ASHGHAL

Interim Advice Note No. 013

Amendments / Additions to QCS 2010

Revision No. A1

EXW-GENL-0000-PE-KBR-IP-00013

Summary
This Interim Advice Note (IAN) provides information and guidance on amendments and additions to QCS (Qatar Construction Specifications) 2010. This IAN takes immediate effect.

This document supersedes IAN 013 Rev 0 dated April 2012. Third parties not working on Ashghal projects make use of this document at their own risk. Paper copies of this document are uncontrolled. Refer to Ashghal's website for the most recent version.

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A1	Sept 2013	Issued for All Relevant Infrastructure Projects	DL	AM	AA
0	Feb. 2013	For issue to EXW Consultants & Contractors	IF	EDF	MG
Rev	**Date**	**Reason For Issue**	**Auth**	**Chk**	**App**

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1. Foreword

1.1 Interim Advice Notes (IANs) may be issued by Ashghal from time to time. They define specific requirements for works on Ashghal projects only, subject to any specific implementation instructions contained within each IAN.

1.2 Whilst IANs shall be read in conjunction with the Qatar Highway Design Manual (QHDM), the Qatar Traffic Manual (QTM) and the Qatar Construction Specifications (QCS), and may incorporate amendments or additions to these documents, they are not official updates to the QHDM, QTM, QCS or any other standards.

1.3 Ashghal directs which IANs shall be applied to its projects on a case by case basis. Where it is agreed that the guidance contained within a particular IAN is not to be incorporated on a particular project (e.g. physical constraints make implementation prohibitive in terms of land use, cost impact or time delay), a departure from standard shall be applied for by the relevant Consultant / Contractor.

1.4 IANs are generally based on international standards and industry best practice and may include modifications to such standards in order to suit Qatar conditions. Their purpose is to fill gaps in existing Qatar standards where relevant guidance is missing and/or provide higher standards in line with current, international best practice.

1.5 The IANs specify Ashghal's requirements in the interim until such time as the current Qatar standards (such as QHDM, QTM, etc.) are updated. These requirements may be incorporated into future updates of the QHDM, QTM or QCS, however this cannot be guaranteed. Therefore, third parties who are not engaged on Ashghal projects make use of Ashghal IANs at their own risk.

1.6 All IANs are owned, controlled and updated as necessary by Ashghal. All technical queries relating to IANs should be directed to Ashghal's Manager of the Design Department, Infrastructure Affairs.

Signed on behalf of Design Department:

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2. Ashghal Interim Advice Note (IAN) – Feedback Form

Ashghal IANs represent the product of consideration of international standards and best practice against what would work most appropriately for Qatar. However, it is possible that not all issues have been considered, or that there are errors or inconsistencies in an IAN.

If you identify any such issues, it would be appreciated if you could let us know so that amendments can be incorporated into the next revision. Similarly, we would be pleased to receive any general comments you may wish to make. Please use the form below for noting any items that you wish to raise.

Please complete all fields necessary to identify the relevant item			
IAN title:			
IAN number:		Appendix letter:	
Page number:		Table number:	
Paragraph number:		Figure number:	
Description comment: Please continue on a separate sheet if required:			
Your name and contact details (optional):			
Name:		Telephone:	
Organisation:		Email:	
Position:		Address:	

Please email the completed form to:

Abdulla Ahin AA Mohd

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We cannot acknowledge every response, but we thank you for contributions. Those contributions which bring new issues to our attention will ensure that the IANs will continue to assist in improving quality on Ashghal's infrastructure projects.

3. Introduction

3.1 This Interim Advice Note (IAN), which takes immediate effect, provides information and guidance on amendments and additions to Qatar Construction Specifications (QCS) 2010. This IAN will provide interim guidance prior to issue of a revision to QCS 2010.

4. Amended Standard

4.1 For application to projects which incorporate QCS 2010 which shall be amended by this IAN.

5. Implementation

5.1 This IAN is to be used with immediate effect on projects as follows:

- All Ashghal projects in Design Stage
- All Ashghal projects in Tender Stage

5.2 Ashghal projects in Construction Stage shall be reviewed by the Project Consultant / Contractor and the implications of adoption of this Interim Advice Note discussed with the respective Ashghal Project Manager.

5.3 The only exceptions are:

- Projects already in Construction, where a significantly high proportion of mechanically stabilised earth structures have been designed or procured, where this would result in significant additional cost or delay.
- Contracts which were signed prior to 11 July 2011, as such contracts should incorporate QCS 2007.

5.4 If in doubt, Consultants / Contractors should seek guidance from the respective Ashghal Project Manager or designated Programme Management Consultant (PMC) on a scheme specific basis.

Appendix A – Amendments / Additions to Qatar Construction Specifications (QCS) 2010

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SECTION 1 GENERAL

PART 1 INTRODUCTION

Add new Clause 1.7 as follows:

1.7 OTHER REQUIREMENTS

➢

➢ **1.7.1 Site Specific Geotechnical Requirements**

1 The Contractor's attention is drawn to the ground conditions likely to be encountered in the area as provided for information in Geotechnical Investigation Report in the Specification. Construction works may involve excavation in very hard rock and in filled and reclaimed land and excavations below the level of the ground water table. The Contractor should assess and make allowance for working in such conditions.

➢ **1.7.2 Blasting Restrictions**

1 The Contractor's attention is drawn to the fact that the Works may be constructed in developed areas where blasting may be restricted.

PART 3 SITE ACCESS AND ENTRY ONTO THE SITE

3.2 ACCESS ROADS

3.2.1 Temporary Access Roads

Delete paragraph 2 and substitute with the following:

2 Reinstatement shall include restoring the area of any route to at least the degree of safety, stability, drainage, level, contour and landscaping that existed at the time the Contractor is given Possession of Site.

3.3 SITE ENTRY

3.3.1 Entry onto the Site

Delete paragraph 3.

Add new paragraph 8 as follows:

8 The work permit for plants, which are under operation by PWA Operations and Maintenance Department will be issued as per 'Operations and Maintenance Department Permit Procedure' based on the Contractor's application through the Engineer or his designated representative.

PART 4 PROTECTION

4.3 PROTECTION OF OTHER WORKS

4.3.2 Procedure for Complaints and Claims for Damage

Delete paragraph 1 and substitute with the following:

1 Details of all claims for damage or warning of intended claims for damage which the Contractor may receive shall be brought to the attention of the Engineer without delay. Likewise, any such claims or warnings, which may be submitted directly to the Engineer shall be passed on to the Contractor without delay.

4.3.3 Protection of Survey Control Points

Add new paragraphs 4 to 7 as follows:

4 The Contractor shall consult the Survey Section of the Ministry of Municipality and Urban Planning (MMUP) and Public Works Authority (PWA) prior to the commencement of any works to determine if the work is likely to disturb survey marks. If the Survey Section requires a survey mark to be moved the Contractor will be responsible for recreating the survey mark to an approved design and specification, and for resurveying the point using survey companies approved by the Survey Section.

5 The Contractor shall be responsible for the protection of the survey marks within the boundaries of the Site for the duration of the Contract and shall be liable for all costs of any remedial work required by the Survey Section.

6 Prior to the issuing of the Certificate of Completion of Works the Survey Section will issue a certificate stating that all survey marks, whether disturbed or otherwise by the Contractor, have been reinstated or protected to the satisfaction of the Survey Section.

7 In the event of failure to comply with the requirements of this Clause the PWA, without prejudice to any other method of recovery, may deduct the costs of any remedial work after the Time for Completion carried out by the Survey Section, from any monies in its hands or which may become due to the Contractor.

PART 5 INTERFERENCE

5.2 GENERAL

5.2.1 Land Interests

Delete paragraph 3 and substitute with the following:

3 The Contractor shall notify the Engineer in writing of his intention to utilise any land outside the Site and obtain the written approval of the Engineer before approaching any landowner for use of their land.

Add new paragraph 4 as follows:

4 Before exercising any right negotiated by him in connection with using land outside the Site, the Contractor shall notify the Engineer in writing of such arrangements. The details of the arrangement shall include drawings and description of the land to be used, purpose of its use and duration of the Contractor's use of the land

5.2.2 Existing Properties

Delete paragraph 1 and substitute with the following:

1 The Contractor shall obtain the approval of the Engineer before interfering with access to any property, and shall also obtain the approval of the Engineer to any alternative access arrangements.

Add new paragraph 2 as follows:

2 The Contractor shall notify the Engineer and the relevant owners and occupiers in writing fourteen (14) days in advance of any such interference and shall confirm to the Engineer that the alternative arrangements have been agreed with the relevant owners and occupiers.

5.2.3 Existing Roads

Add new paragraph 4 as follows:

4 The Contractor shall be held responsible for any damage caused by him, Contractor's Employees, sub-contractors or suppliers to public or private roads, paved areas, paths verges, trees, shrubs, fences, boundary walls, gates, signs, drains, ducts and services arising out of or by reason of the execution of the Works and shall bear the cost of making good any damage to the entire satisfaction of the local and other authorities and owners. The Contractor shall keep all private roads and paths clean and free from dirt and debris and any obstruction associated with the Works, which would prejudice the safe and unimpeded normal use of the said roads and paths.

PART 7 SUBMITTALS

7.9 PHOTOGRAPHS

7.9.1 General

Add new paragraph 5 as follows:

5 The Contractor shall provide six digital cameras and one digital video camera for the exclusive use of the Engineer or his designated representative and supply software, batteries, cables and USB flash drives or external hard drives as required. The digital camera shall have a minimum specification of 35–105 zoom, with a minimum of 10.0 megapixels for prints up to 20" x 30", 4GB internal memory and video/audio facility. The cameras shall be returned to the Contractor at the end of the contract period.

7.9.2 Pre-Construction Photographs

Delete paragraph 1 and substitute with the following:

1 The Contractor shall arrange to obtain a photographic and video record of the Site before the start of the Works to fully record the existing conditions of the Site and other matters of interest in connection with the Works or their surroundings of the Project, by taking photographs and video films from positions agreed with the Engineer. Two number 125 x 90 mm prints of each photograph and a digital copy of the photographs/video film on a CD shall be handed to the Engineer within 7 days of the photographs/videos being taken. Any photograph/video which is not clear and distinct, double exposed, over exposed, blurred, etc., shall be retaken until approved by the Engineer at the Contractor's expense.

7.9.3 Monthly Photographs and Videos

Delete paragraph 1 and substitute with the following:

The Contractor shall obtain a photographic record of the execution of the Works by taking photographs from various points as agreed with the Engineer at the commencement of the Works, and also as he may specify from time to time during the course of the Works. Photographs shall be taken at each of the specified points on a monthly basis until the completion of the Works. The number of photographs to be taken shall be as specified by the Engineer. Any photograph which is not clear and distinct, double exposed, over exposed, etc. shall be retaken until approved by the Engineer at the Contractor's expense. Two number 125 x 90 mm prints of each photograph and a digital copy on CD shall be submitted to the Engineer within 7 days of the photographs being taken. The Contractor shall also obtain video records showing the progress of the Works, at locations and times as specified by the Engineer. The quality and length of the video shall be as specified by the Engineer and may be required to record specialised events or other matters of interest in connection with the Works. The video shall include the actual audio recording taken at the time and it shall be in sync with the visual recording. Any video which is not clear and distinct, double exposed, over exposed, blurred, etc. shall be retaken until approved by the Engineer at the Contractor's expense. A digital copy of the video on CD shall be submitted to the Engineer within 7 days of the recording being taken.

Delete paragraph 4.

PART 9 MATERIALS

9.3 TESTING OF MATERIALS

9.3.1 General

Delete paragraph 9 and substitute with the following:

9 The laboratory shall be provided with equipment and trained personnel sufficient for carrying out all the tests for earthworks, subbase / road base, concrete, asphalt, etc. referred to in the Specification. The laboratory shall be capable of carrying out all the relevant tests at the frequency required by the Specification and by the rate of progress required by the Contractor's approved programme for the Works.

PART 10 HEALTH AND SAFETY

10.1 GENERAL

10.1.1 Scope

Delete paragraph 2 and substitute with the following:

2 Related Sections and Parts are as follows:

This section	Part 4	Protection
	Part 11	Engineer's Site Facilities
Section 2	Part 3	Hazardous Materials
Section 11	Part 1	Regulatory Document
Section 11	Part 2	SAMAS

10.7 WELFARE OF WORKMEN

10.7.2 Safety Equipment

Add new paragraphs 9 and 10 as follows:

9 The Contractor shall provide and maintain in good working order one compressed air escape respirator set (Dräger "Saver Auto PP" or similar) in the Contractor's site office.

10 One oxygen resuscitation unit shall be provided in the Contractor's site office.

10.7.3 Support Facilities for Contractor's Staff and Labour

Delete paragraph 5 and substitute with the following:

5 The Contractor shall provide transportation between staff accommodation and areas of work for his staff and labourers.

Add new Sub-Clauses 10.7.5 and 10.7.6 as follows:

➢ 10.7.5 Additional Environmental Protection and Pollution Control

1 The Contractor shall comply with all conditions of Environmental Clearance issued for the Contract by the Ministry of Environment (MoE), and also where relevant, the predecessor to the MoE, the Supreme Council for the Environment and Natural Reserves.

2 The Contractor shall comply with all rules and regulations regarding environmental protection and pollution control issued by the MoE, and also where relevant, the predecessor to the MoE, the Supreme Council for the Environment and Natural Reserves.

➢ 10.7.6 Plant and Equipment Test Certificates

1 Cranes, whether used to construct the Works or provided as part of the permanent Works, must have a current test certificate.

2 Each sling, shackle or other item of loose lifting tackle, whether used to construct the Works or provided as part of the permanent Works, must have either a current manufacturer's test certificate or a current test certificate.

3 Test certificates must be issued by a competent testing authority approved by the Engineer.

4 The Contractor must have a copy of each test certificate on-site available for inspection by the Engineer.

5 The following British Standards and Code of Practice shall be complied with:

(a) Mobile and Tower Cranes: BS 1757, BS 2799 and CP 3010
(b) Overhead Cranes: BS 466 and BS 5744
(c) Slings: BS 1290
(d) Chain Blocks: BS 3243
(e) Shackles: Alloy: BS 3551, High Tensile Steel: BS 3032

PART 11 ENGINEER'S SITE FACILITIES

Add new Sub-Clause 11.2.5 as follows:

11.2.5 Type 3 Offices

1 The Contractor shall provide, maintain and keep clean and in a sanitary condition, temporary site office facilities with all associated equipment and services for the exclusive use of the Engineer's Representative and his staff form the commencement of the Project. The site office facilities shall remain, in whole or in part as required by the Engineer until the end of the Maintenance Period, or such earlier time as the Engineer may approve.

2 The Contractor shall proceed with the site office facilities immediately following the award of the Contract and shall provide temporary alternative accommodation/offices to the Engineer's approval until such time as the site office facilities are made available.

3 The Contractor shall submit all necessary specifications, drawings and calculations for the fabrication and installation of the site office facilities, showing the accommodation proposed with complete furnishings, equipment and fittings for the Engineer's approval before placing any orders or commencing fabrication and construction and shall be responsible for ensuring that the offices are structurally sound. The Engineer may request alterations at this stage. The drawings shall be approved in writing by the Engineer before installation/construction shall commence.

4 The site office facilities shall conform to the general configuration shown below and shall be either prefabricated portable unit/s or of other form of weatherproof design and construction to the approval of the Engineer. The facilities shall have full partitions and room sizes shall be as shown in the attached Schedule of offices. All rooms shall have individual entrance doors. Corridors and entrance areas shall be additional to the office sizes. The Contractor shall ensure the site offices against fire, burglary and other risks.

5 The site office facilities shall be mounted on adequate concrete foundations and shall be provided with concrete access steps where necessary. Walls and roofs of the facilities may be constructed of composite timber framed panels with metal cladding, or alternative forms to the Engineer's approval, with thermal conductance of 0.60 w/m2 °C and fire resistance of one hour. Roof coverings shall be selected for durability, freedom from excessive maintenance, and the ability to withstand extreme exposure to sun, heat and humidity. All rooms shall have glazed windows complete with fly screens.

6 The offices shall be air-conditioned with the exception of toilets and kitchen areas. The offices shall be air-conditioned with dual (cooling/heating) wall mounted/window units to maintain each room at a maximum steady dry bulb temperature between 20°C and 25°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.

7 Adequate fitted hardware, electrical switches, sockets, lighting and plumbing fittings, sanitary ware and fittings and fixtures etc., shall be provided as necessary for the different areas. The electrical installation shall provide for simultaneous use of all electrical appliances. The installation and testing of wiring and electrical equipment in the unit shall be in accordance with the latest requirements of the Qatar General Electricity & Water Corporation.

8 Throughout the duration of the Contract, the Contractor shall ensure adequate uninterrupted supplies of clean fresh water, electricity, telephones, fax machines, internet connections, photocopiers/plotters, computers and printers, consumables, stationary, refreshments, waste paper baskets, filing trays to the offices.

9 The Contractor shall provide all typical items listed in the following schedules, and final configuration shall be as specified by the Engineer. All keys for the Engineer's site offices shall be held by the Engineer until such offices are removed or vacated by the Engineer.

10 Unless noted otherwise within the following schedules, as a minimum each office shall be provided with the following furniture to the approval of the Engineer:
- 1 No. kneehole pattern desk with lockable drawers, 1500x800x7600mm in size.
- 1 No. swivel chair with armrests.
- 1 No. stacking or folding chairs.
- 1 No. hanging file of plan chest suitable for A0 size prints.
- 1 No. wastepaper basket.
- 1 No. two drawer filing cabinet.
- 1 No. wall mounted pin board, 1000x2000mm in size.

11 Unless noted otherwise within the following schedules, as a minimum, the sample rooms shall be provided with the following furniture to the approval of the Engineer:
- 3 No. low level WC suite.
- 3 No. wash-hand basin.
- 1 No. shower tray, mixer fittings, rose and shower curtains.
- 3 No. toilet roll holder, towel rail, soap dish and mirror.
- 1 No. hand/face dryer.
- Adequate supply of paper towels.

12 Unless otherwise noted within the following schedules, as a minimum, the sample room shall be provided with the following furniture to the approval of the Engineer.
- 2 No. tables, each approximately 1200x2000mm in size.
- Folding or stacking chairs.
- 1 No. wall mounted blackboard, 1000x2000mm in size.
- 1 No. wall mounted pin board, 1000x3000mm in size.
- 1 No. shelf unit for the approved samples with 5 tiers of shelves, 400x2400mm overall.

13 Unless noted otherwise within the following schedules, as a minimum, the meeting room shall be provided with the following furniture to the approval of the Engineer:
- Very long meeting table and chairs to suit room size.
- 42" flat plasma TV, a VCR/DVD, a wall mounted projector, computer connections.
- 1 No. wall mounted white board, 1000x2000mm in size.
- 1 No. wall mounted pin board, 1000x3000mm in size.
- 1 No. wall mounted folding screen, 2000x3000mm in size, for presentations.
- 1 No. shelf unit for approved samples with 5 tiers of shelves, 400x2400mm overall.

14 Unless noted otherwise within the following schedules, as a minimum, the kitchen shall be provided with the following equipment to the approval of the Engineer:
- 1 No. stainless steel dual bowl drainer sink, hot and cold taps, cupboards underneath.
- 4 ring cooker, 1 microwave.
- Cabinets and shelves to match sink, as required.
- 1 No. 20' refrigerator.
- Sufficient pint electrical kettles and crockery and cutlery.
- A suitable number of cups, saucers and drinking glasses.

15 Corridors shall be provided with three portable dry powder fire extinguisher and 3 water coolers.

16 The site office facilities, including all furniture and equipment shall become the property of the Government on completion of the Contract and shall be repaired and redecorated to the satisfaction of the Engineer and they shall then be delivered to a location designated by the Engineer within 50km of the Site.

Type 3: Engineer's Site Offices

Room No.	Post	Room Size	No.	Remarks
1	Resident Engineer (Roads)	6m x 4m	1	
2	Assistant Resident Engineer (Roads)	4m x 4m	1	
3	Assistant Resident Engineer (Utilities & Structures)	6m x 4m	1	
4	Quantity Surveyor	4m x 4m	1	
5	Planning Engineer	4m x 4m	1	
6	Highway Surveyor and Safety Officer	4m x 4m	1	
7	Inspectors (5 Nos.)	8m x 4m	1	
8	CAD Operator	4m x 4m	1	
9	Bilingual Secretary / Document Controller	6m x 4m	1	
10	Kitchen Complete		1	
11	Toilet and Shower Complete		2	
12	Lobby and Reception		1	
13	Archives		1	
14	Store Room		1	
15	Samples Room		1	
16	Server Room		1	
17	Printing / Plotting Room		1	
18	Conference Room		1	
19	As designated by Engineer		1	
20	As designated by Engineer		1	
21	As designated by Engineer		1	
22	As designated by Engineer		1	
23	Shaded Car Park		30	
24	Elevated Water Tank		1	
25	Underground Septic Tank		1	
26	Generator / Generator Room		1	
27	Paved Walkways, Steps			
28	Lit Parking Lot and Access Road		1	
29	Landscaping Area		1	

Type 3: Engineer's Site Furniture

R	Post	XLD	LD	D	CHB	CLB	CT	MT	Cub	Cab	AC	PC	Sc	P	S	PB
1	Resident Engineer (Roads)		1		1	8		1	2	2	2S	1*	19"	1*	1	2
2	Assistant Resident		1		1	1			2	2	1S	1*	19"	1*	1	1
3	Assistant Resident		2		2	2			2	2	2S	2*	19"	2*	2	2
4	Quantity Surveyor		1		1	1			1	1	1S	1*	19"	1*	1	1
5	Planning Engineer		1		1	1			1	1	1S	1*	19"	1*	1	1
6	Highway Surveyor - Safety		2		2	2			2	2	1W	2*	19"	1*	2	2
7	Inspectors (5 Nos.)		6		6	4			3	3	2W	6*	19"	2*	6	6
8	CAD Operator		1		1	1			1	1	1W	1*	19"	1*	1	2
9	Bilingual Secretary / Document Controller		2		2	2			2	2	2S	2*	19"	2*	2	2
10	Kitchen Complete	Refer to item 14 of Engineer's Site Office Facilities – Type 3 above														
11	Toilet & Shower Complete	Refer to item 11 of Engineer's Site Office Facilities – Type 3 above														
12	Lobby & Reception										2S					
13	Archives			2							2W				1	2
14	Store Room							1			1W					
15	Samples Room							1			1W					
16	Server Room										1W					
17	Printing / Plotting Room							1			1W					
18	Conference Room					16	1				2S				1	2
19	As designated by Engineer	1			1	2		1	1	1	2S	1**	19**	1**	1	1
20	As designated by Engineer		1			2			1	1	1S	1**	19**	1**	1	1
21	As designated by Engineer	1			1	2		1	1	1	2S	1**	19**	1**	1	1
22	As designated by Engineer		1			2			1	1	1S	1**	19**	1**	1	1

XLD	Executive Large Desk with 2x3 locking drawers, L shape	**Sc**	Screen, Size indicated, L for flat LCD
LD	Large Desk with 2x3 locking drawers, L shape	**P**	Printer, HP LaserJet A4
D	Straight Desk with 1x3 locking drawers	**Sh**	Shelves, as required
CHB	Chair, High Back, (Room 19 and 21 leather chair)	**PB**	Pin Board, as required
CLB	Chair, Low Back or Visitor Chair (Meeting Table)		
CT	Conference Table		
MT	Meeting Table / Stacking Table		
Cab	Cabinet, vertical, 2 x 6 locking drawers		
Cup	Cupboard		
AC	S: Split Unit, 2.5 tons W: Window Unit, 2.5 tons (All units heating/cooling)		
PC	Personal Computer with screen, on network, See Specifications		

* Computers and printers will be supplied by the Consultant for the use of his staff. The Contractor shall provide and maintain network cable infrastructure, power and data outlet points, internet connections including payment of bills for the Consultants. Internet connectivity shall be of sufficient bandwidth to enable the timely and efficient uploading/downloading of electronic documents and files into the Programme's internet-based collaboration environment provided by the Engineer.

** Computers and printers for the use of the Engineer shall be provided and maintained by the Contractor, in addition to cabling, internet connections, etc.

PART 13 SETTING OUT OF THE WORKS

13.3 LEVELS AND REFERENCE GRID

13.3.1 Temporary Bench Marks

Delete paragraph 1 and substitute with the following:

1 The Contractor shall establish accurate temporary bench marks on permanent blocks from which the levels to which the Works are to be constructed may be transferred. The location of temporary bench marks shall be agreed with the Engineer. The level of temporary bench marks shall be related to the Qatar National Height Datum.

13.3.2 Site Grid

Delete paragraphs 1 and 2 and substitute with the following:

1 Should the Contractor choose to establish a local site grid then the grid shall be tied to the Qatar National Grid and a survey report provided to the Engineer which establishes the process for conversion between the two.

13.4 SURVEYING

13.4.1 Site Survey

Delete paragraphs 1, 2, 3 and 4 and substitute with the following:

1 The Contractor shall provide the Site ground survey and the correctness of that survey shall be entirely the Contractor's responsibility.

2 The Site ground survey shall comply with the requirements of the Qatar Survey Manual as a minimum.

3 The Contractor shall, within 3 weeks of the date of commencement of the Works, carry out a check of the co-ordinates and levels of all permanent monuments, bench marks and survey markers used in the determination of the site survey model and proposed to be used for the setting out of the Works.

PART 15 TEMPORARY CONTROLS

15.2 TEMPORARY CONTROLS

15.2.5 Pollution Control

Add new paragraph 3 as follows:

3 The Contractor will be held responsible for and shall indemnify the PWA and the Engineer against all claims in connection with noise, vibration, dust, smoke, diesel spillage and any other nuisance arising from the execution of the Works.

PART 16 TRAFFIC DIVERSIONS

16.1 GENERAL

Add new Sub-Clause 16.1.6 as follows:

16.1.6 Traffic Safety and Control Officers

1 The Contractor shall appoint a Traffic Safety and Control Officer at the commencement of the Works. The name, address and telephone number(s) (both on and off-site) of the Traffic Safety and Control Officer shall be notified to the Engineer, the Traffic Police and any relevant authority. The Traffic Safety and Control Officer shall be a direct employee of the Contractor and shall not be an employee of a sub-contractor. He shall be experienced in traffic safety and management on similar highway projects, and shall be responsible on behalf of the Contractor for:

(a) liaison with the Engineer, any relevant highway authority, and the police in all matters relating to traffic safety and management;
(b) the establishment, resourcing commissioning prior to the commencement of any work and the decommissioning and removal of all traffic management systems on completion of that element of work;
(c) the management of traffic during periods when traffic restrictions are in place and for ensuring that all traffic safety and management requirements are met;
(d) immediately notifying the Traffic Police, the Engineer and the Contractor of any accidents, spillages or emergencies;
(e) ensuring the safe working of plant, machinery and personnel and ensuring that all personnel engaged in the Works are aware of the Contractor's obligations and duties in respect of site safety when working on trafficked highways.
(f) notifying the Engineer of any deterioration in Traffic Management Equipment and trafficked road surface;
(g) monitoring the flow of traffic within the Traffic Management Area to detect any incident resulting in stationary or delayed traffic and reporting to the Engineer.
(h) submitting information sheets weekly to the Engineer logging all Traffic Management Operations and advising the expected duration of the current system, together with notice of the programmed commencement/duration of the next system;
(i) submitting information sheets weekly to the Engineer logging all incidents and the consequential effect on the Works and, when called, all movements of the emergency vehicles. For the purposes of this Clause, an 'incident' is defined as a shed load, vehicle breakdown, vehicle abandonment, or traffic accident, whether or not the latter involves personal injury;
(j) assisting any member of the public by ensuring that a breakdown recovery vehicle is called when required;
(k) ensuring that no employee of the Contractor or any sub-contractor (not associated with the Traffic Management Operation) enters any part of a carriageway which is not properly signed and coned off. Ensuring that employees of the Contractor or sub-contractor are individually and specifically warned not to step on to any part of the highway which is open to traffic except to cross at designated crossing points when required to access other parts of the Works;
(l) notifying the Engineer of any deterioration of safety precautions including traffic signs, temporary road markings, road surface, safety zones, works access provisions and ensuring that rectification is carried out in accordance with the relevant specified standards;
(m) ensuring that all standing plant, equipment and materials within closed off areas on the highway are "coned-off", placed tidily and in positions so as to minimise restrictions on the passage of vehicles using the highway and so as not to inhibit sight lines for traffic;
(n) checking that lanes, carriageways or roads temporarily closed to traffic are to be reopened at the programmed time and confirming this to the Engineer by means of an agreed pro-forma;

(o) informing all personnel employed on the Works of any changes to the Traffic Management System which may affect their access or egress to the Site, or their working conditions.

2 The Contractor shall appoint at least one deputy Traffic Safety and Control Officer who shall be a direct employee of the Contractor, but not a sub-contractor, and be experienced in traffic safety and management on similar highway projects. The deputy shall undertake the responsibilities of the Traffic Safety and Control Officer when the latter is absent. The name, address and telephone number(s) both on and off-site of the deputy Traffic Safety and Control Officers shall be notified to the Engineer the police and any relevant authority. Contact with either the Traffic Safety, Control Officer or his deputy, shall be possible at all times.

3 The Traffic Safety and Control Officer and his Deputy shall be able to contact the Contractor's main office at any time.

4 The Traffic Safety and Control Officer shall patrol all traffic management systems in service at two hourly intervals to ensure that any defect is immediately corrected.

16.2 TEMPORARY TRAFFIC DIVERSIONS

16.2.1 General Requirements

Delete paragraph 3 and substitute with following:

3 Where paved carriageways, unpaved carriageways or ramps are required, they shall be provided and maintained to a standard suitable in all respects for the class or classes of traffic or pedestrians requiring to use them. The surface provided shall be equivalent to the surface of the existing carriageway or footway.

Delete Sub-Clause 16.2.2 and substitute with the following:

16.2.2 Maintenance of Traffic flow

1 The Contractor shall allow for the construction of temporary diversions to permit all existing traffic movements for the full duration of the Contract period. Temporary diversion routes may be required to be altered or rerouted during the course of the Contract and the Contractor shall allow for this as necessary. Prohibition of any traffic movement, including those shown cut off in the traffic diversion drawings shall be to the approval of the Engineer. Cut off traffic movements shall be properly compensated by installing alternative traffic diversion routes.

2 The Contractor shall prepare and maintain a comprehensive Temporary Traffic Management Plan (TTMP) which shall encompass all traffic diversions required throughout the duration of the contract. It shall provide for working drawings, supporting descriptions and documentation of all proposed traffic diversions within, and outside, the Limit of Works resulting from the Works. The TTMP shall be maintained as a working document that is under continual review. The Contractor shall coordinate the TTMP with, and obtain the approval from the Engineer, Traffic Police and relevant PWA concerned departments and other authorities as may be required.

3 Traffic diversions shall be designed by an International Roads Engineering Consultant accredited by PWA and shall be submitted for both the Engineer and Traffic Police approval prior to implementation. Traffic diversion drawings shall be accompanied by traffic reports prepared by the International Roads Engineering Consultant and presentations to the higher authorities as necessary. The traffic reports shall be supported with data of existing and expected traffic volumes during the course of the contract period. Analysis of traffic volumes at junctions and on road links shall be carried out using industry standard software, or as may be specified by the Engineer.

4 The Contractor shall carryout traffic surveys by an accredited company, including automatic traffic counts and manual classified counts at the main roads, and turning movement counts at the existing junctions, to determine the current level of service and forecast level of service at the junctions upon the implementation of the temporary traffic diversion. Unless otherwise agreed with the Engineer, the main junctions shall perform at a Level of Service “D” as a minimum. Upon the Engineer’s request, the Contractor shall install and commission additional temporary traffic signals capable of handling the diverted traffic.

5 Where traffic diversion drawings are included within the Project Documentation, these shall be considered to be conceptual only, and they shall indicate the main traffic diversion scheme and stages representing the absolute minimum traffic management requirements. At the discretion of the Engineer, the final traffic diversion drawings may show an increased number of lanes at critical locations should the need arise and they may allow for local access points as appropriate. The Contractor shall be responsible for producing drawings which detail the secondary diversions to the local branching roads, and which detail the interim diversions to suit the Contractor’s sequence of work.

6 The temporary traffic diversions shall include, but not be limited to, earthworks, pavement construction, directional signs, traffic signs, road markings, safety barriers, temporary street lighting, temporary traffic signals (if required), relocation of existing street furniture, relocation/protection of underground existing services, reinstatement of permanent works, and subsequent removal of all temporary diversion works, all to the approval of the Engineer, Traffic Police and the other concerned PWA departments and authorities. Power supply for lighting can be from permanent or temporary supplies subject to agreement with the relevant authority.

7 Traffic diversions shall be constructed and maintained in accordance with the UK’s Traffic Signs Manual, Chapter 8 unless otherwise specified by the Engineer. It is the Contractor’s responsibility to ensure that any traffic diversion required is properly signed, demarcated, illuminated and lit as per the category of the diverted road, controlled and maintained at all times. The Contractor shall submit his traffic diversion plans to the Engineer and no diversions shall be put in place until approval is obtained from the Engineer.

8 Special attention shall be given when joining with existing roads and junctions to ensure smooth transitions and ride-ability. Encountered manholes and chambers shall be adjusted to be flush with the traffic diversion. The Contractor shall not open any traffic diversion without the written approval of the Engineer.

9 Sequential arrow boards operating on a 24-hour basis (engine or solar powered) must be used at all diversion points. The Contractor is to allow for any day-time glare and ensure

that arrows are capable of being seen sufficiently by drivers in advance of the diversion and as required by the UK's Traffic Signs Manual, Chapter 8.

10 Within the limits of the project where pedestrian traffic is present, all excavated areas, regardless of depth, must be cordoned off by means of wired mesh panels of a height no less than 1.8 m connected together to form a continuous barrier wall. All existing pedestrian routes shall be kept open at all times for the full duration of the Works. Where a pedestrian route is required to be diverted or realigned, a minimum width of 2.0 m is to be applied to the diverted / realigned route. Where it is impractical to meet the 2.0 m width requirement, a reduced width shall be agreed with the Engineer.

11 The Contractor must ensure that all temporary roads, diversions to be operating in a safe manner. Traffic must be maintained on hard surface asphalt roads free of any dirt, debris, holes and other obstacles. Redundant paint markings are to be removed completely so as not to cause confusion with new temporary paint markings. Redundant paint markings shall not be considered to have been removed completely until written agreement has been provided by the Engineer.

12 Upon approval from the Engineer on any road closure or temporary diversion or realignment for the purpose of carrying out the Works of PWA, the Contractor shall place a sufficient notification to the general public in three local newspapers, coloured, and both in the Arabic and English languages at least on one (1) week and also again on three (3) days prior to the road closure, diversion or realignment. The contents of notification shall be approved by the Engineer and the extent shall not be less than a half of the standard size page of a reputed local newspaper. In order to evident the notification the Contractor shall submit to the Engineer a copy as appeared on the newspaper on the same day of the notification.

PART 17 PROJECT COORDINATION

17.1 GENERAL

17.1.2 Responsibility

Delete paragraph 2 and substitute with the following:

2 No major operations shall be commenced or work outside the usual working hours be carried out without the consent in writing of the Engineer or without full and complete notice also in writing being given to him sufficiently in advance of the time of operation so as to enable him to make such arrangements as he may deem necessary for its inspection.

PART 19 REGULATORY REQUIREMENTS

19.3 MISCELLANEOUS

19.3.2 Regulations of Road Openings

Delete paragraph 1 and substitute with the following:

1 For Works including road openings, the Contractor shall comply with all relevant provisions of the PWA and the relevant provisions of the following Parts of this Section:

Part 16: Traffic Diversions.
Part 21: Inspection and Handover Procedures.

PART 20 CLEARANCE OF SITE

20.2 FINAL CLEARING

20.2.3 The Site

Delete paragraph 3(b) and substitute with the following:

3 (b) In the case of Contractor's delay or refusal to carry out such a job, he shall have to pay a penal compensation of QR 5,000 for delay for each day or part of day. This compensation shall be final and the judiciary shall not be entitled to mitigate it and it does not require establishing the occurrence of any damage to the owner.

SECTION 2 DEMOLITION AND ALTERATION

PART 1 GENERAL

1.3 MATERIALS ARISING

1.3.1 General Requirements

Add new paragraph 5 as follows:

5 The Contractor shall coordinate with the Landscaping Section of the relevant authority for replanting or delivery locations for the trees identified in the Contract to be retained and/or new trees installed.

SECTION 3 GROUND INVESTIGATION

PART 3 PITS AND TRENCHES

3.2 PITS AND TRENCHES GENERALLY

3.2.5 Backfilling and Restoration

Add new paragraph 5 as follows:

5 Restored surfaces shall match the existing surface in both level and appearance.

PART 4 SOIL SAMPLING

4.4 GROUNDWATER SAMPLES

Delete paragraph 1 and substitute with the following:

1 Groundwater samples shall be taken from each exploratory hole where groundwater is encountered. Where more than one groundwater level is found, each one shall be sampled separately. Where water has been previously added, the water shall be baled out before sampling so that only groundwater is present. The sample volume shall not be less than 0.25 litre.

Where groundwater is to be sampled from rotary drilled holes using water flush the sample shall, where practicable, be taken at the start of the subsequent shift, the hole having been baled out at the end of the previous shift. A sample of the flushing water shall be taken for analysis at the same time.

PART 5 IN-SITU TESTING, INSTRUMENTATION AND MONITORING

5.2 TESTING, INSTRUMENTATION AND MONITORING GENERALLY

5.2.2 Instrumentation and Monitoring

Add new paragraph 7 as follows:

7 Previously constructed boreholes and piezometers within the Right of Way as well as those put down by the Contractor shall be suitably marked and protected for as long as practicable during the execution of the Works. The Engineer's written agreement shall be obtained before any of these are destroyed. Any destroyed without prior agreement shall immediately be replaced by the Contractor. Regular monitoring of water levels in these piezometers and boreholes is to be conducted throughout the entire period of the Works. The regularity of the monitoring shall be to the written approval of the Engineer.

5.3 TESTS

5.3.2 Tests in accordance with BS 5930

Add new paragraph 2 as follows:

2 For all in situ permeability testing the Contractor shall establish and record all relevant data relating to the history of boring the hole and the apparent natural groundwater level. He shall interpret the test results only once conditions at the time of test have become established by subsequent monitoring.

SECTION 4 PILING

PART 2 GENERAL REQUIREMENTS FOR CONCRETE PILES

2.2 MATERIALS

2.2.4 Admixtures

Delete paragraph 1 and substitute with the following:

1 Admixtures, when used, shall comply with BS 5075. For use of admixtures refer to Section 5, Part 5.

2.3 CONCRETE MIXES FOR PILING WORK

2.3.3 Designed Mix

Delete paragraph 2 and substitute with the following:

2 Designed mixes shall be in accordance with grade 40 (for cast-in-place piles) or grades 40, 50 or 60 (for precast piles) of BS 5328. Other grades may be approved appropriate to the work. Complete information on the mix and sources of aggregate for each grade of concrete and the water/cementitious material ratio and the proposed degree of workability shall be approved before work commences.

PART 5 BORED CAST-IN-PLACE PILES

5.1 GENERAL

5.1.2 References

Delete paragraph 1 and substitute with the following:

1 The following codes of practice are referred to in this Part:

BS 8008, Guide to safety precautions and procedures for the construction and descent of machine-bored shafts for piling and other purposes
BS 5930, Code of practice for site investigations

5.1.4 Inspection

In paragraph 1 replace BS 5573 with BS 8008.

PART 6 BORED PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS AND CONCRETE OR GROUT INJECTION THROUGH HOLLOW AUGER STEMS

6.3 BORING

Add new Sub-Clause 6.3.6 as follows:

6.3.6 Specified Pile Diameter

The diameter of a pile shall not be less than the specified diameter. The cutting head width shall be checked as necessary and recorded for each pile to ensure the specified diameter is achieved and that the width is greater than the diameter of the following flight. A tolerance of + 5% - 0 on the cutting head width is permissible.

SECTION 5 CONCRETE

PART 2 AGGREGATES

2.1 GENERAL

2.1.3 Source Approval

Add new paragraph 9 as follows:

9 The Contractor shall ensure that the sources of all aggregate have been approved by the PWA.

PART 3 CEMENT

3.2 SOURCE APPROVAL

Insert the following sentence at the start of paragraph 1:

All cement shall be manufactured by Qatar National Cement Company or other manufacturer as approved by the PWA.

