District Cooling ETS Guidelines

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South Energy

District Cooling ETS Guidelines

Contents

1. INTRODUCTION

South Energy will deliver District Cooling chilled water to different developers in order to cater the cooling needs of the buildings. The source of the chilled water is from single or multiple District Cooling Plants (DCP) distributed all over DUBAI SOUTH cities.

These guidelines are issued and controlled by SOUTH ENERGY. Approval for changes may only be given by the Management Representative (MR) or in his/her absence by the nominated deputy. A formal change approval and authorization process will be initiated before revisions to this document. This is a controlled electronic document subject to authorized update and so MUST NOT be copied.

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2. PURPOSE

This document is intended to be used as overview and guidelines for Investors, Building Owners, Client Representatives, Consultants and Contractors to design and operate the Energy Transfer Stations (ETS) chilled water cycle, where in to define the scope of work for DUBAI SOUTH customer and SOUTH ENERGY.

All DUBAI SOUTH Customers, their Consultants and Contractors will be required to demonstrate their compliance incorporating during designing, constructing and handover of District Cooling ETS stations, meeting the SOUTH ENERGY standards and requirements.

3. SCOPE

This document is applicable to customers who shall apply to SOUTH ENERGY for DC connection for chilled water network and ETS design / construction / handover.

4. REFERENCES

- ASHRAE
- ARI
- ASME
- PED – European Pressure Equipment Directive

- API
- AHRI
- EN 55081-1
- CE conformity directive 92/31/EWG
- **American National Standard Institute**
- **International District Energy Association (IDEA)**
- **TRAKHEES**
- **DEWA Regulations**
- **Dubai Municipality Regulations**
- **Dubai Civil Defense Authority**

5. DEFINITIONS & ABBREVIATIONS

- ✓ "Primary side" refers to the plant side chilled water and "Secondary Side" refers to the Customer's side chilled water cycle.
- ✓ ETS means Energy Transfer Station, a set of heat exchangers inside a dedicated room with its piping, pipe fittings, pumping and control system; it is acting as a buffer segregate chilled water cycle produced by the District Cooling Plant and chilled water cycle inside buildings.
- ✓ PHEX's means plate heat exchanger, a type of heat exchanger consisting of parallel gasketed plates to create fluid channels.
- ✓ "Energy Meter" means set of instruments installed inside the ETS to measure the rate of enthalpy change in the chilled water by measuring flow rate and the temperature different which indicates bulk rate of consumption of cooling.
- ✓ "Sub-Metering System" means set of instruments installed at the secondary side's apartment, office, retail, common area, etc., to measure rate of enthalpy change in the chilled water by measuring flow rate and temperature different which indicated rate of consumption of cooling for that dedicated area.
- ✓ AHU means – Air Handling Unit and FCU means fan coil unit, equipments that include a fan or blower, heating and/or cooling coils, regulator controls, condensate drain pans and air filters to blow temperature controlled to a dedicated area.
- ✓ "Customer" means a Master Developer, Building Owner, Individual Customer Unit Owner or other and user of district cooling service provided by SOUTH ENERGY.
- ✓ SI unit means "System International D'Unite".
  a. M; is meter.
  b. mm; is millimeter.
  c. ºC; is degree Celsius.
- ✓ Surcharge means lower than design secondary sides return chilled water.
- ✓ temperature.
- ✓ MCB - Miniature circuit breaker.

- ✓ BMS – Building management System.
- ✓ VFD - Variable Frequency Drive.
- ✓ NOC - No objection Certificate.
- ✓ AAV - Automatic Air Vent
- ✓ MAV - Manual Air Vent.
- ✓ PVC – Plot Valve Chamber
- ✓ DCP – District Cooling Plant
- ✓ DCS – District Cooling Services
- ✓ CHW – Chilled Water
- ✓ PVC – Plot Valve Chamber
- ✓ TR – Tons of Refrigeration
- ✓ SOUTH ENERGY DWC-LLC means, SOUTH ENERGY District Cooling Service provider, PO Box 282228, Dubai, UAE, and its authorized consultants or contractors or its representatives.

6. RESPONSIBILITIES

6.1 SOUTH ENERGY Responsibilities

SOUTH ENERGY shall be responsible for communicating the requirements to its DC customers stated herewith ensuring ETS standard and guidelines compliance, such requirements may correlate with district cooling plant construction and operation, confirming the allocated cooling load for the customers with regards to its development, and therefore SOUTH ENERGY is the authority to control and regulate these ETS guidelines conforming to all relevant ETS standards and requirements to meet design criteria for both primary DC and Building secondary sides at ETS stations.

