LUSAIL DEVELOPMENT

Marafeq's Design Guidelines for the Connection of ETS(s) to the District Cooling System

Document No.: LUS-CPALL-MAQ-SPE-UT-00004

REV. NO.	DATE	DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY
1	09-08-2011		Anders Tvarne	Abdullah Abushaikha	D. Reed Phillips
2	12-04-2012		Muhammad Ali	Abdullah Abushaikha	D. Reed Phillips
3	22-04-2014		Muhammad Ali / Uday Diwakar	Abdullah Abushaikha	D. Reed Phillips
4	10-11-2014	Table 3.1, 4.2 and 5.1 revised.	Muhammad Ali / Uday Diwakar	Vinod Kesavannair	D. Reed Phillips
5	30-09-2017	General editorial, changed primary side scope	Bob Miller / Brajesh Kumar / Uday Diwakar	Vinod Kesavannair	D. Reed Phillips
6	20-08-2026	General editorial	Uday Diwakar /Brajesh Kumar/ Sathish Jayakumar	Osama Elattar/ Abdul Azeez	Mohammed A Razzaq Haider

Marafeq Qatar L.L.C
P.O. Box 5651 Doha - Qatar
T: 974 40120120 F: 974 40120121 Website : www.marafeq.com.qa

CONTENTS

Changes from Revision 5

This revision of the ETS Design and Construction Guidelines has been updated to improve technical requirements, specifications, and clarity in line with Marafeq's current engineering, operational, and quality standards.

The guidelines define the respective responsibilities of Marafeq and the Customer and establish the minimum requirements for the design, procurement, installation, inspection, testing, and commissioning of the Energy Transfer Station (ETS). Compliance with these guidelines is mandatory for all ETS installations. Marafeq reserves the right to review, inspect, witness, and approve relevant activities to ensure compliance with the approved requirements.

Any statements in previous revisions no longer apply.

In the narrative that follows we write the scopes of work for Marafeq and the Customer, but in some cases Marafeq supplies one component and the Customer supplies another. Take for example the flow meter. Marafeq supplies the meter, but the Customer provides the meter run (piping). So, under the Marafeq scope of work you will see it mentioned that the Customer provides the meter run. This is necessary to present a complete picture and should not be taken as a conflict in scope of work. The scope of work is defined by Clause 2 and the schematics in Appendix 3.

The Customer shall refer to the ETS Agreement and the scope matrix in the drawings issued by Marafeq for the definition of responsibilities related to the design, supply, installation, testing, and commissioning of the ETS. If you see a discrepancy or are unclear about the scope of work, please contact us as soon as possible.

1 INTRODUCTION

1.1 The District Cooling System

The Energy Transfer Station (ETS) in Lusail city is the Customer's part of the district cooling system. The district cooling system will be operated by Marafeq. This “Marafeq’s Design Guidelines for the Connection of ETS (s) to the District Cooling System” identifies the general principles and technical requirements to be applied to the design and construction of energy transfer stations. Since the ETS is a part of the district cooling system, the ETS it must be built, maintained and operated in such a way that it complies with the requirements of this document.

District cooling is an environmentally friendly technology for producing and distributing refrigeration to real estate. For an efficient system all included parts of the supply chain need to function efficient. A district cooling system consists of centralized production plant(s), a distribution network, and ETS’s. Marafeq here describes requirements for the ETS in order to optimize the district cooling system function.

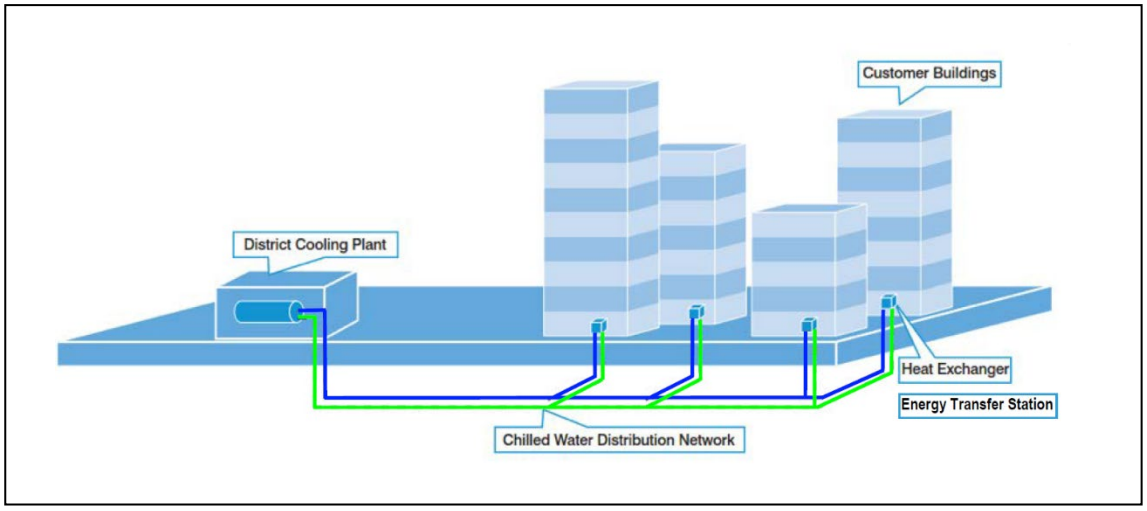


Figure 1: District cooling system general schematic

1.2 General

This document describes the technical requirements for connecting to Marafeq's district cooling system. This document should be used for planning, preparation of specifications, and procurement during initial design phases in advance of the formal agreement between Marafeq and Customers or end-users.

In the event of any discrepancy, conflict, or inconsistency between the documents, the following order of precedence shall apply, with the highest priority listed first:

1. ETS Agreement with the Customer
2. Approved Minutes of meetings (MOM)
3. Approved ETS Design Drawings
4. ETS Guidelines (this document)

1.3 Definitions and Acronyms

Table 1 Definitions and Acronyms

AHRI	Air-Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
AAV	Automatic Air Vent
BSRIA	Building Services Research and Information Association
BMS	Building Management System used to control the secondary side
BTU	British Thermal Unit

CIBSE	The Chartered Institution of Building Services Engineers
Contractor	The organization or its appointed representative appointed by Customer, responsible for execution of the ETS works.
Customer	The owner / sub-developer in charge of the building or his appointed representative which could be a consultant or contractor.
CSA	Cooling Services Agreement between Customer and DC provider to provide air conditioning within the building.
CHW	Chilled Water
CIP	Clean In Place
DB	Electrical Distribution Board
DC, DCP	District Cooling, District Cooling Plant
Design Department	The Marafeq department is the primary contact for matters related to the ETS. (email: dc.ets@marafeq.com.qa & engineering@marafeq.com.qa).
ETS Agreement	Agreement between Customer and Marafeq Qatar for the supply of ETS primary side design for the approved Cooling demand, supply of major equipment (PHEs, PICV, WBV and PLC) and inspection of ETS primary side works.
Energy Meter	A device used to measure the amount of cooling energy.
Engineer	Marafeq's supervision engineer or its appointed representative.
ERW	Electric Resistance Welding
ETS	The Energy Transfer Station (ETS) is the point where the energy from the building is transferred to the district cooling system. An ETS consists of pipes, valves, filter(s), metering equipment and heat exchanger(s).
FM	Flow Meter
IEC	International Electrotechnical Commission
Install	Materials installed but supplied by others. See also provide.
Kahramaa	Regulations for the Installation of Electrical Wiring, Electrical Equipment and Air Conditioning Equipment (applicable parts)
LIAN	Lusail Integrated Access Network provided by LREDC which provides internet connectivity throughout Lusail City.
LREDC	Lusail Real Estate Development Company (LREDC) (aka Lusail) is the developer for Lusail City.

Lusail website	The location where guidelines and documents relevant to Lusail City are stored.
Local standards	All applicable standards, specifications and regulations issued and/or referred to by Authorities, City Council, Civil Services department or other parties.
Marafeq Qatar (Marafeq)	The utility company which provides district cooling.
MCB	Miniature Circuit Breaker
Mega-Developer	The owner of the district
PHE or HEX	Plate Heat Exchanger, component separating the primary water system from the secondary water system. Definition used can sometimes also be for Heat Exchanger (HEX).
PLC	Programmable Logic Controller; a programmable microprocessor used to automate monitoring and control of ETS.
PICV	Pressure Independent Control Valve
PSRV	Pressure Safety Relief Valve
PDT	Pressure Differential Transmitter
PI	Pressure Indicator
AAV	Automatic Air vent
Point of Delivery	The point of delivery is defined as where Marafeq scope of works for the primary chilled water supply ends which normally is one meter outside from the utility tunnel, or one meter into the plot “set-back” for buildings connected by directly buried pipes. In both cases there will be isolation valves in the branch pipes to the building from main network piping system provided by others.
Point of Return	The point of return is defined as where Marafeq scope of works for the primary chilled water return ends which normally is one meter outside from the utility tunnel, or one meter into the plot “set-back” for buildings connected by directly buried pipes. In both cases there will be isolation valves in the branch pipes to the building from main network piping system provided by others.
Primary	"Primary" refers to the supply and return pipe network circulating chilled water produced in District Cooling Plants through the Marafeq distribution network.
Primary Inter-connecting Pipes	The Primary Interconnecting Pipes run from the isolation valves at the points of delivery and return to the ETS PHE(s) located in the ETS plant room.

Provide	Means supplied and installed by the same party.
QCS	Qatar Construction Specifications
QCD	Qatar Civil Defense
SAW	Submerged Arc Welding.
Secondary	The secondary side (aka building) is the Customer's cooling water circuits from the heat exchanger to the building fan coils, air handling units, etc.
Supply	Materials supplied by Marafeq but installed by others. See also provide.
Sub-Developer	The owner of the building
TCP/IP	Transmission Control Protocol/ Internet Protocol
TR	Ton of Refrigeration (12,000 BTU/Hr)
Trial Operation	Testing period of the ETS functions before commercial operations where Marafeq performs test runs and checks the ETS performance.
TT	Temperature Transmitter
TI	Temperature Indicator
UPS	Uninterrupted power supply
Utility Application Procedures	The document prepared by Marafeq describes the procedures for applying for utility services. The full citation is LUS-CPALL-MAQ-PRC-UT-10560 UTILITY APPLICATION PROCEDURES FOR DISTRICT COOLING.
Vendor	Any invited companies being fully eligible to submit the Tender. The successful Vendor will be the contractor/supplier.
VFD/VSD	Variable Frequency/Speed Drive.
WBV	Welded Ball Valve; is an Isolation Valve (IV).

1.4 Norms and Standards

These standards are used for the primary side but are recommended for the secondary side as well.

When an edition date is not indicated for a code or standard, the latest edition in force at the time of contract award shall apply.

- EN 253: 2009 District heating pipes – Pipes (applicable parts)
- EN 448: 2009 District heating pipes – Fittings (applicable parts)
- EN 489: 2009 District heating pipes – Jointing (applicable parts)

• EN 13 480: 2011	Metallic industrial piping
• EN 13 941: 2009	Design and installation of pre-insulated pipes
• EN 10204	Material test certificates
• EN 12266	Testing requirements for industrial valves
• EN 488	pre-insulated valves for district heating & cooling systems
• EN 10216-2	Seamless steel tubes for pressure purposes
• EN 10217-2	Welded steel tubes for pressure purposes
• EN 10217-5	Welded circular steel tubes produced by submerged arc welding for pressure applications.
• EN 10253-2	Butt-welding fittings made from ferritic and alloy steels with specific inspection requirements.
• EN 1092-1	Requirements for steel flanges including dimensions, pressure ratings, and materials
• EN 1514	Dimensions and requirements for gaskets used with PN-designated flanges
• EN 12613	Requirements and test methods for plastic warning tapes and detectable warning devices buried above utility services.
• EN 12201	Plastic piping systems for water supply, drainage, and sewerage under pressure using polyethylene (PE)
• BS 1710	British Standard for colour coding and identification marking of pipelines and services
• ASTM A106	Standard specification for seamless carbon steel pipe for high-temperature service
• ASTM A53	Standard specification for seamless and welded black and hot-dipped galvanized steel pipe
• ASTM A105	Standard specification for carbon steel forgings used in piping components such as flanges, fittings, and valves
• ASME B16.9	Dimensions, tolerances, and markings for factory-made wrought buttwelding fittings
• ASME B16.25	Preparation of buttwelding ends for piping components
• ASME B16.11	Requirements for forged steel socket-welding and threaded Fittings
• ASME B31.3	Process Piping
• ASME IX	Qualification Standard for Welding, Brazing, and Fusing
• ASTM A536	Standard specification for ductile iron castings

- ASME B1.20.1 General-purpose pipe thread standard (NPT)
- ASTM A269 Seamless and welded austenitic stainless-steel tubing for general corrosion-resisting and low/high-temperature service.
- ASTM A182 Forged or rolled alloy and stainless-steel flanges, fittings, valves, and parts for high-temperature service.
- ASME B16.21 Dimensions and tolerances for non-metallic flat gaskets used with flanges
- ASTM A36 Standard specification for carbon structural steel plates, shapes, and bars
- ASTM A123 Zinc (hot dip galvanized) coatings on iron and steel products
- ASTM A153/A153M Zinc coating (hot-dip galvanizing) requirements for iron and steel hardware
- ASTM C552 Standard specification for cellular glass thermal insulation
- ASTM C578 Standard specification for rigid cellular polystyrene thermal insulation.
- ASTM C591 Standard specification for rigid polyisocyanurate thermal insulation board
- ASTM C534 Standard specification for flexible elastomeric cellular thermal Insulation
- ASTM C177 Test method for steady-state heat flux and thermal transmission properties using guarded hot plate apparatus.
- ASTM C518 Test method for thermal transmission properties using heat flow meter apparatus
- ASTM E84 Test method for flame spread and smoke development of building materials
- ASTM B209 Standard specification for aluminum and aluminum-alloy sheet and plate.
- 97/23/EC Pressure Equipment Directive (PED)
- Directive 2006/42/EC on machinery

1.5 Design Criteria

Table 2 Design Criteria

Design pressure, primary side	bar (g)	16
Test pressure, primary side	bar (g)	23
Maximum pressure difference over ETS primary interconnecting piping system (ΔP) **(Note 1)**	bar	10 bars

Design pressure, secondary side	bar	**(Note 2)**
Test pressure, secondary side	bar	1.5 x design pressure
Design ambient temperature for installation	ºC	50
Maximum allowed pressure drops at nominal flow and subscribed load between points of delivery and return. (**Note 3)**	kPa	150
Maximum heat exchanger pressure drops at design flow	kPa	60
Cooling Capacity:	TR	By Customer
Number of equally sized heat exchangers	No.	See Table 4
Supply chilled water temperature, primary side	ºC	+5.0 (+/-1ºC Tolerance)
Return chilled water temperature, primary side	ºC	+14.0
Supply cooling water temperature, secondary side (**Note 4**):	ºC	+6.2 (+/-1ºC Tolerance)
Return cooling water temperature, secondary side **(Note 4)**:	ºC	+15.2
Maximum design chilled water flow per ton cooling load **(Note 5)**	l/s	0.0934

Note 1): The PICV will be selected to meet 10 bar differential pressure between the network supply and return.