PART 7 BATCHING AND MIXING

7.4 READY-MIXED CONCRETE

7.4.1 General

Add new paragraph 17 as follows:

17 Dry batch mixing shall not be permitted.

PART 8 TRANSPORTATION AND PLACING OF CONCRETE

8.3 PLACING CONCRETE

8.3.3 Placing

Delete paragraph 21 and substitute with the following:

21 Wherever necessary and as required by the Engineer, waterstops of a type acceptable to the Engineer shall be embedded in the concrete. The waterstop should be made of a high quality material, which must retain its resilience through the service life of the structure for the double function of movement and sealing. The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints, the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

Water stops shall be carefully maintained in position prior to concreting on accurately profiled stop boards to create rigid conditions.

PART 9 FORMWORK

9.3 CLASS OF FINISH AND MATERIALS

9.3.1 Unformed Surfaces

Delete paragraph 1 and substitute with the following:

1 Unformed surfaces shall be classified as either

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

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

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

Class U4 finish. The concrete shall be levelled and screeded to produce a uniform surface. When the concrete has sufficiently hardened and the bleed water evaporated the surface shall be trowelled to produce a hard dense surface, free from screed marks and exposed aggregate. Finally the surface shall be lightly textured with a wooden float or equivalent.

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

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

Class U5 finish. The concrete shall be levelled and screeded to produce a uniform finish. When the concrete has sufficiently hardened to prevent laitance being worked to the surface it shall be floated to produce a surface free from screed marks and exposed aggregate. Finally the surface shall be textured to suit the requirements of the particular waterproofing and surfacing system. The accuracy of the finished surface shall be such that it does not deviate from the required profile by more than 5 mm over a 3 m length or have any abrupt irregularities.

Other classes. The finishes shall comply with the specific requirements and approved by the Engineer.

Delete paragraphs 6 and 7.

9.3.2 Surface Finish Classifications

Delete paragraph 2 and substitute with the following:

2 Class F1. Formwork for Class F1 finish shall be constructed of timber, or any suitable materials which will prevent loss of grout when the concrete is vibrated.

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

Class F3. The resulting finish shall be smooth and of uniform texture and appearance. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to the backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the finish. Internal ties and embedded metal parts shall not be used.

Class F4. The requirements for Class F4 are as for Class F3 except that internal ties and embedded metal parts shall be permitted. The ties shall be positioned only in rebates.

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

Other classes. The finishes shall be approved by the Engineer.

Permanently exposed concrete surfaces to all Classes of finish other than F1 shall be protected from rust marks and stains of all kinds. All formwork joints for all classes of finish other than F1 shall form a regular pattern with horizontal and vertical lines continuous throughout each structure and all construction joints shall coincide with these horizontal or vertical lines.

9.3.3 Formwork Materials

Delete paragraphs 1, 2 and 3 and substitute with the following:

1 Design and construction. The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and for the appropriate method of placing and compacting. The plywood at the external sides of the box girder or voided slab bridges shall be (18 mm thick) marine ply. Treated Commercial plywood with polyurethane varnish (3 coats) coating or other approved lining may be permitted at curved faces and internal web faces, subject to Engineer's approval.

2 The formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage. Where necessary, the formwork shall be so arranged that the soffit form, properly supported on props only, can be retained in position for such period as may be required by maturing conditions and Cl 9.5.2 of the QCS Section 5. If the component is to be prestressed whilst still resting on the soffit form, provision shall be made to allow for elastic deformation and any variation in weight distribution.

3 Where it is intended to re-use formwork it shall be thoroughly cleaned and made good.

4 Internal metal ties which require to be withdrawn through hardened concrete shall not be used where either face is permanently exposed. Where internal ties are left in, they shall be provided with a mortar cover of at least 50 mm. The pocket shall be scabbled and dampened immediately prior to mortar filling. Cleaning and treatment of forms. The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent.

5 Immediately before concreting, all form shall be thoroughly cleaned out. The source of any compressed air used for clearing of foreign matter from formwork shall be free from oil and other contaminant.

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

7 All void forming material shall be expanded polystyrene with properties as detailed below:

Cross breaking strength – kN/m² minimum	140
Compressive stress kN/m² minimum at 10% compression	70
Water vapour transmission at 38 °C and 90% relative humidity, microgramme metres/newton hour (Mgm/Mh), maximum per 50 mm sample thickness	25
Thermal conductivity W/m² °C at 10 °C mean temperature, maximum	0.037
Dimensional stability at 80 °C per cent maximum	0.5

9.3.4 Exposed Concrete Surfaces Finishes

Delete paragraphs 1 and 4.

9.4.11 Cambers

Delete paragraph 3 and substitute with the following:

3 Allowance shall be made for compression and settlement of the formwork on line and level.

The Contractor shall carry out required investigation (such as plate bearing tests, etc.) to confirm the bearing capacity and settlement of the formwork/falsework supporting ground as instructed by the Engineer.

PART 10 CURING

10.2 CURING

10.2.3 General Requirements

Add new paragraph 9 as follows:

9 In exceptional weather or other conditions the curing period may be varied by the Engineer or his designated representative without additional payment to the Contractor.

10.2.4 Curing of Formed Surfaces

Delete paragraph 2 and substitute with the following:

2 When the forms are stripped within 10 days of the pour, curing shall continue by the same method as unformed surfaces for the remainder of the 10 days.

PART 11 REINFORCEMENT

11.2 REINFORCING MATERIALS

11.2.1 Reinforcing Bars

Add new paragraph 4 as follows:

4 Reinforcement shall meet the requirements for minimum yield stress as follows:

Type	Yield stress	Symbol
Deformed high yield bars	460 N/mm²	T
Mild Steel bars	250 N/mm²	R

Plain round bars shall not be used.

11.5 FIXING OF REINFORCEMENT

11.5.2 Welding

Add at the beginning of paragraph 1:

Welding shall not be used in bridge decks reinforcement.

11.5.3 Mechanical Splices

Add new paragraph 3 as follows:

3 Mechanical splices shall have satisfactory fatigue properties for their location in the structure.

11.5.7 Cover

Delete paragraph 2 and substitute with the following:

2 Minimum cover to ends and sides of reinforcement shall be as follows:

- To deck reinforcement (all types) 50 mm
- To foundation, piers and walls within the groundwater and capillary rise zones 75 mm
- To backfilled areas which are above the groundwater and capillary rise zones 50 mm
- To abutting faces at movement/contraction joints 50 mm
- To exposed faces of walls and piers 50 mm
- To exposed faces to marine environment in direct contact with soil 100 mm
- Bored or cast piles 75 mm

PART 12 JOINTS

12.1 GENERAL

12.1.3 Submittals

Delete paragraph 1.

12.2 CONSTRUCTION JOINTS

12.2.1 General

Delete paragraphs 1 to 9 inclusive and substitute as follows:

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

2 Concreting shall be carried out continuously up to construction joints.

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

(i) When the concrete is self-supporting but still sufficiently green, the formwork shall be removed, as necessary to expose the construction joint, subject to the requirements of QCS Section 5, Part 10. The concrete surface shall be sprayed with a fine spray of water or brushed with a stiff brush, just sufficiently to remove the outer mortar skin and expose the larger aggregate without disturbing it. Alternatively where this preparation proves impracticable the hardened surface skin and laitance shall be removed by grit blasting or a needle gun. Hardened surfaces shall not be hacked.

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

4 Retarding agents shall not be used unless approved by the Engineer.

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

12.2.2 Construction Joints in Water Retaining Structures

Add the following paragraphs after paragraph 9:

10 Where the Contractor wishes to introduce a construction joint between movement joints he shall submit his proposals to the Engineer for approval.

11 Water stop shall be incorporated into construction joints in water retaining structures. Any joint that leaks or weeps shall be rectified by the Contractor to the Engineer's satisfaction.

12 Where the Contractor is responsible for the design of the structure, control of early thermal contraction and restrained shrinkage shall be by Options 2 or 3 of Table 5.1 of BS 8007.

12.3 MOVEMENT JOINTS

12.3.1 General

Add new paragraph 4 as follows:

4 Stainless steel dowels where shown in joints shall be Steel Designation 1.4429 or 1.4436 and Grade 200 or 500 steel bars complying with BS 6744.

12.3.2 Joint Filler

Add new paragraph 5 as follows:

3 When required between two concrete surfaces as a resilient movement joint, the filler shall be an approved granulated cork bound with insoluble synthetic resin.

4 When required between block work and concrete as a low density movement joint filler or for building details it shall be an approved bitumen impregnated fibreboard or preformed closed cell polyethylene.

5 All materials shall be of proprietary manufacture.

12.3.3 Joint Sealants

Delete paragraphs 1 and 5 and substitute with the following:

1 All joints to be sealed shall be formed and the groove grit blasted to remove all traces of deleterious materials such as from oil or curing compounds and also to remove any surface laitance from the sides of the joints. The joint shall be dry prior the application of priming. Where the use of grit blasting is not possible the Contractor may propose alternative methods subject to the approval of the Engineer. At least 28 days shall be allowed for initial shrinkage of new concrete prior to sealing the joint.

5 The sealant material shall be a non-biodegradable multi-component pitch polyurethane elastomeric joint sealant, carefully selected as appropriate for the specific climatic and environment exposure conditions expected. Alternative types of sealant will be considered, including epoxy-polyurethane, rubber bitumen and acrylic, subject to the requirements of the specification and the approval of the Engineer. Where the joint sealant is to be in contact with a protective coating the Contractor shall satisfy the Engineer that the sealant and protective coating are compatible.

PART 14 PROTECTIVE TREATMENTS FOR CONCRETE

14.1 GENERAL

14.1.8 General Requirements for all Treatment

Delete paragraph 4 and substitute with the following:

4 The Engineer shall specify the required final colour of the coating and the Contractor shall submit samples showing the colour before ordering the materials. If not specified elsewhere the final colour shall be white.

14.3 WATERPROOF MEMBRANE

14.3.1 General

Delete paragraph 2 and substitute with the following:

2 All foundations, abutments, and wing walls in contact with the ground shall be protected by a waterproofing membrane.

14.3.3 Waterproofing Membrane

Add new paragraph 3 as follows:

3 All field and laboratory testing of the waterproofing membrane shall be carried out by an independent laboratory approved by the Engineer.

14.3.4 Application

Delete paragraph 1 and substitute with the following:

1 Waterproofing membrane shall be protected by preformed asphaltic boards. On foundation bases the boards shall be placed over the membrane within 24 hours of its installation. Alternatively, waterproofing membrane applied at horizontal surfaces shall be protected by cement-sand protection screed.

Add new Sub-Clause 14.8 as follows:

14.8 WATERPROOFING BELOW GROUND CONCRETE SURFACES

14.8.1 General

1 Waterproofing for below ground concrete surfaces shall be in accordance EXW IAN 004 "Specification for Waterproofing of Cut and Cover Tunnel and Underpass Highway Structures".

PART 15 HOT WEATHER CONCRETING

15.1 GENERAL

15.1.2 References

Include the following reference; BS 5400 Part 4, Code of Practice for design of concrete bridges, wherever it appears in this Part.

15.1.4 System Description

Add new paragraph 2 as follows:

2 In general the recommendations of "The CIRIA guide to Concrete Construction in the Gulf Region", ACI 305R-91 "Recommended Practice for Hot Weather Concreting" and ACI 308 "Recommended Practices for Curing Concrete" shall be followed. In case of conflict, the provisions of the QCS shall prevail.

15.2 PLACING TEMPERATURE

Add new paragraph 6 as follows:

6 Every effort shall be made by the Contractor to keep the temperature of the concrete at the time of placing as low as possible. If the temperature of the concrete is likely to exceed 24 °C at the time of placing, special measures shall be taken to control the temperature. Such measures shall be approved by the Engineer and shall include some, and if decided necessary by the Engineer, all of the following:

(a) Aggregate stockpiles shall be protected from the direct rays of the sun by shades. The stockpiles shall not be watered.
(b) Water for mixing concrete shall be cooled by means of mechanical equipment or the addition of ice. Storage tanks shall be painted white or sited under shade and distribution pipes shall be insulated or painted white
(c) Cement shall be stored in the shade. Bulk storage containers shall be painted white.
(d) The mixing plant and delivery equipment shall be painted white and sited under shade wherever possible. The interval between mixing and placing shall be kept to a minimum.
(e) Reinforcement, metal conduit, etc., shall be kept in the shade for a minimum period of four hours before concreting.
(f) Immediately before the concrete is placed, formwork, conduit, etc., shall be sprinkled with cool water.
(g) During the curing period, exposed concrete surfaces shall always be protected from the direct rays of the sun, and the formwork shall also be protected.
(h) In a prevailing arid wind, temporary wind breaks shall be provided.

15.8 PLACING AND FINISHING

Add new paragraph 4 as follows:

4 Covers shall be placed over reinforcement and steel formwork to shade it from the sun 24 hours prior to concreting. Immediately before the Concrete is placed, formwork, construction joints, etc. shall be sprinkled with cool water complying with QCS Section 5 Part 4. The Contractor shall provide and use an ample and clear water supply, hose and fog nozzle. Fogging equipment to be furnished shall be capable of applying water to the concrete in the form of a mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete resulting from wind, high temperature, low humidity or a combination of these factors. The fog mist shall be applied at times and in a manner directed by the Engineer.

PART 16 MISCELLANEOUS

16.6 REPAIR OF CONCRETE

16.6.1 General

Delete paragraphs 1 and 2 and substitute with the following:

1 The extent and nature of the defects in the concrete shall be established in accordance with Part 13 of this Section 5 for new concrete or following an inspection jointly undertaken by the Engineer and the Contractor where existing concrete is to be refurbished. Typical details to be noted during this inspection are:

(a) Crack less than 0.5 mm
(b) Crack greater than 0.5 mm
(c) Surface staining
(d) Crazing
(e) Surface honeycombing
(f) Extensive honeycombing
(g) Local spalling
(h) Voids greater than 10 mm deep
(i) Voids greater than 15 mm deep
(j) Exposed reinforcement
(k) Significant spoiling
(l) Displaced cracks greater than 5 mm
(m) Any other notable defect
(n) Any area that is beyond refurbishment

2 If remedial works are required the Contractor shall submit a detailed method statement identifying the specific materials to be used and the sequence of activities for the repair to the Engineer for approval. No work shall commence until the method statement has been approved. The method statement shall include but not necessarily be limited to:

(a) Material Details:

(i) Manufacturer
(ii) Product name
(iii) Application procedure
(iv) Primers required
(v) Method of application
(vi) Special precaution required
(vii) Technical details and properties
(viii) References or case studies of previous applications of a similar nature
(ix) Guarantees applicable to the use of the product in the locations to be repaired.

(b) Installation:

(i) Details of temporary scaffolding
(ii) Details of formwork
(iii) Method of mixing
(iv) Method of placing
(v) Equipment to be used
(vi) Method of supporting and protecting existing plant and equipment.

16.6.2 Honeycombing or Spalling

Delete paragraph 1 and substitute with the following:

1 Where there is honeycombed concrete or concrete damaged by physical forces such as impact that has caused spalling, the concrete shall be replaced using a high strength free flowing c**ementitious** micro-concrete. This section also applies to damage caused by gases and chemicals, notably hydrogen sulphide and chlorine.

16.6.5 Repair Methodology

Include after paragraph 3 the following:

The preferred method is high pressure water jetting specifically developed for cleaning concrete. Light mechanical breakers may be used but the use of heavy breakers shall not be allowed.

Delete paragraph 4 and substitute with the following:

4 Water jetting equipment shall be capable of using an entrained abrasive to aid cutting and cleaning. Only potable water shall be used. Provision for protecting the rest of the structure shall be made.

Delete paragraph 8 and substitute with the following:

8 Exposed reinforcement shall be blast cleaned using grit or water to Swedish Standard SIS 05 5900 Sa 2.5 (near white metal). Two coats of zinc based primer shall be applied making sure that the back face of the steel is also coated. Time between coats shall be as the manufacturer's instructions.

Delete paragraph 9 and substitute with the following:

9 Reinforcement damaged during the removal of concrete or eroded by chemical attack shall, if required by the Engineer, be repaired or replaced. Concrete breakout along the reinforcement shall continue a minimum of 100 mm past the point where non-corroded reinforcement is reached, or as directed by the Engineer. Unless otherwise directed by the Engineer, primary tension or compression reinforcement which displays a reduction in diameter due to corrosion of more than 10% shall be supplemented by reinforcement of size suitable to make up the reduction. Such new reinforcement shall be lapped with the existing sound bars for a distance of 600 mm in either direction.

Delete paragraph 16 and substitute with the following:

16 The formwork shall be inspected by the Engineer and, if approved, filled with clean water which demonstrates that the formwork is grout-tight and saturates the prepared concrete surfaces. The existing concrete shall be saturated with potable water for a period of not less than 24 hours. Where formwork is not used saturation shall be by spray. The formwork shall then be completely drained and resealed.

Add new paragraphs 25, 26, 27 and 28 as follows:

25 Where mortar is used for repair polymer modified mortar shall be mixed in a high shear pan-type mixer for the minimum time necessary to produce the required consistency. Free fall mixers may cause air entrainment and shall not be allowed. For quantities of less than 10 kg, hand mixing may be used.

26 The mortar shall be applied by trowel over tacky bond coat in layers not exceeding the thickness recommended by the manufacturer. Each layer shall be surface scored, coated with bonding agent and allowed to take up its initial set prior to the application of subsequent layers. If sagging occurs due to the applied layer being too thick, the material shall be completely removed and fresh mortar re-applied at a reduced thickness.

27 Any fine hair cracks which develop around the perimeter of the repaired area shall be sealed after 28 days by cement grout gauged with a suitable acrylic emulsion.

28 Repairs which do not adhere and display a hollow sound when tapped with a light hammer shall be broken out completely and repeated.

PART 17 STRUCTURAL PRECAST CONCRETE

17.1 GENERAL

17.1.2 References

Delete BS 8110 and substitute BS5400 Part 4, Code of practice for design of concrete bridges.

Include BS 5400 Part 2, as implemented by BD 37/01, Loads for Highway Bridges.

The above substitutions shall apply to all references in subsequent clauses in this Part.

17.1.9 Design Loadings, Actions and Structural Members Selection

Delete paragraph 7 and substitute with the following:

7 Cover to steel shall be in accordance with QCS Section 5 Part 11.

PART 18 PRESTRESSED CONCRETE

18.1 GENERAL

18.1.2 References

Include after paragraph 1 the following:

1

BS 4447, Specification for the performance of prestressing anchorages for post tensioned construction
BS 4486, Specification for hot rolled and processed high tensile alloy steel bars for the prestressing of concrete

18.1.3 Submittals

Add new paragraphs 5 and 6 as follows:

5 Working Drawings

Whenever the plans do not include complete details for a prestressing system and its method of installation, or when complete details are provided in the plans and the Contractor wishes to propose any change, the Contractor shall prepare and submit to the Engineer working drawings of the prestressing system proposed for use. Fabrication or installation of prestressing material shall not begin until the Engineer has approved the drawings. The working drawings of the prestressing system shall show complete details and substantiating calculations of the method, materials and equipment the Contractor proposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel and any revision in dimensions from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, working stresses, anchoring stresses, tendon elongations, type of ducts, and all other data pertaining to the prestressing operation, including the proposed arrangement of the prestressing steel in the members. Working drawings shall be submitted sufficiently in advance of the start of the affected work to allow time for review by the Engineer and correction by the Contractor of the drawings without delaying the work.

6 Composite Placing Drawings

When required by the special provisions, in addition to all required working drawings, the Contractor shall prepare composite placing drawings to scale and in sufficient detail to show the relative positions of all items that are to be embedded in the concrete, and their embedment depth, for the portions of the structure that are to be prestressed. Such embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, reinforcing steel, anchor bolts, earthquake restrainers, deck joint seal assemblies, drainage systems, utility conduits and other such items. Such drawings shall be adequate to ensure that there will be no conflict between the planned positions of any embedded items and that concrete cover will be adequate. If during the preparation of such drawings conflicts are discovered, the Contractor shall revise his working drawings for one or more of the embedded items or propose changes in the dimensions of the work as necessary to eliminate the conflicts or provide proper cover. All such revisions shall be approved by the Engineer before work on any affected item is started. All costs involved with the preparation of such drawings and with making the necessary modifications to the work resulting there from shall be borne by the Contractor.

18.2 PRESTRESSING

18.2.1 General

Delete paragraph 3 and substitute with the following:

3 The system of pre-tensioning and post–tensioning shall be of an internationally recognised manufacturer and acceptable to the Engineer. Such system shall be used strictly in accordance with the manufacturer's recommendation and guidance.

18.2.3 Sheaths and Cores

Add new paragraph 8 as follows:

8 Deflected tendons. For pre-tensioning single tendons the deflector in contact with the tendon shall have a radius of not less than 5 times the tendon diameter for wire or 10 times the tendon diameter for strand. For post tensioning the deflector in contact with the tendon shall have radius of not less than 50 times the diameter of the tendon. The total angle of deflection shall not exceed 15 °C in both cases.

18.2.4 Anchorages

Add new paragraphs 3 and 4 as follows:

3 Anchorages shall be tested in accordance with BS 4447 or FIP/FIB or AASHTO-LRFD Bridge Construction Specifications. The Contractor shall furnish test certificates having endorsement of a recognised independent testing / verification agency. For each anchorage system used in the Works, the characteristic value for the anchorage efficiency shall not be less than 90%. Strength requirements for the anchorages shall be specified on the Drawings.

4 Proprietary anchorages shall be handled and used in accordance with the manufacturer's instructions and recommendations.

Delete Sub-Clauses 18.2.7, 18.2.8 and 18.2.9 and substitute with the following:

18.2.7 Grouting and Duct Systems for Post-tensioned Tendons

Planning, Trials and Basic Requirements

1 The Contractor shall undertake full-scale trials of the grout mix and of the grouting operations as required for duct installation, testing, concreting, grouting and any other associated problems. The trials are required to demonstrate that the grouting methods and procedures proposed by the Contractor will ensure that grout fills the ducts and surrounds the prestressing steel.

2 The Contractor shall submit a detailed method statement; at least 4 weeks prior to use in any trials in the Works, covering proposed materials, ducts, anchorage and vent arrangements, personnel, equipment, grouting procedures and quality control for the approval of the Engineer.

3 Full-scale trials shall be commenced at least 56 days before the planned commencement of fixing ducts for prestressing for the permanent works.

4 The trials shall incorporate all relevant details of ducts, vents, duct supports, prestressing anchorages and couplers, prestressing strands, grout inlets and outlets. The tendons shall be sufficiently tensioned such that the strands within the duct take up a representative alignment. All systems, methods and materials are to be those proposed for the permanent works and shall have been submitted to the Engineer as part of the detailed method statement required.

5 After three days the Contractor shall carefully cut or core the trial section to expose cross sections and longitudinal sections of the duct, anchorages and any other locations where required, or as further directed by the Engineer, to demonstrate that the duct is satisfactorily grouted. A report shall be prepared by the Contractor giving full details of the trial, testing results and photographs of the exposed sections.

6 Grouting of the ducts shall be shown to leave no void which has a radial dimension greater than 5% of the duct diameter (or appropriate dimension, in the case of oval ducts, anchorages, etc.) or which poses a risk to the protective system. The location of any voids with respect to grout vents and their adequate grouting and subsequent sealing, and the disposition of the steel tendons within the body of the grout shall be reported.

7 Prestressing for the permanent works will not be permitted without the prior written approval of the Engineer grouting procedures and formal acceptance of the results of the grouting procedures and formal acceptance of the results of the grouting trial.

8 The Contractor shall carry out a materials suitability assessment in accordance with the 'Grout Materials' section below.

9 Full-scale trials shall be undertaken to demonstrate that the ducts are satisfactorily grouted.

Grout Materials

10 The properties of the grout, made with the materials, and using the plant and personnel proposed for use on-site, shall be assessed for suitability for the intended purpose. This assessment shall be carried out sufficiently in advance of grouting operations to enable adjustments to be made in use of materials or plant or personnel.

11 Common and special grouts shall comply with the requirements in the 'Properties of Grout' section below. The materials assessment shall consist of the preparation of the grout, made with the materials, and using the plant and personnel proposed for use on-site, and the testing of it in accordance with 'Testing of Grout' below. The preparation shall be carried out under representative conditions of temperature expected on-site. If grouting operations are likely to cover different seasons, the assessment shall be carried out for the expected range of temperatures.

12 No departures from the sources of the materials and procedures approved as a result of satisfactory trials will be permitted without the written approval of the Engineer.

13 The grout shall consist only of Portland cement (CEM I) complying with BS EN 197-1 Class 42.5 N, admixtures complying with the 'Admixtures' section below and water complying with BS 3148.

14 Special grout shall not contain a chloride ion content of more than 0.1% by mass of the cement.

Duct Systems

15 The system of ducts, duct connectors, grouting connections, vents, vent connections, drains, transitions to anchorages and caps for anchors shall form a complete encapsulation for the tendons which is resistant to the ingress of air and water. Ducts shall be of proven corrosion resistant durable material. Ducting which may degrade or corrode during the expected life of the structure will not be permitted. The system shall be fully compatible with the prestressing anchorages, couplers and other details. Where ducts are non-conductive, metal parts of anchorages shall be electrically bounded to the adjacent reinforcement at each end of the tendon and electrical continuity of the structure over the length of the tendon shall be confirmed by testing.

16 The following air pressure tests shall be carried out on site.

Duct Assembly Verification Tests

17 Each complete duct system including vents, anchorages, anchorage caps, and where appropriate couplers and their connections, shall be air-pressure tested before concreting. Testing to a pressure of 0.01 N/mm² shall demonstrate that the system is undamaged and has been correctly assembled. The testing shall demonstrate that a loss of pressure no greater than 10% occurs after 5 minutes.

18 The minimum manufactured wall thickness of ducting shall be 2 mm. The duct rigidity and type and spacing of fixings and supports shall be such as to maintain line, position and cross section shape during concreting. Local deformation of the duct at supports shall be avoided.

19 The Contractor shall provide evidence of testing to demonstrate the following requirements:

(a) Wall thickness of ducts after tensioning of the tendons shall be not less than 1.5 mm

(b) The duct shall transmit full bond strength from the tendons to the surrounding concrete over a length no greater than 40 duct diameters.

20 Vents providing an air passage of at least 20 mm internal diameter shall be provided at the anchorages and in the troughs and crests and beyond each intermediate crest in the direction of flow of the grout at the point where the duct is one half diameter lower than the crest, (but no further than 1m from the crest). The maximum spacing of vents shall be 15 m.

21 The vent diameter and spacing may be varied in full-scale trials demonstrating the suitability of alternatives. The vents shall be rigidly connected to the ducts. Holes in the ducts shall be at least the internal diameter of the vents and shall be formed before pressure testing. All ducts shall be kept free from standing water at all times and shall be thoroughly clean before grouting. All anchorages shall be sealed by caps and fitted with grouting connections and vents. Sealing of anchorages shall permit the flow of grout through the anchor head.

22 Vents on each duct shall be identified by labelling and shall be protected against damage at all times.

23 Vents at high points shall extend to a minimum of 500 m above the highest point on the duct profile.

Grouting Equipment

24 Grouting equipment shall consist of a mixer, a storage reservoir and a pump with all the necessary connection hoses, valves, measuring devices for water, dry materials, admixtures and testing equipment.

25 The mixing equipment shall be capable of producing grout of homogenous consistency and shall be capable of providing a continuous supply to the injection equipment. The capacity of the equipment shall be such that each duct can be filled and vented without interruption and at the required rate of injection.

26 The injection equipment shall be capable of continuous operation and shall include a system for re-circulating the grout when grouting is not in progress.

27 The equipment shall provide a constant delivery pressure; it shall have a pressure gauge and a pressure relief valve to prevent pressure gauge and a pressure relief valve to prevent pressures exceeding 1 N/mm². All piping to the grout pump shall have as few bends, valves and changes in diameter as possible, and shall incorporate a sampling Tee with a locking-off valve.

28 The equipment shall be capable of maintaining pressure on completely grouted ducts and shall be fitted with a valve that can be locked off without loss of pressure in the duct.

29 During the grouting operation the Contractor shall provide adequate flushing-out plant to facilitate complete removal of the grout in the event of a breakdown of the grouting equipment or other disruption before the grouting operation has been completed. The Contractor shall demonstrate that this equipment is in full working order.

30 All equipment shall be kept free from build-up of adhering materials.

Batching and Mixing Grout

31 All materials shall be batched by mass except the mixing water and liquid admixtures which may be batched by mass or by volume. Bagged materials shall be weighed before use. The accuracy of batching shall be:

Description	% of specified quantity
(i) Dry materials, cement and admixtures	± 2%
(ii) Mixing water	± 1%

The total amount of mixing water shall include the water content of liquid admixtures.

32 Depending upon environmental or material influence (e.g. temperature, configuration of the tendon and properties of the materials used), the water/cement ratio shall be kept as low as possible having regard to the required plastic properties of the grout.

33 The maximum water/cement ratio shall be 0.40 for common grout unless specified otherwise. For special grout, the maximum water/cement ratio shall be 0.35.

34 The material shall be mixed to produce a homogeneous grout and kept in slow continuous agitation until pumped into the duct. Unless manufacturers specify otherwise, water shall be added to the mixer first, followed by the dry materials which may be added as a whole or in part in sequence until the total quantities are added. The minimum mixing time determined from grouting trials shall be adhered to.

35 The temperature of freshly mixed grout shall be between 5 ºC and 25 ºC. The maximum temperature may be increased provided trials demonstrate that the grout meets the requirements of 'Properties of Grout' below.

Injecting Grout

36 A check shall be made to ensure that the ducts, vents, inlets and outlets are capable of accepting injection of the grout. This check shall be achieved by blowing through the system with dry, oil-free air and testing each vent in turn.

37 Any water in the ducts shall be removed before grouting operations commence.

38 Grouting of the ducts shall be carried out within 28 days of installation of the tendon or as soon as is practicable thereafter, in which case additional measures shall be taken to avoid corrosion of the prestressing steel. The Engineer's written agreement to commence grouting operations shall be obtained. Injection shall be continuous and the rate of injection slow enough to avoid segregation of the grout.

39 Unless otherwise agreed by the Engineer, grout injection shall not result in more than 10 m of duct being grouted per minute. For certain applications, where ducts are outside the normal range of size (i.e. not multi-strand tendons in 80 mm - 125 mm ducts) this limit may be increased to 15 m of duct per minute.

40 The method of injecting grout shall ensure filling of the ducts and that the tendons are surrounded by grout. Grout shall be allowed to flow from each vent and the remote end of the duct until its fluidity is visually equivalent to that of the grout being injected. In the event of disagreement, testing may be carried out in accordance with 'Testing of Grout' below.

41 Following this, a further 5 litres of grout at each vent, shall be vented into a clean receptacle and then discarded. The opening shall be firmly closed. All vents shall be closed in a similar manner one after another in the direction of the flow except that at intermediate crests the vents immediately downstream shall be closed before their associated crest vent.

42 The injection tubes shall then be sealed off under pressure with a pressure of 0.5 N/mm² being maintained for at least one minute. Grout vents at high points shall be reopened immediately after 1 minute, while the grout is still fluid. Any escape of air, water or grout shall be recorded and reported immediately to the Engineer. A further pumping of grout shall then be carried out to expel bleed water - and/or entrapped air. This shall be carried out with the vents open one at a time sequentially in the direction of grouting with a further 5 litres being released at each vent.

43 The injection tubes shall then be sealed off under pressure, with a pressure of 0.5 N/mm² being maintained for at least one minute.

44 The filled ducts shall not be subjected to shock or vibration or at least 24 hours from the time of grouting.

45 When the grout has set, the grout vents shall be reopened and left open. The Engineer may require all or some of the end caps to be removed to demonstrate that they are satisfactorily filled with grout. End caps which have been removed shall then be replaced and permanently sealed against ingress of contaminants, such sealing to be proved to the Engineer.

46 If the method of demonstrating filling of the anchorage caps involves their removal, a photographic record shall be made. The record shall clearly identify the individual anchorages, and shall be included in the report to the Engineer.

47 If, in the opinion of the Engineer, there is doubt that the ducts or any part of the system are not satisfactorily filled with grout, the Engineer may require investigations to be carried out.

48 The Contractor shall keep full records of grouting for each duct in accordance with the certification scheme requirements for the installation of post-tensioning systems. Copies of these records shall be supplied to the Engineer within 24 hours of completing grouting to each duct.

49 On completion of grouting, grout vents shall be positively sealed and water proofed by a means separate from the concrete waterproofing.

Properties of Grout

The following criteria shall apply:

50 Fluidity: When tested by the method specified in 'Testing of Grout' below, the fluidity of the grout shall meet the criteria given in Table 18/1. Additionally, the fluidity (flow cone passage time) at outlets shall not vary from that of the injected grout by more than 20%.

Table 18/1: Test Requirements for Fluidity of Grout

Test Method	Immediately after mixing	At the end of the injection period subject to a minimum of 30 minutes after mixing*	At duct outlet
Cone	≤ 25 s (see note)	≤ 25 s (see note)	≥ 10 s
*Mixing time shall be measured from the time when all of the materials are in the mixer. For pre-bagged grout the minimum time shall be 90 minutes.			
NOTE: The mixer and these limits shall be subject to the approval of the Engineer.			

51 Bleeding: When tested by the method referred to in paragraph 60 below the bleeding for common grout shall be less than 2% of the initial volume of the grout and the average of 4 successive results shall be less than 1%. The water shall be reabsorbed by the grout during the 24 hours after mixing.

For special grout there shall be no bleeding.

52 Volume Change: The volume change assessed may be either an increase or decrease. When tested in accordance with the method referred to in paragraph 60 below the volume change of common grout shall be within the range - 1% to + 5%. For grouts containing expanding agents there shall be no decrease in volume. For special grout the volume change shall be between zero and + 5%.

53 Strength: The compressive strength of 100 mm cubes made of the grout shall exceed 27 N/mm² at 7 days. Cubes shall be made, cured and tested in accordance with BS 1881.

54 Sieve Test: The grout shall contain no lumps. This shall be verified by testing as referred to in paragraph 60 below.

55 Sedimentation Test: When tested by the method referred to in paragraph 60 below the grout shall not exhibit variation in density in excess of 10% within a single test sample.

Testing of Grout

56 General: Suitability and acceptance tests for the properties of grout shall be determined in accordance with the Concrete Society Technical Report 47 "Durable Bonded Post-Tensioned Concrete Bridges". The testing requirements are summarised in Table 18/2.

Table 18/2: Minimum Test Requirements for Grout

Suitability Testing	
Fluidity	Sampled immediately after mixing, one test. Common grout: after estimated time to grout duct or minimum of 30 min. Special grout: after 90 min, two tests averaged in both cases.
Bleed Volume change Sedimentation Strength	Each sampled immediately after mixing, 3 tests averaged.
Acceptance Testing	
Fluidity	Sampled immediately after mixing, one test from mixer. After flow through duct, one test from each anchorage outlet. On completion, one test from the mixer.
Bleed Volume Change Strength	Two tests per day, one of which shall be from grout after flow through duct, taken from end anchorage outlet, the other from the mixer.
Sedimentation	One test per day for common grout, or one test per pre-bagged supplied batch (by manufacturer's reference number), subject to a minimum of one test per continuous grouting operation.

Admixtures

The following criteria shall apply:

57 General: Admixtures shall be used where required to achieve a low water/cement ratio and impart good fluidity, minimum bleed and volume stability or expansion to the grout to comply with paragraphs 54 to 59 above. For common grout admixtures should be added on-site during the mixing process and used in accordance with the manufacturer's recommendations. For special grout the admixtures shall form a pre-blended component.

58 Types: Admixtures are divided into two types, expanding and non-expanding and they may be used to obtain the required grout performance. Admixtures used in combination shall be checked for compatibility.

59 Chemical Composition: Admixtures shall not contain substances in quantities which will adversely affect the grout or the corrosion protection of the prestressing steel.

60 Material Requirements: The admixture shall not segregate and shall be uniform in colour. The composition shall not change and the supplier shall operate a quality system complying with BS EN ISO 9001: 1994 or BS EN ISO 9002: 1994. The quality system shall be certified by an accredited third party acceptable to the Engineer.

Where appropriate, admixtures shall comply with BS EN 934-4. Other admixtures shall be permitted provided they satisfy Clause 8 of BS EN 934-2 and full account is taken of their effects on the finished product and their fitness for purpose. Data on their suitability, including previous experience with such materials, shall be made available and records of the details and performance of such materials shall be maintained.

It should be noted that additional information beyond that required by Clause 8 of BS EN 934-2 must be provided by the manufacturer for admixtures bearing CE marking (see ZA.2.2 and ZA.3 of BS EN 934-2).

61 Corrosion: Grout admixtures shall not cause the grout to promote corrosion of the prestressing steel by rusting, pitting, stress corrosion or hydrogen embrittlement.

62 Dosage: The optimum dosage of any admixture shall be determined by trial mixes with the cement to be used in the grout. This dosage shall be expressed as per cent by mass of the cement. It shall be within the range recommended by the supplier and shall not exceed 5% by mass of the cement. The method of measuring dosage and checking weights of pre-packed dry materials shall comply with section 'Batching and Mixing of Grout' above.

SECTION 6: ROADWORKS

PART 1 GENERAL

1.6 TEMPORARY FENCING

Delete paragraphs 1 and 2 and substitute with the following:

1 Temporary fencing shall be appropriate to the usage of the adjoining land and unless otherwise described on the Drawings shall be a post and six wire (strained) fence, 1.2 m high subject to the approval of the Engineer.

2 As soon as the Contractor is placed in possession of any part of the Site he shall immediately erect fencing on the Site boundaries. In places where permanent fencing cannot be erected immediately or where none is required, the Contractor shall erect, and when and where required re-erect and maintain, temporary fencing and subsequently take down and remove as necessary.

PART 3 EARTHWORKS

3.1.2 References

Add a new Test 9 as follows:

Test 9 Determination of the soil pH value.

3.3 MATERIALS

3.3.3 Unsuitable Material

Delete paragraph (i) and substitute with the following:

(i) Soil having more than 20% passing the 0.075 mm sieve.

Add a new paragraph (j) as follows:

(j) PH of the soil shall be Min 7- Max 9.

3.3.5 Selected Fill

Delete paragraph (a) and substitute with the following:

(a) The material passing the 0.075 mm sieve shall be less than 20%.
(b) The liquid limit shall not exceed 35% and the plasticity index shall not exceed 6%.

Add a new paragraph (d) as follows:

(d) PH of the soil shall be Min 7- Max 9.

3.3.6 Water

Delete paragraph 1 and substitute with the following:

1 Potable or brackish water shall be used for all earthwork operations, except that only potable water shall be used for compaction of backfill material within five metres from all surfaces of a structure and for the backfill of all service trenches.

3.4 MAIN PLANT FOR EARTHWORKS

3.4.1 General

Delete paragraphs 3, 4 and 5 and substitute with the following:

3 The Contractor shall supply sufficient machinery to enable progress of the Works to the agreed programme.

3.5 EXCAVATION GENERAL

3.5.1 Removal of Unsuitable Soil and Soft Spots

Delete paragraph 6 and substitute with the following:

6 Unsuitable excavated material shall be removed and carted away approved dumping areas, after approval has been received from the relevant Authority and the Engineer.

Delete paragraph 10 and substitute with the following:

10 The Contractor shall probe for voids, using a pattern of holes agreed with the Engineer, beneath all underpasses, structural foundations and where limestone materials are encountered. Where such voids are identified, the Contractor shall submit to the Engineer his proposals for treatment.

3.5.2 Excavating High Level Areas

Delete paragraph 4 and substitute with the following:

4 In all excavations, the groundwater level shall be maintained at least 900mm below the formation level.

3.6 FILLING GENERAL

3.6.4 Contractors Imported Fill

Paragraphs 1 to 9 inclusive shall be deleted and substitute with the following:

1 The Contractor shall source all fill material required for the Works.

2 It shall be the Contractor's responsibility to obtain all permits or permission and make any payments that may be required in acquiring the borrow material.

3 It shall be the Contractor's responsibility to carry out all testing to ensure the imported fill meets the specification.

4 The Contractor's haul and traffic management arrangements shall be subject to approval by the Engineer before commencement of the Works.