6.2 DUBAI SOUTH Customers Responsibilities –

The building developer / owner through his consultant and Contractor shall be responsible for the items listed below:

a. To design, procure, supply, install, test and commission all necessary ETS Room equipments such as Plate Heat Exchangers, CS piping / fittings, strainers, valves, flowmeter, energy-meter, and necessary P&ID instrumentation to provide fully functional ETS system to meet design criteria for both District Cooling Plant side & Building side (material submittal and specifications to be submitted to SOUTH ENERGY approval)

b. To supply, install, test and commission underground pre-insulated piping (from tie-in point of DC plot valve chamber up to building penetration point and related ETS piping). The plot valve chamber will be within plot limit where in connected to main District Cooling CHW piping network (Plot Valve Chamber details with levels to be coordinated with DUBAI SOUTH-Planning & Zoning as per infrastructure consultant details)
c. To design (stress / surge analysis), supply, install, test, commission and chemically treated both primary side (from tie-in point of plot valve chamber) and secondary side piping and ETS Room equipments. (The design data, ETS equipment's selected and piping testing and chemical treatment analysis to be by approved third party certified, submitted to SOUTH ENERGY)
d. Customers with high rise buildings must consider their building internal pressures prior to ETS equipments selected. Further PHEX may be required at high levels fed from the primary PHEX's.
e. The customer or its consultant representative to comply and incorporate allocated cooling load in their building design CHW system.
f. Sweet water supply line for filling ETS piping, expansion tank and drain connection to the nearest external manhole and drain.
g. Actual completion dates for ETS completion should be provided in advance to SOUTH ENERGY dept. for readiness to connect / supply DC CHW.
h. To provide proper regular maintenance of ETS DC secondary side CHW network, its associated pumps, chemical dosing / pressurization systems, AHU's / FCU's until the date of hand over. The building CHW chemical analysis is to be done monthly and reports to be submitted to SOUTH ENERGY. However, the Primary side ETS maintenance and its management (Energy-metering, controls) will be done by SOUTH ENERGY.
i. The PHEX shall not be connected to CHW piping for both primary / secondary sides, until the final chemical analysis is done and accepted within limits that should be approved by third party and the reports to be submitted to SOUTH ENERGY.
j. The allocated cooling loads shall be provided either by authorized infrastructure consultant.

7. TECHNICAL REQUIREMENTS

7.1 ETS Room Standard Requirements:

1. SI units to be used while corresponding SOUTH ENERGY Dept.
2. The work will consist of the design, supply, installation, testing and commissioning of all necessary ETS installations such as PHEX, Energy Meter, flow meter, CS piping (from DC plot valve chamber tie-inn to PHEX piping connections), fittings, piping drain & vent points, valves, controls, piping supports, wiring and P&ID instrumentation to provide a fully functioning ETS system to meet designed criteria for both District Cooling Plant side and Building side CHW systems.
3. The Term Primary Side to be read as Plant Side or Cold side, and Secondary side to be read as Customer Side or Hot side.
4. The DC primary CHW supply and return temperatures are 4.5°C and 13.5°C.
5. The DC secondary CHW supply and return temperatures are 5.5°C and 14.5°C.
6. Only one ETS room (with minimum two PHEX) for the given Building project is to be designed and only one building chilled water piping at entry point (CHW supply / CHW return). Selection of PHEX to be considered as per SOUTH ENERGY PHEX Specifications and any Stresses in the PHEX shall be avoided.
7. The CHW pipe penetration for the building entry point to have puddle flange or sleeve installed (MS plate, circumferentially full butt weld, sand blasted and hot dipped galvanized), at take off point from the plot valve chamber coming through the main CHW piping network.
8. Mechanical hydrostatic link seal (complying with international standard for District Cooling application) should be installed between sleeve and CHW-piping entering the building.
9. Each building should have a dedicated plot valve chamber (PVC) within the plot, sized according to chilled water pipe size or cooling load of the building.
10. The room ceiling (soffit) to be designed to allow for the supports of the chilled water piping headers operating loads in the structural design and same to be considered for allowing operational loads of ETS branch CHW piping for ETS room floor area.

11. The flow meter installation should be in the main header of return CHW piping required to be 5D (upstream) and 3D (downstream) of pipe diameter as straight pipe with no fittings and instrumentation. Flow meter to have isolation valves to the extent of 8D straight pipe installed, and separate pipe spool piece of flowmeter size or 8D straight pipe size with flanges to be made available during flowmeter maintenance.
12. The energy meter and flow meter installations to be as per manufacturers requirement and factory calibration / test certificates to be provided to SOUTH ENERGY.
13. Drain and gully traps to be provided in suitable locations of the ETS Room for PHEX condensation and at CHW piping (branch / main) drain points.
14. The ETS room must be located near and practically possible to the main chilled water network piping entry point to the building, preferably at least one side of the ETS wall to be exposed outside.
15. The ETS room location is required to be in the ground floor level unless otherwise specified to be in the first (1^{st}) basement level directly below in order to maintain design static pressure on DC system side and less CHW piping installation that to be approved by SOUTH ENERGY with adequate lighting facility.
16. ETS control schematics with necessary P&ID to be designed for each building DC CHW systems for both primary and secondary sides, to achieve designed parameters.
17. Provide minimum 3-phase, 32A, 5 pin industrial type socket (waterproof) outlet for maintenance purpose
18. Provide separately un-switched power to Energy Meter directly from the SMDB, clearly indicated / labeled for District Cooling BTU Meter.
19. ETS pipe sizing requirement shall be max water velocity of 1.2m/s for pipe size 50mm and smaller, and 3.0m/s for pipe size starting from 65mm and larger sizes. However, the min / max pressure-drop to be 100Pa/m-400Pa/m. The complete ETS system circuit pressure drop shall not exceed 150 Kpa (1.5 bars) (depending on ETS capacity).
20. The PHEX is to be installed on the concrete plinth foundation to be constructed as per the operating loads of PHEX as recommended by the PHEX manufacturer, maintaining clearances as per the section (ETS space requirement) provided in this guideline.