Note 2): 16 bar is the default design pressure with 23 bar test pressure. If building design and test pressures are higher than these values, the Customer shall notify Marafeq early in the design process.

Note 3): The maximum pressure drop from the tie-in points to the heat exchangers shall be used when designing connecting pipes and components.

Note 4): These are the default values unless the Customer requires different supply temperature, in which case the Customer shall inform and agree with Marafeq during the early stages of the design /ETS agreement. Customer to consider +1 ºC above supply temperature for the AHU/FCU selection to overcome supply temperature tolerance.

Note 5): It is critical that all air handling units, fan coil units etc. are designed for the stated secondary side temperatures to provide at least a +14°C primary return temperature. This means that the maximum flow required for 1 ton of cooling load is 0.0934 l/s (1.48 USGPM). If the building cannot meet this requirement, Marafeq cannot guarantee a supply chilled water temperature mentioned on the secondary side at peak load conditions.

Customers are not permitted to use the MQ supplied cooling services for applications other than air conditioning without prior written approval from Marafeq. The supply and return cooling water temperatures of all CHW equipment shall comply with Table 2 above.

2 Definition of Responsibilities

Marafeq will supply the components identified in the tables below under 'Marafeq' at charges applicable at the time of the project. The tables below should be read in conjunction with the ETS schematics in Appendix 3. Customer's scope is also identified below.

Table 3 Definition of Responsibilities

ETS Room		
Description	**Supplied by**	**Installed by**
Lighting	Customer	Customer
Electrical supply	Customer	Customer
Air conditioning	Customer	Customer
Fire detection / Fire protection	Customer	Customer
Floor drain	Customer	Customer
Potable water supply	Customer	Customer
Wall and floor penetrations	Customer	Customer
Access to install / remove equipment	Customer	Customer
Equipment		
Description	**Supplied by**	**Installed by**
Heat exchanger	Marafeq (as part of ETS agreement)	Customer
Secondary side pumps	Customer	Customer
Pressurization system	Customer	Customer
Expansion tanks	Customer	Customer
Water treating equipment	Customer	Customer

Instruments			
Description	**Supplied by**	**Installed by**	**Cable Termination by**
Primary side temperature transmitters including thermowells (2 nos.) and PDT (1no)	Marafeq (as part of CSA)	Customer	Customer (under Marafeq guidance)

Flow meter	Marafeq (as part of CSA)	Customer	Customer (under Marafeq guidance)
Energy meter	Marafeq (as part of CSA)	Customer	Customer (under Marafeq guidance)
Secondary side temperature transmitters including thermowells (2 nos.)	Marafeq (as part of CSA)	Customer	Customer (under Marafeq guidance)
Pressure independent control valve(s) for primary side	Marafeq (as part of ETS agreement)	Customer	Customer (under Marafeq guidance)
Programmable logic controller (PLC) including panel	Marafeq (as part of ETS agreement)	Customer	Marafeq
240V single phase, 25 A SPNE dedicated power supply for ETS PLC system which shall be sourced directly from the dedicated padlocked Isolator/circuit breaker located inside the electrical room. The power cable (Phase, Neutral and Earth) shall be terminated directly to the PLC circuit /incoming breaker	Customer	Customer	Customer Note: Power cables (SPNE) shall be laid from padlocked Isolator/circuit breaker to the PLC the incoming breaker by customer which will be terminated by PLC contractor/Marafeq
Wireless communication from ETS PLC to district cooling plant (until Fiber optic connectivity is available)	Marafeq	Marafeq	Marafeq
Fiber optic connectivity from the Lusail Integrated Access Network (LIAN) to the Customer's telecommunications room	LREDC/ Ooredoo	LREDC/ Ooredoo	Customer
Fiber optic/Ethernet cable from Customer's telecommunications room to the ETS PLC	Customer	Customer	Customer
Wiring and containment for controls and power including energy meter, instruments, control valve(s), PLC panel, Customer's building automation system, etc.	Customer	Customer	Marafeq
Clean Instrument Earth for ETS PLC system	Customer	Customer	Customer

Piping Components		
Description	**Supplied by**	**Installed by**
Primary side isolation ball valves	Marafeq (as part of ETS agreement)	Customer
Pressure safety relief valves (2 no. per PHE)	Customer	Customer
Primary side pipe, fittings, flanges, and air vents and drain valves	Customer	Customer
Threadolets for instruments for both primary and secondary side	Customer	Customer
Spool pieces to replace meter, control valve, heat exchanger, etc. during flushing	Customer	Customer
Meter run (up and downstream straight runs)	Customer	Customer
Strainers & blow off drain valve	Customer	Customer
Pipe insulation & Aluminium cladding	Customer	Customer
Pressure and temperature gauges together with root valves and thermowells	Customer	Customer
All secondary side pumps, valves, control valves, piping, and related components	Customer	Customer

Testing and Commissioning	
Description	**by**
Hydrostatic testing, flushing, and chemical treatment (primary and secondary sides)	Customer
Commissioning of PLC system, energy meter, and integrating communication between the ETS and the DCP for both fiber optic and wireless communications	Marafeq

Document submission and Inspection
All document submissions shall be reviewed and approved by the Customer's appointed Project Supervision Engineer prior to being submitted to Marafeq for final approval.
All inspections shall be witnessed and approved by the Customer's appointed Project Supervision Engineer before the Inspection Notification Request (INR) is submitted to Marafeq for final inspection and approval. .

3 ETS Design:

The following sequence shall be followed as part of the ETS design, review, approval, and implementation process.

3.1 Plot Registration and Customer ID

The Customer shall approach Marafeq Customer Service to register the plot and obtain a unique Customer ID.

3.2 Cooling Demand Submission and Approval

The Customer shall submit a **Design Confirmation Certificate (DCC)** indicating the proposed cooling demand for the plot, supported by detailed building cooling load calculations.

At this stage, the Customer shall also submit the following information for Marafeq's review:

- Architectural drawings indicating the proposed ETS room location.
- Coordinated primary chilled water pipe routing from the plot tie-in point to the ETS room.
- Relevant information such as cooling load calculation required to verify the proposed cooling demand and ETS arrangement.

Marafeq shall review the submitted documents and confirm the approved cooling demand for the plot based on the available district cooling network capacity and applicable Marafeq design requirements.

The Customer shall remain responsible for the building cooling load calculations and for determining the required cooling demand for the development.

3.3 ETS Agreement

Following approval of the cooling demand, an **ETS Agreement** shall be executed between Marafeq and the Customer.

The ETS Agreement shall cover the provision of the **ETS primary-side design** and the supply of the following four major materials:

1. Plate Heat Exchangers (PHEs)
2. Pressure Independent Control Valves (PICVs)
3. Welded Ball Valves (WBVs)
4. Programmable Logic Controller (PLC)

The applicable scope, responsibilities, supply arrangements, and commercial conditions shall be as defined in the ETS Agreement.

3.4 Primary-Side ETS Design

Upon execution of the ETS Agreement, Marafeq shall prepare and issue the **ETS primary-side design** based on the approved cooling demand.

Marafeq shall also inspect the primary-side installation carried out by the Customer to verify compliance with the issued design and applicable Marafeq requirements.

The Marafeq design scope shall extend from the **primary-side points of delivery and return at the DC tie-in** up to and including the **primary side of the heat exchangers**. The secondary-side piping, equipment, controls, and associated installations shall remain within the Customer's scope.

The primary-side ETS design shall generally include, but not be limited to, the following:

a. ETS District Cooling Piping and Instrumentation Diagram (P&ID)

b. DC tie-in details, primary-side piping layout, and ETS room layout

c. Primary-side piping and ETS room sectional drawings

d. Primary-side mechanical details

The Marafeq-issued primary-side ETS design shall be based on the approved cooling demand.

The numbers of heat exchangers that Marafeq will be considering in design and supply are listed below in table 4.

Table 4: ETS configuration

Requested capacity (TR)	Number and portion (#)
Up to 200	One at 100%
201 to 1,000	Two at 50%
1,001 to 3,000	Three at 33-1/3 %
3,001 and above	To be determined by Marafeq based on space, design etc.

 # Cooling demands over 3,000 TR will need special attention since standard concept normally cannot be used. Redundant (standby) PHE is generally not required. If the Customer wants additional heat exchangers or redundant capacity Marafeq can supply them at additional cost.

3.5 Secondary-Side ETS Design

Upon receipt of the Marafeq primary-side design, the Customer shall develop the ETS secondary-side design, including secondary-side pumps, piping, controls, instrumentation, and other associated equipment and accessories, as identified in Appendices 3.1 and 3.2.

The Customer shall submit the completed secondary-side design to Marafeq for review and approval prior to implementation.

As a standard practice, Marafeq shall review the Customer's secondary-side design for compliance with the Marafeq ETS Design Guidelines, primarily to ensure compatibility and proper integration with the district cooling system.

The compatibility review of the secondary-side design by Marafeq shall not relieve the Customer of responsibility for the building cooling load calculations, system sizing, detailed design, performance, installation, testing, commissioning, and operation of the secondary-side system in the compliance of Cooling service agreement (CSA).

4 Material supply (By Marafeq):

The technical details provided below for the equipment supplied by Marafeq are intended for general information and to define the minimum technical requirements applicable to the supplied materials. Detailed equipment specifications, including vendor- and manufacturer-specific requirements, shall be obtained from the Marafeq Procurement Department.

4.1 Energy Meter, Flow Meter and Temperature Sensors (To be supplied by Marafeq as part of CSA)

The metering equipment includes the supply and return pipe temperature sensor and the supply pipe flow meter. Marafeq shall supply ETS energy metering equipment that will be used for billing purpose. Marafeq will supervise the installation and wiring of energy meters. The Customer shall provide a dummy (spool piece) for the flow meter during flushing operations. Energy meters will be used for billing of chiller water energy consumption based on the flow meter and temperature sensors. The energy meter automatically calculates water density and enthalpy. From the flow meter, volume flow is converted into mass flow and used to calculate thermal energy.

1. Energy meter shall be equipped with its necessary flow meter and temperature sensors and shall be provided for billing computation. Metering accuracy shall comply with EN 1434, Class 1.
2. Supply and return temperature shall be measured via resistance temperature devices (RTDs), 4-wire, Pt 500, and shall use matched pairs, class A to IEC 751 standard. RTDs shall be installed in compliance with manufacturer recommendation and enough clearances to be provided for replacement/maintenance.
3. Flow meter shall be electromagnetic flow model. The Customer shall provide appropriate meter run (up and down stream straight lengths of pipe).
4. The energy meter is being installed inside the PLC panel. In case the Customer requests the energy meter to be installed separately from the PLC system, the customer will be required to install it in an IP 55 rated lockable enclosure.
5. Energy meter data is prohibited to monitor from Building Management System (BMS) or any third-party system.

4.2 Heat Exchanger

Type: Counter-current flow

1. The material of the heat exchangers (PHE) must withstand both systems liquid media. Plates will be 316 stainless steel by 0.5 mm thick.
2. PHE shall be designed, built and marked in full compliance to AHRI-400 Liquid-to-Liquid Plate Heat Exchangers with zero tolerances.
3. Manufacturers of heat exchangers should be able to demonstrate heat exchangers meet the test program described in the standard EN 1148 or equal; that the manufacturer's data programs are consistent with product performance and that the latest version of the design program is used.
4. Customer shall provide clean in place (CIP) connections at each heat exchanger. CIP is done without dismantling the PHE. In order to save CIP chemicals, the water volume shall be kept to a minimum by locating isolation valves close to the PHE.
5. PHE pressure drop at design flow shall not exceed 60 kPa. The PHE will be selected to ensure the overall primary side pressure drop shall not exceed 150 kPa.

6. The frames of gasketed PHEs will be specified to have 20% extra space for adding plates in the future. For brazed plate heat exchangers, space will be provided to add an additional 20% plate pack.
7. If the PHE is sized for future expansion allowance, this shall be based on flow capacity by installing additional plates in future with the following limitations:
   a) Design temperatures shall remain the same.
   b) Pressure drops across the heat exchanger shall not increase by more than 10% above design conditions. On the primary side, do not exceed 150 kPa overall pressure drop.
   c) Additional capacity is obtained without changing frame size.
8. The design shall prevent fluid intermixing.
9. The unit shall withstand the maximum 16 bar gauge design pressure on primary side with opposite side at 0 psig gauge. Similarly, unit shall withstand the maximum design pressure of 16 bar on secondary side with opposite side at 0 psig gauge.
10. Metal nameplate shall be provided so it is visible outside the insulation with identification in accordance with the project schedule. Include:
    a. design flow in l/sec
    b. design kW (TR)
    c. Hot side and cold side temperature in and out, ˚C.
    d. Hot side and cold side pressure drop, kPa
    e. Design temperature differential, ˚C.
    f. Provide metal tags to label inlet and outlet connections for hot side and cold side of heat exchanger.
11. A safety relief valve at both primary and secondary side shall be installed for each heat exchanger to prevent over pressure during shutdowns in accordance with appendix 3.1 and 3.2.
12. Service Conditions
    a. Design Pressure: 16 Bars (minimum) 1
    b. Test Pressure: 23 Bars
    c. Suitable for water Temperature Condition: Supply: 4-10 ˚C, Return: 6-20 ˚C
    d. Suitable for ambient temperature: 50 ˚C

4.3 Pressure Independent Control Valve

1. One Pressure Independent Control Valve (PICV) shall be provided for each PHE.
2. PICV flanges shall be as per ANSI class 150 /PN 16. Matching flanges shall be considered by the Customer for installing PICV.
3. The control valve is suitable for precise control and shall maintain linear characteristic under all operating condition.
4. Valve rating is suitable for network design pressure: 16 bar. Test pressure: 23 bar for 6 hours. Differential Pressure 10 bar.
5. Pressure drop across PICV at full flow condition not to exceed 40 kPa.