3.6.8 Work Over Sabkha

Delete Table 3.1 and substitute with the following:

Table 3.1

Definition of Type 1 & 2 backfill materials

Sieve Size (mm)	Percentage Passing	
	Type 1	Type 2
152.400	100	-
127.000	100 – 85	-
101.600	90 – 75	-
50.800	65 – 45	-
38.100	55 – 35	-
19.050	35 – 20	100
12.700	25 – 10	95 – 100
9.525	20 – 5	70 – 100
4.250	-	0 – 55
2.360	-	0 – 10
1.18	-	-
0.075	-	0 – 3

3.7 STRUCTURE EXCAVATION AND FILLING

3.7.3 Dewatering

Delete paragraph 3 and substitute with the following:

3 The Contractor's submitted drawings shall show the arrangement, location and depths of the proposed dewatering system if required. A complete description of the equipment and materials to be used and the procedure to be followed shall be shown, together with the standby equipment, standby power supply, and the proposed location or locations of points of discharge of water. The Contractor shall be required to obtain written approval from the PWA for this discharge.

3.7.4 Excavation for Structures

Add new paragraph 9 as follows:

9 The Contractor may be required to undertake a pattern of rotary percussive probe holes within the footprint of critical structures where there is considered to be a hazard from voids within the rock mass beneath. Details shall be proposed by the Contractor and agreed with the Engineer.

3.7.6 Cofferdams

Delete paragraph 5 and substitute with the following:

5 As an alternative to a cofferdam, the Contractor may propose a wellpoint dewatering system, for approval by the Engineer, to keep structural excavation works dry. Such proposal shall include, but not be limited to, sufficient calculations, sketches and drawings, to justify the wellpoint positions and lengths in addition to pumping capacity required. The use of a wellpoint dewatering system may not preclude the use of support or shoring within the excavation to provide adequate stability and safety to the satisfaction of the Engineer. Where well-point systems are proposed the Contractor shall follow the requirements of Sub-Clause 3.7.3 of Section 6 Part 3.

3.7.7 Backfill Adjacent to Structures

Delete paragraph 1 and substitute with the following:

1 EXW IAN 005 "Excavation and Backfill for Highways Structures" shall be referred to for procedures relating to backfilling to highways structures. For all other structures, this Clause 3.7.7 applies.

3.10 TESTING

3.10.1 General

Delete paragraph 1 and substitute with the following:

1 The Contractor shall be responsible for verifying adherence to the specification of moisture content, compaction, thickness California Bearing Ratio and other properties of the materials or workmanship, and shall supply this information to the Engineer for approval before placement of subsequent layers.

3.10.3 California Bearing Ratio

Delete paragraphs 1, 2 and 3 and substitute with the following:

The soaked value of the California Bearing Ratio shall be determined on the top of the specimen compacted statically at the optimum moisture content and 95% of the maximum dry density after soaking for 4 days in accordance with CML 10-97. Both values shall be reported and both shall comply with the minimum requirements outlined in the most recent issue of the Qatar Construction Specifications.

3.10.4 Testing Levels and Evenness of the Formation

Delete paragraphs 1, 2 and 6 and substitute with the following:

1 The Contractor shall be responsible for verifying adherence to the specification of levels, evenness and cross fall and shall supply this information to the Engineer for approval before placement of subsequent layers.

2 The Contractor shall make available to the Engineer a four-metre straight-edge and a crown template of sturdy and approved design and the necessary labour to carry out audit checking as required.

6 These tests shall be taken at a minimum rate of one test per 100 m run and additionally as directed by the Engineer. In the event of any failure, the Contractor shall correct the unevenness of the surface and resubmit the area for approval by the Engineer.

PART 4 UNBOUND PAVEMENT MATERIALS

4.1 GENERAL

4.1.1 Scope

Add new paragraph 3 as follows:

3 Materials: The materials included by the specification are:

a) Crushed Rock/Crushed Gravel subbase and
b) Crushed Rock/Crushed Gravel Road base

4.2 MATERIALS

4.2.4 Fine Aggregate

Delete paragraph 4 and substitute with the following:

4 For Base and Subbase, the material passing the 0.425 mm sieve shall have a maximum liquid limit of 25% and the plasticity index shall not exceed 6%.

Delete paragraph 6 and substitute with the following:

6 The aggregate bases shall have a minimum sand equivalent value of 40 and the aggregate subbase shall have a minimum sand equivalent of 30, as determined by ASTM D2419.

4.2.5 Coarse / Combined Aggregate

Delete paragraph 3 and 6 and substitute with the following:

3 The Los Angeles Abrasion Loss, as determined by ASTM C131/C535, shall be 30% maximum.

6 The minimum CBR value obtained when preparing samples of aggregate base and aggregate subbase at optimum moisture content and at 100% relative compaction and soaking them for 4 days shall be 80% and 60% respectively. The maximum permitted swell shall be 0.5% and 1.0% respectively.

4.4 MIX DESIGNS – Title to be replaced with: "ROAD BASE AND SUB-BASE MATERIAL"

Delete paragraph 6 and substitute with the following:

6 Aggregate gradation shall conform to the gradation as follows:
(a) Road Base

BS Sieve Size (mm)	Percentage Passing
63	-
50	100
37.5	70-100
25	55-85
20	50-80
10	40-70
5	30-60
2.36	20-50
0.425	10-30
0.075	5-15

(b) Road Subbase

BS Sieve Size (mm)	Percentage Passing [Note]	
	Class A (Heavy Traffic)	**Class B** (Low CBR)
63	-	100
50	-	90-100
37.5	100	60-90
25	70-90	42-77
20	60-90	35-70
10	45-75	25-60
5	35-65	15-40
2.36	25-50	10-26
0.425	15-30	5-15
0.075	0-15	2-9
Note: the selection of subbase class is dependent on the subgrade CBR value and traffic level.		

4.6 SPREADING AND COMPACTION

Delete paragraph 10 and substitute with the following:

10 Material shall spread to a thickness that would result in layers not more than 150mm thick after compaction. Where the finished compacted thickness exceeds 150mm, placing shall be executed in composite layers, each layer not exceeding 150mm. At the approval of the Engineer, 170mm in compacted thickness may be allowable if the contractor can demonstrate that compaction and compaction testing can be achieved.

PART 5 ASPHALT WORKS

5.1 GENERAL

5.1.2 References

Add new tests for Performance Graded (PG) Asphalt and Polymer Modified Bitumen (PMB) as follows:

AASHTO M 320	Performance-Graded Asphalt Binder
AASHTO M 323	Superpave Volumetric Mix Design
AASHTO R 28	Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
AASHTO R 29	Grading or Verifying the Performance Grade (PG) of an Asphalt Binder
AASHTO R 35	Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
AASHTO T 40	Sampling Bituminous Materials
AASHTO T 44	Solubility of Bituminous Materials
AASHTO T 48	Flash and Fire Points by Cleveland Open Cup
AASHTO T 55	Water in Petroleum Products and Bituminous Materials by Distillation
AASHTO T 240	Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
AASHTO T 313	Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
AASHTO T 314	Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)

5.1.4 Quality Assurance

Insert new paragraphs 5 to 15 as follows:

5 Bituminous paving courses shall consist of coarse aggregate, fine aggregate, filler material, and bitumen binder. Mixture of two different types of rocks, e.g. igneous and sedimentary having different specific gravities in a single fraction shall not be permitted.

6 The Contractor shall provide the Engineer with a complete report on the origin and composition of all stone and/or gravel aggregates to be used in the work (Aggregate Resources Report) within thirty (30) days prior to the scheduled beginning of the crushing and screening operations. All materials shall comply with the specified requirements for the various aggregates.

The Contractor shall provide petro graphic analysis including x-ray diffraction of clay minerals conducted by a competent independent testing laboratory which shall include reports on the suitability of the proposed materials for their use in concrete and asphaltic mixes.

7 The source and manufacture of the aggregates, which shall meet the requirements of the specification, is the responsibility of the Contractor. It is also the Contractor's sole responsibility to manufacture and haul such aggregates at the rates and in the quantities required to complete the work within the specified contract period.

8 Delivery of materials produced from commercial manufacturing process shall be accompanied by the manufacturer's certification and test reports showing the materials comply with the specification for which it is stipulated.

9 All sources of aggregates shall be approved by the Engineer prior to the processing of material from such sources. An individual source of aggregate is deemed to be a particular location within a quarry or borrow pit where material of a constant specific gravity is obtained (with possible variation due to minor changes in characteristics of rock).

10 During the execution of the Works variation in the specific gravity of any individual fraction of aggregates used in the asphaltic mixes by more than 0.020 may be a cause for rejection of mix design in which case the Engineer may ask the Contractor for a new mix design.

11 The test certificate obtained by the Contractor or tests performed by the Contractor at his expense are intended to assist him in his estimate of the location, extent and quantities which will comply with the specification, when properly processed, and will no way obviate the need for future testing by the Engineer.

12 Only material from approved sources shall be processed for incorporation into the work. Approval of specific sources of materials shall not be considered as final approval and acceptance of materials from such sources. The presence of weathered materials discovered in the quarry areas shall be a cause of rejection of the source of materials.

13 After having received approval of specific sources of material the Contractor cannot change these without prior written approval of the Engineer.

14 All processed materials shall be tested and approved before being stored on the Site or incorporated in the Works and may be inspected and tested at any time during the progress of their preparation and use. Questionable materials, pending laboratory testing subsequent approval shall not be unloaded and incorporated with materials previously approved and accepted.

15 If the grading and quality of the material delivered to the Site does not conform to the grading and quality as previously inspected and tested, or does not comply with the specifications the Engineer reserves the right to reject such material at the Site of the work.

5.2 MATERIALS

5.2.1 Fine Aggregate

Delete paragraph 1 and substitute with the following:

1 Fine aggregate is that portion of the mineral aggregate passing the 4.76mm BS Sieve.

Delete paragraph 2 and substitute with the following:

2 Fine aggregate shall consist of crushed hard durable rock and shall be of such gradation that when combined with other aggregates in proper proportions, the resultant mixture will meet the required gradation. The use of wadi, beach or dune sand for asphalt works is not permitted. Fine aggregate including filler shall be obtained from 100% crushed gravel or crushed rock pre-screened to exclude natural uncrushed fine material or weathered unsound fines.

Delete paragraph 6 and substitute with the following:

6 Individual stockpiles of crushed fine aggregate shall have a sand equivalent of not less than 45 for base course and not less than 55 for intermediate and wearing course.

Delete paragraph 7 and substitute with the following:

7 The loss by the magnesium sulphate soundness test, as determined by ASTM C 88, shall be a maximum of 14% for base course and 12% for intermediate and wearing course.

Add new paragraph 12 as follows:

12 Should a change in a material be encountered or should a change in a source of material be made a new job-standard mix shall be submitted by the Contractor and approved by the Engineer before the mix containing the new material is delivered. Job materials will be rejected if they are found not to have the characteristics required by the approved job Standard Mix.

5.2.2 Coarse Aggregate

Delete paragraph 1 and substitute with the following:

1 Coarse aggregate is that portion of the mineral aggregate retained on the 4.76mm BS Sieve. Coarse aggregate shall consist of crushed natural stones and gravel. Crushed particles shall be cubic and angular in shape and shall not be thin, flaky or elongated. The gradation shall be such that when combined with other aggregate fraction in proper proportions, the resultant mixture will meet the required gradation. Coarse aggregates shall be of uniform quality and free from decomposed stone, shale, etc. Specific Gravity of individual fraction (size) of approved aggregates shall not vary by more than ± 1%.

Delete paragraph 4 and substitute with the following:

4 The loss by the magnesium sulphate soundness test, as determined by ASTM C 88, shall be a maximum of 12% for base course and 10% for intermediate and wearing course.

5.2.4 Bitumen

Delete all paragraphs and substitute with the following:

1 The bitumen specified for use in the asphalt mixes shall meet the requirements of AASHTO MP 19 and equivalent ASTM, EN and BS International Standards and Test methods.
2 The bitumen shall only be obtained from approved sources.
3 The bitumen shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 175°C.
4 Blending of bitumen materials from different refineries will be permitted only with the written approval of the Engineer.
5 When bitumen grades PG76-10 H, V, or E are specified, the bitumen will be required to meet the requirements of TP 70- Figure 2.1 Passing % recovery.
6 The Bitumen Grade PG 76-10 shall conform to the requirements listed in Table 5.4.

Table 5.4: Bitumen PG76-10 H, V, and E specifications

Test	Standard [a]		Specification
	AASHTO	ASTM	
Original Binder			
Average 7 days maximum pavement design temperature, (°C)			< 76
Minimum pavement design temperature, (°C)			>-10
Flash Point Temperature, Minimum (°C)[b]	T48	-	230
Viscosity, Maximum, 3 Pa.a, Test Temperature (°C)[b]	T316[c]	-	135
Dynamic Shear, G*/sinδ, Minimum, 1.00 kPa[e] Test Temperature (°C) at 10 rad/s	T315[d]		76
Rolling Thin Film Oven (T240) or Rolling Thin Film Oven (T179)			
Mass Loss, Maximum, Percent[f]			1%
MSCR, Standard Traffic "**S**" Grade $J_{nr3.2}$,max 4.0 kPa^{-1} $J_{nr3.2,}$max 75% Test temperature, °C	TP70		76
MSCR, Heavy Traffic "**H**" Grade $J_{nr3.2}$,max 2.0 kPa^{-1} $J_{nr3.2,}$max 75% Test temperature, °C	TP70		76
MSCR,	TP70		76

Very Heavy Traffic "**V**" Grade $J_{nr3.2}$,max 1.0 kPa^{-1} $J_{nr3.2,}$max 75% Test temperature, °C			
MSCR, Extreme Traffic "**E**" Grade $J_{nr3.2}$,max 0.50 kPa^{-1} $J_{nr3.2,}$max 75% Test temperature, °C	TP70		76
Pressurized Aging Vessel Residue (R28)			
PAV Aging Temperature (°C)[g]			110
Dynamic Shear, "**S**" Grade, G*/sinδ, Minimum, 5000 kPa[e] Test Temperature (°C) at 10 rad/s	T315		37
Dynamic Shear, "**H**" , "**V**" , "**E**" Grades, G*/sinδ, Minimum, 5000 kPa[e] Test Temperature (°C) at 10 rad/s	T315		37
Physical Hardening Report			
Creep Stiffness, Stiffness , S, Maximum, 300.0 MPa at 60 seconds m-value, Minimum, 0.300 at 60 seconds Test Temperature (°C)[h]	T313		0
Direct Tension, Failure Strain, Minimum, 1.0% (loading rate of 1.0 mm/min), Test Temperature (°C)	T314		0

a MSCR testing on RTFO residue should be performed at the PG grade based on the environmental high pavement temperature. Grade bumping is accomplished by requiring a lower J_{nr} value while testing at the environmental temperature.

b *Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the specifying agency,* or by following the procedures as outlined in M 323 and R 35, excluding the provisions for "grade bumping".

c This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

d For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of G*/sinδ at test temperatures where the asphalt is a Newtonian fluid.

e G*/sinδ = high temperature stiffness and G* sinδ = intermediate temperature stiffness.

f The mass change shall be less than 1.00 percent for either a positive (mass gain) or a negative (mass loss) change.

g The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures, 90°C, 100°C, or 110°C. Normally the PAV aging temperature is 100°C for PG 58-xx and above. However, in desert climates, the PAV aging temperature for PG 70-xx and above may be specified as 110°C.

h If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The *m*-value requirement must be satisfied in both cases.

7 The contractor shall submit samples of the bitumen and PMB that he proposes to use in the work together with a statement as to its source and properties approved by the Engineer at least 45 days before the asphalt works begins.

8 The PG binder shall show no separation upon mixing with the modifier either when the binder is blended by the method of injection into the asphalt line/mixer or when the binder is blended on site in continuously agitated tanks.

9 As the performance graded bitumen containing polymer modifiers is susceptible to separation of the modifier, the contractor shall ensure proper circulation or agitation in storage if separation of the modifier is suspected.

10 The PMB shall provide high cohesion when combined with mineral aggregate and shall offer good elastic recovery after relief.

11 PG binder or polymer modifier supplier instructions with regard to the recommended application and storage shall be carefully followed.

12 When the Bitumen or PMB is transported in bulk tankers or in drums, the bulk tankers must have good heating and circulation systems and shall have good functional insulation that can maintain the same temperature. No drop in temperature exceeding 10° C /day shall be allowed.

5.3 PLANT GENERALLY

Delete paragraph 3 and substitute with the following:

3 On first erecting a batching plant and at least once every three months thereafter, the plant shall be calibrated by a calibration service organisation approved by the Central Materials Laboratory.

5.4 ASPHALT MIXING PLANT

5.4.2 Automatic Operation

Delete paragraph 3 and substitute as follows:

3 The use of manual and semi-automatic plants for the production of asphalt is not permitted unless specific approval is given in writing by the Engineer. Plant shall be required to be equipped with the facilities to provide computer printout indicating the quantity of materials used in batch against target setting the hot bin fractions, bitumen content, mixing time and cycle, date and time of production, mix type, total production in a given day. The above printout is to be provided to the Engineer for each production day.

5.4.3 Cold Bins System

Delete paragraph 3 and substitute with the following:

3 The cold bins and loading equipment used shall be compatible to prevent overflow between the bins. Baffle plates shall also be used between bins to prevent overflow of one bin into another. Each cold bin shall include an accurate means for continuously feeding the required amount of mineral aggregate so that uniform production is achieved. The settings on the cold bins shall not be altered from the correct calibrated settings without the approval of the Engineer.

5.4.4 Filler Additive System

Delete paragraph 5 and substitute with the following:

5 When filler is added as a slurry, a minimum of two slurry chambers will be provided. One chamber will be used for proportioning the filler and water into slurry consistency. The second slurry chamber shall contain the mixed slurry and shall be provided with an accurate metering device with well-defined settings to enable easy checking, setting and calibration. Both chambers shall be equipped with continuous mixing paddles or recirculation pumps in order to prevent the slurry mixture from separating.

5.4.6 Dust Collector

Delete paragraph 1 and substitute with the following:

1 The plant shall be provided with a dust collector designed to waste, or to return in a constant and uniform flow to the hot elevator, all or part of the material collected. Before permitting the

return of such collected dust, the Contractor will examine its characteristics in relation to the mix requirements and will designate the quantity to be returned. Dust return shall not be permitted without the approval of the Engineer.

Add new paragraph 3 as follows:

3 All plants used for preparation of bituminous mixtures shall consist of an effective filter system to prevent the escape of dust, smoke and any other pollutant to the atmosphere.

5.4.14 Safety Requirements

Delete paragraph 1 and substitute with the following:

1 Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations. Accessibility to the top of truck bodies shall be provided by means of a platform or other suitable device to enable the Contractor to obtain mixture temperature data. To facilitate handling scale calibration equipment and sampling equipment, a hoist or pulley system shall be provided to raise or lower the equipment from the ground to platform or *vice versa.* All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed passage shall be maintained at all times in and around the truck loading space. This space shall be kept free from drippings from the mixing platform.

5.4.16 Scales or Meters

Delete paragraph 1 and substitute with the following:

1 All scales and meters shall be calibrated as detailed in Sub-Clause 5.3 of this Part. Production shall not be permitted if the weight batch calibration fails.

5.5 HAULING EQUIPMENT

Delete paragraphs 3 and 5 and substitute with the following:

3 Any truck causing excessive segregation of material by its spring suspension or other contributing factors, or that shows oil leaks in detrimental amounts, or that causes undue delays, shall be removed from the work until such faults are corrected.

5 The Contractor shall provide an adequate number of trucks of such size, speed and condition to ensure orderly and continuous progress of the work.

5.6 OTHER PLANT

5.6.1 Spreading and Finishing Equipment

Delete paragraphs 2 and 3 and substitute with the following:

2 The pavers shall be self-propelled and equipped with hoppers and distributing screws of the reversing type to place the mixture uniformly in front of adjustable electronic controlled screeds. The pavers shall be so designed to allow a minimum paving width of 2 m and must be capable of paving at least the width of a lane. Paving in widths less than the width of a lane shall require the approval of the Engineer. Tracked pavers shall be used for major roads and tyred pavers shall be used for tight junctions and minor roads.

3 Pavers shall be equipped with such provisions and attachments to suit paving widths specified for road widening as well to as to suit paving on sloped sections. They shall be equipped with fast and efficient steering devices and shall have reversed as well as forward traveling speeds. The operational speed of the pavers shall be adjustable from 3 to 6 m/min.

5.6.2 Rolling Equipment

Delete paragraph 3 and substitute with the following:

3 Pneumatic-tyred rollers shall be self-propelled. The rollers shall be equipped with pneumatic-tyres of equal size and diameter which are capable of exerting varying average contact pressure. Pneumatic-tyred rollers shall be in good condition and with enough ballast space to provide uniform wheel loading as may be required. The Contractor shall furnish to the Engineer charts or tabulations showing the contact areas and contact pressures for the full range of tyre inflation pressures and for the full range of tyre loading for each type and size compactor tyre furnished and used in pneumatic-tyred rollers. The total operating weight and tyre pressure shall be varied by the Contractor to obtain contact pressures which will result in the required asphalt course density.

5.7 BITUMINOUS PAVING COURSES MIX DESIGN

5.7.1 Mix Design Criteria

Delete "Recommended Compacted Layer Thickness" Table outlined immediately after Table 5.2, and substitute with the following:

Recommended Compacted Layer Thickness			
Asphaltic Concrete **Base Course (BC-TYPE 1)**	**Asphaltic Concrete** **Intermediate Course (IC-TYPE 1)**	**Asphaltic Concrete** **Wearing Course (SC-TYPE 1)**	**Dense Bituminous Macadam** **Wearing Course (SC-TYPE 2)***
70mm-100mm	**50mm-80mm**	**50mm-60mm**	**50mm-60mm**
***The 'SC-TYPE 2 Wearing Course is coarser than SC-TYPE 1. It is more open textured and it has more air voids in the mix than SC-TYPE 1. It is intended for more heavily-trafficked roads/locations.			

5.7.2 Mix Design Procedure

Add new paragraph 4 as follows:

4 The job standard mix shall not be used until certification is issued by the Qatar General Organization for Standards and Metrology (QGOSM). The assistance of the Engineer or issuance of a certificate to the Contractor for the job standard mix by the QGOM in no way relieves the Contractor of the responsibility of producing a bituminous mix meeting the requirements of the Specification.

5.8.3 Survey and Preparation

Delete paragraph 2 and substitute with the following:

2 When an asphaltic concrete pavement course is to be placed on top of an existing pavement, the Contractor shall determine the required treatment of the existing pavement surface and submit his proposal to the Engineer for approval.

Delete paragraph 4 and substitute with the following:

4 The surface of kerbs, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin and complete coating of tack coat to provide a closely bonded, watertight joint.

5.9 DELIVERY SPREADING AND FINISHING

5.9.1 Delivery of Mixes

Delete paragraphs 5 and 6 and substitute with the following:

5 The mixture at delivery to the paver shall be not more than 163 ºC and not less than 140 ºC. Material which has fallen below minimum temperature of 140 ºC before discharge shall be rejected and immediately removed from site. Delivery temperature shall not exceed the maximum temperature specified for mixing at the plant.

6 Should a significant proportion of the mixture delivered to the paver fail to meet this requirement, or should cold lumps be found in the mixture, the paving operations shall be suspended until measures are taken, to the approval of the Engineer, to ensure compliance.

5.9.2 Spreading and Finishing

Delete paragraph 3 and substitute with the following:

3 The laid material shall be compacted as soon as rolling can be effected without causing undue displacement and while the temperature does not fall below 135ºC. Material still uncompacted and below this temperature shall be rejected.

Add new paragraphs 13, 14 and 15 as follows:

13 The Contractor shall plan the paving such that longitudinal joints occur on the line of future lane markings wherever possible. Paving shall not be allowed in a greater width than 4 m unless otherwise agreed by the Engineer.

14 Asphaltic concrete mixes, except leveling courses shall be laid at a uncompacted thickness such that, after rolling the thickness of the compacted layer shall be:-

Base course	:	Min. 7 cm	Max. 10 cm
Intermediate course	:	Min. 5 cm	Max. 8 cm
Wearing course	:	Min. 5 cm	Max. 6 cm

15 The maximum thickness for layers may be increased slightly when such increase is more adaptable to total pavement thickness and when in the opinion of the Engineer it is not detrimental to placement and rolling conditions.

5.9.9 Finish Rolling

Delete paragraph 4 and substitute with the following:

4 After final rolling, the smoothness, levels, cross falls, density and thickness shall be checked and any irregularity of the surface exceeding the specified limits and any areas defective in texture, density or composition shall be corrected, including removal and replacement of the lot in question if required.

5.9.10 Protection of Laid Courses

Delete paragraph 1 and substitute with the following:

1 The Contractor shall protect all sections of newly constructed pavement from traffic until they have hardened sufficiently to the approval of the Engineer. In heavily trafficked roads during the summer months a minimum period of 7 days must elapse before the newly compacted pavement is opened to traffic. In no case shall traffic be permitted less than 48 hours after completion of asphaltic course unless a shorter period is authorised by the Engineer.

5.11 SAMPLING TESTING AND ACCEPTANCE

5.11.1 General

Delete paragraph 1 and substitute with the following:

1 Each completed asphalt concrete course shall be tested by the Contractor on a lot basis. The Contractor shall submit a testing plan to the Engineer for approval that demonstrates how he shall prove compliance with the requirements for compaction, mix composition, level, evenness and all other requirements of this Section 6. Each lot shall be approved by the Engineer before placing any subsequent asphalt concrete course. In cases where the asphalt course is laid in more than one lift, each lift shall be tested and approved in accordance with the following requirements before placing the subsequent asphalt concrete lift.

5.11.2 Sampling

Delete paragraphs 1 and substitute with the following:

1 The Contractor shall cut and test samples from each completed asphalt course during the progress of the work and before final acceptance. The Engineer may determine the location of the sample. The test results of each lot demonstrating compliance or otherwise with this specification shall be submitted to the Engineer.

Add new paragraphs 6, 7 and 8 as follows:

6 The Contractor shall provide a sample pair of cores to the Engineer at a rate of not less than 1 per lot for audit testing, unless otherwise instructed by the Engineer.

7 The size of a lot shall be as defined by the Contractor's quality system, but shall not be greater than 300 m run of road or 1500 m², whichever is less. The locations of the samples shall be randomly generated however at least one set of samples per lot shall be at joints as defined in QCS Section 6, Part 5, Clause 5.11.2, paragraph 2.

8 Two copies of the density results and related air voids results shall be submitted to the Engineer within 24 hours of compaction of the lot.

5.11.3 Compaction

Delete paragraph 2 and substitute with the following:

2 The density of the compacted mixes shall be related to the daily Marshall Density, which shall be determined by making four standard Marshall Specimens from samples of the mix taken from the mixing plant or paver (provided compacting temperature is retained). The density of each sample shall be determined and compared with mean value. Any individual result which varies from the mean by more than 0.015 gm/cc shall be rejected. Marshall Tests shall be repeated on a daily basis to establish the daily Marshall Density for that particular day's production. The daily Marshall Density shall not vary from the job mix Design Density by more than ± 0.75%.

The field density, as determined from each core sample, shall be a minimum of 98% of daily Marshall Density for the wearing and intermediate courses and a minimum of 97% for the base course.

Add new paragraph 4 as follows:

4 Should any bituminous course fail to achieve the specified compaction, at the discretion of the Engineer re-rolling may be allowed subject to the following conditions:

(a) Compaction to be achieved shall be 1% or less.
(b) Only PTR's to be used weighing no greater than 18 tons.
(c) Re-rolling to take place within 72 hours from the time of the initial rolling of the asphalt.
(d) Re-rolling to take place at the time of the day when the asphalt has attained its maximum natural temperature.

(e) Re-rolling to be applied for a maximum of two hours.
(f) Re-rolling to be carried out in the presence of the Engineer's Representative.
(g) The section of the Works in question shall be cored for density determination immediately after the completion of re-rolling.
(h) If after re-testing, the compaction achieved is 0.5% below the specified compaction, the asphaltic material will be accepted in the Works subjected to a reduction to the billed rates. If, on the other hand, compaction is not achieved within 0.5% of specified compaction, the asphaltic material shall be removed and new material to the specification laid at the Contractor's cost.

5.11.5 Thickness and Level

Delete paragraph 2 and substitute with the following:

2 In addition, the variations in the falls to cross sections of the road shall not vary from the required value by more than 0.15%.

Delete paragraph 4 and substitute with the following:

4 If the core so taken is not deficient by more than five (5) millimetres from the specified thickness (individual layer), full payment will be made. If the core is deficient in thickness by more than five (5) millimetres, from the specified thickness of individual layer, two (2) additional cores shall be taken from the area represented and if the average of the three (3) cores is not deficient by more than five (5) millimetres from the specified thickness of respective layer, full payment will be made. If the average thickness of three (3) cores is deficient by more than five (5) millimetres, but not more than ten (10) millimetres, or fifteen (15) per cent (whichever is less) from the specified thickness of total asphaltic pavement, an adjusted unit price as provided in the bill of quantities will be paid for the area represented by these cores.

In calculating the average thickness of each bituminous paving course, measurements, which are in excess of the specified thickness by more than five (5) millimetres will be considered as the specified thickness plus five (5) millimetres, the measurements which are less than specified thickness by more than ten (10) millimetres or fifteen (15) per cent (whichever is less for total thickness), will not be included in the average.

When the measurement of any core is less than specified thickness by more than five (5) millimetres, or fifteen per cent (whichever is less), the actual thickness of the bituminous paving course in this area will be determined by taking additional cores at not less than three (3) metre intervals parallel to the centre-line in each direction from the affected location until, in each direction, a core is found which is not deficient by more than five (5) millimetres, or fifteen (15) per cent (whichever is less). Asphalt areas which are deficient by more than ten (10) mm or 15% (whichever is less – for total pavement thickness) shall be removed and replaced at the Contractor's expense. Exploratory cores for deficient thickness may be used average for adjusted unit price.

Paved cross-section as shown on the Drawings and shall not vary by ± 6 mm for base course and ± 4 mm for intermediate and wearing course from the required elevation.

5.11.6 Evenness of Surface (Surface Roughness)

Delete all paragraphs and substitute with the following:

a- Minor Roads & all other pavement layers except wearing course of major roads

1. The Engineer shall test the evenness of surface for each course of various asphalt paving courses and other pavement layers to determine compliance.

2. The Contractor shall put at the disposal of the Engineer a 3 m long straightedge and a crown template of sturdy and approved design and enough labour to assist in the checking operations.

3. Any layer containing deviations or variations exceeding the tolerances specified here shall be corrected or removed and replaced in accordance with the instructions of the Engineer and to his satisfaction.

4. The longitudinal regularity of the surface of various pavement layers shall be within the relevant limits given in Table 5.3.

Table 5.3: Irregularity requirements for asphalt courses of minor roads and other pavement layers

	AC Wearing Course of Minor Roads only				**AC Intermediate and AC Base Course of Minor roads, CBM, Base and Subbase layers**			
Irregularity	**4mm**		**7mm**		**4mm**		**7mm**	
Length (m)	300	75	300	75	300	75	300	75
Number of Irregularities	20	9	4	1	40	18	9	2

5. Any irregularity is a variation of not less than 4 mm or 7 mm of the profile of the road surface as measured by a rolling straight edge. No irregularity exceeding 10 mm shall be permitted.

6. Compliance with Table 5.3 above shall be tested with a rolling straight edge along any line or lines parallel to the centre line of the pavement on sections of 300 m selected by the Engineer, whether or not it is constructed in shorter lengths. Sections shorter than 300 m forming part of a longer pavement shall be assessed using the number of irregularities for a 300 m length prorated to the nearest whole number. Where the total length of pavement is less than 300 m the measurements shall be taken in 75 m lengths.

7. Pavements shall also be measured transversely for irregularities at points decided by the Engineer by a 3 m long straight edge placed at right angles to the centre line of the road. The maximum allowable differences between the pavement surface and the straight edge shall be 3 mm.

b- Major Roads - Freeways, Expressways and Arterials

The rideability (Roughness) of the finished wearing course when tested with a Laser Road Surface Testing Machine shall have an IRI (International Roughness Index) not exceeding the following values:

- **New Construction**
  - Average value over a 400 metre section $\leq$ 0.90 m/km.
- **Pavement Rehabilitation**
  - ***One layer of asphalt*** **:**
    - Average value over a 400 metre section $\leq$ 1.05 m/km
  - ***Two layers or more of asphalt***
    - Average value over a 400 metre section $\leq$ 1.0 m/km

- Peak individual value over a 25 metre section shall be $\leq$ 1.5 m/km (Not more than 2 values per 400 metres) - New construction and Pavement rehabilitation.

- The amplitude of the longitudinal profile of the road, filtered between (a) 1 metre and 3.3 metres and (b) 3.3 metres and 13 metres shall not exceed the following values:

Filtering Length (m)	Amplitude Tolerance (mm)
1 to 3.3	1.8
3.3 to 13	4.0

- All humps and depressions exceeding the specified tolerance shall be corrected by removing the defective work and replacing it with new material as directed by the Engineer at the Contractor's cost.
- The minimum length of any pavement section to be tested shall be 500m.
- Directional ramps on bridges or interchanges and tunnels of minimum length of 500m and with widely spaced joints of more than 25m should be tested, unless otherwise instructed by the Engineer, and shall have an IRI (International Roughness Index) not exceeding the following values:

  - **Flexible Pavement**: Average value over a 400 metre section $\leq$ 0.90 m/km

  - **Rigid Pavement**: Average value over a 400 metre section $\leq$ 1.20 m/km

- Individual roughness readings at joints in rigid pavement shall be excluded during processing of the roughness data and shall be ignored in the analysis. Pavement within 20m of Bridge decks or railroad crossings shall be also excluded.
- Ramps, acceleration and deceleration lanes, loops, U-Turn lanes, shoulders, service roads, sides street tie-ins, parking areas and other links (with a length less than the minimum length specified or those constructed of closely spaced joints shall be excluded.
- The roughness measurements shall be undertaken at minimum 1 week before opening to the traffic
- The minimum length of the rectification work undertaken shall be 100m.
- All rectified segments shall be re-tested following the completion of rectification work at no additional cost to the client.
- **Roughness Pay Factors**

Δ IRI (m/km)	% Deduction/Bonus of the Finished Surface Wearing Course
<0.0	+2%
0.01< Δ IRI <0.05	No Penalties
0.05< Δ IRI <0.10	-3%
0.10< Δ IRI <0.20	-4%
0.20< Δ IRI <0.60	-6%
Δ IRI >0.61	Removal and Rectification

c- Surface tolerance for Bituminous Courses

At final compaction, the finished surfaces of the individual layers shall fall within the following maximum tolerances, measured with a 3m straightedge laid in any direction

Surface Layer	Finished Surface Tolerance (mm)
Base Course	6
Binder Course	6
Wearing Course	4

5.12 PRIME COAT

5.12.2 Materials

Delete paragraphs 2 and 3 and substitute with the following:

2 The application rate shall be between 0.75 to1.00 litre/m². The exact rate of application, which may be varied to suit field conditions, will be determined by the Engineer following trials to be carried out by the Contractor. The Contractor shall ensure that excessive application of prime coat is avoided.

3 The application temperature for the MC-70 liquid asphalt shall be between 60 °C and 85 °C.

5.12.5 Application

Delete paragraph 1 and substitute with the following:

1 After preparing the road surface in accordance with Sub-Clause 5.12.4, the liquid asphalt shall be applied by means of the distributor at the temperature and rate determined by the Contractor and approved by the Engineer. Hand-spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer.

5.13 TACK COAT

5.13.2 Materials

Delete paragraphs 1, 2 and 3 and substitute with the following:

1 The material for bituminous tack coat shall be slow setting emulsified asphalt, grade SS-1h (anionic) or CSS–1h (cationic) conforming to the requirements of AASHTO M140 and AASHTO M208 respectively.

5.13.5 Application

Delete paragraphs 1, 2, 3 and 4 and substitute with the following:

1 Immediately after cleaning the surface, the tack coat shall be applied by means of the distributor at the temperature and rate determined by the Contractor and approved by the Engineer. Hand-spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer.

2 The application rate shall be between 0.30 to 0.50 litre/m². The exact rate of application, which may be varied to suit field conditions, will be determined by the Engineer following trials to be carried out by the Contractor. The Contractor shall ensure that excessive application of tack coat is avoided.

3 The application temperature for the diluted emulsified asphalt shall be between 10 °C and 60 °C. The material should not be applied when the ambient temperature is less than 13 °C or during rain, fog, dust storms or other unsuitable weather.

4 After application the surface shall be allowed to dry to the proper condition of tackiness to receive the following pavement course. Tack coat shall be applied only so far in advance to pavement courses to obtain the proper condition of tackiness and the Contractor shall protect the tack coat from damage during this period.

PART 7 VEHICLE CRASH BARRIERS

7.1 GENERAL REQUIREMENTS

7.1.3 Performance Requirements

Delete paragraph 4 and substitute with the following:

4 The Contractor shall refer to EXW IAN 002 for safety barrier performance levels.

PART 8 KERBS, FOOTWAYS AND PAVED AREAS

8.1 GENERAL

8.1.4 Quality Assurance

Delete paragraph 1 and substitute with the following:

1 The Contractor shall carry out tests on the concrete mix before beginning manufacture of precast kerbs and other items to prove that strength and surface finish requirements can be met. The Contractor shall recommend an alternative tested mix to the Engineer for approval should the strength and finish not meet the specification.

8.2 KERBS

8.2.3 Laying

Delete paragraphs 1, 2 and 6 and substitute with the following:

1 Kerbs shall be laid to the design levels and lines by means of survey. Kerbs shall not be laid by means of direct measurement from pavement layers.

2 Unless otherwise indicated, elements shall be laid directly onto a wet-concrete base or onto a sand/cement (3:1) mortar bedding, 25 mm thick, on a previously laid concrete base or approved subbase.

6 Immediately after any concrete is in place, and for seven days thereafter, the kerbs, base, and backing shall be fully cured and protected from drying out and against the harmful effects of weather, including rain and rapid temperature changes to the requirements of QCS Section 5 Part 10 Curing.

8.4 LAYING PRECAST CONCRETE BLOCKS

Delete paragraph 2 and substitute with the following:

2 A laying course consisting of washed sand, which complies with Table 8.2, shall be constructed. The sand shall be placed in a moist but not saturated condition and shall be compacted so that a laying course thickness of 50 mm is formed. This sand shall be placed on a compacted aggregate subbase or base 200 mm thick to greater than 95% of maximum dry density unless otherwise specified by the Engineer.

8.6 CAST IN PLACE CONCRETE PAVED AREAS

Delete paragraph 3 and substitute with the following:

3 Paving shall be cast in sizes to avoid the formation of shrinkage cracks. The Contractor may be permitted to cast using non-metallic fibers added to the concrete mix to eliminate cracking. In all cases the Contractor shall be responsible for prevention of shrinkage cracks and rectifying cracked works including breaking out and replacing cracked paved areas.

PART 9 FENCING

9.2 FENCING GENERALLY

Delete paragraph 2 and substitute with the following:

2 Where necessary, existing fences, gates and stiles, with posts shall be carefully taken down, laid aside, removed and later re-erected. Fences, gates, stiles and posts which are to be re-erected shall be handled carefully to avoid any damage. Fences, gates, stiles and posts which are in poor condition shall be replaced to the approval of the Engineer.

9.3 CHAIN LINK FENCING

9.3.1 General

Delete paragraph 1 and substitute with the following:

1 This work consists of the supply and installation of all plastic coated chain link fencing complete with all necessary hardware and appurtenances as per the Engineer's drawings and to the lines and levels designed by the Contractor and approved by the Engineer.

PART 10 TRAFFIC SIGNS, MARKINGS AND STUDS

Replace "Qatar Traffic Control Manual" with "Qatar Traffic Manual" wherever it appears in this Part.

10.1 GENERAL

10.1.2 References

Delete paragraph 1 and substitute with the following:

1 The following manuals and standards are referred to in this Part:

Qatar Traffic Manual

BS 381C, Colours for identification purposes
BS 729, Hot dipped galvanizing
BS 873, Road traffic signs
BS 1470, Wrought aluminium for general engineering purposes; plate sheet and strip
BS 1474, Wrought aluminium for general engineering purposes; bar extruded round tubes and sections
BS 1490, Aluminium and aluminium alloy ingots for general casting purposes BS 2000, Part 58, Determination of softening point of bitumen (ring and ball) BS EN 1871:2000, Road marking materials – Physical properties
BS EN 1423:1998, Road marking materials – Drop on materials – Glass beads, antiskid aggregates and mixtures of the two
BS EN 1436:1998, Road marking materials – Road marking performance for road users
BS EN 591-1:2000, Titanium dioxide pigments for paint - Specifications and methods of test
BS EN 1463-1:1997, Road marking materials – Retro-reflecting road studs

ASTM A307, Steel anchor bolts

CML 14-97, Standard method of test for determination of appearance, shape, dimensions and compressive strength of ceramic non-reflecting road studs.