21. The underground CHW piping tie-inn from plot valve chamber and as well as ETS above ground piping, to be NDT tested (10% X-Ray / 100% UT), hydro-tested (16 Bar), chemically flushed and passivated and third party certified and all necessary reports to be submitted for SOUTH ENERGY approval. The CHW lines (supply / return) to be pressurized as per District Cooling Plant operation pressure.
22. PHEX design working pressure shall be defined by the highest point of building chilled water piping network working pressure. Vents to be provided at high points and drains to be provided at lowest points in ETS piping.
23. Air conditioning in the ETS to maintain a temperature between 24 ± 1°C, for correct functioning of control, etc.
24. All ETS piping to be rubber/Armaflex insulated (thickness – 40mm / density - 70Kg/m^3) and aluminum cladded (material submittal and specifications to be submitted for SOUTH ENERGY approval)
25. ETS room to be lighted and Air-Conditioned Temperature shall be maintained between 21 ºC to 26 ºC.
26. As built ETS dossier / drawings, showing the dimensions and clearances of entire ETS room layout, testing and commissioning reports, third party certification, O&M manuals and warranty documents for all ETS equipments / installations to be issued to SOUTH ENERGY Dept.
27. ETS room must be of rectangle in shape (curved, round or sharp shapes not accepted)
28. The above works shall be fully responsible for the correct functioning of the ETS system to meet DC design criteria and to carry any liability or guarantee necessary to protect all parties in this regard.

8. BUILDING SECONDARY SIDE REQUIREMENTS

1. To avoid surcharge phenomena, the Customer shall strictly ensure the following:
   a. Do not oversize cooling coils in the building secondary side cycle from the prevalent / allocated cooling load for the building.
   b. Do not utilize three-way valves to control cooling rate in the cooling coil of the secondary side. Must be used PICV.
2. As minimum requirement, the Customer shall design and select his building cooling coils based on the specified ΔT 9ºC chilled water temperatures; designing such coils at 1.1 ºC above specified (10 ºC differential

temperature) is highly recommended to allow for future unavoidable fouling over time.

3. Secondary or building side CHW circuit shall be with VFD / variable flow system.
4. Cooling valves installed in individual apartments shall be smart valves for remote operation & billing purposes.
5. Sub-metering provision to be taken into consideration for each individual building customer, to be easily interfaced with ETS main metering system (This to be clearly communicated and agreed between SOUTH ENERGY and the client).

9. ETS SPACE REQUIREMENTS

1. The minimum height of the ETS room is 4.2 m.
2. Allow min 1000mm clear space on the back side of the Plate Heat Exchangers.
3. The minimum clear space above the PHE top side to be not less than 800mm.
4. The clearance between the PHEX to be 1500mm.
5. Allow minimum 2000mm clear space in front of the PHEX for branch piping, P&ID, fittings, and control valves installation.
6. The PHEX concrete plinth foundation to be of 300mm height, with 150mm clearance at all sides of PHEX frame.

10. CONTROL SYSTEM FOR THE REMOTE MONITORING AND CONTROL OF THE CUSTOMER CHW ETS FROM THE DCP'S WITH FIBER OPTIC LINK

A PLC based control system with HMI is to be installed in each building ETS room to facilitate remote monitoring and control of the CHW ETS system from the district cooling plant. Details regarding the ETS room and its specifications are listed below.

The system shall be operating as per the control philosophy mentioned below. The System shall have all the data points as mentioned in the data point list (Appendix-4) & the final column of the datapoints list (Address in PLC) shall be filled & submitted to South Energy.

CONTROL PHILOSOPHY

Primary side PICV control mode

The objective of Primary Side PICV is to achieve the required temperature with modulation of Chilled water Flow. This Philosophy is applicable for system where PICV is provided at each HEX primary side.

District cooling side PICV will operate in the following modes. These modes are typical for all PICV.

- Manual override.
- Auto (PICV will operate to achieve operator selected setpoint)

Manual Operation

Operator can override the position of PICV to the desired open position (range 0-100%) and valves mode status should show (A) auto and (M) manual at HMI and SCADA.

Auto Operation

In auto operation, the PICV is Modulating based on the Mode selected by the Operator at HMI / SCADA. During the auto mode operations, the PICV's will operate as per operator selections values at a minimum close (adjustable) and maximum opening (adjustable) of PID. Additionally, an interlock with the HEX secondary supply line water flow status shall be provided to keep the PICV valves remain in the Close position if the corresponding building side supply line has no flow status (Flow Switch). This interlock shall be Enabled/Disabled by the client from HMI or SCADA.

Mode of Operation

Total control of the ETS valve will be in 4 modes, Operator can select the control operation by selecting the below options from HMI/SCADA.

- Delta T (HEX Primary Return Temperature - HEX Primary Supply Temperature)

- Primary Return Temperature
- Secondary Supply Temperature
- HEX Loss (HEX Secondary Supply Temperature - HEX Primary Supply Temperature)

The operator can select multiple control philosophies simultaneously. When this occurs, the system will queue the selected control philosophies for processing based on their priority levels, with the highest priority being Level 1 and the lowest priority being Level 4.