6. Confirm that valve pressure drop (for full flow) is accounted in determining the maximum allowed pressure drop of 150 kPa at nominal flow and subscribed load between incoming isolation valve at the wall penetration.
7. Pressure Independent Control Valves (PICVs) shall be installed as shown in the drawings and strictly as per the recommendations of the manufacturer.
8. These valves shall be of pressure independent design and shall consist of two functional items. First part is a two-way modulating control valve with electric actuator, and the second part is an integral and external differential pressure control valve.
9. The differential pressure control valve shall sense and regulate the differential pressure across the modulating control valve, as per the control valve selection at all flow and pressure conditions.
10. The valves shall be manufactured in accordance with ISO 9001 quality standards.
11. The complete assembly of PICV shall be manufacturer's factory assembled and be ready for field installation.
12. Each valve set shall be pre-calibrated at manufacturer's works to a specified flow and differential pressure, which shall be field adjustable without the removal of the actuator.
13. Control valve range ability shall be 100:1. The actuators provided with the valve(s) shall assure 100:1 turndown.
14. Each control valve shall be individually flow tested and factory verified to deviate not more than ±5% through the selected operating pressure range.
15. A calibrated performance tag shall be provided with each valve that verifies the flow rate in 10° rotation increments up to full rated flow. All testing shall be performed with instruments calibrated to the requirements of ANSI/NCSL Z540-1-1994 with traceability to NIST and/or ISO standards. The flow verification shall be performed at the manufacturer's work.
16. Class IV leakage or better is required for control valves up to 50 mm diameter and Class III or better for valves larger than 50 mm, as per ANSI leakage testing standards.
17. All valves shall have three integral test ports, factory installed, capable of being used to measure pressure or temperature.
18. The control valve flow adjustment stem shall extend out from the control valve and have an indicator that shall be used to verify valve position. The control valve shall have tapped mounting holes for mounting the control valve actuator bracket. The actuator shall rotate / lift the valve stem to provide the required flow independent of pressure across the valve.
19. Control valves shall be compatible with modulating actuators from all major manufacturers. Actuators shall modulate all valves from 0 to 100% design flow while rotating the valve stem a maximum of 90° or moving full stroke. Valve percentage opening and closing indication is required.
20. Valve actuators shall be factory mounted.
21. Actuators shall be selected based on system close-off requirements. Valves and actuator shall be capable of a close-off rating of 10 bar.
22. Torque and linear force requirements for actuator selection shall be provided by the valve manufacturer.
23. For electric actuation it shall be possible to set the end stroke of the actuator with mechanical stops, signal adjustment, or a control signal limit at the full design flow listed on the performance tag furnished with each valve.
24. Valve actuators shall be suitable for fail safe position. In case of power failure valve shall retain its last position.
25. Electric actuator shall be suitable for hardwired input and output 4-20 mA control signal.

26. Manufacturers of pressure independent control valves shall confirm balancing valves, and associated balancing shall not be required where pressure independent modulating control valves are installed.
27. Pressure Independent control valves shall be suitable for thermal insulation all around.
28. Control valves together with actuators shall be suitable to work at ambient temperature of 0 to 50 °C and relative humidity of up to 100%.
29. Actuator housing shall be IP 54 rated or higher.
30. Valve actuator shall have remote, local, and stop selector switch / push button with visual indication of remote/Local/Stop status and % opening of the valve.
31. Control valves shall have control options for Remote (HMI, SCADA) and local operation.
32. Control valve shall have Remote, Local and Stop (Selector switch position) hardware digital input (Potential free contact) to ETS PLC.
33. Control valves shall have manual hand wheel options. In local mode, the control valve shall be capable of manual operation.

4.4 Welded Ball Valves

1. All isolation valves on primary side such as main line & branch valves, temporary connection valves, bypass valve and valves for CIP, gauges, air vents, drains shall be welded type. All valves shall be of industrial standard. Flanges are not allowed.
2. Primary system valves must be thermally insulated with closed cell elastomeric material type with a protective jacket.
3. Main isolation valves for bypass and emergency supply shall be located directly inside the building as close as possible to the walls. Emergency connections shall be accessible from outside at grade level. If valves cannot be located inside, then main isolation valves for bypass and emergency supply shall be pre-insulated and located in a valve chamber located outside the building wall. Emergency connections shall be accessible from outside at grade level.
4. Connection to the district cooling network shall be by welding.
5. For welded valves, caution is needed so that the seals in the valves will not be damaged during the welding process. Follow manufacturer's instructions.
6. All valves shall be easily accessible and tagged according to with BS 1710 or equal.
7. Valve shall be capable to perform at design pressure of 16 bars and test pressure of 24 bars for 6 hours.
8. Provide hand wheel and gear box for valves DN 150 and above.
9. Provide chain operators for elevated valves. Chain operation shall be provided for valve DN 150 and larger, located 2.2 m (7 feet) or higher above finished floor level. Chain shall be extended to elevation of 1.5 m (5 feet) above finished floor level except for valves located at driveways / car parking in basement.
10. Ball seats shall be spring-loaded.
11. Stem shall be provided with double sealing; minimum two O-rings and the upper one shall be changeable from the top without draining the pipeline. (The O-rings are FPM (fluorine rubber/fluoro packing material/VITON) rubber material.
12. Valve shall be full port valve. Reduced port valves are acceptable only if maximum allowable pressure loss of 150 kPa at nominal flow and subscribed load between isolation valves at ETS entrance can be maintained with reduced port valves.

13. Valve shall be provided with position indicator that shows the ball's position in the valve.
14. Valves shall be delivered with plastic end caps (flow port protectors) in order to avoid debris in the valves during transportation, storing, and handling.
15. Pre-insulated valves shall comply with EN 488.

4.5 Programmable Logic Controller (Supply by Marafeq)

PLC system shall be used for control, monitoring and data acquisition at the Energy Transfer Station. Supply, design, engineering, testing, and commissioning of the system will be carried out by Marafeq Qatar. Please refer Clause 2 Definitions of Responsibilities.

PLC System shall provide following capabilities:

- Modbus 485 RTU communication with BTU calculator for chilled water flow and temperature.
- Modbus 485 RTU communication with building automation system (BAS) to monitor the pump speed, pump status, start/stop, Bypass valve status. PDT, PDS.
- Field instrumentation wiring terminations, instrument signal input/output for system, monitor and control functions, and self-diagnostics.
- Data communication between processor and HMI on TCP/Ethernet IP over copper media.
- Open network Modbus TCP/IP communication with district cooling plant over copper media/Fiber optic.
- UPS status (Main, Bypass, Trip, Battery low etc.) to be integrated with ETS PLC/HMI.
- BAS or any third-party system is prohibited to monitor or control the ETS PLC system.
- BAS or any third-party system interface with ETS PLC shall comply with ISO 27001, IEC. 62443 and Qatari National ICS Security Standard version 3.0.

4.5.1 Human Machine Interface (HMI)

- Graphics display capable of accessing information from process automation controllers for local display and control.
- Graphic displays shall be TFT/LCD color touch screen with Ethernet IP over copper media.
- Interactive capability to allow operators to control I/O devices and acknowledge alarms from the graphics display. Operators shall be able to change modes between manual and automatic control and change device states between on and off, enter control setpoints, timer and counter settings, process variables, and loop information by 1 or 2 touch screen operations. The HMI shall be pre-programmed to provide a basic graphical display of the process. Real-time numeric displays of process variables and alarm messages shall be available.
- Security levels shall be accessible by user-defined passwords. Levels shall include engineering configuration of graphic displays and setting system parameters, operator control functions only, and process monitoring only.
- Display size: Nominal 15-inch diagonal.

4.5.2 PLC configuration:

- PLC shall communicate with ETS energy meter calculator to monitor chilled water supply temperature, chilled water return temperature, chilled water flow, and calculated thermal energy usage at ETS.
- PLC shall communicate with the BAS to monitor the pump speed, pump remote/local status, start/stop, secondary side pumps bypass valve open/close status, index PDT on the building chilled water system.

- PLC shall monitor the temperature of the chilled water supply temperature for the building chilled water system.
- Operator selects a setpoint for the building side chilled water supply temperature or building side return temperature or building side delta temperature.
- PLC modulates the control valve to control building side chilled water supply temperature or building side return temperature or building side delta temperature.
- Should the building side chilled water supply temperature/return temperature/delta temperature building side be above setpoint, the PLC shall move the control valve to a more open position.
- Should the building side chilled water supply temperature/return temperature/delta temperature building side be below setpoint, the PLC shall move the control valve to a more closed position.
- PLC shall monitor the differential pressure across the primary side chilled water supply and chilled water return for each ETS.
- UPS status (Main, Bypass, Trip, Battery low etc.) to be integrated with ETS PLC/HMI.
- All process variables shall be communicated from local PLC to district cooling plant control system utilizing standard open Modbus TCP/IP communication protocol.
- BAS or any third-party system is prohibited to monitor or control the ETS PLC system.
- Clean Instrument Earth for ETS PLC system shall be provided by the customer.

4.5.3 Uninterruptible Power Supply (UPS):

Marafeq will supply UPS of 120 minutes battery backup installed within PLC panel which will feed power to programmable logic controller, human machine interface, energy meter, flow meter and panel light. The Customer shall provide 240V single phase, 250A SPNE dedicated power supply for ETS PLC system which shall be sourced directly from the dedicated padlocked Isolator/circuit breaker located inside the electrical room. The power cable (Phase, Neutral and Earth) shall be terminated directly to the PLC.

4.5.4 Project record documents:

- “As built” Panel and General Arrangement diagrams.
- “As built” wiring diagrams.
- “As built” control system architecture.
- Technical documents for PLC and Energy meter system.

4.6 Measuring Devices

Measuring devices include instruments and control equipment, flow sensing devices, pressure sensing devices, gauges, electromagnetic flow meters, and energy meters.

Each instrument and control device shall have tag permanently attached with following information, as applicable:

- Tag number.
- Manufacturer's name.
- Model number.
- Serial number.
- Operating range.
- Calibration setting/range.
- Power rating.

4.6.1 General Requirements

Insect-proof screens shall be installed on all vents. All instruments and control devices supplied under this specification shall be new, unused, and of the latest proven design. The Contractor shall provide all mounting accessories, supports, fittings, and ancillary materials necessary to ensure proper installation, secure fixation, commissioning, and satisfactory operation of the devices.

4.6.2 Instruments and Gauges

1. Resistance Temperature Device (RTD) and or Temperature Transmitter (TT)

- Four-wire platinum nominal 100 ohm.
- Spring loaded with 15 mm threaded connection.
- 6 mm stainless steel sheath.
- Include Type 316 L stainless steel reduced bore thermo well with 20 mm threaded process connection, 75 mm lag extension, 20 mm threaded sensor connection, with insertion length to allow tip to extend past to center of pipe diameter. Immersion length shall be suitably selected as per pipe diameter and manufacturer's recommendations.
- Each temperature sensor shall be provided with a transmitter, selected to match the sensor, from the same manufacturer.
- Accuracy shall be ±0.1% of full-scale reading and calibrated span.
- Transmitter shall be mounted where indicated on approved piping schematic / design / shop drawings or instrument detail.
- Mount transmitter, integrally with sensor, pipe mounted or installed in a control panel, depending on the application, as per the manufacturer's recommendation.
- Distance between sensor and transmitter shall not exceed manufacturer's recommendation.
- Enclosure shall be stainless steel 316, IP 67, NEMA 4. Connection shall be screw terminals.
- Power supply – 24 V DC loop powered.
- Temperature range shall be -20 to 80 ºC.

2. Pressure transmitter

- 4 to 20 mA dc output with local LCD indicator.
- Carbon steel process flanges and body.
- Provide ½" threaded process connections with 2-valve manifold and 50 mm pipe stand mounting hardware, unless otherwise indicated.
- Calibrated span as required for the application.
- Diaphragm of Type 316 stainless steel.
- Accuracy: ±0.1% of calibrated span.
- Design pressure: 1600 kPa maximum.
- Design temperature: -20 to 80°C.
- Over pressure rating shall be a minimum of 200 percent of operating pressure limit.
- Transmitter shall be located where shown in the approved schematic / design / shop drawings, mounted integrally with sensor, pipe mounted or installed in control panel.
- Distance between sensor and transmitter shall not exceed manufacturer's recommendation.
- Wetted parts shall be minimum stainless steel 316, electronic enclosure shall be rated for NEMA 4, IP 67.

3. **Flow meter**

- Flow meters shall be inline electromagnetic type with remote mounted transmitter connecting with Plant SCADA.
- Shall be industrial type, inline electromagnetic type, bidirectional flow meter utilizing Faraday's law of electromagnetic induction to measure the volume flow rate of water.
- Shall be suitable for the medium proposed to be handled by the flow meters.
- Body shall be carbon steel, flanges to ANSI/ASME B16.5 class150/PN16 for system design pressure, pipe to Stainless Steel 304 and electrodes of Stainless Steel 316.
- Liner shall be EPDM or equivalent of approved manufacturers recommended.
- Bidirectional flow rate measurement capability.

4. **Differential pressure transmitter**

- Enclosure: IP 65 minimum
- 4 to 20 mA dc output with local LCD indicator.
- Measuring pressure range: Selected so normal reading is in the middle of the scale range.
- Stainless steel process flanges and body.
- Stainless steel Tubing shall be bent using an appropriate tube-bending roller in lieu of standard elbow fittings. The use of fittings shall be minimized to reduce potential leakage points and improve system reliability.
- Process Connection: 1/2" stainless steel 316L, all wetted parts shall be of stainless steel 316L with mounting bracket for pipe stand mounting.
- 50 mm pipe mounting hardware.
- Power supply: Loop powered 24 volts dc.
- Calibrated span as required for the application. Suppliers shall provide external provision (Keypad) and HART for span and zero configuration
- Diaphragm of Type 316 stainless steel.
- Accuracy: +/-0.1% of calibrated span.
- Stability: +/-0.25% of upper range for minimum 5 years.
- Damping: Adjustable damping with minimum of 0.2 seconds
- Over pressure limit: Twice the operating range.
- Design temperature: -20 to 80°C.
- Provide 1/2" threaded process connections with 3-way valve manifold and 50 mm pipe stand mounting hardware, unless otherwise indicated.

4.6.3 Instrument Wiring

The wiring materials and containment system samples, along with the relevant datasheets and Material Test Certificates (MTCs), shall be submitted to Marafeq for review and approval prior to procurement and installation.

1. **Analog signal cable (Supply & installation by Customer):**

- Configuration: Twisted pair, shielded, and jacketed.
- Insulation: 300-volt, 15 mil, 90ºC, PVC, color-coded to permit identification of each conductor.
- Conductors: 1.0 square mm, 7 strand copper, Class B.
- Shield: Tinned copper braid providing 100% coverage against noise together with 0.05 mm2 stranded tinned drain wire.

2. **Power wire (Supply & installation by Customer):**

- Rating: 600-volt, 90ºC, PVC insulation/jacket.
- Conductors: 2.5/4 square mm stranded copper.

3. **Discrete signal wire (Supply & installation by Customer):**

- Rating: 600-volt, 90ºC, PVC insulation/jacket.
- Conductors: 1.5 square mm, stranded copper.
- Conductors shall be continuous between devices. Splices are not acceptable.
- Conductors shall be terminated with pressure type, pre-insulated, flanged, slotted, tongue, indenter lugs. Soldered terminators are not acceptable.

4.6.4 Cable Identification

Identify each cable with plastic tags permanently affixed to cable. Attach tags to each cable at each termination and wherever cable is accessible in junction or pull boxes. Provide tags with printer-printed circuit number. Provide 3-phase power cables with tag with printer-printed cable number affixed to each phase conductor.