TRL Road Note 27, Skid resistance portable tester.

10.2 TRAFFIC SIGNS

10.2.1 Scope of Work

Delete paragraphs 1, 4 and 6 and substitute with the following:

1 This work shall consist of the design, supply and installation of all road signs and posts. All sign faces and lettering shall be in accordance with the most recent edition of the Qatar Traffic Manual. The required post sizes for different sign sizes shall be as tabulated in the Qatar Traffic Manual. Where in this section of the specification the term 'as designated' is used, this refers to the Contract Drawings and the Qatar Traffic Manual.

4 Permanent traffic signs shall be reflectorised or non-reflectorised and/or illuminated and except where modified herein, shall comply in respect of quality to the requirements of the following documents:

BS 873
Qatar Traffic Manual
Any other Interim Advice Note (IAN) as issued by the Engineer

6 All foundations, posts, framing and fixings shall be suitable for local conditions and be designed to a design wind speed of 120 km/h with gusts to 160 km/h. The Contractor shall supply the calculations confirming this requirement and shall confirm that the nomograms in the Qatar Traffic Manual meet these requirements if he chooses to use them.

Add new paragraphs 9 and 10 as follows:

9 Coefficient of reflectorisation for new sheeting shall not be as per BS 873. Table 2.3 of the Qatar Traffic Manual shall be replaced with the following:

Entrance Angle	Observation Angle	Minimum Coefficient of Retro-reflection (candelas/lux/m²)									
		White		Yellow		Red		Green		Blue	
		Class of Material									
Degrees °	Minutes'	1	2	1	2	1	2	1	2	1	2
-4°	12'	750	380	560	300	150	98	75	45	34	22
	30'	240	275	180	220	48	70	24	32	11	17
	60'	12	80	18	60	3.0	20	1.0	9.0	0.5	4.5
30°	12'	430	225	320	180	86	65	43	28	20	14
	30'	135	135	100	100	27	32	14	16	6.0	8.0
	60'	10	45	8	35	2.4	11	0.8	6.0	0.4	3.0
40°	12'	165	90	130	70	40	26	15	9.8	9.0	4.5
	30'	75	35	65	27	18	10	7.0	3.5	3.0	1.5
	60'	10	10	8.0	8.8	2.4	3.0	0.8	1.6	0.4	0.8

Note: Test to be in accordance with ASTM E-810 "Test Method for Coefficient of Retro-reflection of Retro-reflective Sheeting".

10 After 12 years the minimum percentage of coefficient of reflectorisation retained shall be 70%.

10.2.3 Traffic Sign Materials

Delete paragraphs 3 and 4 and substitute with the following:

3 Illuminated signs shall be covered with Class 1 reflective sheeting.

4 Signs shall be covered over the whole front face with Class 1 or Class 2 reflective sheeting. The rear faces shall be non-reflective grey.

Add new Sub-Clause 10.2.6 as follows:

10.2.6 High Intensity Grade Prismatic – Reflective Sheeting

1 Properties

The initial minimum coefficient of retro-reflection, when measured according to CIE 54.2 conforms to Table 9 of EN 12899-1 for Class Ref. 2 materials (Table A).

Geometry of Measurements		COLORS					
α	B_1 (B_2=0)	White	Yellow	Red	Green	Blue	Orange
0.2°	+5°	250	170	45	45	20	100
	+30°	150	100	25	25	11	60
	+40°	110	70	15	12	8	29
0.33°	+5°	180	120	25	21	14	65
	+30°	100	70	14	12	8	40
	+40°	95	60	13	11	7	20
2°	+5°	5	3	1	0.5	0.2	1.5
	+30°	2.5	1.5	0.4	0.3	-	1
	+40°	1.5	1.0	0.3	0.2	-	-
"-" indicates "Value greater than zero but not significant or applicable"							

Table A: Minimum Coefficient of Retro-reflection [cd/(lx · m²)]

The above angular definitions apply for the CIE Goniometer System (Co-planar Geometry). The sheeting shall be mounted in 90° rotation on the Goniometer (as shown below).

The initial chromaticity coordinates and luminance factor conform to the values of Table 6 of EN 12899-1 for Class Ref. 2 materials (Table B).

COLOR	1		2		3		4		Luminance Factor
	x	y	x	y	x	y	x	y	B
White	0.305	0.315	0.335	0.345	0.325	0.355	0.295	0.325	≥ 0.27
Yellow	0.494	0.505	0.470	0.480	0.513	0.437	0.545	0.454	≥ 0.16
Red	0.735	0.265	0.700	0.250	0.610	0.340	0.660	0.340	≥ 0.03
Blue	0.130	0.090	0.160	0.090	0.160	0.140	0.130	0.140	≥ 0.01
Green	0.110	0.415	0.170	0.415	0.170	0.500	0.110	0.500	≥ 0.03
Orange	0.610	0.390	0.535	0.375	0.506	0.404	0.570	0.429	≥ 0.14

Table B: Chromacity and luminance factors

10.3 PAVEMENT MARKINGS

Delete Sub-Clauses 10.3.2, 10.3.3, 10.3.4 and substitute with the following:

10.3.2 Materials for Permanent Pavement Markings

1 Permanent pavement markings shall be thermoplastic road marking material in accordance with BS EN 1871, except that they shall be white or yellow (Class Y1) complying with BS EN 1436 Table 6.

2 All line markings shall be reflectorised with glass beads in accordance with BS EN 1423 by incorporation into the road marking mixture and into the wet surface of the marking.

3 Glass beads shall be specified by the Contractor to meet the requirements of Sub-Clause 10.3.4.

4 The pavement marking materials shall be such that the final product, when in a molten state, can be sprayed onto the surface at a thickness of 1.5 mm.

5 The capacity of the containers containing the materials shall be not less than 25 kg or more than 100 kg. Each container shall be clearly marked with the manufacturer's name, batch number and date of manufacture.

10.3.3 Application of Thermoplastic Road Marking Materials

1 Road markings shall only be applied to surfaces which are clean and dry and free of all loose and extraneous matter.

2 Markings shall be free from raggedness at their edges and shall be uniform and free of streaks.

3 In addition to the glass beads included in the mix, an additional quantity of glass beads shall be sprayed on to the hot thermoplastic marking at the time of application. The rate of application shall be determined by the Contractor to meet the requirements of Cl 10.3.4, but shall be at the rate of about 0.5 kg/m².

4 Application shall be by mobile sprayer except for special lettering, arrows and symbols which shall be hand applied.

5 Longitudinal markings shall be laid to the lines shown on the Drawings without deviation.

6 The thermoplastic material shall be applied to intermittent and continuous lines to a thickness of 1.5 mm ± 0.3 mm

10.3.4 Performance Requirements and Testing

1 Road markings shall have the following road performance as defined in BS EN 1436 and shall be tested using the methods in that standard:

Property	BS EN 1436 Ref.	Requirement*	Value
Colour	Table 6	1. White 2. Yellow Class Y1	Co-ordinates given Co-ordinates given
Luminance Factor	Table 5	1. Class B2 2. Class B1	≥ 0.3 ≥ 0.2
Skid Resistance	Table 7	1. Class S1 2. Class S1	≥ 45 ≥ 45
Retro-reflectivity	Table 2	1. Class R2 2. Class R1	≥ 100 ≥ 80

* Note: 1 = White, 2 = Yellow

2 Road marking materials shall have the following physical properties as defined in BS EN 1871 and shall be tested using the methods in that standard:

Property	BS EN 1871 Ref.	Requirement*	Value
Luminance Factor	Table 5	1. LF3 2. LF1	≥ 0.65 ≥ 0.4
Softening Point	Table 6	1. Class SP4 2. Class SP4	≥ 110 °C ≥ 110 °C
Cold Impact	Table 7	1. Class CI1 2. Class CI1	0 °C 0 °C
UV Ageing	Table 3	1. Class UV1 2. Class UV1	≤ 0.05 Δß ≤ 0.05 Δß

* Note: 1 = White, 2 = Yellow

3 In addition to the properties in paragraph 2 above, the following physical properties shall be tested:

Flow Resistance Test: The material shall be cast into a conical mould having an apex angle of 60 °C and a vertical height of 100 mm. After cooling and setting for 24 h the cone shall be

removed from the mould, placed on a flat level surface and maintained at a temperature of 23 °C ± 2 °C for 48 h. There shall be no slump.

Abrasive Test: A3 mm thick coating of material shall be screeded on to a Monel alloy panel and subject to wet (water lubricated) abrasion at 23 °C on a Taber Model 503 standard abrasion tester using H-22 Calibrade wheels, refaced between tests. The loss in weight after two successive tests of l00 revolutions shall be recorded and the average taken as the abrasive wear. The abrasive wear shall be less than 0.3 g/100 revolutions.

10.4 TEMPORARY ROAD MARKING

10.4.1 Road Marking Paint

Delete paragraph 7 and substitute with the following:

7 Where markings are to be reflectorised with ballotini it shall be sprayed uniformly on to the wet paint film at the rate of 400 - 500 g/m². Ballotini shall be graded medium to comply with the requirements of BS EN 1423.

10.5 REFLECTIVE STUDS

Delete paragraphs Sub-Clause 10.5.1, 10.5.2, 10.5.3 and 10.5.4 and substitute with the following:

10.5.1 General

1 Reflective road markers shall comply with the requirements of BS EN 1463-1 Road Marking Materials – Retro-reflecting road studs. They shall be capable of withstanding the climatic conditions of Qatar and be maintenance free.
A performance guarantee of five years is required.

2 The road stud dimensions exposed to traffic after installation shall measure 130 mm (across the direction of traffic flow) x 115 mm x 25 mm.

3 All reflective road markers shall be anchored within the road surface. The minimum anchor length below road surface shall be 65 mm.

4 The anchorage part of the stud shall be shaped to prevent rotation of the stud when located on the road surface.

5 The body of the stud shall be constructed in one integral part.

6 The profile of the stud shall be smooth and present no sharp edges to traffic.

7 The studs shall be non-depressible.

8 The Contractor shall submit a sample of the proposed reflective studs to the Engineer for approval before commencing procurement.

10.5.2 Reflectors

1 The reflectors shall be rectangular in shape. The reflective unit shall be firmly located into a recess within the body of the stud.

2 The colour limits of the reflectors shall comply with the chromacity region coordinates in Table 9 of BS EN 1463-1.

3 White (uncoloured) reflectors shall not produce a selective reflection; that is to say, the trichromatic co-ordinates X and Y shall undergo a change of more than 0.91 after reflection by the reflector.

10.5.3 Reflectivity

1 The retro-reflective face of the road stud shall have a coefficient of luminous intensity meeting or exceeding the requirements of a Type 2 reflector in Table 4 of BS EN 1463-1.

2 The daytime visibility of the road stud shall comply with Class DCR 1 of BS EN 1463-1.

Add new Sub-Clause 10.7 as follows:

10.7 SPECIFICATIONS FOR GLASS SPHERES (BEADS)

1 Type I is not coated and Type II is coated to provide moisture proofing for high humidity conditions, where sphere flow may be impaired.

10.7.3 Requirements

1 Glass spheres Type I and Type II shall meet the following requirements:

2 General: Glass spheres shall lend themselves readily to firm embedment in the traffic paint when dropped on a freshly placed paint line. The embedment shall be of such character as to provide a highly reflectorized surface on the paint with reserve reflectorizing capacity in the lower sections of the paint film. The reflection shall be effectively manifest to the operator of a motor vehicle when the headlights of the vehicle are shown on the marking.

3 Appearance: A minimum of 85% of the beads by count shall be colourless, true spheres, free of dark spot, milkiness, air inclusions and surface scratches when viewed under 20 x magnifications. The beads shall be clean and free from foreign matter in accordance with high grade commercial practice.

4 Gradation: The glass spheres shall conform to the following grading requirements:

Sieve Size	% By Weight Passing
600 µm	100
250 µm	40 – 70
180 µm	15 – 35
106 µm	0 – 5

5 Physical Properties: Glass sphere shall conform to the following properties:

Refractive Index, minimum	1.50
Specific Gravity	2.40 to 2.60
Moisture Content, maximum	0.01%

6 Chemical Stability: Refluxing a sample of beads for 8 hours with distilled water shall not produce more than a very slight reduction in luster or reflecting power of the beads.

7 Flow: Beads shall be free flowing. A 23 kg sample of beads, emptied into a service box screen, Sieve Size 1.18 mm shall pass completely through the screen without shaking or any excessive hand manipulation.

8 Type II (Moisture Proof): The Type II beads shall conform to all the requirements for Type I beads and the following requirement for moisture resistance.

9 Moisture Resistance Test (Flow): Moisture resistance of the beads shall be determined by the following procedure:

(a) Use a pre-washed 267 mm x 444 mm unbleached cotton sheeting bag having a 48 x 48 thread count.

(b) Turn the bag inside out to prevent water plus beads from being entrapped within the seams.

(c) Place 907 g of beads in the cotton bag.

(d) Immerse the bag containing the sample in a bucket of water at room temperature 21-22 °C for 30 seconds, or until the water covers the beads (whichever is longer).

(e) Remove the bag and sample from water and squeeze the excess water out of the bag by twisting the neck of the bag.

(f) Allow the bag to be suspended for 2 hours at room temperature. Do not allow the neck to loosen.

(g) Mix the sample thoroughly by releasing the tension in the neck and shaking the bag, thus loosening the beads from bottom and sides.

(h) Transfer the sample to the clean dry funnel (150 mm top diameter, 120 mm deep and 6.35 mm ID stem).

(i) If the beads bridge in the funnel while pouring the sample, the funnel can be tapped lightly to start the flow.

(j) After flow stops, the funnel must be essentially empty of glass spheres.

10.7.4 Quality Assurance Provision

1 Inspection: The material shall be inspected and tested as specified by the Engineer.

2 Index of Refraction: The beads shall show a minimum index of refraction of 1.5 by the oil immersion method using tungsten light, per ASTM Special Publication 500 Paragraph 1.3.2.1.

3 Specific Gravity: The beads shall have a specific gravity from 2.4 to 2.6 at 25 °C per ASTM D-153 Method A.

4 Moisture Content: As determined by weight loss of 25 g of beads in an oven at 105 °C for 3 hours, shall not exceed 0.01%.

5 Chemical Stability: Refluxing of a 50 g sample of beads in a Soxhlet extraction apparatus for 8 hours with distilled water shall not produce more than a very slight reduction in luste.

PART 11 WORKS IN RELATION TO SERVICES

11.1 GENERAL

11.1.4 Notification to Service Authorities & Statutory Bodies

Delete paragraph 1 and substitute with the following:

1 All works in relation to services shall be carried out by a contractor or sub-contractor prequalified and approved by the concerned service authority. Proof of such approval shall be required in writing before the start of Works on the Site. The name of any sub-contractor to be used shall be designated. Any design work to be undertaken for the relocation or protection of an existing or proposed service as part of the Works shall be undertaken by a consultant appointed by the Contractor who is approved by the relevant service authority or statutory body. Written proof of a consultant's approval shall be provided by the Contractor.

11.3 PARTICULAR REQUIREMENTS

11.3.2 Qatar General Electricity and Water Corporation, Water Network Affairs, QGEWC (WNA)

Add new paragraph 4 as follows:

4 The Contractor is to obtain the most recent approved list of manufacturers / suppliers of materials for water works projects from QGEWC. All relevant water works materials used on the project will be obtained from a manufacturer / supplier which is included on this list. The Contractor shall provide a copy of the list to the Engineer prior to ordering any material.

PART 12 ROAD LIGHTING

12.5 HIGH MAST LIGHTNING

Add new Sub-Clause 12.5.19 as follows:

12.5.19 Luminaires

1 General

(a) The Specifications contained in this sub-section are typical for all luminaries to be supplied and utilised. All luminaries supplied and installed shall be in accordance with the Drawings and Bills of Quantities unless specified otherwise by the Engineer.

(b) The luminaries shall be designed to receive one high pressure sodium lamp and internal control gear necessary for the operation of the lamp. Luminaires shall operate on 220/230V AC ± 10% at 50 Hz ± 5%, with 150w/250w/400w/600w HPSV lamps or as otherwise specified by the Engineer.

(c) The street lighting luminaires shall follow the provisions of the latest versions of the following standards:

(i) BS 4533-101:1990, EN 60598-1:1989
(ii) BS 4533-102.1:1990, EN60598-2-1:1989
(iii) BS 1615: 1987
(iv) BS EN 147000: 1995
(v) BS EN 60922: 1997, IEC 60922: 1997
(vi) BS EN 60923:1996
(vii) BS 6500: 2000
(viii) BS EN 60598-2-3:1994, IEC 60598-2-3:1993
(ix) BS 5489 Part 1, 2, 3, 4, 5, 6 and 7: 1992
(x) BS 5225: 1975
(xi) BS 5101–4:1980, BS EN 60061-4:1992, IEC60061-4:1992
(xii) BS 2011-2.1 and IEC 60068-2

2 Construction

Luminaires shall be complete with following assembly:

(a) The luminaires shall accommodate lamps having cap base E40 size.
(b) Body made of die cast aluminium alloy casting in two compartments.
(c) Super purity one piece aluminium reflector of grade S1 with an anodic coating of not less than Grade AA10 of BS 14 1615: 1987.
(d) Strong, very high thermally resistant and mechanically transparent protector. The protector shall be made of clear toughened curved glass with a transparency of no less than 90%. The protector shall be smooth on both sides to minimize dirt accumulation.
(e) Neoprene gaskets or high quality felt gaskets silicon.
(f) Stainless steel hinges, mounting clips and fastening bolts, grade AISI 316.
(g) Movable porcelain Lamp Holder with position markings and anti-vibration fixation device.
(h) Complete control gear mounted on easily removable tray.
(i) A terminal block for the connection of incoming supply cables shall be provided in luminaires incorporating auxiliaries. It shall be situated as close as possible to the point of entry of the supply cable and shall be readily accessible.
(j) A means of clamping the electrical supply cables shall be provided in the lantern where necessary to relieve the termination of strain. The cable clamp arrangement shall not damage the insulation of the cable.
(k) Brass earth terminal set-in housing.
(l) Protective sheath for power supply cable, and expandable nylon cable grip for wiring, conforming to BS 6500:2000.
(m) The lamp caps and the lamp holders shall meet the requirements of BS EN 60061-4:1992, IEC 60061-4:1992.

3 Mechanical Requirements

(a) Luminaires shall be with separate compartments for the optical system and for the control gear.
(b) The tightness of the optical compartment shall be IP66 class as per IEC 598-1 standard. The access to control gear compartment shall be without using any tools.
(c) The tightness of the control rear compartment shall be IP65 or better, according to the IEC 598-1 and 2 standards.
(d) Access to lamp shall be by rotating the lampholder support plug and extracting it from the sleeve. Clips shall not be used for closing the lampholder support plug as clips cause abnormal stress on the gasket and thereby affecting IP rating of optic compartment.
(e) The mechanical strength of the body and its accessories and the protector of the luminaire shall be sufficient to withstand without any damage a mechanical shock having an impact energy complying with BS 2011, and BS EN 60068-2-31:1993.
(f) Special precautions shall be given to the choice of materials which shall be able to resist without any damage or aging or alteration in its structural or physical properties, the severe Qatar climatic conditions, in addition to the heat emitted by the lamp.
(g) Fixing on the bracket shall be of an effective locking means using stainless steel bolts grade AISI316.
(h) All fixings which carry the weight of the lantern and internal accessories shall be provided with suitable locking devices to prevent the dislodgement of any part of the lantern by vibration either in service or in maintenance. Compliance shall be checked as per BS 2011, and BS EN 60068-2-31:1993.

4 Electrical Requirements

(a) Provision for one lamp for each lantern shall be made. The electrical accessories such as ballasts, ignitors and capacitors shall be prewired using heat resistant glass fibre insulated wire and preassmebled on metallic supports that are fixed into the control gear compartment.
(b) Special care shall be taken to allow easy maintenance and quick replacement of the accessories. All control gear accessories shall be bolted (and not riveted) on the removable supports.
(c) All electrical accessories shall be able to withstand in continuous operation and without any damage, the temperature existing inside the control compartment, in an ambient temperature of 50 °C. All wires inside the HPSV luminaires shall be of the heat resistant type with silicon and glass fibre insulated. The arrangement shall comply with BS 4533–102.1:1990 and EN 60598-2-1:1989.
(d) The cable feed terminals and the earth screw shall be fixed inside the control gear compartment. A cable holder shall be mounted near the terminals.
(e) A separate set of control gear shall be provided for the lamp comprising one choke associated with one capacitor and one ignitor. The control gear should be encapsulated in an approved enclosure conforming to IP 65 or better.
(f) Terminals of all ballasts, capacitors, ignitors and starters, if any, shall be shrouded. The ballast shall be designed to operate the lamp and control it continuously in ambient temperatures ranging from 0 °C to 80 °C.
(g) The ignitors used for HPSV lamps shall consist of built-in timer so that; it shall automatically stop its function if lamp does not get ignited within pre-set time period.
(h) The choke shall be tropicalised of Class H insulation and vacuum impregnated. The capacity of the choke should be such as to keep the illumination of the lamp within the design limit.

(i) The capacitor shall be of the diphyenyl impregnated type and shall be in a leak proof metal container fitted with an internal discharge resistor. The permitted operating temperature of the capacitor shall be marked on its case and shall be 85 °C. The capacitors shall have value sufficient to raise the power factor of the complete luminaire to 0.90 or better. Each lamp shall operate using only one capacitor. Any combination of two or more capacitors to have the equivalent value of capacitance will not be accepted. Chokes and capacitors shall comply with the latest BS EN 60922: 1991 and BS EN 60923: 1991.

(j) Complete luminarie assembly shall have a power factor of minimum 0.9 without the need of any power factor correction at mains.

(k) The control gear shall be supplied by the lantern manufacturer and shall be incorporated in a way that heat emitted by lamp is not conducted or transferred to the gear components.

(l) The luminaires shall have a screw type lamp holder. The lead at the higher potential above earth shall be connected to the centre contact.

(m) The operating temperature and thermal endurance characteristics shall conform to Part 2 of BS 4533 Section 102.3: 1990.

5 Photometrical Requirement

(a) The lamp holder position shall be adjustable to allow the luminous flux distribution to be adapted to the geometrical installation condition.

(b) The adjusting device of the lamp shall be sufficiently sturdy, and designed in a way it cannot be disturbed, during its normal life time or during maintenance operations.

(c) The device shall have permanent marking so that the lamp position recommended by the manufacturer can be easily realized.

➢ 6 Photometrical Performance Requirement

(a) Computer calculations relating to illuminance and luminance results indicating overall luminance uniformity ratio (Uo) and longitudinal luminance uniformity ratio (Ul) which will be achieved on the roadway, values of threshold increment (TI) shall be submitted by the Contractor for Engineer's approval.

(b) The calculations shall be performed in accordance with CIE Nr. 30 Publication and shall be based on actual dimensions of the roads, and shall demonstrate that the lighting installation shall achieve the standards required for all parts of the Project, as specified in the Qatar Highway Design Manual, the Contract Documents to the requirements of the Engineer. The results are to be achieved taking into consideration a total Maintenance Factor of 0.9.

7 Documents to be submitted

The Contractor shall supply the following technical documentation and information for each type of luminaire for the approval of the Engineer.

(a) Original catalogue sheet of the luminaire.
(b) Detailed construction drawing of the luminaire.
(c) Polar diagram of luminous intensity in roadway vertical plan and transverse vertical plans.
(d) Utilisation factor curve for actual inclination of luminaire.
(e) Isolux diagram for actual inclination of luminaire.
(f) Intensity table, in the C-gamma co-ordinates recommended by CIE Nr. 27 Publication.
(g) Calculation printout showing the illuminance and luminance levels, Longitudinal Uniformity Ratio (Ul), overall Uniformity Ratio (UO) and threshold increment (TI).
(h) Tightness test certificate conforming to IP66 protection for the optical and control gear compartments of luminaire.
(i) Shock test certificate confirming the resistance of the body to impact energy as per Clause 4.4 Section 1.4 of BS 4533, Part 1.
(j) Total weight of the luminaire (with lamp and control gear).

(k) Power factor of one complete luminaire.
(l) Total electric consumption of the luminaire, including control gear losses.
(m) Rated lumen output of lamps under nominal conditions.
(n) Depreciation curve of the luminous flux with burning hours.
(o) Luminous flux variation with the main voltage.
(p) Make and type of lamp, ballast, ignitors and capacitors separately with their electrical characteristics e.g.: Impedance, power factor, Temperature rise (t), max. Temperature (tw) and power losses.
(q) Specification Compliance Statement covering each clause of this specification.
(r) The Contractor shall submit full details of areas using the same type of luminaires in the Middle East and Gulf Area.
(s) The supplier shall submit for the Engineer's approval dimensioned drawings of the control gear arrangements showing the exact positions of chokes and capacitors within the lantern.
(t) The Contractor shall submit a sample of each type of proposed luminaire for the approval of the Engineer.

Street light fittings shall be from suppliers approved by the PWA.

12.10 UNDERPASS LIGHTING SYSTEM

Add new Sub-Clauses 12.10.9 and 12.10.10 as follows:

12.10.9 Description of Lighting System for Underpass

1 The tunnel lighting is designed for the road design speed.

2 The tunnel lighting at and near the approach shall be used to maintain a sufficiently high lighting level inside the tunnel.

3 This shall enable the driver approaching the tunnel to see into the tunnel thus avoiding the "black hole effect".

4 The level of reinforcing lighting shall be continuously adjustable, using lighting control system.

5 Luminaires shall be selected and positioned to provide a continuity of lighting through traffic routes and lanes.

6 The lighting design and control shall ensure that energy will be conserved and running costs optimized.

12.10.10 Materials

1 Tunnel Lighting Luminaires

(a) Totally enclosed, dust and jet proof, conforming to at least IP65 of IEC529, shock resistant and specially designed to house the required lamps, electrical gear and accessories. Body to be one piece extruded aluminium (Magnesium – silicon alloy) having a wall thickness of not less than 2.5 mm.
(b) Exposed metal parts of luminaries are to be factory finished, stove enameled, with corrosion resisting paint capable of resisting heat emitted by lamp during continuous operation. The whole assembly shall be treated against corrosion by anodizing the aluminium.
(c) Mirror reflectors are to be 99.5% purity, polished aluminium reflectors and coated with transparent layer of silicon protection against wiping.
(d) Optical system and electrical control gear and lamp are to be mounted on a "plug-in" type control gear tray which will have locating pins to ensure alignment when being fitted into the body.
(e) Ground wire is to be connected through the cable connector to ensure that the ground potential is maintained on the gear tray when it is being removed from the luminaire for maintenance purposes.

(f) Luminaires are to have a hinged front glass assembly which shall comprise of a clear toughened glass plate, not less than 5.0 mm thick fixed into an aluminium frame which shall have a full length closing device. The front glass assembly shall seat on to a neoprene non rotting type gasket and once seated shall provide the required degree of protection. Glass used is to be of the type which once broken, no part of the glass will fall on the carriageway. Each lamp is to have an independent HRC fuse for protection. The luminaries shall have radio interference suppression in accordance to CENELEC EN 55014 and EN 55015 and CISPR Publication 14 and 15. The glass shall be parallel to the road surface. The housing shall be suitable for mechanical cleaning.

(g) Luminaires are to be complete with their mounting accessories and are to be supported from unistrut steel channel fixed to the soffit of the tunnel. Fixing details to be submitted for approval by the Engineer. Numbers of mounting brackets shall be a minimum of four pieces. The fixing device shall be removable without any tools.

(h) Luminaires having one circuit for supply and where applicable are to be through wired via a 5 core, LSF/PVC cable, heat resistant rubber insulated. The earth wire shall be solidly bonded to the earthing stud inside the luminaire.

(i) Luminaires shall be aligned to the satisfaction of the Engineer and any necessary realignment shall be made with no additional cost.

(j) Fixings are to be approved by the Engineer and all bolts used are to be stainless steel, painted after installation with a two pack anti-corrosion paint to be approval of the Engineer.

(k) Fixings are to be such that the installation of luminaries, trays, etc. is capable of being carried with a minimum of safety factor 3 to 1 per fixing.

(l) Luminaires are to be wired with approximately one meter length of 2.5 sq. mm / 1.5 mm high temperature flexible copper cable (LSF) insulated and sheathed to be terminated in the junction box as per the drawings. The earthing wire is to be solidly connected to the earthing stud inside the luminaire.

(m) Luminaires having two circuits taken into them are to have proper colour coding. Circuitry within the luminaire is to be designed so that segregation of the two supplies is maintained.

(n) Ballast and control gear are to be mounted in luminaire in separate compartment, isolated from lamp, and with enclosed terminal blocks fitted with quick disconnect electrical leads. Control gear is to be plug-in type for operation at 240 V, 50 Hz ballast is to be specially designed and selected for the particular types of lamps used, and lamps are to be able to start with at least ± 10% variation of nominal voltage and continue in normal operation with dips attaining 20% for four seconds. Control gear losses are not to exceed 10% of normal lamp wattage. RFI suppression device is to be provided. Power factor is to be compensated to at least 0.9 logging.

2 Lighting Control Systems

(a) Luminance Meter

Sensor:
Temperature stabilized photocell measuring range:
1 to 9 000 cd/sqm for use outside the tunnels and

Output:
Load independent current 4 – 20 mA,
Working resistance max. 550 ohm

Housing shall be of stainless steel according to AISI 316 TI with window heating and lens shade.

System of Protection: IP 55
Vario optic with adjustable measuring field 160 to 320.

For each entrance portal there shall be placed one sensor on a column height of 4 m, 110 m before the portals with stainless steel pan/tilt support. Work shall include the column as well as all required civil works as excavation, foundation and back filling.
Microprocessor: 19" plug in unit.

Microprocessor pre-programmed, site programmable by hand, for all necessary functions and placed in the Distribution Buildings. Fault output shall be provided.

Calibrated light sources for testing luminance meter shall be provided.

(b) Tunnel Lighting Control

Entrance Lighting – Automatic

The lighting system shall be controlled in a number of stages in dependence of the access zone luminance. This access zone illuminance shall be measured continuously by the luminance meter in front of the portal. The difference between the required luminance and the effective luminance in the threshold zone shall control the switching of the lighting.

In the event of a failure to the outside sensor, the control shall be done by adjustable switch steps; also a fault alarm shall be transmitted.

(c) Control Unit: A microprocessor controlled 19" unit shall be provided to control the entrance and interior lighting. The lighting control shall fulfill all control work described in the item above.

The control unit shall have a digital display of the external luminance measured by the photometers, switch-on and switch-off level presets for various switching stages, LED indicators show to indicate the activation of a switching stage, delay-on, delay-off and minimum burning time presets with a range of 15 seconds to 15 minutes for each switching stage, automatic switch over to a preset lighting level upon detection of failure of the system, with time delay and fault indication.

The control unit shall send at least the following information to the Bahce Maintenance Centre:

- Luminance meter fault indication
- Control unit fault indication
- Control unit watch dog reset indication
- Control unit configuration parameters shall be down loaded from the sub-control centres.

12.19 INSTALLATION

12.19.5 Road Lighting Column/Lantern Installation

Add new paragraph 13 as follows:

13 Mast raising cable must pull through the head frame to lantern without exposing to the sun light. Head frame shall be fabricated to facilitate the above.

Add new Sub-Clause 12.22 and 12.23 as follows:

12.22 Road Lighting Quality Assurance

Add new paragraph 12.22 as follows:

1 Road lighting works shall be carried out by specialist contractors or sub-contractors having experience in the provision and installation of lighting columns, provision and laying of cables and ducts, and provision and installation of supply connections to all electrical equipment. Specialist contractors or sub-contractors for installation of new street lighting works shall be pre-qualified by the PWA.

2 Climatic conditions – All cables shall be certified by the manufacturer as suitable for installation in Qatar.

3 All material shall be approved by the PWA before ordering. Only products with a proven record of performance, efficiency and long life will be considered for approval by the PWA.

4 All works, equipment and materials shall comply with statutory and other regulations, Codes of Practice and Standards current at the date of Contract signing including the Qatar Wiring Regulations.

5 All columns and brackets shall be produced by lighting column manufacturers registered and certified for the manufacture, supply and certification of lighting columns under their quality assessment schedule to ISO 9000:2000.

6 Column manufacturers not registered and certified accordingly will only be permitted if a satisfactory submission is made for quality assurance and performance within the climatic conditions in Qatar.

7 Facilities shall be provided for the Engineer to inspect the lighting columns during the course of their manufacture and application of the protective treatment.

8 Any equipment or items damaged in transit will not be acceptable for incorporation in the Works and the Engineer shall have the right to reject such items. In the case of minor damage to galvanizing or painting the Engineer may permit repairs to be carried out. Any such repairs shall be carried out in accordance with the recommendations of the supplier and to a recognized internationally accepted repair treatment.

12.23 LIGHTING COLUMNS (MULTI-FUNCTION SMART POLES)

12.23.1 General

1 The pole system shall be decorative type with multi-functionality features to accommodate a variety of services at any one time. All poles shall be designed to accept following services:

(a) Street lighting
(b) Illuminated advertisement banners 1.5 m x 3 m size
(c) CCTV cameras
(d) Street signs
(e) Traffic signs
(f) Traffic signal heads
(g) Street names
(h) Microcells
(i) Antennas, etc.

2 The poles shall be made up of a structural galvanized steel core and an extruded aluminium mast that enables accessory's to be mounted along its length at any height and position.

3 Multi-function poles shall be specially designed for 160 kph with maximum load configuration. By combining different steel cores with the mast profiles, poles shall be suitable for the heights as specified in the Contract Documents. The multi-function shall be decoratively designed with 2 m cladding made of extruded aluminium.

4 The poles shall comply with the requirements of BS 5649: 1985, BS EN 40-3-1:2000, BS 5950: Part 1 1985 and BS 8118: Part 1 1991 and the relevant AASHTO standard.

12.23.2 Materials

1 Structural Steel - All Smartpole steelwork shall be manufactured out of Grade 275 mild steel. Hot dipped galvanising shall be the surface treatment both inside and out.

2 Aluminium Mast - The poles external mast shall be made up of extruded aluminium alloy which has an anodised protective coating to 25 microns.

3 Service Hatches - Each pole shall have a service hatch approx. 600 mm from ground level for installing the service cut-outs (size 300 mm height x 110 mm width x 70 mm depth) where the connection of cables can be made between the outside network and the poles accessories. The service hatch shall be accessible by removing a cover plate or cladding from the pole base. The cover shall be fixed by 2 No. security screws. Poles used for vehicular traffic signals shall have additional hatch to terminate traffic and surveillance related cables.

12.23.3 Bracketry

1 Bracketry required for attaching various other functions on the pole shall be as specified by the Engineer.

12.23.4 Fasteners

1 All fasteners are supplied in stainless steel grade AISI 316. The exception to this is on the cantilever assembly's where the use of high-tensile fixings have been adopted. These fasteners are finished with metal plating to resist corrosion.

12.23.5 Electrical Equipment

1 M8 x 30 mm long threaded stud carrying 2 nuts and 2 washers shall be provided as an earth point. It shall be located within the service hatch.

2 Fuse cut-outs shall be supplied along with poles. Single lantern pole shall have single fuse cut-out and double lantern pole shall have double fuse cut-out.

3 Each pole shall be fitted with polyester "draw wire" to assist in feeding electrical and service cables should they be required.

12.23.6 Light Outreach

1 Suitable type of light outreach shall be supplied with each pole to fix specified number of fittings on that pole. The attachment of the outreach arms shall be made using 4 No. standard fasteners through the arm tube. In turn the light fitting shall be connected to the arm tube end and wired. The light outreach design shall be as shown on the drawings.

12.23.7 Pole Top Feature

1 Where the Engineer specifies, there shall be a decorative pole top feature. This feature shall be made of cast aluminium.

12.23.8 Warranty

1 Manufacturer shall provide 10 year warranty for the poles.

12.23.9 Make and Type

1 Smartpole system by Streetscape.

PART 14 ROAD DRAINAGE

14.4 ROAD GULLIES

Add a new paragraph 9 as follows:

9 Grating for gullies that are flush with the pavement surface shall be of ductile iron and shall comply with loading category D400 as defined in Table 14.1. The gratings shall have 600 mm square openings. Gratings set adjacent to kerbs shall have as a minimum bases on 3 sides of the frame.

14.5 MANHOLE COVERS AND GULLY GRATINGS

Delete paragraph 11 and substitute with the following:

11 The manhole covers shall meet Loading Category D400 as defined in Table 14.1.

14.8 TESTING AND CLEANING SURFACE WATER DRAINS

Add the following:

3 All highway carrier drains shall be watertight and shall be tested in sections, e.g. between chambers, by means of the air test described in paragraph 4 of this Clause. If a pipeline is rejected because of a failed air test, as part of the rectification work, a water test as described in paragraph 5 of this Clause may be carried out as an alternative acceptability test. Before testing, the ends of the pipeline to be tested, including short branches, shall be plugged and sealed.

4 For the pipeline air test, air shall be pumped in by suitable means until a stable pressure of 100 mm head of water is indicated in a U-tube connected to the system. The air pressure shall not fall to less than 75 mm head of water during a period of 5 minutes without further pumping, after an initial period to allow stabilization. Drains with traps shall be tested to 50 mm head of water and the permissible loss shall then be no more than 13 mm head of water in 5 minutes without further pumping after the initial stabilizing period.

5 For the pipeline water test, the pipes shall be filled with water under a head of not less than 1.2 m above the crown of the pipe at the high end and not more than 6 m above the pipe at the low end. Steeply graded pipelines shall be tested in sections so that the above maximum is not exceeded. The test shall commence not less than two hours after filling the test section at which time the level of water at the vertical feed pipe shall be made up to produce the required 1.2 m minimum test head. The loss of water over a 30 minute period shall be measured by adding water at regular 10 minute intervals to restore the original water level and recording the amounts so added. The drain will have passed the test if the volume of water added does not exceed one litre per hour per linear metre of drain per metre of nominal internal diameter.

6 All pipelines less than 350 mm diameter shall be checked by drawing through each completed length of pipe a spherical mandrel of a diameter 10% less than the nominal bore of the pipes being tested.

7 Chambers for carrier drains shall be watertight. Chambers shall be tested as described in paragraph 8 of this clause.

8 Chambers shall be tested hydraulically to a depth of water 1.2 metres above the soffit of the highest pipe entry with all pipe openings plugged. Unless otherwise agreed by the Engineer, the test shall commence two hours after filling the chamber at which time the water level shall be made up to the above stated level. The loss of water over a 30 minute period shall be measured by adding water at regular 10 minute intervals to maintain the original water level and recording the amounts so added. The chamber will be deemed to have passed the test for water tightness if the volume of water added does not exceed one litre per hour per linear metre of depth of water in the chamber per metre of nominal internal diameter of the chamber.

SECTION 8 SEWERAGE

PART 1 GENERAL

1.2 TESTING OF MATERIALS

Add new Sub-Clause 1.2.3 as follows:

1.2.3 Approved laboratories

Testing of concrete and other materials shall only be undertaken by laboratories approved by the PWA.

PART 4 PIPELINE INSTALLATION

4.3 PIPE LAYING

4.3.5 Corrosion Protection of Ferrous Pipelines

Add paragraphs 5 to 14 as follows:

5 Ferrous pipelines shall be supplied with one of the following corrosion protection systems:

(a) Cold applied self-adhesive laminate tape wrapping
(b) Extruded polyethylene coating
(c) Loose polyethylene coating

6 Extruded polyethylene coating shall be as Clause 8.3.8.7

7 Spigot ends of pipes coated in either of the approved manners shall not be coated over the depth of engagement within the socket or flexible coupling, but shall be coated with epoxy, polyethylene or polyurethane for pipes internally lined with these materials.

8 Where DI buried pipe is designated to be encased in loose polythene sleeving, installation shall be in accordance with BS 6076.

9 The pipe shall be supported by a central sling and a length of sleeving pulled over the spigot end and bunched up to the sling.

10 The pipe shall then be rested on blocks placed at its extremities and the sleeving pulled up to the socket and folded and taped or tied in position. The sling shall then be replaced to enable jointing to be carried out. A wide sling shall be used to distribute the weight and thus obviate intense pressure on the sleeving. Care shall be taken to avoid damage when removing the sling from the trench.

