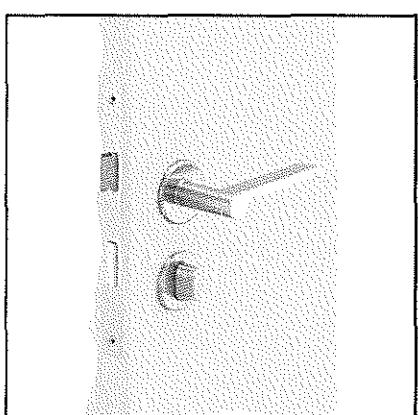
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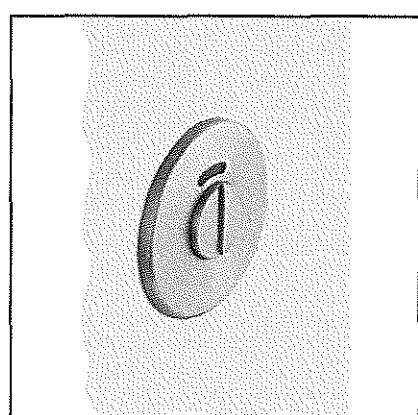
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SS3.6



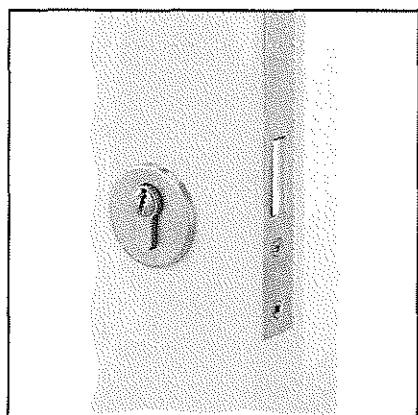
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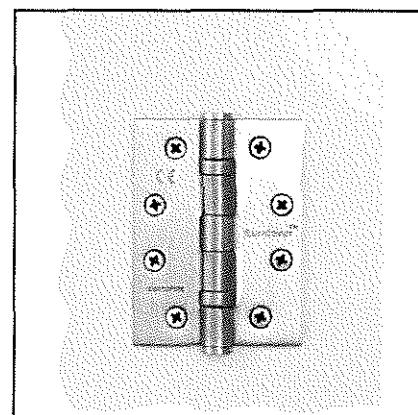
**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



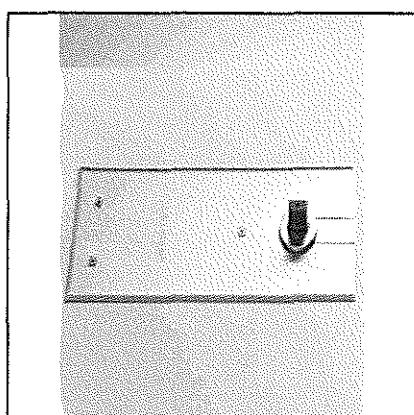
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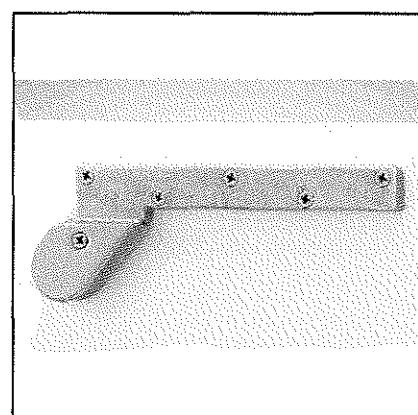
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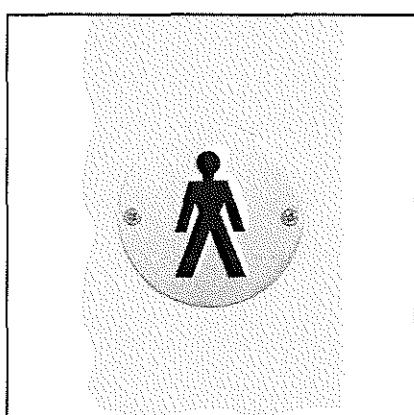
SS504