1. Delta T (HEX Primary Return Temperature - HEX Primary Supply Temperature)

Based on the Set point set at HMI [Touch Panel] /SCADA the PICV PID controller shall modulate to approach to Process variable of the Delta T (HEX Primary Return Temperature – HEX Primary Supply Temperature)

- In this mode of operation Primary Side HEX temperature difference (ΔT) is the index point for ETS control.
- Primary side ΔT is controlled by varying the chilled water flow at primary side. The same is realized by modulating the PICV's installed at each Heat Exchanger primary side return line.
- PICV will be controlled by the PLC with the PID controller function.
- The PICV will be modulated till the process variable, Reaches the set point (Adjustable from HMI/SCADA).

2. Primary Return Temperature

Based on the Set point set at HMI/SCADA the PICV PID controller shall modulate to approach to the Process variable of the DCP (Primary) side Return temperature transmitter signal.

- In this mode of operation, Primary side Return water temperature is the index point for ETS control.
- DCP (Primary) side return water temperature is controlled by varying the chilled water flow at primary side. The same is realized by modulating the PICV's.
- PICV's Valves installed at each Heat Exchanger primary side return line. The PICV operation will be controlled by the PLC with the PID controller function.
- The PICV will be modulated till the process variable Reaches the set point (Adjustable from HMI/SCADA).

3. Secondary Supply Temperature

Based on the Set point set at HMI/SCADA, the PICV PID controller shall modulate to approach to the Process variable of the customer side leaving/supply temperature transmitter signal:

- In this mode of operation, Customer Side Supply water temperature is the index point for ETS control.
- Customer side Supply water temperature is controlled by varying the chilled water flow at primary side. The same is realized by modulating the PICV's.
- PICV Valves are installed at each Heat Exchanger primary side return line.
- The PICV operation will be controlled by the PLC with the PID controller function. The PICV will be modulated till the process variable Reaches the set point (Adjustable from HMI/SCADA).

4. HEX Loss (HEX Secondary Supply Temperature - HEX Primary Supply Temperature)

Based on the Set point set at HMI [Touch Panel] /SCADA the valve PID controller shall modulate to approach to Process variable of the Heat Exchanger Loss (HEX Secondary Supply Temperature – HEX Primary Supply Temperature).

- In this mode of operation, the difference between HEX Secondary Supply TT & HEX Primary Supply TT (ΔT) is the index point for ETS control.
- HEX (ΔT) is controlled by varying the chilled water flow at primary side. The same is realized by PICV's.
- PICV Valves are installed at each Heat Exchanger primary side return line.
- The PICV operation will be controlled by the PLC with the PID controller function. The PICVs will be modulated till the process variable Reaches the set point (Adjustable from HMI/SCADA).

Building Side Chilled Water Pump Controls

The chilled water pumps should operate based on a differential pressure (ΔP) sensor at the index point to ensure optimal flow and energy efficiency. The lead pump should continuously run with a minimum speed, ramping up speed via a Variable Frequency Drive (VFD) to maintain the ΔP setpoint. If the setpoint is not met, additional pumps should start in sequence. The controller shall continuously adjust pump speed to match demand, reducing speed when ΔP exceeds the setpoint and staging pumps as needed. Pumps should be rotated periodically for even wear & run hours. When demand drops, pumps should gradually ramp down till the minimum set speed. Alarms monitor high/low ΔP, pump failures, and dry running, with manual override available for emergencies.

Building Side HEX Supply valves Controls

The objective of Building Side On/Off Valves is to select the heat exchanger in operation as per load requirement. The number of valves open shall be determined by the number of building side chilled water pumps running. One of the HEX valves shall be selected as lead & the lead valve selection shall be rotated periodically for avoiding any stagnancy in the HEX.

Valve status shall be interlocked with the building side chilled water pump command so that pump will not receive any command from the controller when both the valves have close status.

SPECIFICATIONS

PLC:

- PLC Controller should be open to access with no restriction (license) to modify or upgrade. However, access shall be limited to South Energy through password protection. South Energy should have Admin level access to the entire system.
- The PLC Controller should support Modbus TCP/IP communication protocol. IP addresses shall be provided by South Energy.
- The PLC Controller should be able to handle all signals mentioned in the I/O List (Appendix-3) with 20% Spare.
- PLC Controller should communicate with the secondary controller and read all parameters/readings as mentioned in the Data Points List.
- The recommended PLC is Schneider controller Modicon M172 model along with its expansion module as per requirement.

HMI:

- HMI should be colored with a minimum of 7" screen size touch screen, supporting TCP/IP communication.

Instruments:

- Pressure Transmitter range should be from 0 – 10 Bar with output signal 4-20 MA or 0-10 V.
- Temperature Transmitter range should be from 0 – 50 °C with output signal 4-20 MA or 0-10 V.
- Temperature Transmitter should be installed with Thermowell & thermal past/gel. Length of Temperature Transmitter & Thermowell should be according to Pipe Size.
- Paddle type flow Switch should be used for secondary supply line flow status & shall be selected according to pipe size.
- The same Flow Switch should be connected to Primary PLC and Secondary controller hence it must have multiple output contacts.

Primary & Building Side Valves:

- Primary side PICV Valves shall be with modulating actuator from 0% to 100% with command & feedback signal being 0-10V.
- Primary PICV valves shall not have a differential pressure value more than 35Kpa.
- Building side Motorized Valves shall be Open/Close type with Valve Open/Close status via limit switch.