11 The sleeve shall not be drawn up over the pipe joints until the completion of the hydrostatic testing. Immediately after making the pipe joint, the pipe trench shall be backfilled as described hereinbefore in readiness for the hydraulic testing and to prevent damage to the sleeving.

12 After completion of the hydraulic testing, the sleeving shall be drawn up over and fixed around the pipe joints. A pad of sleeving shall first be placed around the joint to prevent damage to the joint sleeve by the edges of the socket or by bolts. A length of sleeving shall then be drawn over joint overlapping itself either side of the joint for a minimum of 300 mm and this shall be tied or taped tightly in position.

13 Any pipe sleeving perforated during fitting shall be repaired by overlaying with a short sleeve folded and secured with tape. Torn or damaged sleeving which is considered by the Engineer as not repairable by this method shall be replaced by the Contractor.

14 Immediately after fitting the pipe sleeving the pipe trench shall be partly backfilled to prevent damage to the sleeving.

4.5 TESTING OF PIPELINES

4.5.3 Pressure Pipelines

Add new paragraph 4 as follows:

4 Plastic irrigation drip pipe work shall be completely filled with water and visually inspected for leakage. No section showing signs of leakage will be accepted. In addition, any length of pipe which in the opinion of the Engineer or his designated representative is showing signs of degradation through contact with sunlight shall be cut out and replaced

4.6 MISCELLANEOUS ITEMS

4.6.1 Manhole Covers and Frames

Delete paragraph 1 and substitute with the following:

1 Manhole covers shall be made from ductile iron and comply with BS EN 124 which shall include:

- Documentation confirming EN 29002 certification; or
- Documentation identified under Annex A to BS EN 124, concerning Independent Third Party Inspection.
- Independent random sample testing at an approved testing facility to demonstrate full compliance with all aspects of the code i.e. load testing and dimensional tolerances.
- Production facilities shall be quality assessed in accordance with ISO 9000 or EN 29002 (BS 5750).

Delete paragraph 5 and substitute with the following:

5 Where indicated on the Drawings or Bills of Quantities, covers and frames shall incorporate a removable self-sealing GRP or similar corrosion resistant plate meeting the requirements of Part 7 of this Section. The plate shall fit between the cover and the frame such that no surface area of the frame shall be exposed to the atmosphere within the manhole. This shall be achieved by the inclusion of a neoprene sealing ring or by a

similar approved method. The plate shall be complete with a lifting handle on the upper surface. The design of the frame and cover and plate shall be subject to the approval of the Engineer. A heavy grease seal is to be formed in all cases between the cover and frame to prevent the ingress of sand where GRP sealing plates are required for the ductile iron manhole cover and frame specific details of the sealing plate to be fitted within the unit offered, should be provided such that those details can be forwarded to the sealing plate supplier.

PART 9 TRENCHLESS PIPELINE CONSTRUCTION

9.1 GENERAL

9.1.6 Submittals

Delete paragraph 1 and substitute with the following:

1 The Contractor shall submit complete data and details for the trenchless pipeline construction for the Engineer's approval as follows:

(a) structural design calculations for the trenchless pipeline and temporary works
  (i) the description and specification of pipes and design calculations
  (ii) details of the permitted angular deflection and draw for the proposed pipes
  (iii) the Contractor shall submit full details of the pipes together with details of previous works undertaken using similar pipes
  (iv) details of proposed manufacturer of pipes with relevant literature and details of manufacturer's Quality Control system
  (v) anticipated jacking loads
  (vi) structural design of thrust walls
(b) shop drawings
(c) materials specifications
(d) method statements which shall include:
  (i) details of the specialist sub-contractor's qualifications and experience in micro-tunnelling together with project references including previous employers' names and current contact details and a curriculum vitae of the proposed tunnelling machine operator including details of relevant experience in Qatar and the Middle East
  (ii) detailed procedure for the Works
  (iii) a description of tunnelling equipment with relevant literature and a statement from the tunnelling machine manufacturer detailing a delivery schedule for spare parts and consumables for the proposed tunnelling machines
  (iv) preconstruction activities (geotechnical investigations including test pits)
  (v) safety procedures
  (vi) handling and fixing of the inner pipe in the case of pipejacking with larger diameter pipes
  (vii) programme of work, including proposed production rates
  (viii) bentonite injection system details
  (ix) detailed method statements for all other aspects of micro-tunnelling work
  (x) where appropriate for the size of machine proposed, details of man access into the tunnel and tunnel boring machine
(e) designs of thrust and reception shafts and detailed drawings
(f) dewatering arrangements and disposal of groundwater
(g) methods for dealing with different ground conditions
(h) equipment layout at the thrust and reception shafts
(i) details of sleeving system
(j) ventilation
(k) lighting and communications

(l) disposal of surplus excavated material
  (i) details of the spoil separation process to produce clean slurry for re-circulation to the tunnel boring machine
  (ii) details of the containment of the excavated material to prevent water and slurry draining from the Contractor's designated working area or wagons. Lagoons for storage and settlement of slurry from the micro-tunnelling process will not be permitted
  (iii) details of the purpose made tanks for settlement of slurry shall be provided.
  (iv) details of the solid waste disposal procedure to an approved tip in a manner which does not cause spillage of slurry, mud or any other solid or liquid waste on the carriageway
  (v) disposal of surplus water, once all solids have been removed, to an approved surface/ground water outfall, if locally available, or removed by tanker to an approved point of disposal

(m) pilot bore

(n) plan at 1:50 scale showing working plant positions, spoil removal faculties, materials storage facilities, launch and reception shafts, fencing, offices, discharge lines, ground water removal facilities, etc.

2 The Contractor shall not procure materials or begin construction of the Works until the Engineer has approved all submittals. The Engineer's approval shall not relieve the Contractor of his obligations.

9.2 TRENCHLESS PIPELINE CONSTRUCTION GENERALLY

9.2.2 Surveys and Setting Out

Delete paragraph 2 and substitute with the following:

2 During construction of a drive between any two working shafts, the Contractor shall observe levels on predetermined cross-section points at regular intervals to determine if there is any subsidence.

Temporary benchmarks shall be set up along the centre of the pipe at 15 metre intervals between the shafts and at 5 and 10 metres offsets. Levels shall be taken along the centre of the pipeline and at offsets of 5 metres and 10 metres each side of the pipeline at 15 metre intervals between shafts. Levels shall be taken and recorded on all of the above points at daily intervals during micro-tunnelling works, again one week before issue of a Completion Certificate, and finally at the end of the 400 day period of maintenance.

Add new paragraph 6 as follows:

6 As-built surveys of each micro-tunnel drive shall be undertaken. For all micro-tunnel drives of internal diameter 800 mm or more, including any permitted sleeves of this size, the Contractor shall employ an approved independent survey company to undertake an as-built survey of the drive. Coordinates and levels shall be provided for every pipe joint. For steel sleeves, coordinates and levels shall be provided at 5 metre intervals. Each completed drive shall be surveyed immediately after completion of the drive. No further micro-tunnel drives may be commenced until the survey results have been submitted to and approved by the Engineer. No pipes may be installed within sleeves until the survey results have been submitted to and approved by the Engineer.

9.2.3 Monitoring Line and Levels

Delete paragraph 3 and substitute with the following:

The invert level of the finished pipeline at the drive shaft shall be within ±10mm of the required level shown on, or interpolated from, the Contract drawings.

The invert level and line of the pipeline shall at no point deviate from the design by more than the following:

Pipe Bore D mm	Vertical mm	Horizontal Mm
D < 600	± 20	± 25
600 ≤ D ≤ 1 000	± 25	± 40
1000 < D ≤ 1 400	± 30	± 100
D > 1 400	± 50	± 200

Delete paragraph 4 and substitute with the following:

4 The pipe manufacturer's stated permitted draw or angular deflection shall not be exceeded at any individual joint.

Add new paragraph 7 as follows:

7 Where micro-tunnelled sewers are required to connect into existing pipelines or pipelines previously completed under this project, due allowance shall be made prior to commencing the drive to ensure that the finished pipeline profile does not require the pipe contents to flow uphill.

9.3 MATERIALS

9.3.1 Pipes

Delete paragraph 2 and substitute with the following:

2 Pipes shall be designed to withstand the maximum axial thrust with a factor of safety of four based on the full effective area of the pipe and the ultimate compressive strength of the pipe material. For reinforced concrete pipes the full effective area at the joint shall be used. The pipe design shall take into account both permanent service loads and temporary loads encountered during installation.

Add new paragraphs 12 to 14 as follows:

12 The nominal internal bore of the micro-tunnelling pipes shall be as indicated on the Drawings or as specified by the Engineer. The Contractor shall select an appropriate external diameter for the pipe which shall be submitted to the Engineer for approval.

13 The design of the jacking pipes and determination of acceptable pipe fabrication tolerances shall be the responsibility of the Contractor. Maximum compressive stresses applied to the pipe shall not exceed 33% of the design compressive strength of the pipe and shall not exceed the pipe manufacturer's recommended allowable stresses.

14 Pipes for surface and ground water drains to be installed by micro-tunnelling shall be fit for purpose and shall be one of the following:

(a) Concrete designed specifically for jacking to BS 5911: Part 120 with a GRP pipe lining in accordance with Section 8 Part 3 Clause 3.4. . The GRP lining pipe shall incorporate watertight joints between adjacent pipes and shall accept no longitudinal load during jacking. The joint between adjacent pipes shall be designed to ensure concentricity of adjacent pipes and shall prevent application of any lateral forces to the GRP pipe. The coarse aggregate used in the manufacture of the pipes shall be crushed Gabbro rock. The external surface of the pipe shall be coated with at least 300μ DFT abrasion resistant epoxy. Pipes shall be factory manufactured by an approved experienced manufacturer. Pipes shall not be manufactured on-site.

(b) Concrete designed specifically for jacking to BS 5911: Part 120 with a polymer lining as described in Section 5 Part 14 Clause 14.6. The coarse aggregate used in the manufacture of the pipes shall be crushed Gabbro rock. The external surface of the pipe shall be coated with at least 300μ DFT abrasion resistant epoxy. Pipes shall be factory manufactured by an approved experienced manufacturer. Pipes shall not be manufactured on-site.

(c) The joint between adjacent jacking pipes shall be designed to ensure concentric alignment of adjacent pipes and uniform transfer of jacking forces from one pipe to the next. For concrete pipes the pipe joint shall consist of a substantial external stainless steel guide ring to achieve this requirement, which shall be welded to the reinforcing cage of the concrete pipe. The joint shall also incorporate one or more EPDM or other approved elastomeric sealing gaskets.

9.3.5 Grout

Add new paragraph 3 as follows:

3 Unless agreed to the contrary in writing by the Engineer, the annulus around the installed pipes shall be filled with cement grout installed under pressure by an approved means.

9.4 THRUST AND RECEPTION SHAFTS

Add new paragraphs 9 to 13 as follows:

9 The Contractor shall select the location of the drive and reception shafts. These locations shall be submitted to the Engineer for approval. These shafts may be incorporated as part of the permanent works. All modifications to the shafts converting them into access manholes shall be completed at the Contractor's own expense. Details of the modifications shall be submitted to the Engineer for approval and shall conform to those shown on the Contract drawings.

10 Prior to commencing work at a shaft, the Contractor shall provide details of the shaft support system, working plant position, spoil facilities, material storage facilities, dewatering arrangements, etc. The details shall include a sketch of all the working facilities at the head of the shaft.

11 Access down into the shaft for personnel and equipment shall be approved by the Engineer. Hand railing set at a height of 1 100 mm above ground level together with toe boards and protective netting to prevent equipment falling into the shaft shall be provided at each shaft. Fencing shall be erected around each shaft site establishment to prevent the entry of unauthorised persons.

12 The dimensions of shafts shall be the minimum necessary to safely construct the Works.

13 Backfilling of shafts shall be undertaken in accordance with Section 8 part 2 Sub-Clause 2.3.3.

Delete Sub-Clause 9.6 and substitute with the following:

9.6 MICRO-TUNNELLING

9.6.1 General

1 Micro-tunnelling shall be defined as a method of installing pipe or casing by jacking the pipe or casing behind a remotely controlled, laser guided, steerable, guided tunnel boring machine which fully supports the excavated face with fluid and/or earth pressure balance at all times.

2 Micro-tunnelling pipe is defined as pipe or casing capable of withstanding installation jacking and any other construction loads in addition to permanent live and dead loads.

3 The method to be employed for micro-tunnelling shall be selected by the Contractor to suit ground conditions and ground water pressure. The Contractor shall submit a detailed method statement which shall be approved by the Engineer prior to commencing micro-tunnelling.

9.6.2 Contractor Responsibilities

1 The Contractor shall carry out, and be responsible for, the detailed design of:

(a) The micro-tunnel;
(b) All associated works (including shafts, connections, etc.).

2 The design shall be prepared by qualified design engineers or other professionals who comply with the criteria stated in the Specifications. The Contractor warrants that he, his designers and design sub-contractors have the experience and capability necessary for the design. The Contractor undertakes to ensure that the designers shall be available to attend discussions with the Engineer at all reasonable times.

3 The Contractor shall satisfy himself that he has sufficient geotechnical details before commencing the detailed design. If available, a copy of existing geotechnical investigation reports shall be provided to the Contractor. These reports are provided for information only and the Contractor is advised to corroborate the details provided and commission any additional site investigation works he deems to be necessary.

4 The Contractor shall be responsible for ensuring that he avails himself of all necessary utilities information, existing and proposed, prior to commencement. Where available, a copy of existing utilities information shall be provided by the Engineer. These reports are provided for information only and the Contractor shall be responsible for ensuring that the information collected is the most recent and factual record of existing and proposed services in the project area. The Contractor shall utilise appropriate equipment and methods to aid him in the determination of the line and level of existing utilities apparatus. This may be undertaken either by the Contractor's own staff or by specialist sub-contractors.

5 The Contractor shall be responsible for obtaining all approvals/consents required for the disposal of excavated material/spoil that is surplus or unsuitable for incorporation in the permanent works. The Contractor may propose, subject to the approval of the Engineer, remedial measures to be taken for the improvement of earthwork arisings, which are not suitable in the as-dug condition, for use in the permanent works.

6 The Contractor shall allow the Engineer full access to real time micro-tunnelling data any time during construction.

9.6.3 Safety and Environment

1 The Contractor shall carry out all works to the requirements outlined in all current appropriate Regulations, Codes of Practice. The following recognised documents shall form the basis for guidance and development of the safety plan and site procedures:

(a) UK Health and Safety at Work Act including the provisions of BS 5228, Parts 1 and 2;
(b) BS 6164: Safety in Tunnelling (Code of Practice);
(c) Guide to Best Practice for the Installation of Pipe-jacks and Micro tunnels.

2 The Contractor shall develop a safety plan to encompass all aspects of safety and environmental requirements prior to commencement of the work. This plan shall be a working document and be subject to continuous review throughout the period of the contract.

3 All machinery, including hoists shall be suitable for quiet and efficient operation and shall be installed and maintained to an acceptable safety standard.

4 A site safety culture shall be instigated on-site prior to work commencing and be developed throughout the course of construction. The culture will comprise of the use of key management tools by the site management (and outlined in the site safety plan) in educating the site operatives in all aspects of best safety practice and awareness in their work. An induction session shall be given to all operatives and staff irrespective of their discipline and experience. This should, in particular outline all local requirements relating to the contract, actions to be taken in event of emergencies, and an overview of the Site and its personnel. The content of the induction may be varied to suit the recipients. Each operative shall receive training, together with any appropriate examination or documentation, to ensure he is completely aware of the requirements of each aspect of his job and the hazards which are inherent in its execution.

5 The Contractor shall produce a risk/hazard analysis of the key elements of the pipe-jacking operation and utilise the results of the analysis in reducing such risks that remain to a minimum. Such hazards shall be communicated to workers through induction, tool box talks and the like.

6 The Contractor shall develop and implement a plan for immediate underground evacuation in the event that the presence of toxic/inflammable gas is identified in the excavation. In such case the Contractor shall identify and take appropriate action to rectify such hazard prior to allowing work to recommence.

7 Appropriate training and certification shall be given to all operators of plant. This shall be carried out only by engineering staff competent in the use and hazards associated with the particular item of plant concerned.

9.6.4 Performance Requirements

1 The micro-tunnelling system shall be selected by the Contractor to suit local ground and groundwater conditions. The Contractor shall submit a detailed method statement for approval by the Engineer prior to starting micro-tunnelling work.

2 Micro-tunnelling operations shall be carried out in a manner that minimizes ground movement in front of and surrounding the pipeline. Settlement of the ground surface shall be minimized. Damage to structures and utilities above and in the vicinity of the underground operations shall be prevented.

3 The ground shall be continuously supported in a manner that prevents loss of ground and maintains the stability of the tunnel face and perimeter at all times.

4 A full work force shall be maintained on a continuous basis (24 hours per day) during any emergency or work stoppage that could endanger the tunnel excavation, sub-surface infrastructure and surface facilities.

5 Dust, noxious gasses or other atmospheric impurities shall be actively controlled in accordance with the relevant Qatar occupational health and safety legislation. Approved instrumentation for monitoring air quality in work areas and pipelines accessed by personnel shall be provided. This environmental control and associated procedures to be followed in monitoring shall be fully documented in the Contractor's Safety Plan.

6 All micro-tunnelling and underground construction work shall be performed in accordance with the relevant Qatar occupational health and safety legislation and the approved Contractor's Safety Plan. This Plan shall include safe procedures to mitigate risks associated with the work, including identification and logging of any and all visitors into and out of the underground works and prevention of unauthorized entry. Safe procedures shall also be established for personnel entering the tunnel to carry out maintenance or for other purposes.

9.6.5 Micro-tunnel Design Elements

1 Tunnel Pipe Design

(a) The watertight lining pipe shall be installed by single pass pipe jacking using a remote controlled tunnelling operation to the alignments and grades shown on the drawings. Remote controlled tunnelling operations apply to trenchless pipe installation by micro-tunnelling where the carrier pipe is installed directly behind the tunnelling machine and the machine provides support to the excavation face at all times.

(b) Jacking pipes shall be of precast concrete, designed and manufactured to meet the requirements of:
  (i) BS 5911 Specification for reinforced concrete jacking pipes with flexible joints.
  (ii) BS EN ISO 9002 Manufacturing.
  (iii) DIN EN 1916 and DIN 1201 in accordance with ATV 125 for reinforced concrete jacking pipes.
  (iv) BS EN ISO 9002 Manufacturing.

(c) All jacking pipes, including special designs, shall be sufficiently reinforced with steel to withstand all stresses induced by handling, jacking, earth and water pressures and all working loads at the depths at which they are to be used without cracking, spalling or distortion. A load factor of not less than 1.5 shall be used in the calculations to determine the strength of the pipes required. The clear cover to any steel reinforcement shall not be less than nominal 50 mm. The pipes are designed and calculated in according ATV 161 (Technical Standard of pipe jacking).

(d) The strength of the pipes shall be tested by a three edge bearing test. When subjected to the design load in such a test, the maximum crack developed on the pipe shall not exceed 0.25 mm. If this test not possible an equivalent quality control and security system has to be developed.

(e) All pipes shall be manufactured by a supplier approved by the Engineer. The process of manufacture may be by centrifugal or vertical casting subject to submission and approval by the Engineer. All pipes shall be cast with a minimum of 3 grout holes equally spaced around the pipe wall. A steel threaded insert (¾ to 1 BSP minimum dimension) shall be cast in each hole. All pipes shall be of spigot and socket design with an integral steel collar cast on the socket or trailing end. The collar shall be suitably and securely fixed to the reinforcing cage of the pipe prior to the pipe being cast. Each pipe shall have a 75 mm dia lifting hole or lifting anchor cast in the top centre to facilitate a lifting device. All pipes shall have their date of manufacture clearly and indelibly marked on them. All pipes shall be fully cured and have reached the designed concrete strength prior to delivery.

(f) The Contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and jointing arrangements, all cast in items and concrete design including specifications for all component materials. A full set of design calculations including the parameters adopted for the design shall also be submitted.

(g) The name of the manufacturer, place of manufacture and manufacturing process shall be identified at an early stage and provision made for inspection of such facilities by the Engineer for his approval.

(h) The jacking equipment including any required intermediate jacking stations shall have a capacity of not less than 20 per cent greater than the calculated theoretical maximum jacking load.

(i) The design of the tunnel shall take into account the required life span, the proposed use, the ground conditions, the sequence and timing of construction and the local existence of adjacent structures. Relaxation of stresses in front of boring machine and excavation, installation and water-tightness of lining pipe should be considered. The required life span is 100 years. 100-year durability design shall meet the requirements of BS 8110.

(j) Numerical methods shall be used to evaluate the loading on the lining pipe. Results of the numerical calculations shall be used to assess surface settlements. The Contractor shall specify, justify and explain the model he intends to use. The Contractor shall also submit two licensed English versions of the software including all manuals, to the Engineer.

(k) The Contractor shall be solely responsible for the accuracy of the numerical model and the assumptions necessary to fully simulate the anticipated ground and the tunnel excavation within it, the installation of any support measures and the construction of the permanent tunnel lining system. The Contractor shall provide in his Design Submission numerical simulations which are applicable to and reflect the work and construction stages proposed by him. State of the art modelling techniques, material properties, simulation procedures and material definition, shall be applied. In addition the Contractor shall at least consider the requirements as outlined below for the modelling process:

2 Tunnel Access Shaft

(a) The positions of the micro-tunnel shafts and tunnel are shown on the Contract Drawings. The Contractor may suggest alternative positions to suit his equipment and works programme. The final depth and position of the shafts and tunnel however shall be subject to the approval of the Engineer. The maximum spacing of micro-tunnel shafts shall be 700 metres.

(b) The working shaft shall be designed to withstand the force applied by the main jacking station and of adequate dimensions to fully cater for the underground installation of all necessary pipe-jacking equipment. This will include the jacking frame and thrust ring assembly, slurry pumping equipment, electrical isolation box and guidance system. Consideration must also be given to safe access and working space for the pit bottom crew. The design of the shaft base shall incorporate the requirements of a thrust block for the jacking frame to bear upon and a tunnel launching eye and sealing ring through which the TBM is launched. The design of these structures will depend on the type of ground and jacking pressures envisaged. They are normally considered to be temporary structures, being removed on completion of the drive, but consideration may be given to incorporating them in the permanent works wherever possible.

(c) Requirements for launching the TBM assembly, which may comprise multiple units of varying length, shall also be taken into consideration when deciding upon the overall size of the shaft base.

(d) Micro-tunnel shafts shall be placed at main road intersections to take drainage from the surrounding areas.

(e) Micro-tunnel shafts shall be built to PWA standards and requirements. The Contractor may propose alternative designs subject to the approval of the Engineer.

(f) Shaft openings shall be located within the central reservation or footway areas. No openings shall be accepted within the highway carriageway.

(g) The design of the tunnel shafts shall take due account of the following:

(i) Need to provide a structurally sound and stable reinforced concrete shaft wall and superstructure that shall comply with all relevant BSI standards. Design calculations and materials shall be submitted for approval to the Engineer prior to any construction work being undertaken.

(ii) All shafts shall be watertight.

(iii) All shafts shall have protective coatings both externally (in accordance with QCS Section 5, Part 14, Clause 14.3 or as directed by the Engineer) and internally (white epoxy coating in accordance with QCS Section 8, Part 8, Clause 8.3.15)

(iv) All ladders and handrails shall be to QCS Section 8, Part 6, Clauses 6.4.1 to 6.4.7. Platforms shall be provided at maximum distances of 6 metres and shall be positioned to allow maintenance equipment to be lowered unhindered to the base of the shaft. Ladders shall terminate at platforms and be staggered between platforms.

(v) Down-pipes shall be secured by stainless steel brackets to the inside of walls.

9.6.6 Design Checking

1 All drawings and calculations intended for incorporation into the design package shall be checked by an approved Independent Checker. Evidence of the extent and scope of checking carried out on each set or subset of calculations shall be provided either in the form of parallel calculations or by marking up the calculation sheets or by providing a summary on the cover sheet.

2 All drawings shall be checked with due consideration for the following:

(a) completeness;
(b) compliance with the relevant requirements of the Contract Documents;
(c) consistency between calculations, schedules, reports, drawings, specifications;
(d) compliance with standards, codes, regulations and statutory requirements;
(e) dimensional accuracy and presentation.

3 With his approval the Independent Checker confirms that the relevant documents are in compliance with the PWA's requirements, relevant local and international standards and designed correctly.

9.6.7 Finite Element (FE) and Finite Difference (FD) Models

1 A numerical analysis shall be carried out and fulfil the following geometrical requirements:

(a) Notwithstanding the requirements as listed below the mesh layout shall be such that numerical accuracy is guaranteed. If required, the Contractor shall perform sensitivity studies with different levels of mesh refinement.
(b) Width of mesh shall extend at least two tunnel diameters beyond the limits of the tunnel lining.
(c) The model used for the design at the ground sections of the tunnel shall be capable of considering the joint system and joint properties of the ground strata, by either explicitly modelling joint systems or applying suitable models with equivalent properties.

2 Element size around excavation contours shall not be larger than those elements that correspond to an angle of 10 degrees along the arch. Infinite elements shall be used along the border of the mesh or a suitably large mesh shall be proposed so that the influence of boundary of mesh is negligible for FE models: The practical limit of the aspect ratio of zones should be kept to approximately 1:4 or less in order to achieve reasonable solution accuracy. The practical limit for FD models of the aspect ratio of zones should be kept to approximately 1:1 or less in order to achieve reasonable solution accuracy.

3 Each computation shall be accompanied by a report that shall at least include a description and interpretation of:

(a) definition of the mesh;
(b) selection of design sections;
(c) definition of geological strata;
(d) selected input parameters;
(e) material models used;
(f) results including surface settlements and expected deformations in the tunnel;
(g) dimensioning of the tunnel lining.

9.6.8 Verification of Results

1 Numerical calculations for the design of the lining shall be verified using different analytical methods.

9.6.9 Design Parameters for the Calculations

1 Parameters required for the design and not defined in this document shall be established by the Contractor. All details on these parameters shall be provided by the Contractor in his Design Basis Report subject to the consent of the Engineer.

2 The results of site investigations carried out are to be summarised in the Data Reports and the Contractor shall conduct supplementary site investigations within the project area as designated and/or where considered appropriate. The interpretation of all site investigation data, including the interpretation of the Data Reports and of the bore logs shall be the responsibility of the Contractor. The Contractor shall justify and explain the derivation of all his geotechnical parameters in his geotechnical interpretative report. The geotechnical parameters used for the design require the consent of the Engineer. The worst credible ground parameters as identified in the site investigation data shall be used to check the micro-tunnel lining (at the ultimate limit state).

9.6.10 Design Loadings

1 The Contractor shall include for the following loads in his calculation of the stresses and strains induced in the installed pipeline:

(a) Ground/Rock Loads;
(b) Water Loads: Groundwater levels with sufficient safety margins for the design shall be determined from groundwater observations. The design calculations shall be carried out both for an upper bound and a lower bound of the ground water level subject to the consent of the Engineer;
(c) Live Loads: For underground structures under a roadway, a live load as defined in BS 5400, Part 2 for highway bridges considering type HA loading combined with 45 units HB loading shall be allowed for in the design;
(d Surcharge Loads: For all underground structures and in locations where live loads as specified above do not apply, a surcharge load of 22.5 kN/m² applied at ground level shall be allowed for in the design;
(e) All other loads.

2 The Contractor shall take into account any other loading criteria which may be applicable to achieve the full performance of the micro-tunnel, including water pressures under operational conditions within the lined tunnel.

3 In addition to the design sections as defined above the Contractor shall carry out case studies of all relevant and possible combinations of geological, hydrogeological and geometrical conditions as necessary for his design and construction. The Contractor shall also provide calculations in accordance with the soil /rock classification proposed by the Contractor and based on the Contractor's geotechnical interpretation. The Contractor's calculations shall cover all possible geotechnical conditions anticipated over the entire tunnel length. Notwithstanding the calculations as requested above, the Contractor shall consider within his design submissions one numerical simulation of the tunnel construction of at least every 400 m of the bored tunnel section. Within the Preliminary Design Submission the Contractor shall propose these calculation sections which shall be subject to the consent of the Engineer.

9.6.11 Design Submissions

1 The Contractor shall submit his proposed detailed design report to the Engineer for approval, not less than four weeks prior to his intended construction start date for this element of work, or as specified by the Engineer. The submission should include, but not be limited to, the following :

(a) Summary of all subjects addressed in the design stages;
(b) Summary of the design criteria adopted in the design stages;
(c) Final hydraulic model for overall drainage system including all input and output data;

(d) Final hydraulic design and calculations for overall drainage system including connections;
(e) Final hydraulic design and calculations for the temporary pumping station if required.

2 For the purpose of obtaining all necessary approvals on completion of the detail design stage, the Contractor shall submit to the Engineer the following:

(a) 4 no. complete sets of detail drawings-paper prints (A1) to include:

- The modified positive surface water drainage system and micro-tunnel plans at 1:1000 scale based on survey sheets and incorporating coordinate grid, proposed sewers connections, access and maintenance shafts, invert, cover and ground levels. Key plan of the proposed system plans including coordinate grid, contract area, sewer connections, main building and road/street names, and layout plan of the temporary pumping station sites at 1:100 or 1:50 scale if required.

Sections of micro-tunnel and the modified positive surface water drainage system at 1:1000 horizontal and 1:100 vertical scales. Sections are to be related to each the system plan and include chainages, access and maintenance shafts number, invert, cover and ground level, tunnel diameter, gradient, terrain crossed, major service crossings and any connecting branch sewer details.

Standard drawings for the modified positive surface water drainage system, micro-tunnel cross section, access and maintenance shafts and miscellaneous details to appropriate scales based on PWA standards.

(b) 4 no. complete sets of the detailed construction specification;
(c) 4 no. Bills of Quantities, containing the principal items;
(d) The submittal of the detail design for approval shall also be accompanied by 4 copies of a comprehensive "Engineering Report" including the design calculations, which will detail revisions and amendments to the design subsequent to the approvals given for design. The report shall include copies of the comments made on the design and corresponding actions taken;
(e) Drawings, designs, documents and reports submitted for approval will not be accepted if there is no evidence of internal, qualified, checking; or if the quality of the contents of the Drawings and documents clearly indicate that they have not been checked thoroughly;
(f) Partial submittals will not be accepted.

If significant changes are required to the above original document submissions, the Contractor shall re-submit to the Engineer.

9.6.12 Certification Procedure

1 The entire design of the Bored and any Cut and Cover Tunnels (layout design, structural design and geotechnical design) shall be checked by the Accredited Checker. On completion of the design and check the respective certificates shall be submitted to the Engineer in accordance with the UK DMRB BD 2/02.

2 The Contractor shall provide a certificate of assurance from a reputable TBM manufacturer or refurbisher to warranty that the proposed TBM is fit for purpose to carry out the intended works.

3 At least four weeks before the commencement of any tunnel excavation works, the Contractor shall submit to the Engineer test certificates concerning all material properties and characteristics as defined in the relevant sections herein and/or used for tunnel design purposes from an independent and acknowledged source.

9.6.13 Contractor's Documents

1 The Contractor's Documents shall comprise, but not be limited to the following:

(a) Safety Procedure Manual (Project Specific Safety Plan);
(b) Risk mitigation plan;
(c) Contingency plan;
(d) Pre-construction inspection reports of adjacent properties and utilities;
(e) List of drilling team (Names, qualifications, experience, training, etc.) and management control.

2 Full details of the micro-tunnelling system shall be supplied with the above submittals, including:

(a) Type(s), number(s) and model reference of proposed micro-tunnelling system. If not from single source, detail main elements of the system.
(b) Written confirmation from manufacturer (with company seal) that the machine configuration is suitable for the external diameter of pipe proposed.
(c) Cutter face details, including tooling and face port opening dimensions.
(d) System of alignment control and steering control and activation.
(e) Full details and justification for excavation and spoil disposal method(s).
(f) Hydraulic jacking system maximum capacity and method of limiting to maximum jacking pipe capacity.
(g) Details of any intermediate jacking stations.
(h) Electrical system and on-site power supply.
(i) Proposed communication system between the MTBM (Micro-Tunnel Boring Machine) and operating personnel on the surface.

3 Full and comprehensive details of the procedures and resources that will be used to perform the work shall be provided, including;

(a) Machine launch and reception;
(b) Pipe handling and connections;
(c) Supplementary alignment surveying;
(d) Excavation and spoil disposal;
(e) Closure of any intermediate jacking stations;
(f) Emergency procedures;
(g) Ventilation of tunnel, including gas monitoring.
(h) All materials, including slurry, lubricants;
(i) Location of approved spoil disposal facility;
(j) Drawings showing layout, temporary equipment locations and complete jacking set-up in typical jacking shaft.

4 Daily logs shall be used to record the micro-tunnelling work and any associated delays. The log shall be submitted to the Engineer for record purposes on a weekly basis. The basis of the log shall be the electronic data recorder that operates with the micro-tunnelling system. The log shall include:

(a) MTBM alignment deviation data and applied jacking load shall be recorded at intervals;
(b) Alignment deviation shall not exceed 0.3 m in 5 minutes;
(c) The commencement and completion of jacking of each pipe section;
(d) The operating pressure if pressure balanced system is used;
(e) Quantities of lubricant injected;
(f) Air quality monitoring results;
(g) Unusual events.

9.6.14 Construction Responsibilities

1 During construction, the Contractor shall be responsible for:

(a) Providing a temporary and secured drainage system for the Works (N.B. restricted access, safe and dry working environment, etc.);
(b) Taking all necessary precautions to protect the tunnel and/or adjacent properties from flooding (e.g. groundwater may be problematic in the area);
(c) Provision of a temporary wall, if required, to enable the executed tunnel section to serve as temporary storage.

2 The Contractor shall provide temporary pumping facilities to the extent required to avoid delays to the construction programme and quality of the work. The Contractor shall also indicate any EFA sites (Emergency Flood Area) if required for flood alleviation works during the construction works and confirm the availability of the land. The Contractor shall be responsible for the fencing, safety and security of any temporary EFA areas. Any fuel and/or power sources shall be provided as appropriate. All facilities/connections in this respect shall comply with standard regulations regarding their storage and/or use.

3 The Contractor however shall be responsible at his cost for providing temporary submersible pumps to evacuate any flooded tunnel sections and discharge to an acceptable outfall point.

9.6.15 Quality Assurance/Control

1 All pipes delivered to site shall be the subject of inspection and approval by the Engineer before they can be incorporated in the Works. Any and all rejected pipes shall be immediately removed from site and replaced with pipes acceptable to the Engineer. Pipes and pipe gaskets shall be stored or stacked on-site in accordance with the manufacturer's recommendations.

2 Every jacking shift shall be supervised by at least one person with previous experience of micro-tunnelling work. Operators of the micro-tunnelling system shall have prior knowledge and ability in its proper operation and shall run test the system after set-up and before starting the drive. The Contractor shall follow manufacturers' instructions when operating the complete system and operational manuals shall be available to site operational personnel at all times.

3 The installed pipeline shall be subject to visual inspection. Visible leaks (flowing or dripping water) in pipes, pipe joints, manholes and structures shall be repaired even if leakage test requirements are satisfied.

9.6.16 Materials

1 Pipe repair materials shall be supplied by the pipe manufacturer as suitable for the intended purpose and applied strictly in accordance with the pipe manufacturer's instructions. Water used for lubricant or grout shall be of neutral pH and shall be clean, fresh and free from oil, organic or other deleterious matter. Polymers shall be non-toxic and grout for filling voids outside the installed micro-tunnel pipeline shall be designed by the Contractor and submitted for approval. The pipe material shall be reinforced concrete (RC) or GRP subject to the approval of the Engineer.

2 The Contractor shall also submit a sample of the pipe wall section, joint band and gasket seal. This wall section shall be completely fitted with the proposed grout bush and flush fitting plug to be watertight.

3 The Contractor shall obtain the pipe manufacturer's warranty that the pipe conforms to the specifications and shall be free from defects in materials and workmanship.

9.6.17 Temporary Works

1 The Contractor shall develop his temporary works design taking into account all site constraints identified elsewhere in the Contract Documents. The Contractor shall provide clear method statements detailing all stages of the temporary works including supporting calculations for the temporary works. These method statements shall be issued to the Engineer before works can commence. Calculations shall be included where relevant, e.g. as part of settlement checks on adjacent structures. A "Detailed Safety Plan" identifying hazards and mitigating measures shall also be included in the Temporary Works Method Statements.

9.6.18 Construction Preparation

1 The Contractor shall be responsible for:

(a) the means and methods of micro-tunnelling and pipe jacking operations and shall be solely responsible for and shall ensure the safety of the work, his site personnel, the public and adjacent property (public and private);
(b) maintenance of clean working conditions at all locations at all times;
(c) control and implementation of safety precautions for personnel entering pipeline;
(d) organizing equipment in all areas to ensure safe operation at all times;
(e) providing safeguards to prevent leakage of fuel or lubrication oils from micro-tunnelling system equipment. Hydraulic oils used by the Contractor's plant shall be bio-degradable and non-flammable.

9.6.19 Pipeline Installation

1 The pipeline shall be placed within 50 mm of the vertical and 200 mm of the horizontal alignment shown on the Drawings. Steering corrections shall be made to the pipeline so that the joint to joint angle of any two adjacent pipes does not exceed 0.5 degrees. The Contractor shall submit daily records of deviations.

2 Each section of pipe shall be jacked forward as the excavation progresses in such a manner that complete and adequate ground support is provided at all times and such that joints maintain their integrity and the pipe train continuity is maintained.

3 The Contractor shall ensure that jacking loads do not exceed the manufacturer's safe jacking capacity by effective management of the pipe jacking alignment and pipe lubrication controls (intermediate jacking stations).

4 No damaged pipes shall be permitted to be used in the permanent works. Pipes damaged in the casting and handling process in the factory shall not be permitted on-site. Repairs to cast pipes, either in the factory or on-site shall be confined to minor cosmetic repairs only. All repairs shall be subject to the approval of the Engineer and carried out to an approved procedure. Any pipes identified as being unfit for use in the tunnel shall either be removed from site and destroyed or clearly marked and quarantined for later inspection and possible repair.

5 A proprietary seal of rubber or EPDM shall be incorporated in each pipe joint, including joints between pipes and inter-jacks / TBM. The design of the seal shall be commensurate with the detailing of the pipe joint. Seals may be fitted either at the place of manufacture or on-site prior to placing of the pipe below ground. In either case the seals shall be fitted in accordance with the manufacturer's instructions. Seals shall be inspected for damage by the surface crew immediately prior to pipe use and any damaged seals replaced. Pipe seals shall be suitably lubricated with a soap solution or other such compound in the pit bottom immediately prior to closing the joint with the jacking frame.

6 A minimum of 30 mm thick Medium Density Fibreboard (MDF) packer shall be fitted to the socket face of each pipe prior to the pipe being used in the tunnel. The packer,

comprising several segments to form the 360% annulus, shall be firmly glued to the socket end and in such manner as to be 25 mm inset from the intrados of the pipe. These packers may be fitted on either at the factory or on-site, however it should be noted that in wet weather conditions suitable protection may be required in cases of lengthy exposures.

7 Pipes shall only be lifted on-site using the cast in lifting hole or lifting anchor and a purpose made lifting device. Such device shall be fully tested and carry relevant certification. Pipes shall be stored in an orderly fashion in a designated area, not more than two pipes high and on purpose made timber supports.

8 Pipes shall be power lowered by crane or gantry down the working shaft and set on a purpose made cradle comprising the base of the jacking frame assembly. The cradle shall have been set true to line and level prior to commencement of the jacking and secured to the shaft bottom. The thrust wall assembly behind the jacking frame shall also be set at right angles to the line of drive to ensure that no misalignment occurs at the pipe joint on closure. The lifting device shall be removed from the pipe prior to the joint being closed and jacking of the pipeline recommenced. The lifting hole shall be sealed with a precast concrete plug and rapid setting mortar prior to the hole location passing through the eye seal. Jacking of the pipeline shall be carried out in such manner as to limit any deflection at a joint to the manufacturer's recommended maximum. Pipe loadings shall normally be limited to 50% of the design load (or similar as agreed) whereupon an inter-jack assembly shall be installed.

9 On completion of a drive the line shall be fully inspected for damage or leaking joints. The Contractor shall propose remedial works in such cases. Holes used for injection of lubricants shall be filled with an approved mortar to a smooth finish at the intrados of the pipe.