SS504D



SS8036M



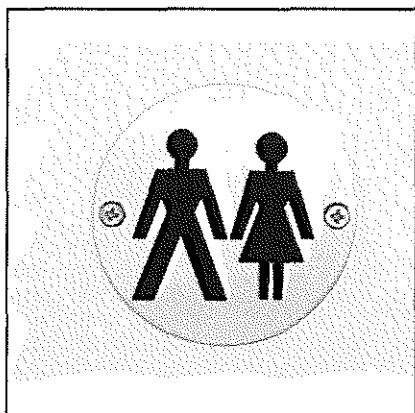
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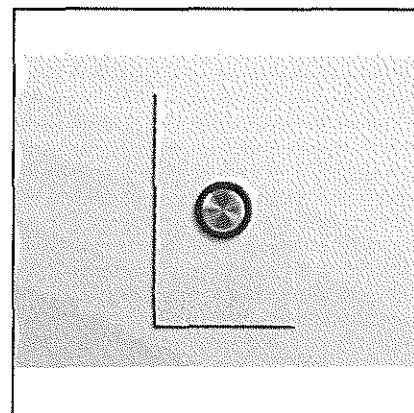
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**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



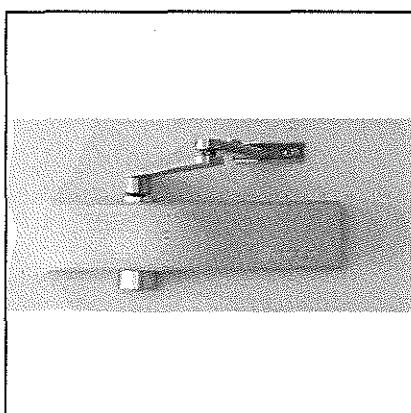
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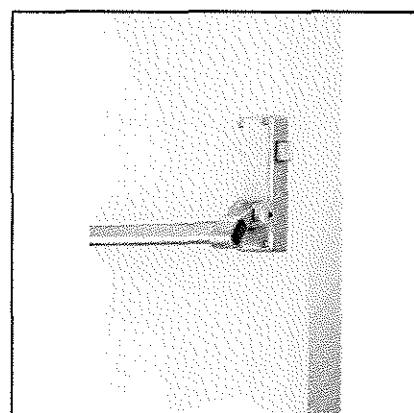
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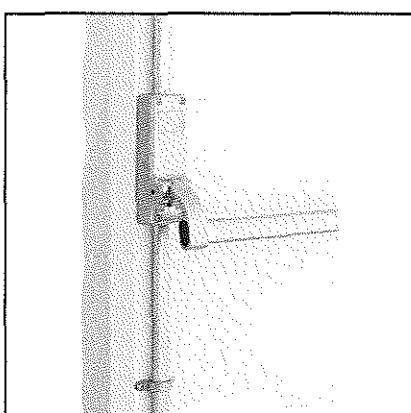
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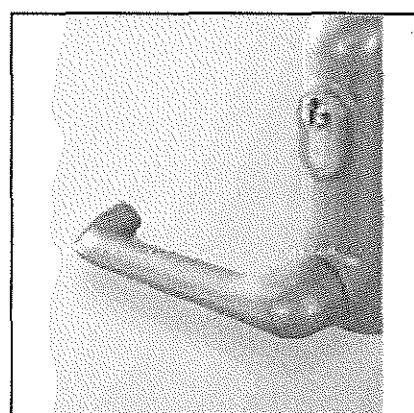
XX10020



XX10021



XX10022



**Qatar General Electricity & Water Corporation**  
**Tender NO. GTC 626/2014**  
**Construction of Mega Reservoir PRPSs**  
**(Packages A, B, C, D & E)**



XX9105