Tag colors:

- Power cables: Red tags.
- Analog and discrete signal cables: Yellow tags.

4.6.5 Installation - General

- Install instrument and control devices in accordance with manufacturer's recommendations and/or where approved by Marafeq Qatar.
- Mount instruments to be rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock and vibration; and freedom from interference with other equipment, piping, and electrical work.
- To avoid damage, do not install instruments until heavy construction work adjacent to instruments has been completed.
- Instrumentation mounted outdoors shall be housed in insulated/heated housings to maintain operational temperature limits.
- Maximum convenience in operation and servicing of instrument. Orient connections so instruments or piping will not obstruct aisles, platforms, or ladders. Transmitters shall be visible and accessible for maintenance.
- Install field-mounted instruments so they are accessible from grade, platform, or permanent ladder. Instruments requiring adjustment or inspection shall be accessible for servicing from grade, walkway, platform, or permanent ladder.
- All valves shall be accessible from grade or platforms. Use manufacturer's recommended clearance distances.
- Mount local indicators, recorders, and controllers so they are readable, controllable, and serviceable from grade or platforms.

5 Customer's Scope of Work

As part of ETS agreement Marafeq shall inspect, and approve the primary side ETS installation, but the Customer is responsible for construction and supervision. The Customer shall arrange and provide temporary facilities to store material supplied by Marafeq away from water, heat, and direct sunlight. The energy meter, flow meter, instruments, PICV, and PLC shall be stored in an air-conditioned area.

Building Automation System (BAS) or any third-party system is prohibited to monitor or control the ETS PLC system.

Building Automation System (BAS) or any third-party system interface with ETS PLC shall comply with ISO 27001, IEC 62443 and Qatari National ICS Security Standard version 3.0.

5.1 ETS Room

The Customer shall provide a suitable space to install the ETS in accordance with the preliminary design and ultimately with the final design supplied by Marafeq. Space shall be provided for equipment, maintenance access, service lines, interconnecting pipes as well as lighting, air conditioning with makeup air, floor drain and potable water piping. Consideration should be given to transportation and access so that repair, replacement, etc. can be made easily and rapidly. If the Customer does not allow free passage through the building, a separate access door from outside must be arranged. The transport ways to the ETS plant room, including all doors, shall allow access for the heat exchanger(s) without any need for disassembling. Adequate space shall be provided so equipment can be accessed for maintenance.

1. The ETS shall be installed in a basement level (preferred), or ground level, or but not higher than 7.5 meters above Qatar national datum.
2. The Customer shall grant Marafeq full and direct access to the ETS room 24/7.
3. Lockable, insulated security doors shall be provided.
4. The room shall have sufficient ceiling height below any obstructions such as beams, drop slabs etc. Minimum four meters below any structural slab/ beam is recommended.
5. The ETS room space shall be provided with all necessary overhead and under-floor plumbing including service water piping and floor drains near each PHE and for general purpose. In the ETS room, a floor drain or sump (with lifting pump) shall be provided to evacuate drain water, washing water, and various drips. Open gutters with grated covers are preferred.
6. A DN 20 potable water supply shall be provided with a ball valve, and a water line should be stubbed to the space with a hose bib connection for maintenance and housekeeping.
7. Air conditioning shall be as required to meet the operating requirements/limits for all ETS equipment or to a max temperature of 28±2°C and 50-60% RH. Minimum fresh air ventilation shall be as per ASHRAE std. 62.1-2016 or the latest revision, good engineering practice, and to keep a positive pressure in the ETS room. Ventilation air shall be continuous, filtered and cooled.
8. Clean Instrument Earth for ETS PLC system shall be provided by the customer
9. The Customer shall provide 240V single phase, 25A SPNE dedicated power supply for ETS PLC system which shall be sourced directly from the dedicated padlocked Isolator/circuit breaker located inside the electrical room. The power cable (Phase, Neutral and Earth) shall be terminated directly to the PLC circuit /incoming breaker.
10. In addition to above item #9 the Customer shall provide a dedicated distribution board (DB) in the ETS room. The distribution board shall be 6-way, single phase, 240V, 50Hz, with

40A incomer and six 10A Miniature Circuit Breakers (MCBs) to feed the energy meter, Flow meter etc. in absence of PLC system.

11. The room shall be sufficiently well illuminated with overhead white, fluorescent type lighting so maintenance operations can be carried out safely. ETS room lighting shall consist of overhead white, fluorescent type lighting (not less than 150 Lux).
12. Fire detection and alarm system shall be provided in accordance with authority requirement.
13. The room should be acoustically treated so the noise level meets the Customer's expectations.
14. The room should have finished painted walls and oil-resistant non-slip finished floor.

5.2 Communication

Fiber optic communication shall be provided by others from the district cooling plant to the Customer's telecom room. The Customer, therefore, is requested to follow the latest Lusail Smart City Guideline and Lusail Smart Services Interface Guideline for seamless system integration. These guidelines are uploaded on the Lusail website.

The Customer shall supply and install cable from the telecom room to the ETS PLC panel. If the distance from the telecom room to the ETS PLC panel is less than 90 meters, the Customer shall lay Ethernet (CAT6 with RJ45) cable. If the distance is exceeding 90 meters, the Customer shall lay fiber optic, single mode, redundant cables with LC/APC ports with Fiber to Copper managed convertor to be installed in the customer's telecom room.

Marafeq will supply and install wireless equipment and its accessories in the PLC panel. In the event, the communication signal is too weak; the Customer will have to relocate the antenna to a better location.

5.3 Primary Service Lines

The Customer shall supply and install piping from the Points of Delivery/Return (plot valves on the network) to the ETS room including up to the heat exchanger(s). Buried service shall use pre-insulated pipe. Above ground service shall use field insulated pipes. The pipes shall be of industrial standard of district cooling and by the quality approved by Marafeq as outlined below.

Pipes shall be protected from the weather, water splashes, and shocks and in general any risk of degradation along the path of the primary network in rooms through which it passes. Pipe protectors should be added to any piping within garbage rooms, parking ramps or other highly trafficked areas where piping could get damaged.

Pipes passing through any fire-rated rooms shall be properly protected with fire-rated enclosures, and the pipe penetrations in the walls shall be properly sealed with authority-approved fire sealant.

5.4 Customer Secondary-Side Chilled Water System

The Customer shall design, provide, operate and maintain the secondary side chilled water system in accordance with the technical requirements. Variable speed chilled water pumps and two-way modulating control valves shall be used for varying the Customer's chilled water flow.

1. One set of duty + 1 standby (min) variable speed pumps for internal chilled water distribution for each ETS, with an expansion tank complete with a safety relief valve for each closed loop. The CHW pumps (duty) quantity shall match with the PHE quantity. Refer to *Appendix 3.1 & 3.2.*

2. CHW pump (duty) capacity shall match with PHE capacity. The CHW pump operating flow rate shall be in accordance with the approved cooling capacity, based on a design temperature differential (ΔT) of 9°C.
3. CHW pumps may be sized with a maximum of 20% excess (rated) capacity for future expansion. However, during commissioning and operation, the flow shall be restricted to the approved design flow (equal to DC design flowrate) via VFD control. The pump selection and performance curve shall be aligned to ensure compliance with this operational requirement.
4. Variable speed pumps shall be controlled by utilizing at least two industrial grade pressure differential transmitters (PDT) across the two most hydraulically remote terminal units in each building as shown in *Appendix 3.1 & 3.2.* Exact location shall be as per the design of the building HVAC system.
5. Variable speed pumps shall be equipped with at least one pressure switch in the supply line that will stop the pumps at max design pressure in case of a valve closure and/or a failure with the VFDs (Variable Frequency Drive). The pressure switch should be hardwired to the pumps and not through the ordinary control system.
6. As indicated on PI&D *Appendix 3.1 & 3.2,* it is recommended for low flow control for VFD pumps to add a 2-way control bypass valve across the pump. The size of bypass line and 2-way modulating control bypass valve shall correspond to the minimum flow requirement of one pump. Alternatively, the 2-way control valve could be strategically located in the building. The practice of using 3-way valves at select cooling coils to provide minimum flow is not allowed.
7. Secondary side CHW system shall be provided with air separator at the building return header pipe in the ETS room. Automatic air releasing valves shall be provided in the highest points of secondary side CHW system.
8. The Customer shall be responsible for filling the secondary side (secondary) chilled water system along with providing break tanks of suitable capacities, and expansion tanks / pressurization units.
9. The water treatment system shall include manual feed chemicals dosing pot with necessary rust inhibitors and biocides including quantities necessary for testing, commissioning and operation. A specialized professional company shall handle the water treatment system. The Customer shall provide an analysis of the physicochemical characteristics of the water in his secondary circuit before the Commercial Operation of his ETS.
10. The Marafeq Operation service reserves the right to draw off water samples from the secondary circuit and analyse it at any time. The Customer shall pay for maintenance and water sampling costs if his water treatment is not conforming to the specifications mentioned in Table 5. These characteristics may be maintained by conditioning the secondary network.
11. CHW inlet & outlet temperatures of all secondary side equipment (FCU, FAHU, AHU & etc.) shall be 6.2° C & 15.2°C (ΔT shall be 9°C. Thus, the maximum CHW flow rate required for 1 TR cooling load is 0.0934 l/s (1.48 GPM) for all secondary side equipment (FCU, FAHU & AHU).
12. The practice of using 3-way valves at select cooling coils to provide minimum flow is strictly not allowed.
13. The Customer shall use pressure independent control valves (PICV) in all air handling units, fan coil units and other CHW equipment for highest possible ΔT, minimum energy use, and reduced labour cost. When pressure independent control valves are used, normally no manual balancing valves are required. The valves shall be capable of controlling flow through full range of expected turn-down and through full range of expected ΔP across the valve.

14. The Customer shall provide a sub-metering system for the secondary-side building CHW system. Each tenant space shall be equipped with a BTU/Energy Meter and associated M-Bus valve(s) in accordance with the latest Marafeq Sub-Metering Specifications.
15. The sub-metering system shall be designed and installed in compliance with Marafeq's approved specifications and schematic diagrams. Separate material submittals for all sub-metering components shall be submitted to Marafeq for review and approval prior to procurement and installation.
16. The latest Sub-Metering Specification is available on the Marafeq website and shall be adhered to in full.
17. The Customer shall notify and invite Marafeq to inspect the sub-metering installation upon completion of the installation works and prior to concealment, testing, commissioning, and handover. The installation shall not be considered accepted until it has been inspected and approved by Marafeq.
18. Test, adjust and balance the hydraulic system to make sure that the chilled water requirement of each fan coil unit and air handling unit is met as per the design, preferably the Testing, Adjusting and Balancing (TAB) shall be carried out by a specialized third-party commissioning firm. Marafeq reserves the right to inspect the secondary-side building CHW system, including equipment, installations, testing, and commissioning activities to ensure its compliance with Marafeq specifications.
19. The standard FCU capacity is typically higher than the actual design capacity. During CHW balancing, the PICV shall be set to achieve the design flow rate based on the calculated cooling load and not based on the equipment’s nominal capacity.
20. The VFD-operated CHW pumps shall be controlled such that the maximum flow rate does not exceed the District Cooling (DC) design flow rate corresponding to the diversified building cooling load, where applicable, as approved by Marafeq. Pump operation shall not be based on the total installed equipment flow rate.

5.5 ETS Installation and Component Requirements

1. Primary system piping, valves and equipment must be all welded. All materials/equipment shall be of industrial standard. No flanges are allowed except for the heat exchanger, flanged spool piece, strainer, control valve(s) and flow meter. Components of the ETS should be of the same material to avoid galvanic corrosion.
2. The secondary-side PHE connections shall be provided with two (2) successive flanged spool pieces incorporating 45-degree elbows in front of the PHE to facilitate welding, insulation, cladding, and future maintenance activities.
3. A minimum straight pipe length of 5D upstream and 3D downstream of the flow meter shall be provided, where D represents the pipe diameter, measured from the respective ends of the flow meter or follow manufacturer recommendations.
4. Primary system piping and valves must be thermally insulated in accordance with clause 5.2.
5. Main isolation valves (supplied by Marafeq) shall be located directly inside the building as close as possible to the walls. Connection to the district cooling network shall be by welding. Isolation valves must be provided in the supply and return pipe around the heat exchanger(s) to allow for maintenance and cleaning. All isolating valves shall be welded ball valve or welded butterfly valve. Caution is needed and the manufacturer’s recommendations shall be followed, so that the seals in the valves will not be damaged during the welding process. All valves shall be easily accessible and tagged. Valves smaller than DN 50 may be welded or threaded ball valve. Isolation valves must be provided in the supply and return pipe at both primary & second sides of the heat exchanger(s) to allow for maintenance and cleaning.
6. The bypass valve and temporary connection valves shall be installed within the building in an accessible location.

7. The temporary connection chamber shall be located outside the building, within the plot boundary, and coordinated with the landscape design.
8. The temporary connection pipe terminations inside the chamber shall be closed with blind flanges and provided with 25 mm vent loops complete with manual air vent valves. Refer to *Appendix 3.1 and Appendix 3.2* for details.
9. PICV shall be installed on the primary-side return branch piping of each PHE. Refer to *Appendix 3.1 and Appendix 3.2* for details.
10. A safety relief valve at both primary and secondary side shall be installed for each heat exchanger to prevent over pressure during shutdowns in accordance with appendix 3.1 and 3.2.
11. A ball valve (DN50) with hose connection and cap for CIP/manual vent on the top connection side of the heat exchanger as shown on the schematic diagram. Also, a ball valve (DN50) with hose connection and cap for drainage at the bottom connection of the heat exchanger. End caps can be removed from each end to allow connection to clean water so the heat exchanger can be flushed and cleaned while the isolation valves are closed. These CIP & drain points are required at both primary & secondary sides of each PHE. Ball valves for primary side CIP shall be supplied by Marafeq, whereas the secondary side by the customer. For secondary side CIP, provide ball valve that body, disc and seat rated for a zero-leakage shut off at pressure class not less than the heat exchanger(s) design pressure.
12. Other than the 50 mm CIP/manual vent valves at the heat exchangers, all other vent valves shall be DN 25 (supplied by Marafeq for primary side) installed on the highest point in the direction of flow of the district cooling pipes. Bleeds shall be provided for manual extraction of air from the system. The bleeds shall be fitted with valves, and end caps located 400 mm above floor. Automatic air vents shall be provided at all venting locations.
13. Other than the 50 mm CIP/drain valves at the heat exchangers, all other drain valves shall be DN 25 (supplied by Marafeq for primary side) installed at the lowest point of the pipes. The bleeds shall be fitted with end caps. During maintenance operations, it must be possible to discharge water to nearby drains. The details of each shall be specified on construction drawings and on detail drawings. Venting and drain points shall remain accessible for network maintenance.
14. Installation of thread-o-lets on both the primary side and the secondary side, to be used for temperature transmitters (TT) and temperature gauges.
15. A strainer with blow off drain valve is required at the inlet of the heat exchanger(s). A differential pressure gauge shall be arranged with 25mm piping loop and isolation valves at both primary and secondary side PHE connections, so that it is possible to measure the pressure upstream / downstream the strainer and in the supply/return pipes as per attached PI&D schematic, s*ee Appendix 3.1 & 3.2.*
16. The PLC panel shall be mounted on 150mm concrete pad. The panel shall have top cable entry. Install PLC panel and enclosures in accordance with manufacturer's recommendations and/or where designated by Marafeq Qatar. The Panel shall be positioned to allow doors to be fully opened for easy access to wiring and components. Install panel in safe location that is clear of water pipes and minimizes potential for water spray or dripping onto the panel. Install panel rigidly supported, level and plumb, and in such manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment, piping, and electrical work.
17. PDT and flow meter monitor shall be wall mounted adjacent to the PLC panel. PDT impulse tubing shall be taken from the primary headers and shall be provided with isolation valves for maintenance and calibration purposes.
18. Air vents shall be provided in high points and drains in low points along with isolation valves.
19. Do not install equipment until adjacent heavy construction work has been completed to extent that damage will be unlikely to installation by such construction work.