PLC Panel:

- 2Nos PLC panels should be provided in the ETS room, one for the primary controls & the other for the secondary control. The cabling & layout shall be as per the system layout in Appendix – 1.
- Primary PLC panel size shall not be less than 800X600mm & shall be of enough size to occupy FOC hardware, controllers etc.
- All Panel components, including Transformers, shall be provided as per requirement.
- PLC panels shall be at least IP54 rated to avoid any dust or splashing water.

UPS Power:

- UPS power backup shall be available for the PLC panels, BTU meter & Valves
- UPS shall be at least 1KVA capacity with a backup of at least one hour.

BTU METER

- BTU meter shall be installed on the return line to the District Cooling Plant (Primary Side).
- BTU meter shall be directly connected to a power supply source (UPS).
- BTU Calculator, Sensor & flowmeter installation & cabling shall be strictly as per manufacturer guidelines.
- Flowmeter shall be inline type, both ultrasonic or Electromagnetic type (recommended) can be utilized.
- The BTU calculator shall be positioned at an accessible height (not more than 1.5 meters from ground level) with an enclosure box for protection (at least IP57 rating).
- Recommended BTU meter brands are KAMSTRUP, E&H, Landis & Gyr, Siemens or equivalent (subject to prior approval).
- Primary side BTU meter shall be integrated with the PLC control system via MODBUS TCP/IP with a separate IP address. IP address shall be provided by South Energy.

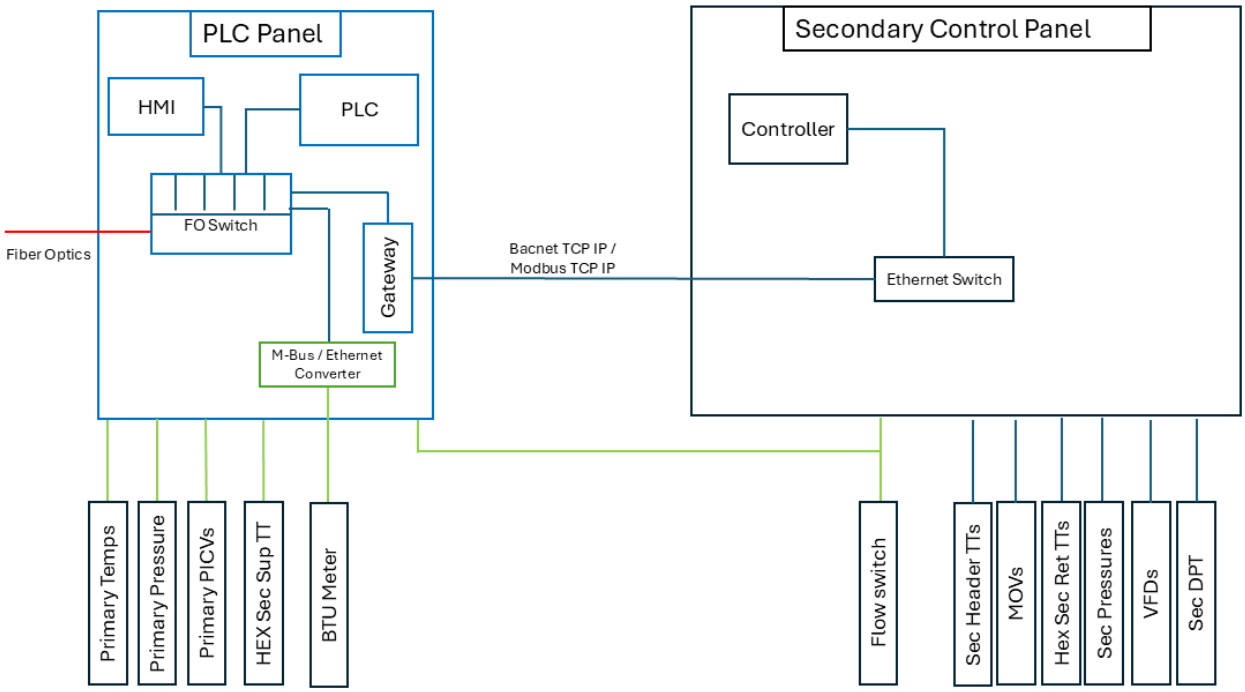
FIBRE OPTIC CABLE CONNECTIVITY

- Managed Ethernet Switch with a minimum of 2 FO single-mode ports and 8 Ethernet ports.

APPENDICES

Appendix - 1: System Layout

Appendix - 2: System Architecure



Appendix - 3: PLC Input/Output List

S NO	Signal	DI	DO	AI	AO
1	Primary Header Supply PT			1	
2	Primary Header Return PT			1	
3	Primary Header Supply TT			1	
4	Primary Header Return TT			1	
5	Primary HEX-1 Supply PT			1	
6	Primary HEX-1 Return PT			1	
7	Primary HEX-1 Supply TT			1	
8	Primary HEX-1 Return TT			1	
9	Primary HEX-2 Supply PT			1	
10	Primary HEX-2 Return PT			1	
11	Primary HEX-2 Supply TT			1	
12	Primary HEX-2 Return TT			1	
13	Primary HEX-1 PICV SP				1
14	Primary HEX-1 PICV FB			1	
15	Primary HEX-2 PICV SP				1
16	Primary HEX-2 PICV FB			1	
25	Secondary HEX-1 Supply TT			1	
29	Secondary HEX-2 Supply TT			1	
32	Secondary HEX-1 Flow Switch	1			
33	Secondary HEX-2 Flow Switch	1			
	Total	2	0	16	2
		DI	DO	AI	AO