9.6.20 Construction Execution

1 All excavation works shall be properly set out to the line, level, curve or slope required within accepted tolerances. Survey stations, centre lines, bench marks and grade lines shall be clearly marked in paint on the tunnel walls. Chainages at 10 metre intervals shall also be clearly marked by appropriate permanent means.

2 Internal tunnel marking shall be done prior to jacking any “lining” pipes. This method can be used to mark the exact location of any problem areas during the jacking operation.

3 The Contractor shall establish and maintain reference control lines and grades for the Works, which shall be used to exactly locate the pipeline and structures. The primary control for the micro-tunnelling system shall be checked at least once per week or not more than 60 metre intervals of constructed pipeline.

9.6.21 Working in Compressed Air

1 Provisions shall be made on the tunnelling machine to facilitate entry into the face of the machine under compressed air for inspections and maintenance. These provisions shall comply in all respects with all relevant statutory regulations governing work in compressed air. The airlocks and other equipment fitted to the machine shall comply with the requirements of CENprEN12110.

2 All equipment and personnel necessary to perform such interventions for inspection or maintenance shall be available throughout the pipe-jacking operations.

3 The Contractor shall submit details of the compressed air installation for the Engineer’s approval, along with details of the qualification and previous experience of lock attendants, medical lock attendants, compressor attendants and supervisory staff.

4 In highly permeable ground where air losses might be excessive, arrangements shall be made to inject thick bentonite slurry into the face prior to an intervention to form a cake on the exposed face in order to limit air loss.

5 Air compressors shall have a standby capacity of at least 50% and be powered by an independent power source.

6 All essential parts of the compressed air system, including pipelines carrying compressed air to the face, shall be duplicated. All pipework, valves, gauges, etc. must be protected from impact damage. Where flexible hoses are used to carry the compressed air through the pit bottom jacking arrangement they shall also be protected from entrapment. In the event of failure of one part of the system it should be possible to isolate that part without interrupting the air supply.

7 A safety valve shall be fitted to free air side of the pressure bulkhead of the tunnelling machine. This safety valve shall be set to relieve at marginally above the working pressure and shall be of adequate size to match the installed capacity of the air compressors. Prior to any work in compressed air the system should be tested to working pressure.

8 Any airlock fitted to the tunnelling machine shall be at least 1.5 meters diameter. The air lock should be designed as a pressure vessel, subjected to a hydraulic test and issued with an appropriate test certificate. Air lock doors should be at least 500 millimetres by 400 millimetres. Doors should normally be kept closed by the air pressure but the door opening to the front of the tunnelling machine should also be able to be locked shut whilst persons are being decompressed in the lock. The airlock should be comprised of two chambers to allow access into the working chamber in case of emergency. For use at pressures above one bar the lock should be fitted with seating for the persons being decompressed. Where the working pressure is above 0.7 bar a medical lock shall be provided which shall be manned by a medical lock attendant whenever work in compressed air is in progress and for twenty four hours afterwards. If necessary the quality of the compressed air supplied to the working chamber shall be improved by coolers and filters to ensure compliance with the specified requirements. The supply of compressed air to the working chamber shall be sufficient to ensure that the level of any contaminant shall not exceed 10% of the short term exposure level when measured at atmospheric pressure. Air quality should be monitored at least once per day.

9 The Contractor shall appoint a registered medical practitioner experienced in compressed air work to advise on decompression methods to be adopted and on all other aspects of health relating to the work in compressed air. All employees will be medically examined prior to working in compressed air. Records will kept of all medical examinations and details of each compressed air exposure including working pressure, working time, decompression procedures, etc. No person shall be allowed to work in compressed air if the Contractor has reason to suspect that person is under the influence of drink or drugs such that his capacity is impaired. No one shall be allowed to enter the compressed air working chamber alone.

10 An experienced lock attendant shall be on duty at the free air side of the air lock at all times when there are persons in the compressed air working chamber. All valves gauges and controls at the lock attendant's station shall be clearly marked with their function and method of operation.

11 Smoking shall be banned in compressed air and no person shall take smoking materials into compressed air. As far as is practicable no combustible material shall be taken into the air locks and or the working chamber. The use of burning or welding equipment should be strictly limited and shall be subject to a permit to work system. Fire extinguishers shall be provided in the air locks and the working chamber whenever work in compressed air is in progress.

9.6.22 Ground Pre-treatment

1 Pre-treatment of the ground, where applicable, shall be applied in advance of the tunnel excavation to provide sufficient stability of the excavated area. Execution of such works shall not commence before consent has been given to the design of such works by the Engineer. The surface settlement monitoring shall be installed, initialised and baselined prior to any ground modification work.

9.6.23 Drainage During Construction

1 The Contractor shall supply, install, operate and maintain sufficient pumps and pipe work to control and remove water from any part of the underground works. Standing water shall not be allowed. The capacity of pumps installed where required, including at launch/reception pits, shall always be at least twice the normal volume of the inflow of water plus the volume of flushing water if drilling equipment is used. The minimum capacity of the pumps shall be 20 l/s.

2 The Contractor shall store or immediately have available standby pumps in good working conditions of the same capacity. This equipment shall be maintained properly and tested frequently.

3 The Contractor shall provide settlement tanks or other decontamination facilities before the water is discharged. The Contractor shall submit his design for these facilities as part of his method statement. The Contractor shall remove all accumulated slurry, silt or other debris from the Works on an ongoing basis.

9.6.24 Disposal of Tunnel Seepage and Waste Water

1 Tunnel seepage and wastewater arising from the Works shall be collected and discharged via a settlement tank. Seepage and wastewater shall not be discharged into the public drainage system unless it meets the standards listed below. Where necessary, the water shall be treated to achieve these standards.

2 The Contractor shall comply with BS 6031:1981 Code of Practice for Earthworks or equivalent, regarding the general control of site drainage and the requirements of the Relevant Authority. The Contractor shall ensure that water which may have come into contact with contaminated material shall be disposed of in an appropriate manner. The Contractor shall have to apply for consents and approvals as follows:

(a) obtain and complete standard “permit application form” for proposed discharge into a PWA system.
(b) before any discharges can be permitted into a PWA pipeline, written approval shall be obtained from the relevant department of the PWA. Failure to obtain the permit can result in immediate closure of the Works.

3 The Contractor shall make provisions that all hazardous substances including oil drums or containers on-site are controlled in accordance with the relevant legislation and are properly stored so that no oil or their contaminants are allowed to reach watercourses or groundwater.

9.6.25 Testing

1 The Contractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumable, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Contractor shall agree, with the Engineer, the time and place for the specified testing of any plant, materials and other parts of the Works.

2 The Engineer may vary the locations of details of specified tests, or instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested Materials or workmanship is not in accordance with the Contract, the cost of carrying out this Variation shall be borne by the Contractor, notwithstanding other provisions of the Contract.

3 The Contractor shall promptly forward to the Engineer duly certified reports of the tests. When the specified tests have been passed, the Engineer shall endorse the Contractor's test certificate, or issue a certificate to him to that effect.

9.6.26 Grouting

1 As soon as each section of pipeline has been installed, its periphery shall be grouted using a cement based grout with a minimum 48 hour compressive strength of 345 kPa (50psi) and minimum 28 days compressive strength of 1380 kPa (200psi). Every effort shall be made by the Contractor to place the grout even when it is known that the periphery contains polymer or other lubricant and shall demonstrate that grout is not being taken before the grouting operation is terminated.

2 The grouting pressure shall be sufficient to move the grout to fill the annulus along the pipe but shall not be greater at the injection nozzle than the pressure limit set by the pipe manufacturer. The injection points shall be placed at not more than 6 metre intervals along the pipeline. Grouting shall be carried out around pipelines at launch and reception shafts as soon as the pipeline is placed at these locations to prevent water and soil from entering the shafts. Additional grouting shall be carried out at the Contractor's expense, if required to ensure that the joints are watertight.

3 The micro-tunnel shall be adequately lit and ventilated for safe access, egress and for working. If open flames are to be used where combustible gasses may enter the air, tests for combustible gas shall be conducted continuously during the work. The tunnel workers shall carry a gas meter that automatically records the level of combustible gas. Particular care shall be taken that pipe repairs are carried out in accordance with approved ventilation and safety procedures.

4 Infiltration Acceptance Test of the installed pipe, which shall be witnessed by the Engineer, shall be in accordance with ASTM C969. The internal inspection of the completed pipeline shall be the subject of approval by the Engineer.

9.6.27 Surface and Building Settlement Monitoring

1 The Contractor shall submit, for the consent of the Engineer, the detailed proposal for positioning of ground and building monitoring points and other instruments and the frequency of the measurements. Excavation works shall not start until the consent of the Engineer to that submission has been obtained. During construction the Contractor shall review monitoring frequencies depending on settlement trends, the extent of construction activity in an area and the behaviour of the structures.

2 The monitoring data shall be copied to the Engineer on the same day that the readings are taken, followed by hard copies with analysis within 24 hours. In addition to carrying out all the normal surveying requirements for carrying out a pipe-jack the Contractor shall set-up surface settlement monitoring points at suitable intervals along the projected pipeline. The spacing of such points may be as close as 10 metres in sensitive areas however may vary according to the depth and location of the jack.

3 In addition to monitoring over the centre line of the drive readings shall be taken at suitable lateral distances to the centreline at each monitoring chainage. In roads these cross sections shall extend the full width of the road corridor.

4 Settlement monitoring points shall also be installed at the corner of each building or structure within a recognised distance from the tunnel centreline. The distance shall

normally be equivalent to the depth to invert of the proposed pipeline with a minimum of 20 metres.

5 A full record of existing ground and structure levels shall be taken and agreed prior to commencement of pipe-jacking operations.

6 A photographic record of existing damage and faults to all adjacent surface structures shall be made by the Contractor and agreed prior to commencement of pipe-jacking operations.

7 During the jacking operation between any two shafts the Contractor shall survey the levels of the appropriate monitoring points on a daily basis.

8 Monitoring shall be carried out on any particular section of points when the tunnel face is within 20-50 metres of that section dependent on the tunnel depth and ground conditions. Monitoring shall continue at each section until the tunnel drive has been completed or in the case of excessive settlement until the settlement has ceased or the rate of settlement becomes acceptable.

9 If during jacking operations the actual movement of the ground reaches 90% of the predicted value the Contractor shall immediately review his predictions and if appropriate revise his operational procedures accordingly. Where such movement occurs suddenly and adjacent to the tunnel face the Contractor shall not proceed with the jacking operation until a revised method has been agreed with the Engineer.

9.6.28 Contractor's Obligations

1 The Contractor shall carry out the Tests on Completion in accordance with this Clause after providing the "*As-Built"* documents for the part to be tested.

2 Unless otherwise stated in the Particular Conditions, the Tests on Completion shall be carried out in the following sequence:

(a) Pre-commissioning tests per stage, which shall include the appropriate inspections and pressure tests to demonstrate that each item of the stage is acceptable and that the Works can safely proceed to the next stage

(b) Commissioning tests, which shall include the specified operational tests to demonstrate that the Works or Section can be operated safely and as specified, under all available operating conditions.

3 For all tests described in sub-paragraph (a) and (b) the pipe and joints shall be considered watertight if water infiltration is so low that it can only be detected as damp patches without flowing or dripping water. Likewise, the tests described in sub-paragraph (a) and (b) shall be used to confirm that the pipeline remains equally watertight throughout the leak testing.

4 As soon as the Works, or a Section, have passed each of the Tests on Completion described in sub-paragraph (a) and/or (b), the Contractor shall submit a certified report of the results of these tests to the Engineer.

SECTION 19 PLUMBING WORK

PART 1 GENERAL

1.3 CONTRACTOR'S RESPONSIBILITY

1.3.4 Notice of Intent

Delete paragraph 1 and substitute with the following:

1 The Contractor shall notify QGEWC in writing at least 28 days prior to the commencement of any plumbing work.

SECTION 21 ELECTRICAL WORKS

PART 1 General Provision for Electrical Installation

1.1.1 Scope

Delete paragraph 2 and substitute with the following:

2 The Scope of Work shall include but not be limited to:

(a) The supply and installation of all services, equipment, components, accessories and fittings required for the operation of the facility to the extent specified and detailed on the Drawings and Specifications including 400 days maintenance after provisional handover

(b) Builder's work in connection with the Electrical Installations, including supply, necessary inserts and sleeves(c) Any work which can be reasonably inferred as necessary for the safe, satisfactory operation of each system, whether such work is specified or shown on drawings or not

(d) The supply and installation of cables, conduits, boxes and termination points, for the motors, starters, controls and the like for the process equipment, heating, ventilation and air-conditioning and plumbing services

(e) Supply and installation of permanent electrical supply equipment in compliance with QGEWC requirements. The electrical equipment is required for the implementation of the diversions that result from the expansion of the road as well for the supply of new loads, including new street lighting feeder pillars and other loads. The supply includes EHV cables, HV/MV substations, HV and MV cables and accessories, consumption meters, and all related civil works, and including submission of all necessary documents to QGEWC, and carrying all necessary approvals

8 (f) Coordinating with QGEWC regarding outage schedule and carrying out all necessary tests

9 (g) Supply and installation of the new telecom infrastructure to achieve the required diversion schemes, which will be done directly by Q-Tel

10 (h) Arranging and carrying out all necessary approvals with the Qatar Civil Defence Department for the Fire Alarm System, extinguishing and protection systems.

11

12 Add new paragraph 3 to 6 as follows:

3 The electrical design drawings and specifications are categorised as follows:

(a) The STL package, which includes road lighting, traffic signals, and the Motor Control Centre for the drainage pumping stations. For all major further details related to road lighting, refer to Section 6, Part 12, Road Lighting.

(b) The MV package, which includes power supply requirements for road lighting and other loads as well as the existing MV cables and the proposed diversion schemes where necessary.

(c) The EHV package, which includes the existing EHV services and the proposed relocation schemes for EHV cables, HV cables, and HV/MV substations.

(d) The TEL package, which includes the existing telecommunication services. Relocation schemes of telecommunication utilities are left exclusively to Q-Tel.

4 The Scope of Works related to QGEWC is as shown on the Contract Drawings or as specified by the Engineer, and will include the power supply requirements for the road lighting and the miscellaneous loads.

5 The Scope of Works related to Q-Tel will include all necessary relocation works for the fibre optic and copper transmission and distribution lines, as will be designed by Q-Tel.

6 It is the Contractor's responsibility to ascertain that all the authorities' requirements are complied with and that any additional works not specifically mentioned herein are covered within his prices and quoted for.

1.1.4 Contract Drawings

Add new paragraph 6 as follows:

6 The design specifications and criteria shall not relieve the Contractor from continuously following up with the respective authorities to obtain up-to-date requirements and instructions.

1.1.16 Quality of Materials

Add new paragraph 5 as follows:

5 Supplies of electrical distribution equipment to be as per QGEWC document Assessment of Manufacturers of Electrical Distribution Equipment.

1.1.21 Electricity Supply

Delete paragraph 1 and substitute with the following:

1 Following connection to the high voltage network, the Contractor shall verify in coordination with QGEWC the following measurements at the terminals of each street lighting feeder pillar or the Motor Control Centre, related to the 3 phase + neutral, 4 wire, 415 V, 50 Hz supply:

(a) Voltage ± 6%
(b) Frequency ± 4%

Add new paragraph 11 as follows:

11 Allow for adequate appropriate glands, lugs, and boxes for the cables to be supplied to the Motor Control Centre.

Add new Sub-Clause 1.1.28 as follows:

1.1.28 Testing and Commissioning

1 Testing and Commissioning of the installation shall be carried out in accordance with the regulations and standards listed in the documents after completion of the work to prove compliance with the Specification. The tests will be carried out in the presence of and to the satisfaction of the Engineer.

2 Manufacturer's test certification for appropriate equipment shall be handed to the Engineer prior to the site testing being carried out.

3 All results of the tests shall be recorded on-site and signed by all witnessing parties. Subsequently, three copies of all such documents shall be submitted to the Engineer.

4 Prior results of the tests shall be recorded on-site and signed by all witnessing parties. Subsequently, three copies of all such documents shall be submitted to the Engineer.

5 Prior notice shall be given to the Engineer of proposed tests together with a list of the equipment to be used. In particular proposals shall be submitted for measuring the luminance and illumination levels and for calculating the average levels as specified elsewhere in the Specification.

6 All tests including, where applicable, insulation tests, continuity tests, effectiveness of earthing, measuring of earth electrode resistance, shall be carried out.

7 No repeat test shall be carried out until the cause has been established and rectification of the failure has been carried out.

8 The following tests shall be carried out on-site

(a) Switching Station, Sub-Station:
- (i) Insulation resistance test with 1000 volts megger.
- (ii) Phasing out and polarity check.
- (iii) Operation and protection tests.
- (iv) Primary/Secondary Injection tests.

(b) EHV Cables:
EHV cables shall be tested in accordance with the requirements in Part 35 below.

(c) HV Cables:
HV cables shall be tested to the requirements of I.E.C. 502 and shall include:
- (i) HV d.c. test between conductors to earth.
- (ii) Di-electric leakage current at the test voltage.
- (iii) Insulation resistance test after above tests taken with a 1 000 volts megger.
- (iv) Upon completion of all tests the cables shall be left in a fully discharged condition.

(d) MV Cables:
Insulation resistance test taken between conductors and between conductors and separate earthing cable taken with a 500 volt megger.
Continuity tests:
Approval shall be obtained from the Engineer before starting any tests, for authorisation of connection of the power supply to the installation.

(e) Lighting equipment and Visual Inspection:
The following tests shall be carried out in addition to those previously called for:
- (i) Condition of the equipment and quality of the workmanship.
- (ii) Level, perpendicularity and alignment of the poles and luminaires.
- (iii) Actual characteristics of the equipment.

(f) Lighting circuits:
Measurement of Insulation Resistance: Insulation resistance test on the various MV circuits. The tests shall be performed after installation, in accordance with approved standards to determine the adequacy of insulation between phases and also between phases neutral and earth (lamps shall be removed during the test where applicable).
Resistance of the earthing of all metallic frames shall also be carried out.

(g) Operational Tests of lighting fixtures:
Normal functioning of all lamps.
Operation test on all power equipment including recording the voltage at the terminals of each ballast on the final column in each circuit.

(h) Performance Tests of lighting levels after 100 hours normal functioning:
Measurement of the lighting levels and uniformities on the road surfaces.
The result of which should be submitted to the Engineer in tabulated form.

(i) Operational Tests on pumps:
After checking insulation resistance of motors and control gear and proving it to be satisfactory, all pumps should be operated by means of automatic control and proved to be performing to specification. Pump failure to be simulated and operation of standby system proved.
The Engineer will reserve the right to take any action he may consider necessary, in the event of the measure values not conforming with the lighting design criteria D.2 Section 7.01. Any other tests found necessary by the Engineer to verify conformity of the installation with the specifications, shall be carried out by the Contractor as necessary.

(j) Earthing Tests:
After installation of the individual earthing system in accordance with the above for the various parts of the Specification and after the whole installation has been connected up, an earth resistance test shall be carried out on the earth bar and the readings obtained officially recorded. Three readings shall be obtained for each sub-station relating to the two earth paths connected individually and in parallel. An Evershed and Vignoles or similar earth tester shall be used and all results tabulated and handed to the Engineer.

PART 2 MV Factory Built Assemblies (FBA's)

2.2 PRODUCTS

2.2.2 Motor Control Centres

1 General

Add the following new items:

(f) The electrical feed to the MCC panel shall be a 415 V, 3 phase, 4 wire, 50 Hz public electricity supply. The introduction of the supply shall be by MCCB. The supply incomers shall be rated to carry the full installed pumping station load including the starting load.

(g) The panel shall be of the composite front access, cubicle type and shall comprise several sections of equal depth and height arranged to stand side by side to form a uniform panel of pleasing appearance. The panel shall be arranged for full front access with removable back covers and hinged doors.

(h) The panel shall be provided with feeders for, pumps, pump house equipment, instrument distribution board, lighting and small power distribution board and spare feeders as indicated in the Drawings or as specified by the Engineer.

(i) The different panel compartments shall be arranged in the following order when facing the front of the MCC and reading from left to right:
  (i) Electricity Supply Authority metering.
  (ii) Supply incoming MCCB and mobile generator incoming.
  (iii) Pump starters (current pump installation).
  (iv) Pump starters (future pumps) - only cubicle with feeder MCCB to be provided.
  (v) Miscellaneous feeders / valve actuators, etc.
  (vi) PLC
  (vii) Instrumentation

(j) The units shall incorporate adequate damping to override transient disturbances.

(k) All control circuits shall be so arranged as to be "dead" when the door is open. A test switch shall be incorporated to override this. The switch shall be suitably labelled to draw attention to its function.

Add new Sub-Clause 2.2.5 as follows:

2.2.5 Free Standing LV Feeder Pillar

Refer to QGEWC up-to-date version of Specification No. ED/02-10.

PART 3 Protective Devices

3.2 PRODUCTS

3.2.2 Moulded Case Circuit Breakers

➢

Add new paragraph 16 as follows:

16 MCCB'S to be provided as the MCC incoming and outgoing circuits breakers.

3.2.3 Miniature Circuit Breakers

Add new paragraph 6 as follows:

6 MCCB's to be provided as per distribution board final branch outgoing circuit breakers as well as breakers for control circuits within the MCC.

PART 6 Cables and Small Wiring

6.1 GENERAL

6.1.2 References

Add new paragraphs 3 to 5 as follows:

3 Refer to QGEWC up-to-date version of Specification ED 03-40 and ED 03-140 for further reference on XLPE Cables and accessories used on the MV distribution system.

4 Refer to QCS Specification 6 Part 12 for details related to road lighting cabling.

5 Refer to additional Parts 34 and 35 within this Specification for details related to HV and EHV cables.

6.2 PRODUCTS

6.2.4 Jointing 11 kV, L.V. and Pilot Cables

Add new paragraph 5 as follows:

5 EHV Cables

For details on EHV cable jointing, refer to Part 35.

Add new Sub-Clause 6.2.5 as follows:

6.2.5 Operating Conditions for HV Cables

1 11 kV Cables

The basic technical values shall be as follows, determinded in accordance with the recommendations of IEC 38, IEC 71-1, IEC 71-2 and other relevant IEC Publications:

(a)	Nominal system voltage (r.m.s value, phase to phase voltage)	:	Un = 11 kV
(b)	Highest value of system operating voltage (r.m.s. phase to phase voltage)	:	Um = 12 kV
(c)	Highest voltage for equipment (r.m.s. phase to phase voltage)	:	Um = 12 kV
(d)	Standard rated frequency	:	50 cycles
(e)	Rated short circuit breaking	:	25 kA r.m.s, 1 second capacity
(f)	System configuration	:	3 phase, non-effectively earthed
(g)	Range of highest voltage for equipment (according to IEC 71-1, clause 38)	:	A
(h)	Standard insulation level for equipment (B.I.L.)		
	(i) rated lighting impulse withstand voltage (peak)	:	75 kV
	(ii) power frequency short duration withstand voltage (r.m.s)	:	28 kV
(i)	Insulation co-ordination	:	according to IEC 71-1 and IEC 71-2

Add new Sub-Clause 6.2.6 as follows:

6.2.6 Electrical Criteria for HV Cables

1 Operating Criteria

a) Maximum Power Rating

(i)	Continuous operation	:	as per existing cables and QGEWC's requirements
(ii)	Cyclic operation	:	No special requirements (but the Contractors should advise the proposed cable capacity)
(iii)	Emergency operation	:	No special requirements (but the Tenderers should advise the proposed cable capacity)
(iv)	Short circuit current rating	:	25 kA, 1 sec.

2 Installation Data

(a)	Reference Drawing	:	EHV-01, 02, 03, 11
(b)	Length of cable route	:	Refer to Dwgs
(c)	Laying arrangement	:	
	(i) Type of laying		
	- In PVC ducts at crossings		
	- Directly buried		
	(ii) Type of sheath		
	- earthing	:	Single end bonded
(d)	Maximum air temperature	:	50 °C
(e)	Type of termination and joints	:	Heat shrinkable

3 Construction Data

(a) Conductor

(i) The conductor shall be segmental stranded conductor, size similar to existing one made of annealed uncoated high conductivity copper wires according to IEC No. 228 (1978). The copper wire before shaping shall be smooth, uniform in quality, and free from scale, inequalities, spills, splits and other defects.

(ii) The term "annealed" signifies that the wire can stand elongation of at least 15 per cent without fracturing before stranding, the test piece being not shorter than 150 mm and not longer than 300 mm.

(iii) When made up from shaped wires the conductor shall be clean and uniform in size and shape and its surface shall be free from sharp edges and unless otherwise approved shall be taped with a layer of conductive or semi-conductive material.

(iv) Not more than two joints shall be allowed in any of the single wires forming each length of conductor and no joint shall be allowed within 300 mm of any other joint in the same layer. The jointing of wires shall be made by brazing, silver soldering or electrical welding. No joint shall be made in the wire after it has been formed up into the required length.

(b) Conductor Screen

(i) The conductor screen shall consist of an extruded semi conductive XLPE compound. The screen shall fill the interstices between the individual strand wires forming the conductor and shall provide a smooth, regular finish that shall be firmly bonded to the inner surface of the insulation.

(c) Insulation

(i) The XLPE insulation shall be triple extruded solid di-electric subjected to a dry curing process. The inner semi-conductive layer (conductor screen), solid insulation and outer semi-conductive layer (insulation screen) shall be extruded and cured in a single process.

(ii) All dimensions and tolerances must comply with IEC 502 and the subsequent Amendments.

(iii) MDCV or VCV process only shall be acceptable for the insulation extrusion, curing and cooling.

(d) Insulation Screen

(i) The insulation screen shall be of an extruded layer of semi-conductive compound having a smooth even surface and shall be in close contact with the core insulation.

(e) Metallic Sheath

(i) The sheath of all cables shall consist of new lead of approved origin and purity applied in the form of a seamless tube. The nominal and minimum thickness of the sheath shall be confirmed before each shipment and shall be in accordance with relevant clause of IEC 502 and as per technical schedules. The sheath shall consist of lead alloy type 0.5 °C and shall be free from blowholes and other defects. Special care shall be taken to ensure that dross or other impurities are excluded from the lead press when the press is being charged.

(ii) The metallic sheath thickness and its composition shall be sufficient to ensure adequate mechanical strength and to resist fatigue caused by vibration.

(iii) The sheath shall be capable of carrying, without damage, the fault current for one second under the most severe fault condition, which has to be confirmed by calculations.

(f) Metallic Sheath Bedding

(i) The compounds applied under and over metallic sheaths shall be of such a nature that in the finished cables they do not crack or run at any temperature likely to be attained in transit to the Site, during installation or when the cables are in operation. The compounds used shall have no detrimental effect on the sheath or outer covering.

(ii) The bedding shall ensure the cable longitudinal water tightness, which is to be demonstrated by test.

(g) Anti-Corrosion Outer Protective Covering

(i) The outer covering over the metallic screen and impervious metallic lead sheath shall be extruded black PVC suitable for the operating temperature of the cable.

(ii) The minimum average thickness and minimum thickness at a point shall comply with requirements of IEC 502 and not less than the value stated in technical schedules.

(iii) Means shall be provided to prevent adhesion between turns and layers of the cable on the drum and between the table and the drum or container at such temperatures as may be met with during transit to the Site, at Site, before laying or while stored.

(iv) The design and efficiency of the coverings shall not be affected by clearing or clamping arrangements supporting the cable. Particular care shall be taken to ensure that the outer covering is not damaged in any way.

(v) An outer conductive coating (graphite coating or extruded layer) shall be applied to the covering to serve as an electrode for the voltage test on the outer covering.

(h) Anti-Termite Protection and Flame Resistance

(i) All cables installed in troughs shall have anti-termite protection applied to the outer covering in the form of a chemical additive such as Gamma BHC, anti-termite poison of similar. The manufacturer shall state the chemical to be used, percentage strength and the reduction in electrical and mechanical properties of the outer covering. The flame resistance shall be confirmed for all cables installed in air (according to IEC 332-1).

(i) Sealing of Cable Lengths

(i) Immediately after the completion of the factory acceptance tests, both ends of every length of cable shall be sealed and shall remain sealed until installed in their final position.

(ii) The sealing shall be done by means of a lead cap fitted over each end and plumed to the metal sheath and finally covered by heat shrinkable cap. The cable ends, which left projecting from the drum for the purpose of the test, shall be protected to avoid damage to the sheathing during transport.

(iii) The same type of the sealing shall be applied on installed lengths if there is a time gap between cable laying and jointing activities.

(j) Cable Identification

(i) The outer covering of all cables shall be embossed with the manufacturer's name, year of manufacturer, voltage level, type of insulation, number of cores and size in accordance with BS 6346.

(ii) The embossed letters/figures shall be raised and shall consist of upright block capitals/figures the size of which shall be not less than 15 per cent of the nominal or specified external diameter of the cable except that in no case shall they by greater than 13 mm.

(iii) The maximum gap between the end of one set of embossed lettering and figures as above and the beginning of the next shall be 500 mm.

(iv) Cables shall be identified at each end of the run (including joint bays) with a marker consisting of a label incorporating 4 mm characters. The labels shall be attached to the cables with two PVC straps.

6.3 INSTALLATION

Add new Sub-Clause 6.3.9 as follows:

6.3.9 Testing

The requirements of IEC 502 shall be applicable on this Contract.

PART 7 Conduits and Conduit Boxes

7.2 PRODUCTS

7.2.1 Rigid PVC Conduit and Fittings

Add new paragraph 7 as follows:

7 Rigid PVC conduits shall be provided for embedded and/or exposed installation at regular indoor locations.

7.2.2 Rigid Steel Conduit and Fittings

Add new paragraph 1(h) and 2(g) as follows:

1 Rigid Steel Conduit

(h) Rigid steel conduit shall be provided for exposed installations at all hazardous locations.

2 Metallic Conduit Boxes

(g) All floor boxes to be of watertight construction.

PART 10 Wiring Accessories and General Power

10.2 PRODUCTS

10.2.1 General

Add new paragraph 2 as follows:

2 Unless otherwise indicated in the sections to follow, the faceplate of all devices shall be polycarbonate.

10.2.3 Switches

Add new paragraph 7 as follows:

7 Lighting Switches

Lighting switches are to be provided for local control of all indoor lighting.

10.2.5 Socket Outlets

Delete paragraph 1 and substitute with the following:

1 General Purpose socket outlets

(a) to BS 1363
(b) 3 rectangular pin (2P + E) shuttered with combined switch, rated 13A, 250 V
(c) to be supplied with plug complete with fuse.
(d) to be provided as required for all indoor areas.

PART 13 Telephone Installations

13.1 GENERAL

13.1.1 Scope

Add new paragraphs 3 to 5 as follows:

3 Telecommunication services that fall under the carriageway or within unacceptable proximity to the new limit of the upgraded road shall be relocated at the approval of Q-Tel. The Contractor shall be responsible for liaising with Q-Tel and obtain from them, prior to the completion of the Works, written confirmation that all existing and relocated telecommunications infrastructure is no longer within unacceptable proximity to the new limit of the upgraded road. The Contractor shall be responsible for the relocation of any telecommunications infrastructure unless specified otherwise by Q-Tel of the Engineer.

4 The Contractor is to confirm the exact location of existing telecommunication services with Q-Tel prior to the commencement of the Works.

5 Relocation of fibre optic main lines where relevant, which unless stated to the contrary are anticipated to be almost wholly replaced, generally entails the following:

(a) All necessary infrastructure (ducts, manholes, etc.) for the new system in the new reservation.
(b) Retrieval of existing fibre optic lines and manhole covers and delivery to Q-Tel.
(c) Financial reimbursement to Q-Tel for their supply and installation of the new fibre optic lines.

13.3 INSTALLATION

Add new Sub-Clauses 13.3.5 and 13.3.6 as follows:

13.3.5 Modification to Q-Tel Specifications

1 The Q-Tel Specification S.006 shall be modified as follows:

(a) The Supervising officer shall mean any accredited official from Q-Tel or a representative as designated by the Engineer.
(b) All cement used shall be sulphate resisting cement as specified in Section 5 of the Qatar Construction Specification.
(c) The concrete quality classes specified in Clause 202 of the Q-Tel specifications shall be as per the following classes specified in QCS Section 5 Part 6.
(d) In clause 105 of Q-Tel Specification “earth, free from stones” is replaced “dune sand, free of salt to a fine grading as approved by the Engineer”

13.3.6 Record Drawings

1 The Contractor shall keep accurate record drawings of the arrangement, positions and details of all works constructed by him. These drawings will be of forms and to scales approved by the Engineer and his designated representative.

2 As soon as each drawing has been completed, two prints shall be submitted to the Engineer and his designated representative for approval.

3 If the Drawings or documents are not approved, one copy shall be returned to the Contractor with marked indications of the alterations required. Upon final approval one copy of the drawing or document shall be stamped "Approved" by the Engineer or his designated representative and returned to the Contractor forthwith.

4 After such approval is given, the Contractor shall supply to the Engineer two prints of the finalised drawings, and the digital files in CAD format on CD, for the use of the Engineer.

5 All record drawings shall be completed within 30 days of the commencement of the Maintenance Period.

6 Record drawings will show accurately the exact locations of all road crossings, ducts, joint boxes, etc., fully dimensioned and triangulated.

Part 22 Earthing and Bonding

22.3 INSTALLATION

22.3.1 Installation

Delete paragraph 14 and substitute with the following:

14 Cable Armour Earthing:

(a) Connect steel armour to the earthing system
(b) Coordinate with QGEWC regarding any specific earthing requirements for the EHV cable sheaths.

Add new paragraph 17 as follows:

17 Transformer Earthing:

(a) Transformer Earthing Terminal is to be connected to MV main earthing bar by bare copper earthing conductor not less than 20 mm² per 100 kVA of transformer rating, with a minimum of 35 mm².
(b) Transformer Neutral (Star Point) is to be connected by insulated earthing conductor (colour black) to MV side main earthing bar. Neutral earthing conductor is to be sized for maximum earth fault current for 5 seconds with final conductor temperature not exceeding 160 °C or sized not less than 30 mm² per 100 kVA of transformer rating, and with a minimum of 50 mm². Where a neutral is directly connected to earth electrode, an insulated disconnecting device is to be provided at the transformer.

Part 23 Inspection and Testing

23.3 ELECTRICAL EQUIPMENT TESTING

23.3.1 General

Delete paragraph 2 and substitute with the following:

2 The following equipment will be inspected and tested on-site after installation. Any omission or defects, or faults raised by the Engineer are to be remedied or corrected by the Contractor and re-testing made at the direction of the Engineer at the Contractor's expense:

(a) 415 V switchgear
(b) Mains cable
(c) Motors
(d) Starters and control gear
(e) Control and starter panels
(f) Small wiring, etc.
(g) Elevator, walkway system
(h) Radio and TV interference
(i) Fire alarm and detection system
(j) Public address system
(k) HV switchgear
(l) HV cables
(m) Power transformer
(n) EHV cables
(o) Main telephone installations

Delete paragraph 3 and substitute with the following:

3 The following functional tests shall be carried out to ensure proper functioning of the plant and all apparatus.

(a) All protective circuits, interlocks, control and alarm shall be tested for correct operation
(b) All lighting circuits shall be energised and checked to ensure that they are operational
(c) All motors, plants and electrical equipment connected with mechanical services shall be checked to ensure that they run freely in the correct direction/rotation and in correct sequence
(d) Fire alarm system, elevator system and building management system (if applicable) shall be tested for correct operation
(e) All major authority related testing requirements shall be witnessed by the relevant authority representative (QGEWC or Q-Tel). The Contractor shall give a minimum of one-week advance notice prior to performing any major tests
(f) The Contractor shall obtain all relevant testing requirements from QGEWC and Q-Tel and make available all necessary testing apparatus.

PART 31 Power Transformers

31.1 GENERAL

31.1.1 Scope

Add new paragraphs 2 to 4 as follows:

2 This Part is additional to QCS and it specifies the general requirements for 11 kV/415 V power transformer.

3 Related Parts and Sections are as follows:

This Section:	Part 6	HV Cables
	Part 22	Earthing and bonding
	Part 32	HV Switchgear

4 Power transformers are required as shown on the Contract Drawings.

Insert new clauses as follows:

31.6 SUBMITTALS

1 The following documents to be submitted to QGEWC for approval:

(a) Product data for each product specified, detailed description of construction, including dimensioned plans, sections, and elevations. Show minimum clearances and installed devices and features, weight and bearing forces, incoming and outgoing terminals and provisions for feeder terminations.
(b) Wiring diagrams of transformers and accessory components, differentiating between manufacturer-installed and field-installed wiring and cabling.
(c) Routine Tests And Special Tests are to include measurement of noise level, winding resistance, voltage ratio, check of polarity/vector group, impedance voltage, load loss, no-load loss, no-load current, induced overvoltage withstand test and separate source voltage withstand test.
(d) Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of relevant completed projects with project names and addresses, and names and addresses of the respective Engineers and Government.
(e) Shop and construction drawings including foundation details, grouting holes, base frames and installation details. All civil works are to be approved by END, Civil Section (EWD).
(f) Operation and maintenance data for materials and products.

31.7 QUALITY ASSURANCE

1 Installer Qualifications: Engage an experienced Installer (approved by QGEWC) of high voltage electrical distribution equipment to perform the installation specified in this Section.

2 Standards: Comply with IEC 76, 354, 726 - Power Transformers and IEC 296 - Insulating Oil.

31.8 DELIVERY, STORAGE AND HANDLING

1 Spare Parts: provide spare parts as recommended by the manufacturer, for one year maintenance as expected under local conditions, and to allow for emergency replacement due to accidental breakage or failure.

2 Spare Parts for Oil Filled Transformers are to include, but are not limited to, one set of 11 kV bushings, drain plug, fragile parts which are subject to external damage and suitable quantity of make-up insulating oil.

3 Tools and Instruments: provide tools and instruments required for normal routine inspection, testing, operation and maintenance, recommended by the manufacturer.

31.9 PRODUCTS

31.9.1 Oil Filled Transformer

1 Transformer to be 3-phase, two-winding, liquid immersed, sealed type, rated for continuous operation under site ambient conditions at full rated power, naturally cooled (ONAN), with off-load, manual, externally operated tap-changer, lockable in all positions on primary side. Transformer is to comply with IEC 76, 354 and 404-2.

2 Transformer Construction is to be variable volume steel tank, with corrugated wall design forming integral cooling pockets, heavy rolled and welded steel bottom and base frame and hermetically sealed bolted-on cover. Tank is to be completely filled with insulating liquid drawn in under vacuum. Tank cover is to have provision for two thermometers or temperature sensors, lugs for lifting, four lashing lugs and filler- pipe with valve. Tank is to have drain plug at bottom, earthing bolt on cover and earthing pad on base-frame, and a rating plate.

3 Transformer Noise Level in general is to be less than 76 dB at 0.3 m for ratings up to 1600 kVA and 69 dB for ratings up to 630 kVA and in accordance with IEC 551. Windings are to be copper, unless otherwise approved.

4 Transformer Bushings are to be porcelain, tank-cover mounted, or tank-side mounted to manufacturer's standard, and as approved, with plug-in or bolt-on arrangements.

5 Finish for surfaces are to be steel grit blasted, caustic washed and phosphatized, primed with waterproof primer and finished with weather-resistant enamel and final coat of air-drying enamel. Alternative finish may be used subject to approval.

6 Characteristics of Transformer are:

(a)	Rated power (net site rating)	:	1,000 kVA
(b)	Winding connection	:	Dyn 11, neutral insulated and brought out
(c)	Frequency	:	50 Hz
(d)	Type of insulating liquid	:	Oil natural with radiator sealed type ONAN liquid
(e)	Rated voltage:		
	(i) primary	:	11 kV
	(ii) secondary (no load)	:	415 V
(f)	Impedance voltage at rated current	:	6%
(g)	Tap-changer positions at	:	± 25% and ± 5%
(h)	Rated power frequency withstand voltage	:	50 kV
(i)	Rated lightning impulse withstand voltage	:	75 kV
(j)	Short-circuit apparent power of system at location	:	500 MVA
(k)	Duration of short-circuit	:	two seconds
(l)	Terminal connections:		

(i)	HV side	:	fully insulated with cable sealing ends, bolted type.
(ii)	MV side	:	MV busbars or cables to MV compartment.

7 Accessories are to include the following:

(a) magnetic liquid level gauge with N.O. low level alarm contact;
(b) dial type thermometer with N.O. contact and maximum pointer;
(c) pressure relief device with N.O. contact.

31.10 EXECUTION

31.10.1 Installation

1 Comply with QGEWC electrical safety codes and the manufacturer's written installation instructions.

2 Equipment Bases: ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturer's drawings and that holes for fixings bolts and provisions for passage of cables etc. are provided as required.