5.6 Welding and Non-Destructive Test

Works on the primary side pipes shall be carried out by a contractor possessing the necessary welding qualifications and employing certified welders who have successfully completed approved welder qualification tests. Welding procedures shall be qualified in accordance with ASME Section IX or an equivalent internationally recognized standard. Valid Welder Performance Qualification (WPQ) records and Welding Procedure Specification/Procedure Qualification Record (WPS/PQR) documents shall be submitted to Marafeq for review and approval prior to the commencement of welding works.

For pipe sizes 3 inches (DN 80) and below, all root and fill passes shall be performed using the Tungsten Inert Gas (TIG) welding process. For pipe sizes above 3 inches (DN 80), Shielded Metal Arc Welding (SMAW) using E6010 for the root pass and E7018 for fill and cap passes may be used. Alternatively, a combination of Gas Metal Arc Welding (GMAW) using ER70S-series filler metal for the root pass and SMAW using E7018 electrodes for fill and cap passes may be adopted, subject to approval of the applicable WPS/PQR.

For primary-side piping, a minimum of 25% of above-ground weld joints and 100% of below-ground (pre-insulated pipe) weld joints shall be subjected to Non-Destructive Testing (NDT) by Radiographic Testing (RT) or an approved equivalent method. Radiographic films, NDT reports, and all supporting documentation shall be submitted to Marafeq for review and approval.

All welding, inspection, examination, and testing activities shall be performed in accordance with the latest edition of ASME B31.3 – Process Piping Code. Weld acceptance criteria shall comply with the requirements of ASME B31.3 and shall be verified through the applicable visual examinations and non-destructive examination (NDE) methods, including radiographic testing, ultrasonic testing, or other approved methods, as specified by the code and project requirements.

5.7 Pressure Tests, Inspections, and Quality Control

After successful completion of ETS installation inspections and welding tests, the customer shall proceed with hydrostatic pressure test for the primary side piping.

Refer pressure testing requirement of primary side under Appendix 5.2.

Pipes shall be hydrostatically tested for 23 bar for 6 hours, before proceeding to cleaning and flushing stages, which shall be demonstrated to Marafeq and obtain approval.

5.8 Pipe Cleaning and Commissioning

Immediately after the successful hydro test (not more than 48 hours) and prior to commissioning, the Customer shall perform a complete and thorough pipe flushing, cleaning and passivation of the primary side. Flushing, pipe cleaning, passivation and chemical water treatment of the secondary side chilled water piping network also to be completed, so that at the time of connection to the ETS PHE, the Customer's piping system is full of clean water and is clear from unwanted debris and particles.

The Customer shall submit method statements for testing, pipe flushing, cleaning and passivation of primary side piping system at least 4 weeks prior to the proposed starting of flushing and cleaning. Only after the method statement is reviewed and No Objection is issued by Marafeq, can the process of flushing and cleaning start. Refer *Appendix 5.3* for flushing/ pipe cleaning requirement of primary side.

After Marafeq approves the water quality analysis of primary side and satisfied with the water quality of the secondary side, the primary side may be supplied with chilled water from District Cooling system, subject to the terms and conditions in 'Cooling Services Agreement'.

Customer shall be responsible to maintain approved passivation water quality until supply of chilled water.

The system operation is dependent on the heat transfer between the primary and the secondary. A clean PHE must be assured. It is important that the Customer secure a minimum water quality in the secondary side systems in order to reduce impact of fouling and also to reduce corrosion of PHE. A fouled PHE surface will lead to reduced capacity. The following characteristics shall be followed:

Table 4 Water Quality Criteria

Parameters	**Unit**	**Standard**
pH	--	8.5 to 10.5
Total dissolved solids	ppm	< 2000
Conductivity	µSiemens/cm	< 3000
Total iron as Fe	ppm	< 1.0
Nitrite as NaNO2	ppm	> 800
Total Suspended Solids	ppm	< 20
Chlorides as Cl^-	ppm	< 150
Total Alkalinity as CaCO3	ppm	< 250
Total Calcium hardness as CaCO3	ppm	< 100

5.9 Procedures for Connection to District Cooling

The Customer shall obtain Marafeq's approval for all works carried out by the Customer prior to Marafeq assuming operational responsibility for the primary side of the ETS. This includes all the customer's activities regarding cleaning and commissioning as mentioned in 4.8, but also necessary inspections, NDT, quality control and pressure tests. This approval shall be obtained before Marafeq will allow the Customer to connect to the District Cooling Network and start commissioning/test run followed by commercial operation.

The connection procedure starts when the Customer contacts Marafeq for an introduction meeting. A Cooling Services Agreement (CSA) shall be signed. The Customer shall submit his estimate of the cooling demands (see Utility Application Procedure, Application 2 District Cooling Design Conformance Certificate). This request for capacity shall be in the form of 'Design Conformance Certificate (DCC)' in the prescribed format. Marafeq will review them and determine if they are acceptable in line with infrastructure and district cooling plants design.

Marafeq shall approve the location of the ETS room. The actual location of connection point from the primary district cooling pipe system (point of supply and return) is given by the as built drawings from LREDC, and Marafeq can share this data where available.

The ETS design, material supply and approval procedures are outlined in the Utility Application Procedure.

During various stages of installation works, Marafeq will inspect the installation. These stages are generally identified in the Utility Application Procedure. When Marafeq finally approves the installation; Marafeq will issue an "ETS Conformance Certificate". Refer also the 'Cooling Services Agreement' for the requirements of issuing the "ETS Conformance Certificate".

The application for "Design Conformance Certificate" can be found in document number LUS-CPALL-MAQ-PRC-UT-10560 UTILITY APPLICATION PROCEDURES FOR DISTRICT COOLING, Application No. 2. The "ETS Conformance Certificate" is attached in Appendix 2. Cooling operations start after Marafeq opens the chilled water valves connecting the building to the district cooling network.

6 TECHNICAL SPECIFICATIONS

The materials specified herein shall be supplied, installed, tested, and commissioned by the Customer. The following material submittals shall be reviewed and approved by the Project Consultant and subsequently submitted to Marafeq for review and approval prior to procurement and installation.

All material submittals shall include independent third-party certification in accordance with EN 10204 Type 3.2, or equivalent Certified Material Test Reports (CMTRs) with independent third-party verification in accordance with applicable ASME/ASTM standards.

Table 6 List of Material Submittals

Sl. No.	List of Material Submittals	Applicable side in ETS
5.1	Above ground Bare pipes and fittings	Primary side
5.2	Above ground pipe Insulation and Aluminium cladding	Primary & Secondary side
5.3	Buried pre-insulated pipes, fittings and Field joint kits	Primary side
5.4	Y-Strainer and Blow off Drain Valve	Primary & Secondary side
5.5	Pressure Safety Relief Valve	Primary & Secondary side
5.6	Pressure Gauge	Primary & Secondary side
5.7	Temperature Gauge	Primary & Secondary side
5.8	Automatic Air Release Valve	Primary side
5.9	Sub-metering for Building side CHW system	Secondary side

6.1 Above Ground Bare Pipes and Fittings

Pipes, fittings and other piping components shall be of same materials and have at least the pressure class (minimum PN16) required in the actual system. Connections including any gaskets shall meet requirements of the applicable ANSI/ASME/EN standards and shall be rated for the system pressure and temperatures.

For above-ground piping, seamless carbon steel tubes conforming to EN 10216-2 shall be used for pipe sizes up to and including DN 350. For pipe sizes DN 400 and larger, welded carbon steel tubes conforming to EN 10217-2 (ERW) or EN 10217-5 (SAW) shall be used. Steel grades for EN standard pipes shall be P235GH or P265GH. As an alternative to EN standards, carbon steel pipes conforming to ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, with standard wall thickness (minimum schedule 40) and bevelled ends, may be used for above-ground piping, subject to Marafeq approval.

Pipe fittings such as elbows, reducers, tees and other shall be seamless carbon steel butt-welding fittings with bevelled ends, manufactured in accordance with ASTM A234 Grade WPB and ASME B16.9/ASME B16.25, or EN 10253-2 Type B of equivalent material grade and pressure rating. To avoid trapping air, reducers shall be eccentric type with flat on top. The wall thickness of fittings shall match the pipe wall thickness where the fittings are used. Elbows shall be long radius. In terms of dimensions, class, raised or flat face, etc., flanges shall match the components they attach to.

The flanges used shall be weld neck type. Flanges shall be forged carbon steel flanges conforming to EN 1092-1 Type 11 (welding neck), manufactured from material grade P245GH or equivalent, or ASTM A105 forged carbon steel flanges in accordance with ASME B16.5, as applicable.

Weld-O-Lets shall be seamless, butt-welded, bevelled-end carbon steel branch fittings conforming to ASTM A234 Grade WPB and ASME B16.25, or MSS SP-97.

Thread-O-Lets shall be Class 3000 forged carbon steel threaded branch fittings conforming to ASTM A105 and ASME B16.11, or MSS SP-97.

Threaded fittings shall only be used for instrument connections. They shall be forged carbon steel fittings conforming to ASTM A105 and ASME B16.11, with threaded ends in accordance with ASME B1.20.1.

Instrumentation tubing shall be seamless annealed type 316/316L stainless steel tubing conforming to ASTM A269. Tubing fittings shall be stainless steel double-ferrule compression type, manufactured from ASTM A182 F316/F316L stainless steel. The instrumentation tubing dimensions shall be selected to suit the PDT connection ports. The tubing wall thickness shall be designed and rated to safely withstand the system design pressure, operating pressure, and any anticipated pressure fluctuations or surges.

Gaskets shall be premium-quality compressed non-asbestos fiber (CNAF) or expanded PTFE, factory-cut and suitable for the flange faces. Gaskets shall conform to ASME B16.21 or EN 1514, as applicable, and shall be suitable for chilled water service with pressure and temperature ratings equal to or exceeding the system design conditions.

Pipe supports shall be rigid type, fabricated from hot-dip galvanized carbon steel complying with ASTM A123 and ASTM A36, or approved equivalent. Supports shall be floor-, wall-, or ceiling-mounted as required. Adequate supports, including trunnions, guides, anchors, and elbow support, shall be provided to ensure piping stability and prevent excessive loads on connected equipment.

U-bolts shall be galvanized carbon steel or stainless steel, sized to suit the pipe diameter and support configuration. Galvanized U-bolts shall comply with ASTM A153/A153M. Pipe supports for insulated chilled water piping shall be provided with high-density rigid insulation inserts complying with ASTM C552, ASTM C578, or ASTM C591, as applicable. Inserts shall have adequate compressive strength, be moisture-resistant, and prevent thermal bridging and condensation. U-bolts shall bear on the inserts and not directly on the insulation.

Nuts, bolts, and washers shall be carbon steel, hot dip galvanized in accordance with ASTM A153/A153M. Bolts shall conform to ISO 898-1 Grade 8.8, nuts to ISO 898-2 Grade 8, and washers to ASTM F436 or approved equivalent.

For materials such as threaded fittings, instrumentation piping, gaskets, pipe supports, and fasteners, project consultant approval is required, and sample material approval from Marafeq shall be obtained. Material submittals are not required for Marafeq review.

Mill test certificates, which can be correlated to the pipes and fittings delivered, shall be submitted to the Customer for each consignment of pipes. The Customer shall forward the mill test certificates to Marafeq.

6.2 Above ground pipe Insulation and Aluminium cladding

Insulation shall be of closed cell elastomeric/cellular rubber, which is glued together, edge to edge. Insulation thicknesses for all pipe sizes shall be not less than 50 mm (2 inch) thick, single layer.

Use closed cell elastomeric; expanded, flexible conforming to ASTM C534, and ASTM C177 or ASTM C518 latest editions. Insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's. It shall also be formaldehyde free, low VOC's, fiber free, dust free and resists mold and mildew.

Density shall be not less than 68 kg/m^3.

Thermal conductivity shall not exceed 0.035 W/m-K at 23.9 ^{0}C (75 ^{0}F) mean temperature (0.27 Btu-in/h-ft2-^{0}F) when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

Flame/smoke spread rating of 25/50 tested by ASTM E84-91A.

Maximum water vapour transmission of 1.16x10-6 Kg/s-m-Pa (0.8 perm-inches).

For piping up to 150 mm (6 inch); tubular or pre-slit with pre-glued longitudinal seams. For larger piping, flat sheets.

Insulation glue and adhesive tapes shall be from the same manufacturer of insulation material.

Field nitrile rubber insulation is applicable only on aboveground pipes.

The chilled water piping systems and pumps shall be insulated and jacketed with aluminium insulation jacketing. The contractor shall clad all insulated pipe work and duct work with aluminium hammer finish (stucco) sheets ASTMB209 and ASTMB209M with a minimum thickness of 0.9-1.0mm.

Insulation and aluminium cladding work for ETS primary & secondary side piping shall be carried out by a contractor with proven experience in thermal insulation installation.

6.3 Buried Pre-insulated Pipes, Fittings and Field joint kits

For directly buried piping and piping inside temporary valve chamber, pre-insulated bonded pipe system shall be used. Pre-insulated pipe system shall be assembled carbon steel service pipe, polyurethane thermal insulation and outer casing of high-density polyethylene (HDPE). The pre-insulated bonded piping shall comply with standard EN 253, and pre-insulated fittings shall comply with EN 448 as minimum. (Valves inside chamber shall be pre-insulated).

The core pipe of the buried pipes shall be carbon steel pipe and shall conform to dimensions in accordance with DIN 2458 and steel quality P235GH in accordance with standard EN10216-2, EN10217-2 and 10217-5.