Appendix - 4: Data Point List in PLC Controller

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
1	Header Primary Supply TT	Feedback	Decimal		Deg C	
2	Header Primary Return TT	Feedback	Decimal		Deg C	
3	HEX-1 Primary Supply TT	Feedback	Decimal		Deg C	
4	HEX-1 Primary Return TT	Feedback	Decimal		Deg C	
5	HEX-2 Primary Supply TT	Feedback	Decimal		Deg C	
6	HEX-2 Primary Return TT	Feedback	Decimal		Deg C	
7	Header Primary Supply PT	Feedback	Decimal		Bar	
8	Header Primary Return PT	Feedback	Decimal		Bar	
9	HEX-1 Primary Supply PT	Feedback	Decimal		Bar	
10	HEX-1 Primary Return PT	Feedback	Decimal		Bar	
11	HEX-2 Primary Supply PT	Feedback	Decimal		Bar	
12	HEX-2 Primary Return PT	Feedback	Decimal		Bar	
13	HEX-1 PICV	Feedback	Decimal		%	
14	HEX-1 PICV	Manual Setpoint	Decimal		%	
15	HEX-1 PICV	Auto Setpoint	Decimal		%	
16	HEX-1 PICV	Auto/Manual	Binary		1:Auto/0:Manual	
17	HEX-1 PICV	Discrepancy Alarm	Binary		1:Discrepancy 0:No Discrepancy	
18	HEX-1 PICV	Minimum Open	Decimal	5%	%	
19	HEX-1 PICV	Maximum Open	Decimal	100%	%	

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
20	HEX-2 PICV	Feedback	Decimal		%	
21	HEX-2 PICV	Manual Setpoint	Decimal		%	
22	HEX-2 PICV	Auto Setpoint	Decimal		%	
23	HEX-2 PICV	Auto/Manual	Binary		1:Auto/0:Manual	
24	HEX-2 PICV	Discrepancy Alarm	Binary		1:Discrepancy 0:No Discrepancy	
25	HEX-2 PICV	Minimum Open	Decimal	15%	%	
26	HEX-2 PICV	Maximum Open	Decimal	100%	%	
27	Header Secondary Supply TT	Feedback	Decimal		Deg C	
28	Header Secondary Return TT	Feedback	Decimal		Deg C	
29	HEX-1 Secondary Supply TT	Feedback	Decimal		Deg C	
30	HEX-1 Secondary Return TT	Feedback	Decimal		Deg C	
31	HEX-2 Secondary Supply TT	Feedback	Decimal		Deg C	
32	HEX-2 Secondary Return TT	Feedback	Decimal		Deg C	
33	Header Secondary Supply PT	Feedback	Decimal		Bar	
34	Header Secondary Return PT	Feedback	Decimal		Bar	
35	HEX-1 Secondary Supply PT	Feedback	Decimal		Bar	
36	HEX-1 Secondary Return PT	Feedback	Decimal		Bar	
37	HEX-2 Secondary Supply PT	Feedback	Decimal		Bar	
38	HEX-2 Secondary Return PT	Feedback	Decimal		Bar	

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
39	HEX-1 MOV	Feedback	Binary		1:Open/ 0:Close	
40	HEX-2 MOV	Feedback	Binary		1:Open/ 0:Close	
41	HEX-1 Flow Switch	Feedback	Binary		1:Open/ 0:Close	
42	HEX-2 Flow Switch	Feedback	Binary		1:Open/ 0:Close	
43	Secondary DPT	Feedback	Decimal		Bar	
44	CHW Pump-1 (VFD)	Speed Feedback	Decimal		%	
45	CHW Pump-1 (VFD)	Auto/Manual	Binary		1:Auto/0:Manual	
46	CHW Pump-1 (VFD)	Trip Status	Binary		1:Trip / 0: No Trip	
47	CHW Pump-1 (VFD)	Run Status	Binary		1:Running / 0:Stopped	
48	CHW Pump-2 (VFD)	Speed Feedback	Decimal		%	
49	CHW Pump-2 (VFD)	Auto/Manual	Binary		1:Auto/0:Manual	
50	CHW Pump-2 (VFD)	Trip Status	Binary		1:Trip / 0: No Trip	
51	CHW Pump-2 (VFD)	Run Status	Binary		1:Running / 0:Stopped	
52	CHW Pump-3 (VFD)	Speed Feedback	Decimal		%	
53	CHW Pump-3 (VFD)	Auto/Manual	Binary		1:Auto/0:Manual	
54	CHW Pump-3 (VFD)	Trip Status	Binary		1:Trip / 0: No Trip	
55	CHW Pump-3 (VFD)	Run Status	Binary		1:Running / 0:Stopped	
56	Control	Philosophy-1 Select	Binary	0	1:Selected / 0:Not Selected	
57	Control	Philosophy-1 Active	Binary		1:Activated / 0:Not Active	

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
58	Control	Philosophy-1 Priority Level	Integer	3	1,2,3,4	
59	Control	Philosophy-1 Setpoint	Decimal	8	Deg C	
60	Control	Philosophy-1 Feedback	Decimal		Deg C	
61	Control	Philosophy-1 Deadband	Decimal	1	Deg C	
62	Control	Philosophy-2 Select	Binary	1	1:Selected / 0:Not Selected	
63	Control	Philosophy-2 Active	Binary		1:Activated / 0:Not Active	
64	Control	Philosophy-2 Priority Level	Integer	1	1,2,3,4	
65	Control	Philosophy-2 Setpoint	Decimal	12.5	Deg C	
66	Control	Philosophy-2 Feedback	Decimal		Deg C	
67	Control	Philosophy-2 Dead Band	Decimal	1	Deg C	
68	Control	Philosophy-3 Select	Binary	0	1:Selected / 0:Not Selected	
69	Control	Philosophy-3 Active	Binary		1:Activated / 0:Not Active	
70	Control	Philosophy-3 Priority Level	Integer	2	1,2,3,4	
71	Control	Philosophy-3 Setpoint	Decimal	5.5	Deg C	
72	Control	Philosophy-3 Feedback	Decimal		Deg C	
73	Control	Philosophy-3 Deadband	Decimal	1	Deg C	
74	Control	Philosophy-4 Select	Binary	0	1:Selected / 0:Not Selected	
75	Control	Philosophy-4 Active	Binary		1:Activated / 0:Not Active	
76	Control	Philosophy-4 Priority Level	Integer	4	1,2,3,4	

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
77	Control	Philosophy-4 Setpoint	Decimal	1	Deg C	
78	Control	Philosophy-4 Feedback	Decimal		Deg C	
79	Control	Philosophy-4 Deadband	Decimal	.3	Deg C	
80	Control	PICV-1 PID KP	Decimal	-0.3		
81	Control	PICV-1 PID KI	Decimal	30	ms	
82	Control	PICV-1 PID KD	Decimal	0	ms	
83	Control	PICV-2 PID KP	Decimal	-0.3		
84	Control	PICV-2 PID KI	Decimal	30	ms	
85	Control	PICV-2 PID KD	Decimal	0	ms	
86	Control	PICV-1 Auto/Manual	Binary	1	1:Auto/0:Manual	
87	Control	PICV-2 Auto/Manual	Binary	1	1:Auto/0:Manual	
88	Control	Sec Flow PICV Interlock	Binary	0	1:Activated / 0:Not Active	
89	BTU Integration	Cooling Energy	Decimal		MWH	
90	BTU Integration	Accumulated Flow	Decimal		M3	
91	BTU Integration	Primary Flow	Decimal		M3/Hr	
92	BTU Integration	Supply Temperature	Decimal		Deg C	
93	BTU Integration	Return Temperature	Decimal		Deg C	
94	BTU Integration	Cooling Power	Decimal		MW	
95	BTU Integration	Differential Temperature	Decimal		Dec C	

S NO	Equipment	Data Point	Type	Default Value	Unit	Address in PLC
96	BTU Integration	BTU Run Hours	Decimal		Hours	

- Some items of the CHW supply agreement, relevant to the ETS control system implementation, operation and maintenance are listed below for understanding and implementation:

Metering and Testing:

Installation and Maintenance - On or before the Start Date the Customer shall, at its own expense, supply and install the Metering Equipment and ETS control system in accordance with above guidelines, thereafter and throughout the Supply Period (and any Extension Period) the Customer shall maintain the above Equipment in good condition, all at its sole cost, risk and expense and in accordance with the above guidelines.

Right of Access - For the purposes of fulfilling its obligations pursuant to Clause the Supplier-DS (and its employees, agents and representatives) shall have right of access at all times to the Customer Premises and the Metering Equipment. The Customer shall ensure such access and shall further ensure that such access may be always obtained safely.

Meter Readings - The readings of the Metering Equipment for billing purposes shall be recorded by the Supplier-DS, at the end of each month or at such time as otherwise mutually agreed between the Parties. If requested, copies of the meter readings shall be provided to the Customer within 5 Business Days of request.

Inaccuracy - If either Party becomes aware of, or should reasonably have been aware of, any inaccuracy in the meter readings or defect in the Metering Equipment, then it shall forthwith notify in writing the other Party of such inaccuracy or defect (as the case may be).

Testing and Calibration - The Customer shall test and calibrate the Metering Equipment for accuracy every two years, or at any time within 30 days after a written request by the Customer in the event that the Customer reasonably believes that the measurements from the Metering Equipment are inaccurate by more than 3%. The following shall apply to all such tests:

(a) at the Customer's option, testing of the Metering Equipment may be witnessed by a representative of the Customer.

(b) metering measurement accuracy of the Metering Equipment (or any part thereof) between 97% and 103% shall be deemed acceptable.

(c) In the event that the Metering Equipment are found to be operating outside the parameters provided in Claus above, the Metering Equipment shall be immediately repaired, calibrated or replaced at the Supplier DS's cost and expense.

(d) Upon completion of any examination, maintenance, repair, calibration or replacement of any Metering Equipment, such equipment shall be sealed by the Supplier DS.

Reconciliation for Inaccurate Readings - In the event that the Metering Equipment (or any part thereof) are found to be inaccurate the amount of Chilled Water delivered to the Customer for the period during which such inaccurate measurement were made shall be determined by the Parties jointly preparing an estimate of the reading on the basis of the available information (including the assumption that if the duration of metering inaccuracy cannot be reasonable estimated, such duration shall be deemed to have persisted for 50% of the time between the last meter reading and the discovery of the inaccuracy). Following such determination, adjustments shall be made to the amounts payable under the next invoice submitted in accordance with Clause To account for any under or over payment which may have been made.

Measurement Disputes - In the event of any dispute in relation to the accuracy of the Metering Equipment, any reading therefrom, any estimate of the reading pursuant to Clause or any other matter in connection with the Metering Equipment (a "Measurement Dispute") then either Party may at any time refer such dispute to determination in accordance with Schedule.

Representations and Warranties

Supplier Warranties - The Supplier DS warrants and represents that:

(a) It has good and merchantable title to the Chilled Water delivered to the Customer, free and clear of all encumbrances and claims.

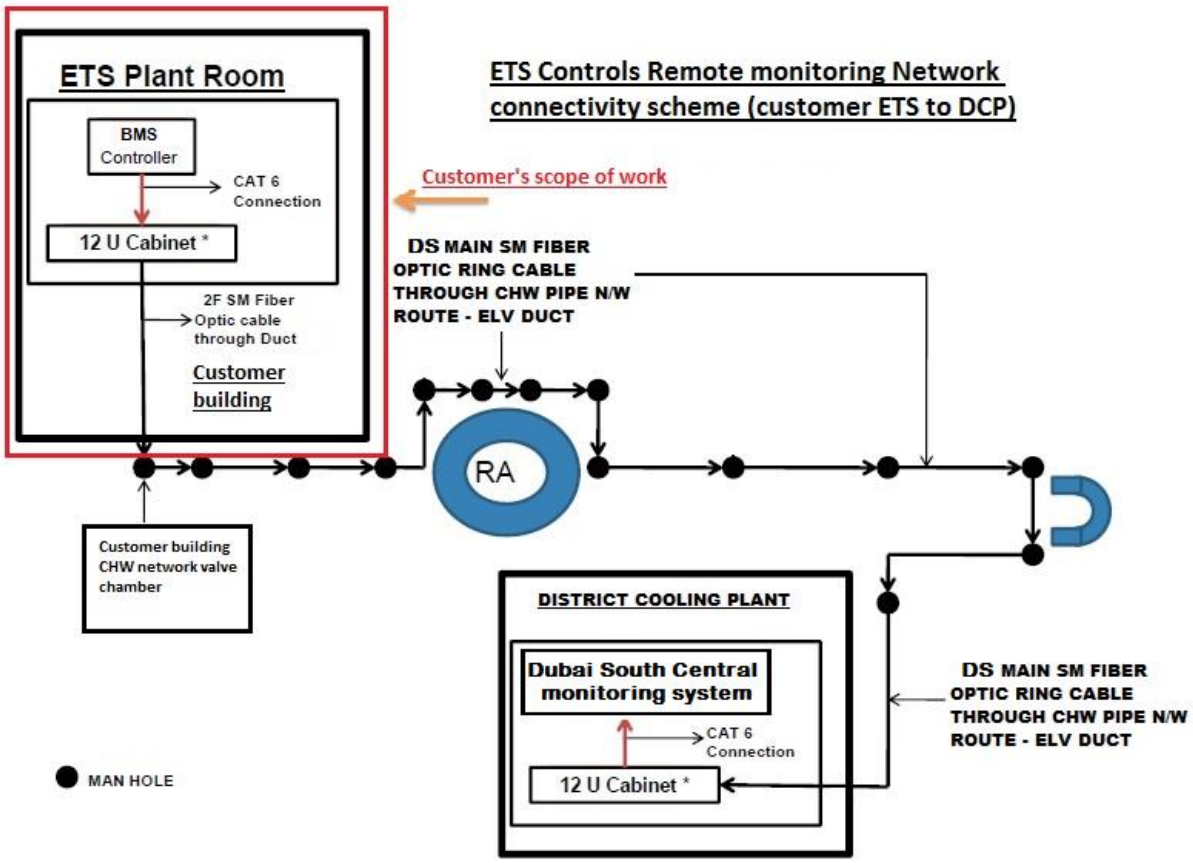
(b) It has secured approvals from all relevant regulatory bodies, made any filings or reports, as required, pertaining to (i) the construction, operation and maintenance of the District Cooling Generating Facilities and (ii) the acquisition and transportation of Chilled Water on the Supplier DS's transmission pipeline.

(c) It is in compliance in all respects with all applicable laws (including, without limitation, those regulating or affecting any spillage, discharge or release of any hazardous waste into or upon any of its land, air, surface water, ground water or improvements located thereon); and

(d) In performing its obligations under this Agreement, it shall operate in accordance with Good Industry Practice and all relevant governmental rules and shall seek to minimise costs.

Customer Warranties - The Customer warrants and represents that it will take all economically reasonable steps to ensure that the Chilled Water supply is used efficiently and effectively and will avoid excessive use or wastage of cooling.

SCHEMATIC DIAGRAM AND FIBER ROUTE



The following conditions to be noted and considered:

1. The SMDB should preferably be separate for ETS control panel with 32A, 3-phase MCCB
2. Chilled water flow shall be based on the ΔT = 9°C, with tolerance of +1.1°C

11. ATTACHMENTS

- ETS NOC format ref SE-DCS-F-001

- ETS Drawing title: Details of ETS Room Controls Schematics
- ETS Drawing title: Connections detail of Heat Exchangers (Primary DC side).
- ETS Drawing title: ETS Room Spacing.
- South Energy PHEX specifications