3 Cable Trenches: ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

4 Cabling And Wiring: install cables, wires, raceways, supports, cable ends and termination fittings in accordance with the appropriate sections of the Specification and/or as shown on the Drawings. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

31.10.2 Earthing

1 Earth transformers shall be in accordance with Part 22.

31.10.3 Testing and Commissioning

1 Transformer to be tested in accordance with QGEWC requirements.

2 Schedule tests and provide notification at least one week in advance of test commencement.

3 Report: Submit a written report of observations and tests. Report defective materials and workmanship.

4 Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. For test method and data correction factors, conform to applicable Standards.

(a) Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.
(b) Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of applicable Standards.

(c) Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground according to the following:

WINDING RATING (VOLTS)	MINIMUM TEST VOLTS (d.c.)	MINIMUM INSULATION RESISTANCE (MEGOHMS) FOR LIQUID FILLED
601 – 5.000	2.500	1.000
5.000 – 35.000	5.000	5.000

(i) Duration of Each Test: 10 minutes.
(ii) Temperature Correction: correct results for test temperature, deviation from 20 C standards.

(d) Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 per cent from the calculated ratio or the measured ratio for adjacent coil are not acceptable.
(e) Winding Resistance: Measure for winding at nominal tap setting. Measured resistance deviating more than 1 per cent from that of adjacent winding is not acceptable.

5 Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

31.10.4 Final Adjustments

1 After completing installation and cleaning, touch up scratches and mars on finish to match original finish.

2 Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

31.10.5 Demonstration

1 Training: Include a minimum of 2 days of training in operation and maintenance. Provide both classroom training and hands-on equipment operation covering the following:

(a) Safety precautions
(b) Features and construction of project transformers and accessories
(c) Routine inspection, test and maintenance procedures
(d) Routine cleaning
(e) Features, operation, and maintenance of integral disconnect and protective devices
(f) Interpretation of readings of indicating and alarm devices
(g) Protective relay setting considerations
(h) Features, operation and maintenance of separable insulated connector system
(i) Tap-changing procedures.

2 Schedule training with at least 7 days advance notice.

Add new Part 34 as follows:

PART 34 High Voltage Switchgear

34.1 GENERAL

34.1.1 Scope

1 This Part covers the requirements for high voltage switchgear and associated auxiliary equipment. It is based on QGEWC Specification ED/02-60.

2 Related Parts and Sections are as follows:

Part 1	General Provisions for Electrical Installations
Part 31	Power Distribution Transformer
Part 35	HV Cables

3 For the package substations, the HV switchgear is an integral part and should be furnished pre-installed as a complete unit.

34.1.2 Submittals

1 The following documents to be submitted to QGEWC for approval:

(a) Product data for each product specified, including complete manufacturer's catalogues, operating characteristics, provisions for extension or for addition of components, protective relays and characteristics, instrument transformers and metering components, accuracies and curves.
(b) Shop drawings for each switchgear line up and accessory component. Include dimensional plans, sections, and elevations showing minimum clearances, installed devices, major features, and materials lists, weights cable accesses in slabs, grouting holes and installation details.
(c) Wiring diagrams, both elementary and schematic, differentiating between manufacturer-installed and field-installed wiring including detailed identification of relays, control gear and any other components.
(d) Manufacturer's certification, signed by the manufacturer certifying that equipment complies with the requirements specified in Quality Assurance below. Upon request submit evidence of experience.
(e) Product Certification: Signed by manufacturer of equipment certifying that products comply with the specified requirements.
(f) Routine Tests of each complete switchgear unit is to undergo routine tests at the manufacturer's works in accordance with the relevant standards. Submit routine test reports, prior to shipping equipment, indicating ambient test conditions and guaranteed rating of equipment under site conditions.
(g) Installers' certificates signed by the Contractor, certifying that the Installers comply with the requirements specified under Quality Assurance below.
(h) Report of Field Tests: Certified copies of field tests including ground resistance tests.
(i) Maintenance data for materials and products.
(j) Protection coordination scheme with pick-up time-current settings as required to coordinate with upstream and downstream protective devices of the complete system.

34.1.3 Quality Assurance

1 Installer Qualifications: Engage an experienced Installer (approved by QGEWC) of high-voltage electrical distribution equipment to perform the installation specified in this section.

2 Manufacturer Qualifications: Manufacturer shall be regularly engaged in manufacturing switchgear complying with the requirements of these Specifications, experienced with at least 5 projects of similar size and scope.

3 Type Test Certificates are to be submitted to verify compliance of main equipment with the relevant IEC Standards, including, but not limited to, the following: impulse withstand voltage tests, power frequency withstand voltage tests, temperature rise tests, short time current tests, verification of making and breaking capacity, mechanical endurance/operation tests, verification of degrees of protection for persons against contact with live and moving parts, internal arc test, protection degree test.

4. Standards equipment and component parts are to comply with the following Standards:

(a)	common clauses for HV switchgear and control gear standards	:	IEC 694
(b)	a.c. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 72.5 kV	:	IEC 298
(c)	HV a.c. circuit breakers	:	IEC 56
(d)	insulation coordination	:	IEC 71
(e)	HV a.c. fuse-switch combinations and fuse-circuit-breaker combinations	:	IEC 420
(f)	a.c. disconnectors (isolators) and earthing switches		IEC 129
(g)	HV switches	:	IEC 265
(h)	metering and protective current transformers (CTs)	:	IEC 185
(i)	metering and protective voltage transformers (VTs)	:	IEC 186
(j)	relays	:	IEC 225
(k)	reading instruments	:	IEC 51
(l)	watt-hour meters	:	IEC 521
(m)	power transformers	:	IEC 76 (for)
(n)	insulating oil	:	IEC 296
(p)	sulphur hexafluoride	:	IEC 376
(q)	fuses	:	IEC 282-1
(r)	surge arrestors	:	IEC 99

5 Electrical Component Standard: Components and installation shall comply with the local applicable codes and regulations of the Authority having jurisdiction.

6 Manufacturer/Product Selection: The Drawings indicate sizes, profiles, and dimensional requirements of high-voltage switchgear which are based on specific types and models of manufacturers. Switchgear having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept and space requirements or intended performance as judged by the Engineer.

34.1.4 Delivery, Storage, and Handling

1 Deliver Switchgear and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for Switchgear and components which protect equipment from damage. Inspect equipment to ensure that no damage has occurred during shipment.

2 Store Switchgear in original packaging and protect from weather and construction traffic. Store above grade and enclose with watertight wrapping.

3 Handle Switchgear carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

34.1.5 Sequencing and Scheduling

1 Schedule delivery of switchgear and accessories equipment that permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

2 Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in QCS Section 5.

3 Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchgear with other work.

34.2 PRODUCTS

34.2.1 High voltage Switchgear, General Requirements

1 HV Switchgear Compartment is to include metal-enclosed ring main switchgear unit with SF6 switching and SF6 insulated busbars comprising two incoming switch-disconnectors for ring main network feeders, one transformer protection fuse-switch combination, cable terminal fittings behind dead front panels, and front mounted switchgear operating handles, control, indication and metering devices.

2 HV Switchgear Characteristics

(a)	rated voltage	:	12 kV
(b)	nominal service voltage	:	11 kV
(c)	rated impulse withstand voltage (peak)	:	75 kV
(d)	rated frequency	:	50 Hz
(e)	rated one minute power frequency withstand voltage (r.m.s)	:	28 kV
(f)	rated short-time withstand current for one second	:	25 kA
(g)	busbar current rating	:	630 A (minimum)
(h)	rated peak withstand current	:	63 kA

3 HV switch-disconnector is to be of the general purpose, 3-pole, load-break, short-circuit make, category B to IEC 265.

(a)	rated normal current	:	630 A
(b)	rated short-circuit making		
(c)	capacity (peak)	:	equal to rated peak with-stand current.

4 Switch-disconnector Operation is to be by removable handles at front of unit. Switching mechanism is to be manual, or automatic with remote control, spring charged, quick-make, quick-break, with speed of switching independent of operator. Switch is to be provided with a suitably rated universal motor capable of one complete off-on-off cycle in case of loss of control power. Main switch and earth switch operations are to be separated and safety interlocked with the manual handle inserted in separate access holes for on/off operation of main switch and earth on/earth off operation of earth switch. Handle design is to ensure delay between closing and re-opening of main switch or earthing switch, to provide an anti-reflex operation. It is to be impossible to move earth switch inadvertently into or from earth position except when main switch is in the open position. Indication of switch position is to be mechanical, directly connected to moving contacts. Each switch is to have padlocking device in the open, closed and earth positions.

5 Fuse-Switch Combination is to consist of trip-free, load- break, short-circuit make fuse-switch combination, with operational requirements as for switch-disconnector. Fuse is to be separately located in fuse chamber with interlocked earthing switches providing upstream and downstream earthing of the fuse assembly. Automatic trip switching is to be actuated by fuse striker pins which actuate common trip-bar in switch mechanism. Once operated, striker pins remain in ejected position, preventing reclosure of switch until fuse has been replaced. Single phasing is not to be possible. Fuses are to be totally enclosed, current limiting, cartridge type, high-breaking capacity, with striker pins, and withdrawable from front of unit. Fuse switch combination is to have the following ratings.

(a)	rated normal current	:	200 A
(b)	rated prospective short-circuit breaking current	:	25 kA to IEC 420
(c)	rated prospective short-circuit making current	:	65 kA
(d)	rated current of fuse link	:	100 A

6 Incoming/Outgoing Cables of type and size are to be as shown on the Drawings.

7 Cable Terminal Connectors to stress-relieving, epoxy sealed end, bolted type, complete with all accessories. Alternative arrangement may be proposed by manufacturer.

8 Potential Indicators to be neon type provided at front of each unit, one per phase, using capacitive potential divider to indicate voltage at switch-disconnector cable terminals.

9 Accessories are to include the following:
(a) two N.C. and two N.O. auxiliary contacts on each switch
(b) shunt trip release on fuse-switch combination
(c) earth fault indicator, operated by core-balance type current transformer, located near and outside cable box/termination's with indicator visible from front and with automatic reset.

34.3 EXECUTION

34.3.1 Installation

1 Equipment Bases: ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturer's drawings and that holes for fixings bolts and provisions for passage of cables, etc. are provided as required.

2 Install switchgear and accessory items in accordance with manufacturer's written installation instructions and the following specifications:

(a) Anchoring: Anchor each switchgear assembly to two 100 mm minimum channel iron sills by tack welding or bolting.
(b) Sills shall suit the switchgear and shall be levelled and grouted flush into the floor.
(c) Platform: Where a membrane-waterproofed floor or pressure slab is indicated under a switchgear location and elsewhere, where indicated, there shall be provided a concrete housekeeping pad. The 100 mm channel sills specified above shall be provided in the pad.

3 Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

4 Framed Operating Instructions: Printed basic operational instructions for switchgear, including key interlocking sequence, if any, and emergency procedures, framed under clear acrylic plastic on the front of the switchgear are to be provided.

5 Cable Trenches: ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

34.3.2 Earthing

1 Earthing to be as per paragraph 9.4 of QGEWC Specification ED/02-60.

34.3.4 Connections

1 Install all incoming and outgoing cable supports, cable ends and termination fittings required for HV, MV and control cables.

2 Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values.

34.3.5 Testing and Commissioning

1 General: Comply with applicable IEC standards or the international Electrical Testing Association (INETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" where no other local standards have precedence.

2 Pre-testing: Upon completing installation of the system, perform the following preparations:

(a) Equipment: inspect equipment upon delivery to site and report any damage to the Engineer.
(b) Switchgear: inspect and check switchgear for completeness and as recommended by the manufacturer and check phasing of buses, contact alignment and clearances.
(c) Components: check component ratings, types, sizes and wiring connections, including current and voltage transformers, fuses, switches, instruments and relays.
(d) Make insulation resistance tests of switchgear buses, components, and connecting supply, feeder, and control circuits.
(e) Make continuity test of circuits.
(f) Provide Manufacturer's installation and testing instructions to test organization.

3 Test Procedure: Conform to the following:

(a) Test objectives: To assure switchgear installation is operational within industry tolerances and is installed in accordance with the specified requirements, and is suitable for energizing.
(b) Procedures: Make field tests in accordance with applicable IEC standards.
(c) Schedule tests and notify Engineer at least one week in advance of test commencement.

4 Protective Relay Settings:

Set in accordance with manufacturer's instructions and the coordinated QGEWC systems requirements. Settings given on drawings shall be verified to be accurate for final system configuration and parameters. Where discrepancies are found, final relay settings shall be recommended to the Engineer, and any revised settings accepted by him shall be used by the test organization to make the final adjustments.

5 Tests: Perform high-potential test of switchgear and accessories and such other tests and examinations as are needed to achieve specified objectives, including the following:

(a) Perform mechanical and electrical operator tests. Check main and auxiliary contact alignment.
(b) Check arc-interrupter operation on load-interrupter switches.
(c) Verify key interlock operation.
(d) Test insulation resistance on each phase to ground and from each phase to each other phase.
(e) Test a.c. overpotential as recommended by IEC standards.
(f) Test contact resistance across each main contact set. Report contact resistance in excess of manufacturer's tolerances.
(g) Test polarity and ratio of CT's.
(h) Test protective relays to determine pickup parameters. Verify accuracy of timing setting for three points on time dial curve.
(i) Trip each circuit breaker by operating each associated protective relay.
(j) Measure minimum pickup voltage of each trip and close coil.
(k) Test arc chutes for losses in accordance with manufacturer's instructions.
(l) Check integrity and insulation of ground and test device.
(m) Check calibration and adjust ammeters and voltmeters.
(n) Verify operation of all auxiliary and emergency equipment.

6 Retesting: Correct deficiencies identified by tests and retest switchgear under such circumstances. Verify by the system test that the total system meets the specified requirements.

34.3.6 Final Adjustments

1 Upon completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

34.3.7 Demonstration

1 Training: Conduct a minimum of two days' training in operation and maintenance. Include both classroom training and hands-on equipment operation and maintenance procedures.

2 Schedule training with at least seven days' advance notice.

Add new Part 35 as follows:

PART 35 Extra High Voltage Cables

35.1 GENERAL

35.1.1 Scope

1 This Part includes single and multiple conductor cables and splices, terminations, and accessories for cables above 11,000 V rating.

2 Related Parts and Sections are as follows:

This Section:	Part 1	General Provisions for Electrical Installations
	Part 6	Cables and Small Wiring
	Part 31	Power Distribution Transformers
	Part 32	11 KV Switchgear

3 General

This section deals with the specific technical requirements related to material, equipment, execution of works and all other activities necessary for the implementation of works related to 132 kV and 66 kV cables.

132 and 66 kV power cables shall be connected to the existing QGEWC transmission system and, after connection, shall form part of the system. The EHV circuits that will be installed and connected shall be as specified by the Engineer. The new lines shall meet the requirements of the existing system.

The 11 kV circuits that require diversion and hence new installation in specific locations are indicated on the Drawings, and they are covered in QCS Section 21, Part 6.

35.1.2 Submittals

1 The following documents to be submitted to QGEWC for approval:

(a) Product data on cables and cable accessories including descriptions and detailed specifications.
(b) Shop drawings of joints and terminations.
(c) Product certificate signed by manufacturer that its products comply with the specified requirements.
(d) Installer certificates signed by manufacturer of cable splicing and terminating products that Installers comply with training requirements specified under "Quality Assurance".
(e) Installer certificates signed by Contractor that Installers of cable splices and terminations meet the experience qualifications specified under "Quality Assurance".
(f) Product Test Reports: Certified reports of manufacturers' factory production and final tests indicating compliance of cable and accessories with referenced standards.
(g) Report of Field Tests: Certified copies of field test records.
(h) Maintenance data for cables and accessories, manufacturer's written instructions for periodic tests of cables in service, operating instructions for fault indicators and separable insulated connectors and their accessories.

35.1.3 Quality Assurance

1 Installer Qualifications: Engage an experienced Installer (approved by QGEWC) of high-voltage electrical cable to perform the installation specified in this section. In addition, for the specific work of cable splicing and terminating, engage Installers who are experienced in cable splices for the specific types of cable and cable accessories specified in this Section.

2 Standards Compliance: Cables and components shall be marked, listed and labelled by Manufacturer in accordance with the approved standards of manufacture (IEC, BS, UL, DIN, UTE, NFC, ICEA, etc.).

3 IEC Compliance: Components and installation shall comply with the relevant IEC Standards and the local Authority specification having jurisdiction.

4 Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code".

5 IEEE Compliance: Comply with applicable IEEE standards including C2 "National Electrical Safety Code".

35.1.4 Delivery, Storage and Handling

1 Deliver extra high and high-voltage cable on factory reels conforming to Standard applicable or as otherwise specified.

2 Store cables on reels on elevated platforms in a clean, dry location.

35.1.5 Warranty

1 Special Project Warranty: Submit a written warranty, mutually executed by manufacturer and the principal Installer, agreeing to repair or replace high voltage cables, splices, and terminations that fail in materials or workmanship within the special project warranty period specified below. This warranty shall be in addition to, and not a limitation of, other rights and remedies the PWA may have against the Contractor under the Contract Documents.

2 Special Project Warranty Period: 2 years beginning on the date of Substantial Completion.

35.2 PRODUCTS

35.2.1 Environmental Conditions

1 The following conditions apply:

(a)	Altitude above sea level	:	Below 1000 m
(b)	Distance from sea	:	Less than 10 km
(c)	Wind speed	:	140 km/h Prevailing wind direction NW to NNW
(d)	Ground water level	:	2-70 m
(e)	Pollution level	:	Air heavily laden with dust and salt (vide IEC 8.15, Table 1) with high percentage of salt
(f)	Creepage distance phase to phase	:	35 mm/kV (Vide IEC 815) (based on the highest phase to phase system voltage)
(g)	Isokeraunical level	:	20 thunderstorm days per year

(h)	Lightning current (peak) (for protective earthing)	:	60 kA
(i)	Earthquake factor	:	intensity approx. VI of M.M Scale (Modified Mercalli Scale)
(j)	Design absolute maximum temperature	:	50 °C
(k)	Rainfall Summer	:	13 mm, 1 month
	Winter	:	29 mm, 1 month

35.2.2 Current Carrying Capacity

1 The maximum continuous current capacity, maximum permissible conductor temperature and the factors for determining such rating and temperature shall be based on IEC recommendation No. 287 and subsequent amendments and all actual conditions at site.

2 Cable rating calculations shall be submitted along with the offer based on the data provided under "Design Criteria". The calculations shall be reconfirmed and approved after the Site investigations and before the manufacture.

3 The Contractor shall carry out, at his own expense, moisture content, water table level, and soil thermal resistivity tests along the 132 and 66kV cable route and such other tests as he may consider necessary, sufficiently in advance of the manufacture of any cable, to satisfy himself that, the conditions on-site and his proposed arrangement of cables and method of installation are such that the maximum current carrying capacity can be maintained. If the Contractor considers that the conditions and the proximity to other power cables, spacing and method of installation are likely to reduce the maximum current carrying capacity below the declared value, he shall immediately notify QGEWC as to what the maximum current carrying capacity would be under these conditions and shall not proceed with the work on that portion of the route affected until QGEWC has given its permission.

4 Power cable sizes proposed for this project are based on the sizes of the existing cables to which the new ones will be jointed.

5 The conductor and metallic sheath shall be adequate for carrying the specified short-circuit current when operating under the specified load conditions without deterioration of the di-electric or other component materials of the cable. The overall performance of the new circuit under specified load and short circuit conditions will be equivalent or superior to the original circuit.

35.2.3 Electrical Criteria for EHV Oil Filled Cables

Item No.	Description	132 kV	66 kV
1	Voltage between phases of three phase circuit kV	132	66
2	Number of cores	1	1
3	Sectional area of conductor (2) sq.mm	500	500
4	Conductor details:		
	4.1 Material	Plain Copper	
	4.2 Special features, e.g. plain, tinned, died down, screened shaped, etc.	(Hollow, self-supporting type, screened)	
5	Oil ducts:		
	5.1 Material	Formed by segments	
	5.2 Nominal internal diameter	12.0	12.0
6	Maximum di-electric stress at the conductor, assumed smooth - MV/m	11.2	9.6
7	Minimum radial thickness of insulation between conductor and screen - mm	8.7	4.6
8	Insulating paper:		
	8.1 Type	Kraft Paper Tape	
	8.2 Nominal thickness - mm	0.100	0.150
9	Core screen:		
	9.1 Material		
	9.2 Nominal thickness - mm	*1	*2
10	Materials used for fillers	Paper	
11	Type of Impregnant (º)	Low Viscosity Insulating Oil	
	Viscosity 20ºC - Centipoise	12 ~ 15	
	Viscosity 50ºC“	4 ~ 6	
	Viscosity 85ºC“	2 ~ 3	
12	Binder cover laid-up cores:		
	12.1 Material	Copper Woven Fabric	
	12.2 Nominal thickness - mm	0.3	0.3
13	Minimum radial thickness of metal sheath - mm	2.3	2.1

Note: *1 *One carbon paper tape and one metallized paper tape intercalated with one carbon paper tape: 0,13, 0,14 and 0,13 respectively.*

*2 *Ditto as above, but: 0,15, 0,14 and 0,13 respectively.*

Item No.	Description	132 kV	66 kV
14	Nominal diameter over metal sheath - mm	54	45
15	Composition of lead Sheath		
	Lead alloy:		
	Tin %	0.175 to 0.225	
	Cadmium %	0.06 to 0.09	
	Antimony %	- - - - - - - - - - - - - - - - -	
	Lead %	The Remainder	
16	Wrappings under reinforcement:		
	Material	Rubber coated fabric tape	
	Nominal Thickness - mm	0.5	
17	Reinforcement material		
	0.1% proof stress - MN/sq.m.	600	600
	Nominal thickness - mm	0.10	0.10
	Number of layers - mm	2	2
	Maximum working stress – MN/sq.m at maximum static pressure of 525 kN/sq.m	71	59
18	Protective outer covering nominal thickness P.V.C. sheath - mm	3.0	2.8
19	Nominal overall diameter of: completed cable - mm	63	54
20	Nominal weight per metre of completed cable - kg	12.5	10.4
21	Minimum radius of bend round which cable can be laid:		
	2 1.1 Laid Direct or in air - m	1.9	1.7
	21.2 In ducts - m	2.2	1.9
22	Minimum internal diameter of pipes or ducts that can be used - mm	100	100
23	Maximum D.C. resistance of conductor per 1.000 m of cable at 20 ºC - ohm	0.0366	0.0366
24.	Maximum A.C. resistance of conductor per 1.000 m of cable at 85 ºC and 50Hz - ohm	0.04715	0.0473

Item No.	Description	132 kV	66 kV
25	Equivalent star reactance per 1.000 m of three-phase circuit at 50Hz		
	(a) In spaced formation ohm	0.23	0.23
	(b) In trefoil - ohm ohm	0.11	0.10
26	Maximum. electrostatic capacitance per core per 1.000 m of cable at 50Hz - pF	415 x 10^3	707 X 10^3
27	Maximum charging current per conductor per 1.000 m of cable at nominal voltage - amp	9.9	8.5
28	Maximum continuous current carrying capacity per conductor when laid direct in the ground (Net g = 2.5 ºC/m/Watt) 1.1 m to top of cable at a ground temperature of 35 ºC	Sheaths bonded at both ends	
	28.1 One Three Phase circuit per trench (a) 132 kV 500 mm²: 3 x single core cables laid in Trefoil	389 A	-
	(b) 66 kV 500 mm²: 3 x single core cables laid in Trefoil	-	417 A
	28.2 Two Three Phase Circuit per trench (a) 132 kV 500 mm²: 6 x single core cables laid in two Trefoil groups with 700 mm between circuits	328 A	-
	(b) 66 kV 500 mm²: 6 x single core cables laid as (a) between circuits.	-	361 A -
	28.3 Assumed maximum conductor temperature	85 ºC	85 ºC

Item No.	Description	132 kV	66 kV
29	Maximum continuous current carrying capacity per conductor when drawn into pipes (filled with Bentonite Grout) at ground temperature of 35 ºC with Net g = 2.5 ºC/m/Watt with l. 1 m to top of cable.		
	29.1 One three phase circuit (a) 132 kV 500 mm²: 3 x single core cables laid Trefoil.	390 A	-
	(b) 66 kV 500 mm²: 3 x single core cables laid Trefoil	-	415 A
	29.2 Two three phase circuits (a) 132 kV 500 mm²: 6 x single core cables laid. in two Trefoil groups with 700 mm between circuits.	319 A	-
	(b) 66 kV 500 mm²: 6 x single core cables laid as (a)	-	350 A
	29.3 Assumed maximum conductor temperature	85 ºC	85 ºC
30	Maximum continuous current carrying capacity per conductor when laid on rack in air at ambient temperature of 50 ºC (with cable duly clamped)		
	30.1 One three -phase circuit - amp.	708	728
	30.2 Assumed maximum conductor temperature - ºC	85	85
31	Maximum power factor of charging kVA of cable when laid direct in the ground at nominal voltage, normal frequency and operating oil pressure, at a conductor temperature of:		
	15 ºC %	0.35	0.35
	30 ºC %	0.30	0.30
	45 ºC %	0.30	0.30
	65 ºC %	0.28	0.30
	85 ºC %	0.28	0.30

Item No.	Description	132 kV	66 kV
32	Maximum di-electric loss of cable per 1.000 metres of three-phase circuit when laid direct in the ground at nominal voltage, normal frequency and operating oil pressure at maximum conductor temperature - kW	6.36	2.90
33	Maximum power factor of charging kVA of cable at normal frequency and operating oil pressure at a conductor temperature of 20 ºC at		
	50% nominal voltage %	0.30	0.35
	Nominal voltage %	0.30	0.35
	150% nominal voltage %	0.32	0.37
	200% nominal voltage %	0.35	0.40
34	Sheath loss, including reinforcement of cable per 1.000 metres of three phase circuit at nominal voltage, normal frequency and operating oil pressure, at maximum current rating:		
	34.1 Laid direct in the ground with current per conductor as stated in item 28.1 (a) Trefoil - kW	2.1	1.93
	34.2 Drawn into duct cluster with current pet conductor as stated in item 29.1 (a) Trefoil - kW	6.61	7.55
35	Cable thermal resistance nominal design value		
36	Oil pressure, above atmospheric Pressure		
	36.1 Minimum operating pressure kN/sq.m		
	Cable and joints	20	
	Sealing ends	20	

Item No.	Description	132 kV	66 kV
36 (cont)	Pressure tanks:		
	1 Atmos - kN/sq.m		
	1 ½ Atmos	59	
	2 Atmos		
	3 Atmos		
	36.2 Maximum operating pressure:		
	Static conditions		
	Cable and joints	525	
	Sealing ends	525	
	Pressure tanks:		
	1 Atmos	-	
	1 ½ Atmos	441	
	2 Atmos	-	
	3 Atmos	-	
	Tiansient conditions		
	Cable and joints	784	
	Sealing ends	784	
37	Pressure/Volume characteristics of Pressure tanks: Nominal size : 44 litre 88 litre 135 litre 180 litre 225 litre 300 litre	REFER TO QGEWC DRAWING NO. 7660/26/169	
38	Oil Feed pipes: 38.1 Material and dimensions 38.2 Protective covering EXTRUMED BLACK PUC	Copper inner diameter 12 mm EXTRUDED BLACK PVC	
39	Total oil volume per km of cable approx. litres/km	900	600
40	Maximum length per drum approx. - m	650	700
41	Maximum dimensions and weight of drum arranged for shipping		
	Diameter m	2.42	2.42
	Width m	1.50	1.35
	Weight (Gross weight) kg	9.300	8.100
42	Is the impregnating oil compatible with Butmah Oil Type C6 and Pirelli Volfoil 10	Yes	
43	Electrical resistance of cable sheath: 43.1 Nominal resistance at 20 °C ohm/Km	0.523	0.677

35.2.4 Site Survey

1 The proposed routes of the cable lines will be established within the way leave accepted and approved by QGEWC.

2 Within a reasonable time after the Contract has come into force, the Contractor shall verify the route through Design Enquiry Letter Procedure survey and agree a final route with QGEWC and confirm the arrangements.

3 Trial pits shall be opened by the Contractor at approved positions proposed by him, to determine the most suitable detailed route and position for the trenches. The width of trial pit shall be sufficient to determine the cable route, but not smaller than that of cable trench.

4 On the basis of the trial pits, detailed survey and the requirements of concerned Government authorities relating to safety clearances, the Contractor shall arrange the necessary drawings to process the necessary RO (Road Opening) forms before the installation commences, as detailed in General Technical Requirements. Obtaining of RO approvals shall be Contractor's responsibility and cost for these works shall be deemed to have been included in his Contract price. However, QGEWC will assist by issue of necessary letters, etc.

5 All routes shall be defined precisely, and shown in drawings at an approved scale (1:500). The stable structures shall be indicated clearly as well as distances. The crossings with roads and underground installation shall be shown. Joint locations shall be identified clearly and sufficient section views shall be shown. Joint locations shall be identified clearly and sufficient section views shall be provided where necessary. The dates of installation of cable joints, cable drum serial No's., name of jointers, shall be included in the "as-built" drawings. Cable section lengths shall also be given.

6 All drawings shall be subject to QGEWC's approval.

7 The quantity of cables, accessories, etc. to be supplied shall be based upon this survey. The programme for route survey works shall be agreed upon with QGEWC prior to commencement of the Works.

35.3 FURTHER REQUIREMENTS FOR EHV CABLES

35.3.1 132 and 66 kV Cable Line

1 WhereEHV circuits that require new sectionsare oil filled, these shall be replaced with oil filled cables.

2 Cable lines shall consist of independent circuits similar to existing requirements, with the minimum spacing to QGEWC's requirements.

3 The minimum following tests are required for the EHV cables:

(a) <u>Conductor Resistance Tests:</u>

The copper resistance of the conductors shall be measured by direct current at room temperature in accordance with IEC publication 141-1 and BSS 6480. The values thus obtained shall not be greater than the guaranteed values as per IEC Publication 141-1 and BSS 6480.

(b) Capacitance Tests:

The electrostatic capacitance of each drum length of completed cable shall be measured at length of completed cable shall be measured at power frequency and shall not be greater than the guaranteed values specified by the Engineer.

(c) High Voltage Tests:

The voltage tests shall be carried out with alternative current in accordance with IEC publications 141-1 for oil filled cables.

(d) Di-electric Power Factor/Voltage Tests:

Each drum length of completed cable shall be tested for power factor at normal frequency and at ambient temperature and at 100 and 200 per cent of normal. The power factor of the charging kVA, after correction to a temperature of 20 °C shall not exceed the guaranteed values stated in the schedules of guarantees. These guaranteed values shall be in accordance with IEC publication 141-1 and BSS 6480.

(e) Voltage Tests on Anti-Corrosion Coverings:

This shall be carried out in accordance with IEC-141 and IEC-229.

Accessories:

(i) Visual dimensional checks on selected samples of each batch of joint boxes (not less than one joint box of each 50 boxes).
(ii) Tests to check inner lead sleeve composition.
(iii) Tests analysis of plumbing and solder to check compliance with B.S 219. Tests should be carried out on samples selected from each batch (but not less than one sample of each 200 sticks)

4 The continuous power rating per circuit under the conditions specified above must be ensured for entire life span of the installation. The Contractor shall submit detailed calculations according to IEC 287, for the proposed equipment to confirm this requirement along with the bids.

5 In order to meet the specified current rating capacity, cross bonding of the metallic sheathes with phase transposition at each joint shall be adopted.

6 The maximum conductor operating temperature shall be limited to 85 °C.

7 The special bonding of the metallic sheathes shall be designed according to Engineer Recommendation C.55/2, issued by Electricity Council – Insulated Sheath Power Cable System.

8 The maximum value of circulating current losses in the metallic sheath and screen shall be 3% of the conductor losses at full rated load current at maximum temperature and shall be taken into account when cable size is determined.

9 The maximum induced voltage at cable sheath at rated load current shall not exceed:

(a) 65 V normal working conditions
(b) 2.5 kV for ground fault conditions (25 kA earth fault current).

10 The metallic sheath (lead alloy) shall be able to carry the complete earth fault current for the specified period. Each component shall be checked to ensure that there is no overloading when they carry fault current together. This shall be confirmed by calculation as per IEC 949.

11 Cyclic and emergency ratings shall be guaranteed by the Contractor. Calculation of these rating shall be carried out according to IEC 853.

12 During installation, when crossing with other heat sources, or laying at depths deeper than 1.1 m at the crossings or such similar conditions, the Contractor shall maintain the specified rating, either by application of the special stabilised backfill or by increasing the phase spacing. For every situation the arrangement with relevant calculations shall be submitted to QGEWC for approval, prior to installation.

13 Specific thermal resistance of 2.5 °C m/W shall be maintained even for completely dry backfilling material. This has to be confirmed before placing the backfill materials in the trench. The ground temperature at depth of laying as well as the thermal resistance of the backfilling material shall be controlled during the cable installation and shall form part of the installation procedure. The Works, material or labour supply necessary to meet this requirement is deemed included in the Contract price.

14 Application of the special backfill in order to achieve cable rating shall be allowed where conditions require so, without additional cost.

35.4 CABLE ACCESSORIES

35.4.1 General

1 All cable accessories (sealing ends, straight joints, link boxes, etc.) must be of an approved and reliable design. The accessories design shall be confirmed by performance of the type test as defined elsewhere. For the EHV cables, the joints should be furnished from the cable supplier or from a supplier with a previous history with the cable supplier.

2 The maintenance requirement shall be brought to minimum, but the design shall be such to enable easy maintenance without disturbing the other items in the system.

3 The voltage stress grading shall be achieved by stress cone device.

4 Design of sealing ends shall comply with IEC 859.
Bonding and earthing system shall comply with IEEE 80 and C55/4 requirements.

5 The earthing resistance of the joint bay earthing system shall not exceed value of 5 ohms.

35.5 TELECOMMUNICATION REQUIREMENTS

35.5.1 General

The following clauses provide information about the existing telecommunication system:

1 The QGEWC Telecommunication System of Qatar Power Transmission System covers transmission of data, tele-protection signals and telephone messages.

The QGEWC telecommunication System consists of 3 networks:

(a) Data communication network
(b) Tele-protection signalling network and
(c) Telephone network

2 Communication lines of newly relocated 132, 66 and 11 kV cables shall be connected to QGEWC Telecommunication System on the same principles of existing system. Each EHV and HV circuit shall be accompanied by a fibre optic cable, which will be connected to the communication equipment in each respective location. The fibre optic cables will be installed and tested to insure that all tele-protection, data communication, and voice communication systems are maintained as the existing system. All signals between substations shall be retested following installation of new circuits.

35.5.2 Fibre Optic Links

1 Two fibre optic pilot cables along the proposed power cables laid on independent way leaves with two appropriate optical line equipment of capacity of 120 telephone channels and one multiplex equipment shall be applied for connection of Existing Substation, to QGEWC Telecommunication System.

2 Error performance and availability objective from ITU-T Recommendation and Reports has been used as criterion in fibre optic links calculations, as well as:

(a)	Guaranteed BER during life time of the system	10-10
(b)	System margin (dB)	3

3 Requirements for fibre optic cable and accessories are given below under the heading entitled "35.16 Fibre Optic Cable and Accessories".

35.6 CROSSING WITH OTHER UTILITIES AND INTERFERENCE WITH PIPELINES

35.6.1 General

1 In case of crossing with the other installations the following have to be observed:

(a) Clearances between installations shall be according to "Guideline for Planning Works in the Vicinity of EHV Installations", issued by QGEWC (old MEW), May, 91.
(b) The service authorities may imply additional requirements (mechanical protection, etc.) through the work permit procedure. This has to be complied with by the Contractor, and it is considered included in the Contract price.
(c) In case of the crossing with the other heat sources the special attention shall be paid to cable current rating calculations, and additional measures have to be applied.

2 At the crossing with the existing installations the new cable shall be preferably installed beneath, always taking into account the current rating requirements. If necessary, the phase spacing could be increased at the crossing point.

3 After opening of the existing installations and before cable laying, the sketch of the final arrangement shall be approved.

4 Each crossing point shall be clearly marked with the route markers, after backfilling.

5 In case of running parallel with pipelines, the Contractor shall carry out the following checking before starting installation works:

(a) calculation of the induced voltage on the pipeline for the normal working conditions and earth fault conditions
(b) influence due to galvanic coupling between the installations
(c) checking of influence on the pipeline cathodic protection system
(d) possibility of the accelerated corrosion of the metallic structures of the cable line
(e) any requirement arising from these calculations shall be implemented by the Contractor, and are deemed included in the Contract price.

35.7 CIVIL WORKS CRITERIA

35.7.1 General

1 Two circuits in one trench shall be accepted only following QGEWC's approval of the clearance requirements.

2 Method of laying is direct burial in ground with exception of the road crossing where cables are to be laid in ducts. The supply and installation of the supporting structures is part of this Contract.

3 Concrete pits and tunnels/trenches at road crossing and area subject to traffic shall be designed for the maximum wheel load of 6T. (maximum axle load of 12.5T).

4 Concrete structures at and below ground level are to be constructed using sulphate resistant cement only.

5 All foundations and concrete surface at and below ground level are to be isolated from contact with soil in accordance to QGEWC specifications.

The cable route is mainly located parallel with existing or proposed roads, and in principle agreed with the concerned authorities.

35.7.2 Cable Laying Condition

1 The cables shall be laid in flat formation.

2 The material surrounding the cable in its trench must not damage the cable surface and must be suitable for restraining the cable against any thermal expansion or traffic induced movements and, also must be suitable for thermal dissipation from the cable to its surrounding. The material commonly used in Qatar is dune sand. Bedding material must be sufficiently dense to ensure that the value of thermal resistivity of cable environment should not exceed 2.5°K - m/W even if dried out due to cable loading. The compaction of backfill to obtain a low thermal resistivity is usually carried out with vibrating plates and punners. The cables shall be laid on approximately 200 mm of sand fill, which will be placed to form a bed for a cable. Upon completed laying of a cable it shall be covered with additional sand layer 200 mm thick above the top of the uppermost cable.

3 The reinforced concrete slabs are to be used as mechanical protection over the cables. They shall be carefully centred over the cables, and each cover being closely interlocked with the adjacent covers along the entire length of cable.

4 The width of protective covers shall be enough to overlap cable circuits on both sides with 100 mm at least. Cable slabs shall be covered with a 50 mm layer of dune sand followed by 250 mm of backfill over which PVC warning taped shall be laid.
Semi-permeable membrane shall be provided where the water table is found above the cable laying depth.

5 QCS requirements shall be applied where necessary. After installation of the cables, regularly spaced markers will identify the routes. Route markers are required at both ends of joints crossing points, location where route changes direction at both ends of road crossing ducts, locations where site repairs have been carried out to the approval. Different designs of route markers will be required to suit: (a) unmade ground, (b) paved areas, (c) landscaped areas. Route markers shall be installed at specific intervals of about 50 m.

6 Before commencement of excavation works, opening of trial pits shall be carried out at points where obstacles or crossings with other underground installations might be expected and final cable route and method of cable laying shall be determined after this checking. Appropriate sketches/drawings shall be submitted for approval for each crossing before commencement of cable laying.

7 On road crossings cables are to be laid in PVC ducts embedded in concrete 1:3:6 to enable fastest repair of carriageways and easier replacement of cable in case of cable fault. Also on crossings with the proposed roads cable are to be laid in ducts. Continuous ducts length shall not exceed 30 m. Before commencement of excavation works it is necessary to install all ducts under the future streets at cable crossings which shall be extended by at least 1 m on either side of the crossings, to prevent damage to the cables during the construction of the streets. At all crossings one set of spare ducts for each cable circuit shall be provided to avoid future excavation on roads.

To maintain thermal resistance in ducts equal to the adjacent directly buried sections, pumpable filling materials have to be used. Bentonite mixture with a small quantity of cement or similar materials can be used. This material has to be such that it is easily removable. Sample of mixture shall be prepared and tested for thermal resistivity and easy removal before its acceptance for implementation.

8 The procedure of applying for cable route approval shall be as per QGEWC requirements and shall be carried out prior to the commencement of the installation works.

9 The former Ministry of Municipal Affairs and Agriculture specifications shall be used as a guide for the reinstatement of road works, unless specified otherwise by the Engineer.

10 The cable route shall follow the hierarchy specified by QGEWC. Route drawings shall be produced by the Contractor and shall be detailed and accurate in order that they offer easy reference to locate the cables exactly at a later date, by showing the arrangement of cables as laid with complete information regarding their depth, joint locations, services crossed, their location with respect to adjacent permanent structures, etc.

11 Position of each joint bay shall be exactly determined during route identification. This position thus chosen shall be easily accessible for installation works and later for maintenance of the installations.

35.7.3 Cable Joint Bay - Arrangement

1 Joint bay shall be constructed with concrete floor on which the finished joint rest and with width sufficient to allow an increase of spacing between the phases within the joint bay as compared with that in the cable trench.2 This increase of spacing is necessary for the practical reasons to allow adequate access for the jointer to carry out his work but is also necessary for thermal reasons to avoid excessive temperatures within the joint. Joints shall be staggered fully and segregated, and mounted on concrete supports. The final arrangement shall be submitted for approval.

3 Cables have to be supported in the length between the point where they enter the joint and the floor of the trench. Concrete blocks with clamps may be used under the cable and joint for their support. The joint bays shall be filled with fine dune sand.

Covers of joints, pits, etc., should carry truck load 6T per wheel (and the specified axle load). They shall be of removable type with facility for lifting.

4 Pilot cable joints shall always be located at the main cable joint pit and shall include the laying or re-make loop at each joint.

5 Each joint bay has to be properly marked.

35.7.4 Soil Thermal Condition

1 The soil thermal conditions are assumed as follows:

2 Maximum temperature of soil at 1.2 m depth: 40 °C

3 Maximum thermal resistivity of ground: 2.5°K- m/W

4 In the calculation of current rating, the soil has been assumed to have constant thermal resistivity of 2.5°K - m/W regardless of the heat input from the cables. The Contractor shall maintain this figure even in case of the moisture migration and completely dry soil.

5 The main factors determining thermal resistivity are: composition density, moisture content and degree of saturation, burial depth of cables and soil and cable surface temperature.

6 The Contractor shall check these factors at two stages:

(a) The Contractor shall carry out tests of soil characteristics along the cable route prior to excavation of trenches. These tests shall be carried out at as many points as are dictated by variations in soil material and levels, and in any case at each trial pit.
(b) Upon completed trench excavation, the Contractor shall, if and when required so by QGEWC, test the thermal properties of the soil in an open trench.
(c) The costs of these tests are deemed to be included in the installation costs of the Contract price.
(d) Each test shall comprise the excavation of a trial pit down to 1.3 m depth and the measurement of soil thermal properties and its temperature and moisture content.
(e) A sample of soil shall also be taken from the trial pit for further laboratory analysis if required by QGEWC.

7 After completion of the trial tests specified, the Contractor shall submit his proposals for meeting the requirements for a maximum net thermal resistivity as specified, for approval by in case of crossings with the other installation the following have to be observed.

(a) Clearances between installations shall be according to "Guideline for Planning Works in the Vicinity of EHV Installations", issued by QGEWC (old MEW), May, 91.
(b) The existing installation authority may imply additional requirements (mechanical protection, etc.) through the work permit procedure. This has to be complied with by the Contractor, and it is considered included in the Contract Price.

(c) In case of the crossing with the other heat sources the special attention shall be paid to cable current rating calculations, and additional measures have to be applied.

8 Ministerial Circular No. 6 (with all latest revisions and additions) shall be followed for working in the vicinity of power cables.

9 At the crossing with the existing installations, the new cables shall be preferably installed beneath, always taking into account the current rating requirements. If necessary, the phase spacing could be increased at the crossing point.

10 After opening of the existing installations and before cable laying the sketch of the final arrangement and method statement shall be approved, before cable installation.

11 Each crossing point shall be clearly marked with the route markers, after backfilling.

12 In case of running parallel with pipelines, the Contractor shall carry out the following checking before starting installation works:

(a) calculation of the induced voltage on the pipeline for the normal working conditions and earth fault conditions
(b) influence due to galvanic coupling between the installations
(c) checking of influence on the pipeline cathodic protection system
(d) possibility of the accelerated corrosion of the metallic structures of the cable line
(e) any requirement arising from these calculations shall be implemented by the Contractor, and are deemed included in the Contractor Price
(f) the minimum size of cable trench is specified in the Contract Drawings, but the Contractor may propose and increase this size to meet his obligations with no extra cost.

13 During the construction (backfilling) before placing the material in the trench. This checking could be repeated during the cable laying at the discretion of QGEWC.

14 During the site survey the trial pits shall be opened and the following measurements shall be taken:

(a) ground temperature
(b) moisture content
(c) thermal resistivity

15 The location of the trial pits shall be chosen based on the local soil conditions as well as at the zones where other services are expected to decide exact cable routing.

16 The measurement results shall be provided in the form of chart with the cable length on X-axis and other parameter shown on the Y-axis for each measured location. This will enable identification of the hot spots along the route.

17 Prior to placing in the trench, the backfilling has to be confirmed through the site tests and current rating calculations before it is approved for application.

35.8 TESTING

35.8.1 132 and 66 kV Cables

1 Apart from the testing requirements specified herein, the Contractor shall coordinate with QGEWC for additional testing requirements.

35.9 SEALING ENDS

35.9.1 General Construction

1 The cable termination shall be of an approved and reliable design. Terminating proposals shall be made available by the Contractor before the final approval on the equipment design. Satisfactory type test certificates shall be submitted to the Engineer. The Contractor shall be obliged to carry out one example termination to demonstrate satisfactory performance of the same in gas and oil tight enclosures under all conditions of maximum and operating pressures as well as during testing.

2 The termination shall be designed to restrict the voltage gradients to the safe values both inside and outside the termination and shall be compatible with the SF6 switchgear or transformer cable box.

3 The terminations shall be complete with suitable supporting and lifting arrangements. The design shall be such that stresses due to expansion and contraction in each part of the insulator and fittings shall not lead to the development of defects.

4 The design of all terminations (if any) shall be such as to permit easy cleaning.

5 The termination shall be solid type or filled with oil of an approved type compatible with the main cable insulation. The design shall be such as to prevent the formation of air spaces and air pockets during filling. Means shall be provided to ensure that the filling medium is maintained under pressure if required during the termination procedure. External oil expansion tanks are not permitted.

35.9.2 Accessories

1 Disconnecting link box shall be provided on all sealing ends terminating metallic sheathed cables. Earthing clamps shall be fitted to all boxes.

2 A separated earth terminal of adequate dimensions shall be provided on the main metalwork of all termination points.

3 Supporting structures for all cable terminations shall be provided as part of this Contract. They shall be of an approved design and as appropriate.

4 All steelwork shall be galvanized in accordance with BS 729 and the requirements specified in the QCS and herein.

5 Foundation bolts and plates or steel stubs shall be provided and shall be firmly keyed and grouted into foundation blocks. Complete details of the structures with dimensions and loading shall be provided by the Contractor to enable the foundation design to be checked. Responsibility for final grounding and levelling of the structures and co-operation with the other contractors shall form part of this Contract.

6 All steel structures shall be provided in accordance with the requirements of Section 16 of QCS.

35.9.3 Execution

1 Support structures adjacent to the termination shall be earthed against accidental touch (in accordance with IEEE 80).

2 The Contractor shall liaise with manufacturer of existing switchgear to obtain details of equipment into which the new cables would be terminated in order to clarify the design and manufacture of the cable termination and its enclosure.

35.10 EHV CABLE JOINT

35.10.1 General Construction

1 All cable joints shall be of an approved and reliable design.

2 Complete description and instructions for the jointing method to be used at site shall be submitted before equipment approval. The instructions shall contain information concerning jointing of the cores, copper to copper, insulation, semi-conductive layers, metallic screen or sheath, sheath covering, bedding, etc.

3 The Contractor shall provide joint boxes to protect the joint under all conditions of service and the joint boxes shall be designed to exclude ingress of moisture and all foreign matters.

4 The Contractor shall note that the specially constructed jointing bays are required and shall recommend horizontal distance and staggering to be maintained between joints of adjacent cables. Full details of joint bays shall be submitted by the Contractor.

5 For the 132 kV circuits, the Contractor will lower the existing joints and link boxes in the new underground joint chamber, in coordination with QGEWC. The link boxes will be disconnected and re-connected in the new location. All existing components of the existing link boxes will be safeguarded and protected to insure proper relocation.

35.11 BONDING OF METALLIC SHEATHS

35.11.1 General

1 The metallic sheaths of the 132 and 66 kV cables shall be specially bonded (i.e. sectionalising cross bonding method shall be applied).
The installation shall fully comply with Engineering Recommendation C.55/4 issued by Electricity Association, 1989.

2 The conductors and sheath of single-core 132 and 66 kV cables shall be successively transposed at each joint pit location.

3 The cross-bonding system of the single-core 132 and 66 kV cable sheath circuit as well as design of the relative individual accessories shall be subject to the approval. Insulation flanges at each joint are required to simplify fault locations at the cable sheath.

4 The standard delivered drum length shall include a maximum tolerance of approximately ± 50 metres for achievement of perfect cross bonding and the pertinent calculation shall be submitted with the approved cable route.

35.11.2 Execution

1 The cable sheaths shall be directly earthed through link boxes at every third joint pit and at terminations.

2 At intermediate joints the sheaths shall be earthed through voltage limiters to limit steep-fronted transient over voltages to a value which can be safely withstood by the sheath insulation (i.e. in addition to the cable over-sheath this includes external joint insulation, terminal base insulation, sheath sectionalising insulation if any, as well as the insulation of the bonding leads and link boxes themselves). The specification of surge voltage limiters is given in clause 2.10.

35.11.3 Characteristics

1 The bond connection must be able to carry the normal sheath current as well as the maximum fault current without undue heating. The completed bonding system shall be subject to a test after installation. The cables used for cross-bonding leads shall be of a twin conductor concentric design with an inner insulation of PVC or XLPE and an outer insulation of PVC.

Earthing at each joint location shall comprise of tinned copper wires and insulated copper earth connections of not less than 300 mm² copper cross section, all supplied and installed by the Contractor complete with stainless steel link boxes at each joint and cross-bonding links. All DLBs shall be housed in reinforced underground concrete pits necessary for easy access and disconnection to facilitate periodical serving tests.
Lids of concrete pits shall be made of steel reinforced concrete with two handles sufficiently strong to the weight of lids used. These shall move freely and shall not project after being placed in position. They shall be designed for heavy traffic loading.

2 The size of lead covered copper earth cable shall be adequate to carry the full, expected fault current for the cable system.

3 The individual ground resistance at each earthing point shall not exceed 5.0 ohm and shall comply with requirements of IEEE 80. Where necessary, additional earth rods shall be provided to obtain this value.

35.12 LINK BOXES

35.12.1 General

1 All link boxes shall be designed, manufactured, tested and supplied as per Engineering Recommendation C.55/4 – Insulated Sheath Power Cable Systems.

2 All bonding links and SVL shall be housed in stainless steel boxes, which shall be earthed by connection to the adjacent earth electrode system. Voltage Limiters (SVL) and associated links shall be housed in a common box. Cross bonding link boxes shall be buried, horizontal type with diving bell lids suitable for installation in shallow pits below ground surface. Cross bonding cabinets shall be mounted clear of the bottom of pit.
The highest point of a pit-mounted box shall be not more than 1m below ground level.

35.12.2 Characteristics

1 Link boxes shall be water and dust proof, with protection class IP 65. The lid of each box shall have a label fitted externally bearing the Company's standard message. The label shall also give circuit identification details.

2 Phase identification label shall be provided adjacent to each terminal.

3 Link boxes shall be lockable and supplied complete with padlock and keys to suit master series.

4 The containment of the link box shall be designed so that it can withstand the effects of at least a moderate power arc. The insulation between links must be capable of withstanding the following voltages, with an additional margin of 25%.

(a) DC voltage of 10 kV, used for maintenance testing of the sheath insulation,
(b) Highest 50 Hz voltage arising between sheaths during a system fault,
(c) A 1.2/50 microsecond impulse voltage with a maximum value equal to the protective level as stated in C55/2 Recommendation.

35.12.3 Execution

1 Bonding cable entries at sealing end terminations shall be from bottom only and shall be gantry mounted.

2 Inside the box, cross bonding connection shall be made by links, which shall be removable to allow voltage testing of the cable sheaths. The links shall be able to be removed for testing without distributing the cable leads.

35.13 BONDING LEADS

35.13.1 General

1 All bonding and earthing leads shall have PVC insulated stranded plain copper conductors and shall be of concentric construction.

2 Design of bonding leads shall be based on data given in paragraph 1 above. Electrical criteria,Cross section of copper conductors shall be sufficient to meet the imposed short circuit duty without excessive temperature rise, but not less than 300 mm². Relevant calculations shall be made according to IEC Recommendation Nos. 949 and 986. The electric strength between inner and outer conductors must be consistent with the electric strength of the joint sleeve-sectionalising insulator, both at power and impulse frequency. The insulation level between outer conductor and ground must be half this value.

3 The exterior surface of all bonding leads shall be coated with graphite to serve as an electrode for voltage testing. The outer insulation shall be embossed with words as per Company's Standard.

4 All concentric leads shall be as short as possible, and no bonding lead shall exceed 10 metres in length.

35.14 SHEATH VOLTAGE LIMITERS (SVLS)

35.14.1 General

1 The Sheath Voltage Limiters shall be of gap-less type arrester (zinc oxide type) with the characteristics of the non-linear resistor. SVL shall be star connected with the star point normally earthed.

2 The SVL unit must be capable of continuously withstanding the sheath standing voltage applied to it during full load or emergency overload.

3 The unit selected for service in each and every situation shall be such as not to be endangered by the calculated impressed voltage resulting from the maximum prospective short circuit current in the cable system.

4 When subjected to transient currents up to 10 kA, their residual voltage must not exceed approximate 10 kV. It must be capable of dissipating without damage the energy developed in case of switching associated with faults external to the cables.

35.15 CABLE TILES, WARNING TAPE AND ROUTE MARKERS

35.15.1 General

1 Refer to QCS Section 21, Part 25 or as specified by the Engineer.

35.16 FIBRE OPTIC CABLE AND ACCESSORIES

35.16.1 General

1 This item contains equipment requirements for pilot fibre optic cable and accessories. Design criteria shall be in accordance with IEC (793-1, 2 794-1, 2) and ITU-T (G.652) recommendations as well as Telecommunication system requirements, as given above. Type test certificate for FO cable is required.

35.16.2 Characteristics

1 Fibre Optic Pilot Cable

(a) Operating conditions:

Type of optical cable	metal-free, with single mode fibres	
Number of optical fibres	min. 12	
Refractive index profile	matched	
Cut-off wavelength	at 1.300 nm	at 1.550
	1.100 to 1.280 nm	1.350 to 1.580 nm
Operational wavelength window	1.300 or 1.550 nm	
Attenuation coefficient (dB/km)	at 1.300 nm	at 1.550 nm
	≤ 0.40	≤ 0.25
Dispersion coefficient (ps/(nm-km))	at 1.300 nm	at 1.550 nm
	≤ 3.5	≤ 20
Temperature dependence		
Range 0 °C to 40 °C (dB/km)	< ± 0.05	
Application	trunk or junction networks, for transmission speeds up to 565 Mbit/s	

(b) Installation data:

Laying arrangement	"below in" of cables in HDPE ducts (40 mm) buried in ground along with power cables, under roads in PVC ducts 100 m
Depth of laying	1.0 to 1.5 m
Width of the trench	depending on power cable formation
Maximum soil temperature at 1.2 m depth	40 °C
Maximum pulling force	1.000 N
Minimum bending radius	400 mm

(c) Cable Construction Data:

Type of optical fibre	single mode
Mode field diameter	9.5 ± 0.5 µm
Mode field non-circularity	max. 6%
Mode field concentricity error	1 µm
Cladding diameter	125 µm
Cladding non circularity	max. 2%
Primary coating	acrylate or silicon
Diameter over primary coating	250 ± 10 µm
Type of secondary coating	Loose-buffered
Type of central strength element	fibre-reinforced plastic material
Peripheral tensile strength elements	high-tensile plastic and/or glass yarns
Type or belt insulation	PVC tapes
Type of outer sheath	PVC
Type of anti-termite protection	"rigid" plastic over the cable sheath
Typical delivery length	up to 4.000 m (usually 2.100 ± 100 m)
Fibre optic joint closures	

2 Fibre optic joint closures for fibre optic communication / pilot cables (if any) shall have following characteristics:

Splice capacity	min. 12 fibres with a loose buffered
Installation alternatives	direct buried, in manholes, on portal support
Attenuation	max. 0.1 dB/splice

3 Optical terminal boxes for fibre communication and approach cables shall have the following characteristics:

Splice capacity	min. 12 fibres with a loose buffered
Installations	wall - mounted type
Attenuation	0.5 - 1 dB/per connector
0.1	dB/per splice
Optical connectors	F.C. - P.C. type

35.17 INSTALLATION REQUIREMENTS

35.17.1 General

1 The arrangement of cables and all methods of laying and installation, including any special methods, which may be necessary, shall be subject to approval of QGEWC.

2 Each length of cable and joint bay shall be allotted a distinctive and separate reference number. This number shall appear on the test sheet covering the respective length of cable, shall be clearly marked on the cable drum on which the cable length is delivered to site. It shall be referred to in invoices and Advice Notes and recorded on the route plans.

3 The cables may be laid directly in the ground, installed in cable trenches, shafts, pipes, ducts on concrete troughs or on racks in air in accordance with the route requirements and approved installation practices.

4 Adjacent to terminations and joints the cables shall be laid in a loop or snaked in the ground in order to provide approximately 3 metres spare length on each side to facilitate re-termination and re-jointing at a later date, if necessary. It may not be possible, however, to loop the power cables adjacent to terminations due to the dimensions allocated for the cable route and this requirement will therefore be assessed by QGEWC on a case-by-case basis.

5 The Contractor shall ascertain from the cable manufacturer, the limitations of the PVC over-sheath with respect to exposure to sunlight and the maximum temperature for cable laying governed by the tensile strength of the over-sheath at high ambient to QGEWC in writing and approval of the method of repair must be obtained. The position of the damage must be accurately recorded prior to commencement of repair.

6 Only damages to outer PVC sheath shall be permitted for repairs.

7 The depth of laying cables from the surface of the ground to the top of the cable must satisfy the requirements of the Local Municipality and relevant Statutory Authority. The said depth shall not be less than 1.1 m.

8 It shall be measured from the ground level to the upper surface of the top most cable. This depth may be increased in selected parts of the route or locally to avoid other service installations. On the Central Reserve and on the foot path the depth shall be measured from the Finished Road Level.

9 Unless it has been agreed that the construction of cables is such as to permit laying at sub-zero temperatures, cable laying shall take place only when the ambient temperature is above 0 °C and has been at this temperature for at least 24 hours, and approved special precautions have been taken to keep the cable above this temperature to avoid risk of damage during handling. Cabling laying shall not be permitted above ambient temperatures recommended by the cable manufacturer.

10 All cables shall be installed with a bending radius not less than that recommended by the cable manufacturer.

11 All combustible outer coverings of cables installed within buildings shall be protected against the spread of fire in an approved manner. Cables passing through floors shall be installed in the manner specified and where required shall be sealed into bushes employing fire resisting material to minimize the risk of spreading fire.

12 Where PVC sheath cables are to have a flame-retardant paint finish applied this shall be applied after completion of cable glanding and termination.

13 All cables specified under this Contract shall be installed in an approved manner. Pilot cables shall be installed in the same trench as power cables.

35.17.2 Provision of Labour and Skilled Supervision

1 The Contractor shall be responsible for providing all labour and skilled supervisors for handling equipment, and laying cable in accordance with this Specification.

2 The Contractor shall also provide the necessary trained staff and tools for terminating and jointing all cables supplied and laid under this Contract.

35.17.3 Responsibility

1 The Contractor shall be responsible for all Site Works associated with the Contract Works, installation and termination of all cables in accordance with this specification.

35.17.4 Trial Pits

1 Trial pits shall be carried out at approved positions proposed by the Contractor, early enough to check the data of the Drawings, to make sure that passage is possible and to determine the most suitable detailed route and position for the trenches and to ascertain the original soil properties. They shall be kept open until QGEWC inspects them and lets the Contractor know it's decision about definitive route adjustment.

35.17.5 Method of Cable Laying

1 The procedure of cable laying shall be subject to QGEWC's approval.

2 Unless instructed to the contrary by QGEWC, the Contractor shall lay cables direct in the ground in the following manner:

The material surrounding the cables, between trench floor, walls and cable titles, shall be at least, 150 mm of sand or other approved material free of stones or any other material likely to damage or penetrate the cable outer sheath. It may be necessary to use an approved semi-permeable membrane to avoid migration of the fill under wet conditions.

The backfill in the reminder of the trench shall be adequate to meet the required thermal resistivity value as specified. A high degree of compaction is required, sufficient to restore and maintain thermal resistivity levels equal or better than undisturbed ground.

At the direction of QGEWC, the Contractor shall remove any material, which is considered harmful, and replace it with an approved backfilling material, if the thermal resistivity of this material can rise above 2.5° Km/W, the Contractor shall provide calculations to ensure that effective external thermal resistivity shall remain below the specified value under all operating conditions.

3 The results of all tests shall be logged and shown on as-laid records of the route.

4 After any cable has been laid and until the whole length of the cables to be laid in the trenches have been covered with protective covers, no sharp metal tools such as spaces or facing stakes shall be used in the trench or placed in such a position that they may fall into the trench. The protective covers shall consist of interlocked slabs of the hydraulically pressed concrete or other approved material of approved dimension and of ample width to protect the cables.

5 If more than one cover is required to cover a group of cables, the width for the covers shall be such that the longitudinal joint between adjacent covers shall be placed above the space between the groups of cables and not immediately above a cable. The position of cables or groups of cables in a trench shall be staked out once the cable has been laid so that covers may be placed in the correct position when the top layer of riddled soil or dune sand has been applied. The width of the cover or covers shall be such that there is a minimum 100 mm overlap on each outside edge of the cable or group of cables.

6 A provisional sheath test shall be carried out for every section before backfilling over the cable tile.

7 The route markers shall be installed as specified by the Engineer. Where, in the opinion of QGEWC, the soil
on-site is unsuitable for ridding or back-filling, the Contractor shall arrange for the importation of suitable material (at Contractor's own expanse), which shall be subject to approval of QGEWC.

8 The Contractor shall take all reasonable steps to ascertain where the cables and associated corrodible materials may be subjected to chemical or electrolytic action and shall submit his recommendations for special precautions to the Engineer for his approval.

9 Where auxiliary cables are laid under the same covers as power cables, there shall be at least 75 mm of riddled earth between the two types of cables.

10 The position of the cables and joints shall be recorded on the route plans. The route shall be identified by means of a grid with at least two reference points for each length of straight cable run.

11 The distance between the centres of power cables and power cable circuits shall be in accordance with the cable manufacturer's specification and recommendation. The Contractor shall be responsible for obtaining the correct spacing parameters from the cable manufacturer and details of installation limitations from QGEWC to ensure cables operation at the pre-determined operation temperatures when installed.

12 The Contractor shall be responsible for obtaining values of the minimum bending radii for all cables required under the Works from the cable manufacturer prior to the commencement of installation.

13 Rollers used during the installation of the cables shall have no sharp projecting metal parts liable to damage the cable.

14 All cables on vertical runs or horizontal runs in the vertical plane shall be cleated.

15 The Contractor shall provide all necessary pulling tools and equipment such as jacks, shafts, rollers, self-driven rollers, pulling cords, etc. including any required power for this equipment. The procedure for unwinding and pulling the cables shall be approved by QGEWC. Pulling by use of stockings is not allowed.

16 The Contractor shall strictly conform to the prescriptions given by QGEWC for all handling of cables and their accessories.

17 The Contractor shall have as many men as necessary for all pulling and supervising operations to be carried out according to the best procedure. The number of men shall be stated in the cable laying procedure and approved by QGEWC.

18 The Contractor shall be solely responsible for any damage due to the carelessness of his staff or workmen. Any cable length so damaged shall be rejected as destroyed.

19 Mechanical pull with a winch solely from one end will be only in special cases because of the cables greater fragility. The self-driven cable rollers shall be used for installation of power cables.

20 Extra snaking 3.0 m length at termination and joints location shall be provided.

21 The Contractor shall allow for installation of permanent thermocouples for sheath temperature test in his Contract Price. At least one set of permanent thermocouples shall be installed at every 3 000 m. The locations, number and arrangement of testing (the number of thermocouples at each location shall be at least seven) shall be submitted to QGEWC for review and approval, prior to installation.

35.17.6 Excavation of Trenches

1 The Contractor's attention is drawn to the procedures and requirements detailed in the Contract Documents and Specifications.

2 The exact location of each trench shall be approved on-site. Trenches shall be kept as tight as possible and each trench shall be excavated to the approved formation and dimensions and shall have vertical sides which shall be timbered or otherwise secured where necessary so as to avoid subsidence and damage to all walls, roads, sewers, drains, pipes, cables and other structures. Timber and other material for this purpose shall be supplied by the Contractor.

3 The depth of all excavations for trenches shall be measured from the surface of the ground and the width of the trench shall be measured between the vertical sides of the trench or between the inside faces of the sheeting (if any).

4 The bottom of each trench shall be firm and of smooth contour. The Contractor shall take reasonable precautions to prevent damage to the road or highway or ground surface from a slip of breaking away of the sides of the trench. Where trenches pass from a footway to a roadway or at other positions where a change of level is necessary, the bottom of the trench shall rise or fall gradually. The rate of rise or fall shall be approved.

5 It is the Contractor's responsibility to ensure that he is acquainted with the nature of the ground conditions prevailing along the cable route and the installation rates of the cables shall include for any and all types of excavation and backfill on the "as found" basis.

6 The Contractor shall deal with and dispose of water to prevent any risk of cables and other materials to be laid in the trenches being adversely affected. He shall provide all pumps and appliances required and shall carry out necessary pumping and baling.

7 Unless otherwise agreed, provision shall be made during excavation and until interim restoration has been completed for reasonable access of persons and vehicles to property or places adjacent to the route.

8 When the excavation for trenches has been accurately executed, the relevant notice shall be given by the Contractor to QGEWC. Laying of cables, shall not be started until the Contractor has obtained the QGEWC's approval to proceed with the work.

9 The maximum length of trench open at any time shall be as per Traffic Police and PWA regulations. It should not cover more than one drum length.

10 The Contractor shall not work in any area where other underground services are still covered. QGEWC shall have the right to stop the work or part of the Works where the Contractor fails to take the necessary measures to uncover these utilities and the Contractor shall not claim for additional compensation in time or money.

11 The Contractor shall perform all hand excavations, protection and other work as specified herein or as required to locate existing utilities and services within the limits of this Contract, or at off-site locations as designed by QGEWC and in accordance with the requirements of all Contract Documents. The existing utilities and services referred to herein shall include, but shall not be limited to all sewers, water mains and lines, gas mains, electric (both power and lighting), telephone and such others as may be encountered under this Contract.

12 The Contractor shall notify the concerned Municipality and other relevant authorities in good time of his intention to excavate sections of road, which include plantation and shall not start digging before getting approval from PWA. All works shall be done according to the rules and regulations from the relevant department of the PWA.

13 During the execution of works related to laying of cable lines within gardens and road landscaping areas, the Contractor shall comply with the following rules and regulations:

(a) Power cable lines shall not be closer than a horizontal distance of 1.50 m to the nearest tree trunk axis.
(b) The details of the irrigation lines shall be obtained from the PWA.
(c) The approval to the excavation works shall be obtained from the PWA.
(d) Branch irrigation lines are usually laid at a depth of 60 cm from ground level.
(e) The Contractor shall bear the full expenses of reinstating the disturbed irrigation lines network to its original shape existing before the start of the excavation works. Approval from the relevant authority of the quality of the agricultural clay soil to be reinstated and its levelling procedures shall be provided by the Contractor.
(f) The Contractor shall bear the full expenses incurred in the process of removal of the plantations, their subsequent reinstatement as well as the cost of the plantations within the excavation zone.
(g) The Contractor shall include the cost of relocating the path of the irrigation lines or the cost of irrigation of the plantations, if necessary.
(h) QGEWC shall withhold payment of the dues of the Contractor until a confirmation from the relevant authority to the effect that the Contractor has abided by the above-mentioned rules and regulations is obtained. Such confirmation shall be given either in writing it through a site meeting.

14 The Contractor's attention is drawn to the following:

(a) He must use all necessary precautions and protective measures to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the Contractor shall take adequate measures to prevent undermining of utilities and services, which are presently in service.

(b) He must protect existing or new utilities and services when considered necessary and as directed by QGEWC. The Contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement of drainage. The protection of utilities and services as specified herein, will not be paid for separately but shall be considered as subsidiary obligation to the work under this Contract unless specified otherwise by the Engineer.

(c) The Contractor shall not remove any utility or service line, conduit or any structure, above or below the ground, within the limits of the works before receiving written permission from QGEWC.

(d) The Contractor prepares appropriate drawings for protection work of other utility services and shall obtain the approval of the appropriate utility authorities before commencing the construction.

(e) The Contractor shall not interfere with supplies and services of whatsoever nature such as but not limited to water, electric power and light, telephone, buried cables and sewerage. If any such supply or service is damaged as a result of the Contractor's actions, the Contractor shall report it to the owner of the supply or service immediately.

(f) The Contractor shall be responsible for any damage caused to such supplies or services as the result of his operations and shall fully indemnity and keep indemnified the PWA, the Engineer, QGEWC and the owner of such supplies and services for all consequences of the damage of whatsoever nature.

(g) The method of execution of repairs shall be decided by the owner of the supply or service and shall be carried out by the Contractor at no extra cost.

15 In cases where the excavation is to be made on asphalt, paved or concrete roads and/or pavements, the asphalt or concrete surfacing shall be cut using a suitable disk cutter at a depth of not less than 120 mm. The Contractor shall take all necessary measures to minimise damage of the asphalt beyond the width of the excavated trench. Reinstatement of roads is to be as per the requirements of the latest issue of the "Code of Practice and Specification of Road openings in the Highway" or as specified by the Engineer.

16 The method of cutting of road surfacing is essential and shall be strictly adhered to.

17 The use of an air compressor and associated cutting tools will not be allowed.

18 There shall not be any soil classification for excavating either in soft or in hard material. The Contractor is responsible for obtaining information he considers necessary regarding the possibility of encountering soil with varying degree of hardness, and shall be deemed to have allowed for it in his Contract price.

18 The excavation of hard material, if any, shall be carried out by pneumatic tools. Blasting shall not be allowed under any circumstances.

20 All trenches shall be excavated with vertical sides to the width, lines, grades and depths as shown on the Drawings or as specified in writing by QGEWC.

21 All excavations shall be adequately supported and kept free from water from any source at the Contractor's expense and to the satisfaction of QGEWC.

22 Any over-excavation shall be backfilled with suitable fill material and completed in accordance with the specifications. Where directed by the Company such over excavations shall be backfilled with mass concrete at the Contractor's expense.

23 The unsuitable or surplus excavated material shall be removed, to an area approved by the PWA, by the Contractor and at his expense.

24 The Contractor shall take all necessary security measures, such as signs, lights, supports, etc. and generally comply with the recommendations and requirements of the relevant authorities and/or Police in order to avoid accidents, landslides and other damages.

25 The closing of roads should be avoided. Where this is unavoidable the Contractor shall obtain the approval of the relevant authorities.

26 Prior to commencement of excavation the Contractor shall survey and submit the existing ground levels.

35.17.7 Excavated Material

1 The material excavated from each trench shall be placed so as to prevent nuisance or damage to adjacent hedges, trees, ditches, drains, gateways and other property, objects or things. Excavated material shall be stacked so as to avoid undue interference with traffic. Where, owing to traffic or other considerations, this is not permissible, the excavated material shall be removed from the Site and returned for refilling the trench on completion of laying. Surplus materials shall be disposed of by and at the cost of the Contractor as specified by the Engineer. Surplus material shall never be left on-site for more than one week.

2 Excavated material shall be stacked at a minimum distance of 300 mm from the edge of the trench to provide a walkway and eliminate risk of stones falling in the trench.

35.17.8 Galvanised Support Built In

1 Where required for security of the Works and adjacent buildings or structures, the galvanized support shall be placed in trenches and built in as QGEWC may instruct or approve and shall form part of the Works.

35.17.9 Obstructions

1 When, in the course of the Contract Works, obstructions are encountered which necessitate the diversion or alteration to gas, electric, hydraulic, water of sewage mains, or other works, or alterations to buildings, foundations and tunnels, or when conditions necessitate adoption of a special construction of trench, the Contractor shall immediately notify QGEWC.

35.17.10 Filling In and Reinstatement

1 Filling in of trenches shall not commence until QGEWC has inspected and approved the cables and accessories in situ. Such inspection shall not be unreasonably delayed.

2 Where the cable route passes along public roads or pavements or areas designed for future roads or pavement the backfilling shall comply with PWA requirements.

3 All excavations made (whether for the purpose of cable laying or trial holes) shall be backfilled in 150 mm layers. Each layer shall be adequately sprayed with water in such manner that, in conjunction with the means of compaction that are to be used, a density of at least 95% of the dry density at the optimum moisture content shall be achieved. The backfilling and the interim restoration of the upper levels shall be completed to the satisfaction of QGEWC.

4 If the Contractor is required by QGEWC to carry out permanent reinstatement of any portion of the route, the refilled trench shall be temporarily reinstated and left and maintained in a thoroughly safe condition until the work of permanent reinstatement is carried out. On any portion of the route where the Contractor is not required by QGEWC to carry out the permanent reinstatement, the refilled trench shall be temporarily reinstated and left and maintained in a thoroughly safe condition and be in suitable state for permanent reinstatement.

5 The work of permanent reinstatement shall include all necessary keying into the existing surface and shall be carried out to the approval of QGEWC.

6 If at any time road traffic is required to cross the cable trench or route, the part of the trench or route affected by the road crossing shall be permanently reinstated. It shall remain in place until permission is granted by QGEWC to proceed with the road crossing.

35.17.11 Excavation of Tunnels

1 Where required by QGEWC, a tunnel shall be driven, such as will allow ducts, pipes or cables to be laid as specified. The cross section and levels of each tunnel shall be approved, and the Works shall be carried out in accordance with the provisions of the relevant clauses of these specifications.

35.17.12 Cables Drawn Into Ducts and Pipes

1 Cable ducts are required at all road crossings, regardless of whether they are minor or major.

2 Where existing road crossing ducts are indicated on Drawings, their existence or their adequacy for the cable sizes cannot be guaranteed. The Contractor shall clearly understand that the information provided shall be used as a guideline and they shall be responsible for providing necessary ducts and ensure they are adequately sized.

3 On the crossings with the marked future roads, the Contractor shall install the standard ducts arrangement, extending them minimum 1 m beyond the proposed kerb lines into each verge or verge and centre reservation.

4 On the roads less than two years old, open cutting is not permitted. If it becomes necessary, "Thrust Boring" method is acceptable.

5 At all road crossings 50% spare duct arrangement for double circuit and 100% spare ducts for single circuit are required.

6 The Contractor shall provide the ducts and pipes. The Contractor shall remove any loose material from the ducts, and prove them by drawing through a mandrel of slightly less diameter than the duct, immediately before pulling in the cables. A suitable draw line shall be used to facilitate cable pulling. If the pipe or ducts form a tortuous path with friction a suitable lubrication may be used to ease the stress on the cables when pulled. Any lubricant used shall have no detrimental effect on the cables.

7 The Contractor shall reapply graphite coating if it is scraped off while pulling or after the application of a lubricant. Where specified by QGEWC, two split pipes shall fit around the cable. The splits shall be positioned on opposite sides of the cable after its installation.

8 All ducts or pipes, whether in use for cables or not, shall be sealed against entry of water, oil and vermin with a suitable semi-plastic compound supplied and installed by the Contractor after the approval of QGEWC. Cable ducts on the existing road shall be extended 500 mm beyond verge.

9 All ducts, floor bushings, etc. shall be completely filled and sealed at either end. The filling material shall be bentonite mixture with addition of a small quantity of cement to stabilize the gell and sand to improve load bearing. The material shall be pumped into suitably prepared ducts with a cement pump and must be able of being removed by the application of high-pressure water jets. The content of bentonite mix shall be subject to QGEWC's approval.

10 It is preferable that cable ducts are not longer than 12 m, but the maximum allowed length is 30 m.

11 When the cable route is such that changes in direction of pipes do not facilitate a continuous pipe or where a pipe is too long to allow a continuous cable run, facilities shall be made for cable draw pits in which the cables shall be supported and routed in accordance with these specifications.

35.17.13 Concrete Structures

1 Concrete structures for joint-pits, etc. shall be provided and the concrete shall be in accordance with Section 5 (Concrete). Grade of concrete shall be SRC 25. Concrete structures at and below ground level are to be constructed using sulphate resistant cement. All foundations and concrete surfaces at and below ground level are to be isolated from contact with soil in accordance with concrete protection details as specified by the Engineer.

2 Complete designs of joint bays and draw-pits shall be submitted with by the Contractor. Cover slabs for joint-bays and draws-pits and the joint-bays and draw-pits themselves shall be designed by the Contractor and shall allow for a 36 tonne truck to pass over it and axle load of 12.5 tons. The point load under such a condition shall be indicated accordingly.

35.17.14 Guards

1 Where cables are exposed to mechanical damage, sheet steel guards shall be provided to protect them. Detailed drawings of all cable guards produced by the Contractor shall be approved by QGEWC before fabrication has commenced.

35.17.15 Cable Markers and Records

1 Cable markers and other approved means shall be provided to mark the position of each joint and shall also be used in approved positions to show the positions of all cables, pipes and ducts, particularly where they cross a road, or are laid along a road or where there is an abrupt deviation on the route, and such cable markers shall be erected as reinstatement is being carried out. At road crossings permanent markers shall be provided on both sides of the crossings in the event of damage to or removal of one of the markers.

2 The Contractor shall supply as soon as possible after installation two copies of the route plan showing the certified depth and position of all buried cables including these laid to the specified instructions of QGEWC. An up-to-date copy must be available at site at all times.

35.17.16 Tests During Cable Laying

1 During the process of laying, the Contractor shall subject the cable and other accessories to the provisional sheath test for every section, before backfilling over cable tile.

35.17.17 Cable Routes

1 The Contractor shall verify all the cable routes through Design Enquiry Letter Procedure with the QGEWC.

2 The Contractor shall apply for access to all cable routes, prior to commencement of works.

3 The procedure of applying for cable routes shall be the responsibility of the Contractor. Based on trial holes and information obtained during site surveys and from concerned Government authorities the Contractor shall arrange the necessary drawings and circulate RO (Road Openings) forms as necessary. The Contractors responsibility shall be to provide all road-crossing ducts, which are necessary and/or replace existing ducts which are found not suitable under the existing system.

35.17.18 Route Plan

1 Where cable routes are shown on Drawings, these shall be verified with the concerned authorities. Within a reasonable time after the contract has come into force, the Contractor shall survey the route and agree a final route with QGEWC. He shall confirm the arrangements and submit required drawings for processing the necessary RO forms before the installation commences. The quantity of cables, accessories, etc. to be supplied shall be based upon this survey. The programme for route survey works shall be agreed with QGEWC prior to commencement of works.

2 The Contractor shall, during the progress of the work, record on a set of route plans at 1:500 scale or other approved scale, such particulars as will allow an accurate reference to be made afterwards in case of any fault of projected modifications. The plans shall show exact position of every joint termination and oil feeding point, location of oil pressure tanks, gauges and terminal boxes.

3 The Contractor shall also record on approved cross-section plans particulars of the depth of the trench, the arrangement of the cables, the positions of all obstructions beneath or above which the cables are laid and such other particulars as may be required. These plans shall be made as reproducible drawings of approved dimensions and shall be the property of QGEWC. They shall be submitted to QGEWC within one month of completion of each section of the Works together with such prints as may be required.

4 Suitable binders shall be provided for the route plans.

35.17.19 Cable Termination

1 The Contractor is to terminate and connect up the cables in accordance with details approved by QGEWC.

2 Necessary sunshields shall be provided and installed for cables exposed to direct solar radiation.

3 The Contractor is to be responsible for the correct phase rotation and connections in accordance with information supplied by QGEWC. Particular care is to be taken in case of these cables, where subsequent correction may be difficult. Phase tests will be carried out by the Contractor to the satisfaction of QGEWC. All equipment required to carry out these tests shall be provided under this contact.

4 Where insulated glands are provided, the Contractor is to ensure that the insulations are maintained after jointing the cable, and shall demonstrate this to the satisfaction of QGEWC.