Seamless steel tubes in accordance with EN10216-2 shall be used for dimensions up to DN350. Welded steel tubes in accordance with EN10217-2 (ERW) or EN10217-5 (SAW) shall be used from dimension DN400 and larger.

As an alternative to the above EN standards, Core pipes shall be seamless type up to size DN 350mm conforming to ASTM A 106 Gr B SCH40 bevelled ends, and welded steel tubes in accordance with ASTM A 53 Gr B SCH40 bevelled ends shall be used from dimension DN400 and larger.

Core pipe fittings such as Elbows, reducers, tees and other shall be seamless carbon steel butt-welding fittings with bevelled ends, manufactured in accordance with ASTM A234 Grade WPB and ASME B16.9/ASME B16.25, or EN 10253-2 Type B of equivalent material grade and pressure rating. The wall thickness of fittings shall match the pipe wall thickness where the fittings are used. Elbows shall be long radius.

Following dimensions will apply for the service carbon steel pipe:

Table 7 Pipe Dimensions

Pipe Dimensions		
Dimension	**Outer diameter**	**Nominal Wall thickness**
DN100	114.3 mm	3.6 mm
DN125	139.7 mm	3.6 mm
DN150	168.3 mm	4.0 mm

DN200	219.1 mm	4.5 mm
DN250	273.0 mm	5.0 mm
DN300	323.9 mm	5.6 mm
DN400	406.4 mm	6.3 mm
DN450	457.0 mm	6.3 mm
DN500	508.0 mm	6.3 mm
DN600	610.0 mm	7.1 mm
DN700	711.0 mm	8.0 mm

Thermal insulation is a part of the pre-insulated pipes material scope. The pre-insulated pipes and fittings will be delivered with hard polyurethane foam applied at factory. The polyurethane foam is bonded to the service pipe and the outer casing jacket pipe. Minimum insulation requirements:

Table 8 Insulation Properties

Insulation Properties	
Property	**Min. requirement**
Closed cell content	> 90.0 %
Size of cells	< 0.3 mm
Core density	≥ 60 kg/m3 (Note1)
Thermal conductivity at 50°C (λ50)	< 0.03 W/m K
Water absorption	< 5 % (volume)
Compression strength	> 0.30 MPa
Axial shear strength, 23 deg C unaged (new)	> 0.12 MPa
Axial shear strength, 23 deg C aged	> 0.12 MPa

Note 1: Not defined in present EN253:2009. However, for securing the handling of pipes of large dimensions this is required. (It was included in the previous EN253:2003. Requirements are considered by CEN/TC 107, to be included again in next EN253 standard version.)

Thickness of insulation varies depending on pipe dimension, see dimensions of outer casing jacket pipe below.

The outer casing jacket pipe works as the condensation barrier and is a part of the pre-insulated pipes material scope. The outer casing pipe will be manufactured in UV-stabilized HDPE in accordance with EN253 or equal.

Table 9 Casing Jacket Properties

Casing Jacket Properties	
Materials	High density polyethylene (HDPE) bimodal minimum PE80, ISO 12162
Density	Min. 944 kg/m3
Pipe wall thickness	According to EN253 or equal

Table 10 Casing Jacket Dimensions

Casing Jacket Dimensions		
Dimension (mm)	**Outer diameter casing pipe**	**Minimum casing wall thickness**
DN100	200 mm	3.2 mm
DN125	225 mm	3.4 mm
DN150	250 mm	3.9 mm
DN200	315 mm	4.5 mm
DN250	400 mm	4.8 mm
DN300	450 mm	5.2 mm
DN350	500 mm	5.6 mm
DN400	520 mm	5.7 mm
DN450	560 mm	6.6 mm
DN500	630 mm	7.2 mm
DN600	780 mm	7.9 mm
DN700	900 mm	8.7 mm

A leak detection/surveillance system is NOT required for buried piping associated with ETS applications.

HDPE casing jacket shall be in accordance with EN 489. Joint casing jackets shall be marked with the following details as per EN 489, name of manufacturer, name of product, year and week of manufacture and type of sealing material shall be mentioned.

Joint kits shall be supplied by the pipe material supplier. Materials specified in EHP certificate (Polyol, blowing agent, casing pipe) shall be used for FJK installation.

Foam packs shall have the details of quantity, size of joint at which it will be used, production and expiry date, opening instruction and first aid measure etc.

The tubular joint casings must be applied before the core pipes are welded together.

Joint kits shall include electro welded band joint jacket for DN 150 and smaller pipes. Length of the casing shall minimum overlap 100 mm of adjacent pipe component's casing. Installation of wide sealant mastics strips on the HDPE casing ends shall be included for double security.

Butt welding shall be done for the casing jacket in pipe dimensions DN 200 and larger. Certified welders shall do the HDPE welding as per EN448.

HDPE jacket thickness, density & other technical parameters shall match pre-insulated pipe casing jacket.

Air pressure test shall be conducted after HDPE jacket welding process before pouring the chemicals.

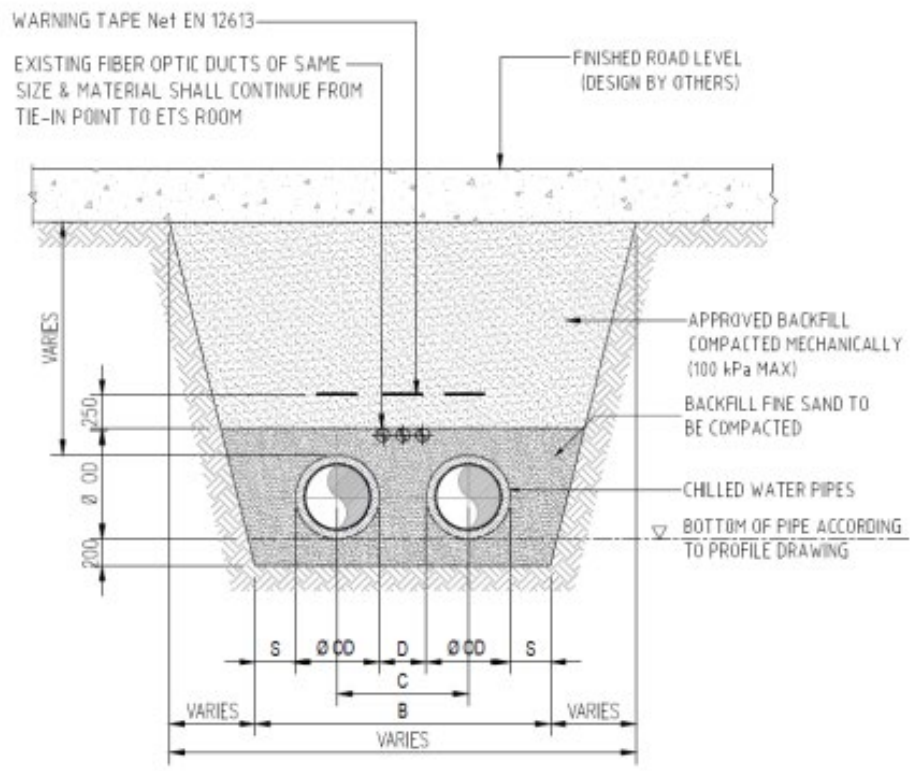
Polyurethane foam shall be delivered in sets/kits for mixing and applying on site.

End caps / seals shall be provided for all pipes during transportation and storage to prevent ingress of moisture and dirt.

Warning tapes shall be in accordance with EN12613. Plastic net warning devices with a width of 400 mm shall be rolled out in the trench embedding above the chilled water pipes. Two, three or four nets (depending on pipe dimension) shall be rolled out in parallel as shown in below drawing.

Three (3) nos. of 40mm diameter HDPE duct pipes shall be laid from the DC tie-in point to the building basement retaining wall / ETS room. HDPE duct pipes shall comply with EN 12201 and shall be PE100, SDR 11.

Mill test certificates and radiography test certificates, which can be correlated to the pipes and fittings delivered and installed, shall be submitted to the Customer for each consignment of pipes. The Customer shall forward the test certificates to Marafeq.



Insulation and jacket test certificates issued by the pre insulated pipe manufacturer shall be submitted to Customer for every consignment of pipes. The Customer shall forward the test certificates to Marafeq.

Figure 3 Trench detail for buried pre-insulated pipe

6.4 Y-Strainer and Blow off Drain Valve

To protect the heat exchange and control valves from any suspended particles and debris, strainers are required on both inlet nozzles on the heat exchanger (primary and secondary side). The strainer element shall allow for cleaning without being dismantled. The connections shall be flanged or welded.

1. Strainer shall be Y-pattern with blow off drain valve with the minimum pressure rating of PN16. Strainer & screen mesh shall be suitable for 23 bar hydrostatic test pressure.
2. Screen shall be made of stainless steel (SS316 grade) with max perforation mesh size 0.6 – 0.8 mm, or as required to protect the PICV and heat exchanger.
3. Screen shall be accessed by way of threaded or bolted cover.
4. A bronze-bodied ball valve, minimum PN16 rating, with threaded connection shall be provided on the strainer cover for blow-off drain purposes.

6.5 Pressure Safety Relief Valve

A safety relief valve at both primary and secondary side shall be installed for each heat exchanger to prevent over pressure during shutdowns in accordance with appendix 3.1 and 3. 2. The valve shall be sized for thermal expansion at design load conditions, and the set pressure shall be equal to the heat exchanger design pressure.

1. PN16 & minimum size ¾" or 1" (inlet & outlet)
2. Direct spring-loaded type (proportional flow).
3. Packed lift lever operated, with non-adjustable factory set discharge pressure
4. Stainless steel (SS316) internals & PTFE seating.

6.6 Pressure Gauge

Industrial grade pressure gauges shall be provided.

- The pressure gauge shall be bourdon tube type, phenolic or stainless-steel case with plastic lens, black letters on white surface, solid front and blow out back style. 100 mm phenolic case, black on white scale, glycerin filled, Bourdon type gauge with stainless steel movement.
- All units complete with stainless steel block & bleed gauge valves, Ø15mm stainless steel threaded process connection.
- Scale range: (0-28 bar) & (0 to 400 psi), normal reading shall be in the middle of the scale range.
- Accuracy: : ± 1.0% of range

6.7 Temperature Gauge

Industrial grade thermometers shall be provided in the supply and return line of each heat exchanger on both the primary and building side.

- Thermometers shall be bi-metal type thermometers with 125 mm diameter stainless steel dial and shatter proof glass, black letters on white surface, external pointer adjustment and rear angle adjustable with connection to thermo well.
- Temperature range shall be suitable for chilled water supply and return temperatures, and the scale shall be in °C & °F. The indicator shall be suitable for operating water temperatures specified and ambient temperature of up to 50 °C.
- Scale Range: (-20°C to +50°C) & (0°F to 122°F), normal reading is in the middle of the scale range.
- 15 mm adjustable "every angle" stainless steel bottom connection, stainless steel welded construction sheath to suit thermowell.
- Thermowells shall be 316 stainless steel bar stock construction, step type.
- The thermowell shall protrude 3/4 pipe diameter inside the pipe and lagging extension suitable for the insulated pipe.
- Accuracy: ± 1.0% of range

6.8 Automatic Air release Valve

- 1" (DN25), minimum PN16 automatic air release valve, float-operated type,
- Industrial grade, valve body and cover shall be ductile iron conforming to ASTM A536, Grade 65-45-12
- Float and all internal wetted parts shall be stainless steel (AISI 316)
- Provide a full-port isolation ball valve (WBV) before AAV.
- Seal materials shall be EPDM or NBR or equivalent suitable for CHW service.

6.9 Sub-metering for Building side CHW system

Customer shall follow Marafeq sub-meter system guideline (Document No.: LUS-CPALL-MAQ-SPE-UT-10174) & schematic diagram for Sub-metering system and submit material submittal for Marafeq review.

6.10 Connection with the District Cooling Network

Generally, the district cooling tie-in point is extended one meter inside the plot boundary; however, the Customer shall obtain tie-in point information (coordinates and levels) from LREDC and verify them at site. Any piling work for the basement construction adjacent to the infrastructure district cooling tie-in point shall be protected by the Customer to ensure that the existing infrastructure district cooling pipe is not damaged.

Following the successful completion and approval of the flushing and pipe cleaning works, the tie-in works shall commence only after obtaining the required tie-in permits. The Customer shall ensure that no leakage is present following the isolation of the main valve from the District Cooling Network (DCN) by Marafeq personnel.

Tie-in welding activities shall commence only after Marafeq has witnessed and approved the valve isolation, confirmed the absence of leakage, and completed the fit-up inspection.

All tie-in weld joints shall be subjected to radiographic testing (RT). The radiographic films and test reports shall be submitted to Marafeq for review and approval. Upon approval of the RT results, field joint insulation shall be installed in accordance with the approved material submittal and project specifications.

Before connecting to the district cooling network, the Customer shall submit a method statement to Marafeq for approval.

6.11 Tagging

Tagging and identification of the ETS equipment and component shall be in accordance with the following document titled below:

- District Cooling Tagging and Identification System for Plants, Network and ETS: Document No: LUS-CP13B-MAQ-REP-UT-001. (Latest Revision)

The above referred document can be downloaded from Marafeq website Customer Service | Marafeq Qatar

6.12 Changes to the System

Once the design has been approved, the Customer shall not change or replace any equipment during the installation without informing Marafeq. The Customer shall ensure that all equipment dimensions and footprints conform to the approved/stamped ETS design drawings, including but not limited to pumps, expansion tanks, air separators, pressurization units, chemical dosing units, and control panels. Any proposed changes shall be subject to Marafeq's review and approval prior to implementation.

Any future changes to the building's cooling water system that will impact the district cooling system must be reported to and, when appropriate, reviewed by Marafeq.

The Customer is responsible for maintaining his secondary side system so that it continues to perform as intended.

If warranted by changes in temperatures and flow conditions, the Customer should verify that his side of the ETS is properly balanced.

7 APPENDICES

Appendix 1: Design Conformance Certificate (Refer document number LUS-CPALL-MAQ-PRC-UT-10560 Utility Application Procedure for District Cooling, Application No. 2)

Appendix 2: ETS Conformance Certificate

Appendix 3.1: Schematic of ETS installation for Single Heat Exchanger

Appendix 3.2: Schematic of ETS installation for Multiple Heat Exchangers

Appendix 4.1: Compliance statement: Method statement for Installation, Testing and Commissioning of Equipment inside ETS (Primary side)

Appendix 4.2: Compliance statement: Method statement for Hydro static test (Primary side)

Appendix 4.3: Compliance statement: Method statement for Flushing/Pipe conditioning (Primary side)

Notes:

Appendix 2 Submitted for “ETS Conformance Certificate” after testing and commissioning of ETS.

Appendices 3.1 and 3.2 shall be used as guideline for specific ETS design.

Appendices 4.1, 4.2 and 4.3 shall be submitted as a part of method statement submittals.

Appendix:1

APPLICATION NO.2: DISTRICT COOLING – DESIGN CONFORMANCE CERTIFICATE (DCC)				
DETAILS OF BUILDING				
District Name				
Customer Id No:				
Plot No.				
Building Name				
COOLING DEMAND (1TR = 3.517 kW)				
Gross Floor Area (GFA) approved by LREDC	m^2			
Gross floor Area (GFA) actual	m^2			
Parking Area	m^2			
AHU (Air handling Units)	TR		kW	
FCU (Fan Coil Units)	TR		kW	
Process cooling	TR		kW	
Others (Specify)	TR		kW	
Total Coincident Cooling Demand	TR		kW	
DISTRICT COOLING SYSTEM (PRIMARY)				
Total Design flow (l/s)				
Design temperature ºC (In/Out)				
BUILDING COOLING SYSTEM (SECONDARY)				
Total Design flow (l/s)				
Design temperature ºC (In/Out)				

Compliance Statement:

The design shall comply with Marafeq Technical Guidelines for the connection of ETS Document No: LUS-CPALL-MAQ-SPE-UT-00004 without any exception unless otherwise a written confirmation from Marafeq Qatar is provided. The design and installation liabilities/responsibilities remain with the Sub-developer/Owner at all times.

…… ……..

(Signature and Stamp of Design Consultant) (Checked and received by Marafeq Qatar)

Date: …….. Date :…….

Appendix: 2 Application for ETS Conformance Certificate

مـــرافـــق قـــطر
Marafeq Qatar

ETS Examination Summary

ETS ID:

Date:	Executed by:
Customer/Company:	Type of control:

DISTRICT COOLING SYSTEM

BUILDING COOLING SYSTEM

Meter readings

1 Energy	TRh		
2 Volume	m^3		

Temperature District Cooling

6 Temperature supply	°C
7 Temperature return	°C

Secondary side

8 Temperature supply	°C
9 Temperature return	°C

Pressure

3 Supply, before strainer	MPa/kPa
4 Supply, after strainer	MPa/kPa
5 Return	MPa/kPa

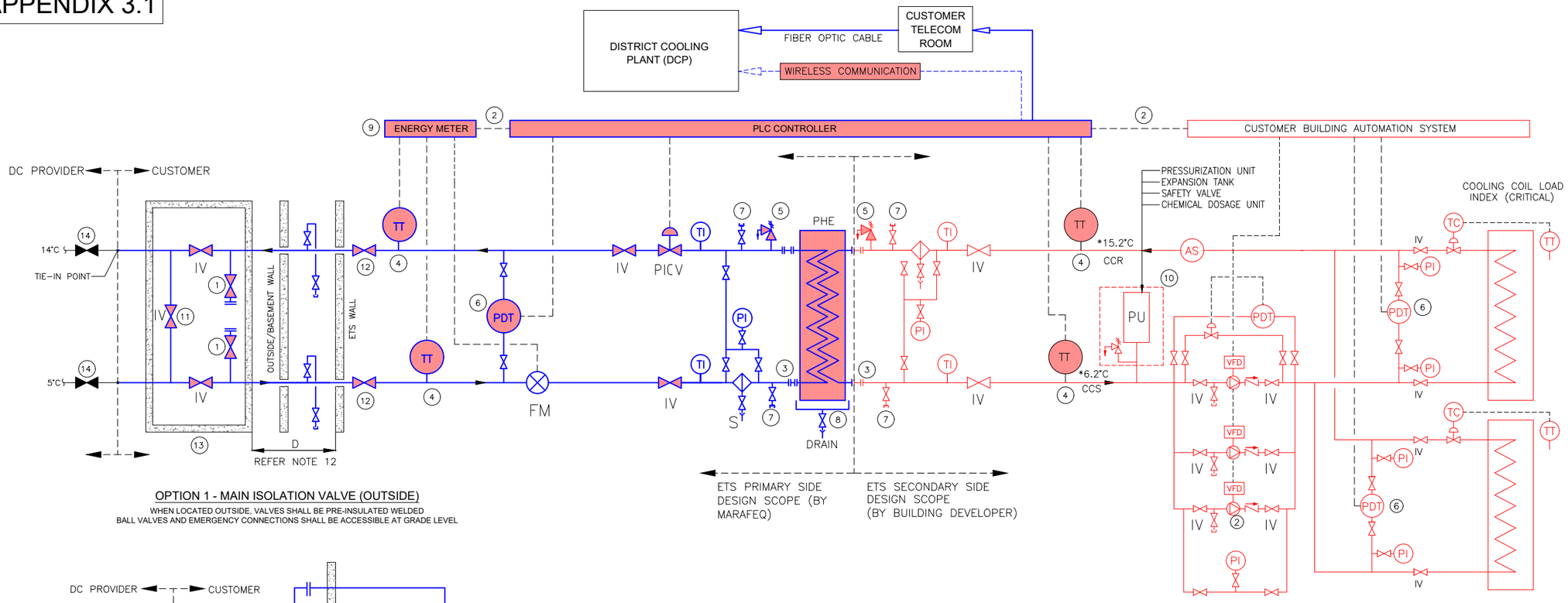
Other

10 Outside temperature	°C

S. No	System / component	Fault Description / Remark	Status[1] 1-4	Proposed Action
	District Cooling System			
	Isolating valves			
	Strainer			
	Pressure sensors			
	Temperature sensors			
	Flow Meter			
	Energy Meter			
	Temperature transmitter			
	PDT			
	PHE			
	PLC			
	Control valve (PICV)			
	Building Cooling System			
	Strainer			
	Pressure sensors			
	Temperature sensors			
	Pumps			
	Expansion tank / safety valve			
	Flow Sensor Switch			
	Pump By-pass			
	VFD			
	Other Equipment			

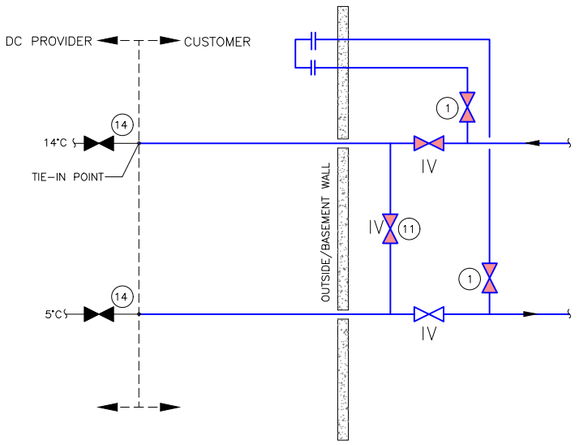
[1] **Status: 1=Acute, 2=Action needed, 3=Info, 4=Executed by Observer**

APPENDIX 3.1



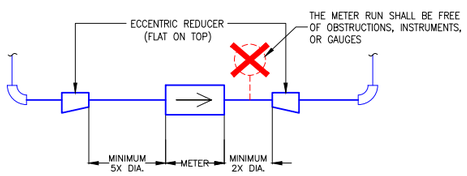
OPTION 1 - MAIN ISOLATION VALVE (OUTSIDE)

WHEN LOCATED OUTSIDE, VALVES SHALL BE PRE-INSULATED WELDED BALL VALVES AND EMERGENCY CONNECTIONS SHALL BE ACCESSIBLE AT GRADE LEVEL



OPTION 2 - MAIN ISOLATION VALVE (INSIDE)

WHEN LOCATED INSIDE, EMERGENCY CONNECTIONS SHALL BE ACCESSIBLE FROM OUTSIDE AT GRADE LEVEL



FLOW METER RUN

METER RUN WITHOUT ANY FLOW DISTURBANCES

NOTES:

1	FLUSHING AND TEMPORARY CONNECTIONS. MAX ONE STEP LESS THAN MAIN PIPE.
2	MOD BUS INTERFACE TO CUSTOMER BUILDING AUTOMATION SYSTEM, FOR MONITORING ONLY.
3	FLANGED SPOOL PIECE MINIMUM LENGTH; TO FIT ONE FULL SIZE BEND
4	THERMOWELL AND TEMPERATURE TRANSMITTER
5	ROUTE SAFETY RELIEF VALVE DISCHARGE TO HEAT EXCHANGER DRAIN PAN.
6	PRESSURE DIFFERENTIAL TRANSMITTER ACROSS THE TWO MOST HYDRAULICALLY REMOTE LOADS.
7	DRAIN AND MANUAL AIR VENT WITH HOSE CONNECTION (DN50) FOR CIP
8	DRIP TRAY WITH DRAIN FOR GASKETED PHE
9	ENERGY METER FOR BILLING.
10	EXPANSION UNIT
11	BY–PASS CONNECTION. MAX ONE STEP LESS THAN MAINPIPE
12	PROVIDE ISOLTATION VALVES IF D > 10m
13	VALVE CHAMBER WITH BYPASS AND TEMPORARY CONNECTION TO BE CONSTRUCTED WITHIN PLOT SETBACK. USE FACTORY PRE–INSULATED BALL VALVE & PIPE.
14	PLOT TIE–IN POINT (WELDED CONNECTION) (POINTS OF DELIVERY AND RETURN)

LEGENDS:

SYM.	DESCRIPTION	SYM.	DESCRIPTION
	PRIMARY CHILLED WATER SYSTEM (DC)		MOD BUS COMMUNICATION
	SECONDARY CHILLED WATER SYSTEM (CC)		SUPPLY BY MARAFEQ AND INSTALLATION BY CUSTOMER
PT	PRESSURE TRANSMITTER		VALVE
PI	PRESSURE INDICATOR		2–WAY CONTROL VALVE
TT	TEMPERATURE TRANSMITTER		CHECK VALVE
TC	TEMPERATURE CONTROLLER		WITH THREADED CAP
TI	TEMPERATURE INDICATOR		STRAINER WITH BLOW OFF VALVE
PDT	PRESSURE DIFF. TRANSMITTER		
AS	AIR SEPARATOR		FLOW METER
VFD	VARIABLE FREQUENCY DRIVE		PUMP
DCS	DISTRICT COOLING SUPPLY	TT	INSTR. TAG
DCR	DISTRICT COOLING RETURN		WITH HOSE CONNECTION
CCS	CUSTOMER COOLING SUPPLY		PSV
CCR	CUSTOMER COOLING RETURN		FLOW ARROW
IV	ISOLATION VALVE		

1. PROVIDE VENTS AND DRAINS AT ALL HIGH/LOW POINTS AND/OR AS SHOWN IN LAYOUTS AND SECTIONS.
2. ROUTE DRAINS TO NEAREST FLOOR DRAIN.
3. PRIMARY SIDE ISOLATION VALVE (IV) SHALL BE WELDED BALL VALVE.

* INDICATIVE VALUES ONLY. CUSTOMER TO DESIGN THE CHILLED WATER TEMPERATURES ON SECONDARY SIDE BASED ON THE BUILDING SIDE A/CDESIGN WITH DELTA T OF 9°C.

4. BURIED PIPE SHALL BE PRE–INSULATED.
5. SECONDARY SIDE DESIGN BY CUSTOMER.

مـــرافـق قـــطر
Marafeq Qatar

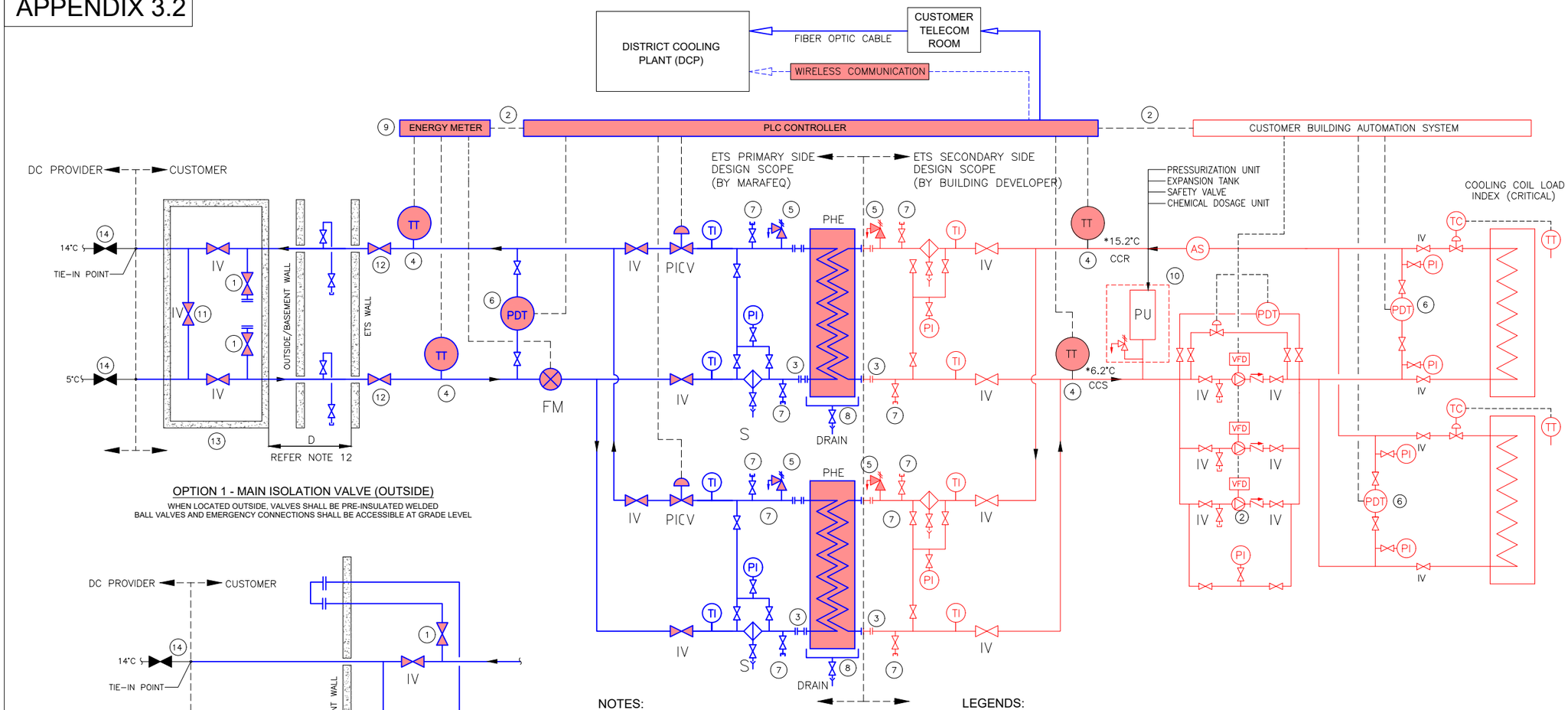
DRAWING TITLE:

ETS-GENERAL DISTRICT COOLING PIPING AND INSTRUMENTATION DIAGRAM FOR SINGLE HEAT EXCHANGERS

DRAWING NO. LUS-CPALL-MAQ-DWG-UT-10601 | DATE: 26-AUG-26

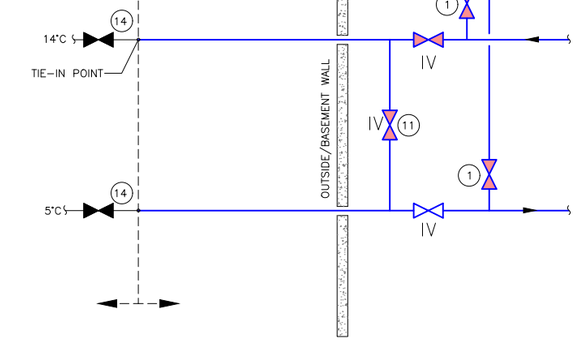
CAD Ref: Q:\Projects\Lusail Development\Project Guidelines & Technical Requirements\Sub-developers\DC\ETS Layout drawing DWG format\ LUS-CPALL-MAQ-DWG-UT-10600-601_26.08.2026.dwg Last saved: Mon, 31 Aug 2026 09:28 am Plotted By : rollie.labadan

APPENDIX 3.2



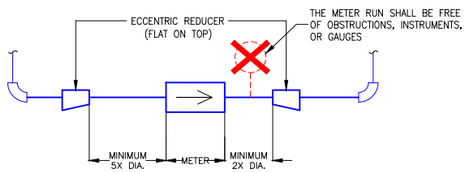
OPTION 1 - MAIN ISOLATION VALVE (OUTSIDE)

WHEN LOCATED OUTSIDE, VALVES SHALL BE PRE-INSULATED WELDED BALL VALVES AND EMERGENCY CONNECTIONS SHALL BE ACCESSIBLE AT GRADE LEVEL



OPTION 2 - MAIN ISOLATION VALVE (INSIDE)

WHEN LOCATED INSIDE, EMERGENCY CONNECTIONS SHALL BE ACCESSIBLE FROM OUTSIDE AT GRADE LEVEL



FLOW METER RUN

METER RUN WITHOUT ANY FLOW DISTURBANCES

NOTES:

1	FLUSHING AND TEMPORARY CONNECTIONS. MAX ONE STEP LESS THAN MAIN PIPE.
2	MOD BUS INTERFACE TO CUSTOMER BUILDING AUTOMATION SYSTEM, FOR MONITORING ONLY.
3	FLANGED SPOOL PIECE MINIMUM LENGTH; TO FIT ONE FULL SIZE BEND
4	THERMOWELL AND TEMPERATURE TRANSMITTER
5	ROUTE SAFETY RELIEF VALVE DISCHARGE TO HEAT EXCHANGER DRAIN PAN.
6	PRESSURE DIFFERENTIAL TRANSMITTER ACROSS THE TWO MOST HYDRAULICALLY REMOTE LOADS.
7	DRAIN AND MANUAL AIR VENT WITH HOSE CONNECTION (DN50) FOR CIP
8	DRIP TRAY WITH DRAIN FOR GASKETED PHE
9	ENERGY METER FOR BILLING.
10	EXPANSION UNIT
11	BY-PASS CONNECTION. MAX ONE STEP LESS THAN MAINPIPE
12	PROVIDE ISOLTATION VALVES IF D > 10m
13	VALVE CHAMBER WITH BYPASS AND TEMPORARY CONNECTION TO BE CONSTRUCTED WITHIN PLOT SETBACK. USE FACTORY PRE-INSULATED BALL VALVE & PIPE.
14	PLOT TIE-IN POINT (WELDED CONNECTION) (POINTS OF DELIVERY AND RETURN)

LEGENDS:

SYM.	DESCRIPTION	SYM.	DESCRIPTION
	PRIMARY CHILLED WATER SYSTEM (DC)		MOD BUS COMMUNICATION
	SECONDARY CHILLED WATER SYSTEM (CC)		SUPPLY BY MARAFEQ AND INSTALLATION BY CUSTOMER
PT	PRESSURE TRANSMITTER		VALVE
PI	PRESSURE INDICATOR		2-WAY CONTROL VALVE
TT	TEMPERATURE TRANSMITTER		CHECK VALVE
TC	TEMPERATURE CONTROLLER		WITH THREADED CAP
TI	TEMPERATURE INDICATOR		STRAINER WITH
PDT	PRESSURE DIFF. TRANSMITTER		BLOW OFF VALVE
AS	AIR SEPARATOR		FLOW METER
VFD	VARIABLE FREQUENCY DRIVE		PUMP
DCS	DISTRICT COOLING SUPPLY	TT	INSTR. TAG
DCR	DISTRICT COOLING RETURN		WITH HOSE CONNECTION
CCS	CUSTOMER COOLING SUPPLY		PSV
CCR	CUSTOMER COOLING RETURN		FLOW ARROW
IV	ISOLATION VALVE		

1. PROVIDE VENTS AND DRAINS AT ALL HIGH/LOW POINTS AND/OR AS SHOWN IN LAYOUTS AND SECTIONS.
2. ROUTE DRAINS TO NEAREST FLOOR DRAIN.
3. PRIMARY SIDE ISOLATION VALVE (IV) SHALL BE WELDED BALL VALVE.
* INDICATIVE VALUES ONLY. CUSTOMER TO DESIGN THE CHILLED WATER TEMPERATURES ON SECONDARY SIDE BASED ON THE BUILDING SIDE A/CDESIGN WITH DELTA T OF 9°C.
4. BURIED PIPE SHALL BE PRE-INSULATED.
5. SECONDARY SIDE DESIGN BY CUSTOMER.

مـــرافـق قـــطر
Marafeq Qatar

DRAWING TITLE:

ETS-GENERAL DISTRICT COOLING PIPING AND INSTRUMENTATION DIAGRAM FOR MULTIPLE HEAT EXCHANGERS

DRAWING NO. LUS-CPALL-MAQ-DWG-UT-10600 | DATE: 26-AUG-26

CAD Ref: Q:\Projects\Lusail Development\Project Guidelines & Technical Requirements\Sub-developers\DC\ETS Layout drawing DWG format\ LUS-CPALL-MAQ-DWG-UT-10600-601_26.08.2026.dwg Last saved: Mon, 31 Aug 2026 09:23 am Plotted By : rollie.labadan

Appendix: 4.1

Marafeq Technical Requirements for the connection of ETS(s) to the District Cooling System

Compliance Statement: Method Statement for Installation, Testing and Commissioning of equipment inside ETS (Primary side)

S. No.	Description	Status
A	**Documentation requirements**	
1	The following documents shall be submitted to Marafeq for review and approval. Upon approval contractor may proceed for commissioning with due notice to Marafeq where applicable: ➢ Compliance sheet for installation, testing and commissioning (this document) ➢ Vendor approved installation, testing and commissioning procedures for each material mentioned in section-B of this document. ➢ Installation, testing and commissioning template sheet	
B	**Material**	
1	➢ Heat exchanger ➢ Pre-insulated pipe ➢ PICV (Pressure Independent Control Valve) ➢ Strainer ➢ Ball valve ➢ Instruments (Pressure gauge, pressure differential transmitter, temperature gauge, temperature transmitter, flow meter, Energy meter) ➢ PLC	
	Installation/Testing/Commissioning/Calibration	
C	**Heat Exchanger**	
1	Ensure that the material is received, inspected and stored in good condition	
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	
D	**Pre-insulated pipe/Field joint kits/ Bare pipes and fittings**	
1	Ensure that the material is received, inspected and stored in good condition	
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	
E	**PICV**	
1	Ensure that the material is received, inspected and stored in good condition	

Appendix: 4.1

S. No.	Description	Status
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	
F	**Strainer**	
1	Ensure that the material is received, inspected and stored in good condition	
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	
G	**Ball Valve**	
1	Ensure that the material is received, inspected and stored in good condition	
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	
H	**Instruments (Pressure gauge, pressure differential transmitter, temperature gauge, temperature transmitter, flow meter, relief valve)**	
1	Ensure that the material is received, inspected and stored in good condition	
2	Ensure that material shall be installed as per manufacturer installation recommendation/procedure	
3	Ensure that the material shall be tested/ commissioned/calibrated as per manufacturer recommendation/procedure	
4	Ensure that the installation, testing/commissioning/calibration record sheet duly filled shall be available for Marafeq signature/acceptance	

Signature and Stamp of Consultant

Date:

Signature and Stamp of Contractor/Supplier

Date:

Appendix: 4.2

Marafeq Technical Requirements for the connection of ETS(s) to the District Cooling System

Compliance Statement: Method Statement for Hydrostatic test (Primary side)

S. No.	Description	Status
A	**Documentation requirements**	
1	The following documents shall be submitted to Marafeq for review and approval. Upon approval contractor may proceed for flushing with due notice to Marafeq for witness of the test: ➢ Compliance sheet for hydro static test (this document) ➢ Marafeq approved ETS P&ID ➢ Building services consultant approved ETS section drawing showing all equipment, piping and instruments inside ETS room ➢ Method statement for hydrostatic test, including risk assessment program ➢ All necessary local authorities approval pertaining to Hydro testing ➢ Hydro static test record sheet template	
B	**System Preparation**	
1	Installation inspection shall be completed based on Marafeq approved drawing/ procedures, and all outstanding snags shall be closed prior to the start of hydro test	
2	All instruments used during hydro test shall be calibrated and the calibration certificates shall be available for Marafeq information.	
3	Ensure all valves are opened during hydro test	
4	Pressure gauge shall be installed at the lowest and highest point. Temperature gauge shall be installed near to pressure gauge.	
5	Safety relief valve shall be installed at the highest point of which shall be set at 105% of the test pressure, to prevent the over pressurization of the lines	
6	Ensure all necessary HSE arrangements for the successful completion of hydro testing activities	
C	**Hydro test procedure**	
1	Fill-up the pipe system with potable water to be tested	
2	Ensure that air is released completely	
3	Gradually pump up pressure to the level stated below Test pressure, 23 bar (2300 kPa)	
4	Pressure holding time shall be 6 hours, before the inspection of joints	
5	Pressure and temperature shall be recorded every hour in an approved hydro test record sheet	
D	**Hydro test acceptance**	
1	No visible leak shall be notice during hydro test period, which is the passing criteria for the hydro test	
2	Once the pressure test is successfully completed, depressurize the system gradually	
3	Pressure and temperature readings which was recorded during the hydro test shall be submitted to Marafeq Qatar for the approval/acceptance of hydro test	

Signature and Stamp of Consultant

Date:

Signature and Stamp of Contractor/Supplier

Date:

Appendix: 4.3

Marafeq Technical Requirements for the connection of ETS(s) to the District Cooling System

Compliance Statement: Method Statement for Flushing/Pipe conditioning (Primary side)

S. No.	Description	Status
A	**Documentation requirements**	
1	➢ The following documents shall be submitted to Marafeq for review and approval. Upon approval contractor may proceed for flushing with due notice to Marafeq for witness of the test: ➢ ➢ Compliance sheet for flushing (this document) ➢ Method of statement for flushing/pipe conditioning including risk assessment program. (BSRIA application guide AC 1/2001.1 shall be used as the reference guide.) ➢ All necessary local authorities approval pertaining to flushing/pipe conditioning activities ➢ Flushing/pipe conditioning record sheet template for each stage ➢ Marafeq-approved ITP shall be followed for all inspections	
B	**System Preparation**	
1	All equipment, bypasses, drain and vent shall be installed as per the approved method statement for flushing	
2	Ensure that all utilities/consumables (including but not limited to potable water, fuel, chemicals, filters etc.) are available at site to proceed for flushing	
3	Critical drain points shall be connected to the nearest drain pit to facilitate emergency draining if situation demands	
4	Flow meter shall be available at site to monitor the velocity on maximum pipe dia and same shall be reflected in method statement .	
5	Pressure gauge shall be installed at the lowest and highest point. Temperature gauge shall be installed near to pressure gauge.	
6	All instruments used during flushing shall be calibrated and the calibration certificates shall be available for Marafeq information.	
7	Water treatment specialist shall be available at site to monitor the progress of flushing activities	
8	Ensure all necessary HSE arrangements for the successful completion of flushing/pipe conditioning activities	
9	Marafeq will inspect the system readiness, and accordingly will release the “request to proceed” submitted by the flushing contractor	
C	**Flushing Procedure**	
1	The whole flushing/pipe conditioning process generally falls under the following stages: ➢ Flushing ➢ Chemical cleaning ➢ Passivation and Corrosion Inhibitors	
2	Flushing shall start within 48 hours of the hydrostatic test; otherwise preventive measures shall be taken to avoid corrosion.	
3	Top up the system completely with potable water and release the air	
4	Start the pump at low speed and vent the air out of the system completely	
5	Gradually increase the speed of the pump to meet with sufficient flushing velocity	

Appendix: 4.3

<table>
<tr><th>S. No.</th><th>Description</th><th>Status</th></tr>
<tr><td>6</td><td>Follow the procedure as mentioned in the approved method of statement for flushing/pipe conditioning</td><td></td></tr>
<tr><td>7</td><td>After final passivation is achieved , the system shall be preserved in line with passivation water quality</td><td></td></tr>
<tr><td>D</td><td>Flushing /Pipe conditioning acceptance</td><td></td></tr>
<tr><td>1</td><td>Each stage of flushing/pipe conditioning shall be approved by Marafeq before proceeding to next stage</td><td></td></tr>
<tr><td>2</td><td>Final -water quality shall be as per the below chart:

<table>
<tr><th>Parameters</th><th>Unit</th><th>Standard</th></tr>
<tr><td>pH</td><td>--</td><td>8.5 to 10.5</td></tr>
<tr><td>Total dissolved solids</td><td>ppm</td><td>< 2000</td></tr>
<tr><td>Conductivity</td><td>µSiemens/cm</td><td>< 3000</td></tr>
<tr><td>Total iron as Fe</td><td>ppm</td><td>< 1.0</td></tr>
<tr><td>Nitrite as NaNO2</td><td>ppm</td><td>> 800</td></tr>
<tr><td>Total Suspended Solids</td><td>ppm</td><td>< 20</td></tr>
<tr><td>Chlorides as Cl—</td><td>ppm</td><td>< 150</td></tr>
<tr><td>Total Alkalinity as CaCO3</td><td>ppm</td><td>< 250</td></tr>
<tr><td>Total Calcium hardness as CaCO3</td><td>ppm</td><td>< 100</td></tr>
</table></td><td></td></tr>
<tr><td>3</td><td>To obtain clearance from Marafeq for connecting the PHE spool pieces, the contractor shall submit water quality reports for both the primary and secondary systems</td><td></td></tr>
<tr><td>4</td><td>Water analysis results based on the above parameters shall be recorded in passivation record sheet and shall be submitted to Marafeq for final acceptance along with the water treatment specialist water analysis report</td><td></td></tr>
<tr><td>5</td><td>Tie in with the other adjoining system shall be executed (wherever applicable)</td><td></td></tr>
</table>

Signature and Stamp of Consultant

Date:

Signature and Stamp of Contractor/Supplier

Date: