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COOLING CAPACITY of One chiller
For duplex chiller – Use the total capacity of Up and DN

1. PUMP SELECTION

Duplex Chiller

2675RT + 2325 RT

1.1 Chilled Water Pump Selection

1.1.1 Primary Chilled Water Pump for EC 1UP- EC 12 UP and EC 1DN- EC 12 DN at 5000 RT (PCHP 1-12)

(a) Flow Rate Calculation

CONVERSION

(i) Stage 1 Operation

Flow Rate Calculation:

Cooling Capacity = 5000 RT x 3.024 Mcal/h·RT = 15120Mcal/h

Differential Temp of Chilled Water = 14.44°C – 4.44°C = 10 °C

Flow Rate:

$$\frac{15120\ \text{Mcal/h}}{1.0\ \text{Mcal / m}^3\cdot{}^\circ\text{C} \times 10\ {}^\circ\text{C}} = \underline{1512\ \text{m}^3\text{/h}}$$

Q = m * cp * TD
m = rho * V
V = Q / [(rho* cp)* TD]

Specific Density = rho * Cp

Selected: 1512 m³/h.

SPECIFIC HEAT OF WATER, c

(b) Pump head

Pipe, Fittings, Valves	8 mAq
Safety Factor (10%)	0.8 mAq
Control Valves (FCV)	3 mAq
Y- Strainer	3 mAq
Air Separator	1.5 mAq
Equipment Pressure Drop	
Cooling Tower	0 mAq
Chiller	7 mAq
TES	0 mAq
HEX	0 mAq
TOTAL	23.3 mAq
SELECTED	24 mAq

Estimation

(c) Specification

Item	Description
EQUIPMENT NO.	PCHP – 1– 12

Will BE SELECTED AND LISTED IN SCHEDULE

TYPE	Horizontal Split Case Pump					
SPECIFICATION	1,512 m^3/h x 24 mAq x 160 kW					
MOTOR	3∅ x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1					
	12					

Specified in Equip. Schedule. Or calculated from the total chillers capacity by the numbers of pumps.

Not applicable to BURJ DUBAI Project as the secondary pumps are not to supply to customer. They to supply in plant use.

1.1.2 Secondary Chilled Water Pump for 4,886 RT (SCHP 1~3)

(a) Flow Rate Calculation

Capacity of pump = 4886 RT x 3.024 Mcal/h·RT = 14,775 Mcal/h
Differential Temp. of Chilled Water = 14.0 °C - 5.0 °C = 9.0°C.
Flow Rate:

$$\frac{14{,}775\ \text{Mcal/h}}{1.0\ \text{Mcal / m}^3\cdot{}^\circ\text{C} \times 9.0\ {}^\circ\text{C}} = 1642\ \text{m}^3\text{/h}$$

Selected = 1642 m³/h

(b) **Pump Head**

Pipe, Fittings, Valves	6 mAq
Safety Factor (10%)	0.6 mAq
Control Valves (FCV)	0 mAq
Y- Strainer	3 mAq
Distribution Losses	
Distribution Piping	25 mAq
Customer Station Piping	4 mAq
Y- Strainer	3 mAq
TCV	3 mAq
HEX	10 mAq
TOTAL	54.6 mAq
SELECTED	55 mAq

(c) Specification

Item	**Description**					
EQUIPMENT NO.	SCHP 1-3					
TYPE	Horizontal Split Case Pump					
SPECIFICATION	1,642 m^3/h x 55 mAq x 380 kW					
MOTOR	3∅ x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1					
	3					

Specified in Equip. Schedule. Or calculated from the total chillers capacity by the numbers of pumps.

1.1.3 Secondary Chilled Water Pump for 9,772 RT (SCHP 4~6)

(a) Flow Rate Calculation

Capacity of pump = 9772 RT x 3.024 Mcal/h·RT = 29,551 Mcal/h
Differential Temp. of Chilled Water = 14.0 °C - 5.0 °C = 9.0°C.
Flow Rate:

$$\frac{29{,}551\ \text{Mcal/h}}{1.0\ \text{Mcal / m}^3\cdot{}^\circ\text{C} \times 9.0\ {}^\circ\text{C}} = 3{,}284\ \text{m}^3\text{/h}$$

Selected = 3,284 m³/h

(b) **Pump Head**

Pipe, Fittings, Valves	6 mAq
Safety Factor (10%)	0.6 mAq
Control Valves (FCV)	0 mAq
Y- Strainer	3 mAq
Distribution Losses	
Distribution Piping	25 mAq
Customer Station Piping	4 mAq
Y- Strainer	3 mAq
TCV	3 mAq
HEX	10 mAq
TOTAL	54.6 mAq
SELECTED	55 mAq

(c) Specification

Item	Description					
EQUIPMENT NO.	SCHP- 4-6					
TYPE	Horizontal Split Case Pump					
SPECIFICATION	3,284 m^3/h x 55 mAq x 750 kW					
MOTOR	3∅ x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
	2	0	0	1	0	0

1.2 Cooling Water Pump Selection

1.2.1 Cooling Water Pump for EC 1 – EC 12 (CWP 1-12)

(a) Flow Rate Calculation

Chiller capacity

Flow Rate Calculation:

Cooling Capacity = 5000 RT x 3.024 Mcal/h · RT = 15,120 Mcal/h
Differential Temp of cooling Water 41.11°C – 33.33°C = 7.78°C
Flow Rate

$$\frac{15120\,\text{Mcal/h} \times 1.2}{1.0\ \text{Mcal / m}^3\cdot{}^\circ\text{C} \times 7.78^\circ\text{C}} = \underline{2{,}332\ \text{m}^3\text{/h}}$$

Estimated Evaporation loss in chiller's condenser. (20%)

Selected = 2332 m^3/h

b) Pump Head

Pipe, Fittings, Valves	9 mAq
Safety Factor (10%)	0.9 mAq
Control Valves (XCV)	0 mAq
Y- Strainer	3 mAq
Equipment Pressure Drop	
Cooling Tower	7 mAq
Chiller	8 mAq
TES	0 mAq
HEX	0 mAq
TOTAL	27.9 mAq
SELECTED	30 mAq

c) Specification

Item	Description					
EQUIPMENT NO.	CWP 1-12					
TYPE	Horizontal Split Case Pump					
SPECIFICATION	2,332 m^3/h x 30 mAq x 280 kW					
MOTOR	3ø x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1					
	12					

1.3 Make - Up Water Pump Selection

1.3.1 Make- Up Water Pump for Chilled Water

1.3.1.1 Pressurization Pump for Chilled Water (PPchw 1- 2)

From primary chiller pump calculated above

(a) Capacity

Flow Rate per Chiller = 1,512 m^3/h per chiller
Loss per Chiller = 0.05% x 1,512 m^3/h = 0.756 m^3/h

Loss percentage given by manufacturer

Total Chilled Water Loss = 0.756 m^3/h x 12chillers = 9.072m3/h
= 9.1 m^3/h

(b) **Pump Head**

Pipe, Fittings, Valves	7 mAq
Safety Factor (10%)	0.7 mAq
Control Valves (LCV)	3 mAq
Y- Strainer	3 mAq
Equipment Pressure Drop	
System Pressure	30 mAq
Actual Valve	6 mAq
TES	0 mAq
HEX	0 mAq
TOTAL	49.7 mAq
SELECTED	55 mAq

(c) Capacity

Item	Description					
EQUIPMENT NO.	PPchw 1-2 (1 standby)					
TYPE	Vertical Multi Stage Pump					
SPECIFICATION	9.1 m^3/h x 55 mAq x 2.2 kW					
MOTOR	3∅ x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1					
	2					

1.3.1.2 Make- Up Water Pump for Chilled Water

(a) Capacity

Calculated above

Considering Stable Condition:

Sort of safety factor for the make up water pumps

Chilled Make- Up Water Flow Rate = 9.1 m^3/h x 4
= 36.4 m^3/h

(b) **Pump Head**

Pipe, Fittings, Valves	7 mAq
Safety Factor (10%)	0.7 mAq
Control Valves (LCV)	3 mAq
Y- Strainer	3 mAq
Equipment Pressure Drop	
System Pressure	30 mAq
Actual Valve	6 mAq
TES	0 mAq
HEX	0 mAq
TOTAL	49.7 mAq
SELECTED	55 mAq

(c) **Specification**

Item	**Description**					
EQUIPMENT NO.	MPchw 1-3 (1 standby)					
TYPE	Vertical Multi Stage Pump					
SPECIFICATION	36.4 m^3/h x 55 mAq x 11 kW					
MOTOR	3∅ x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
	3	0	0	0	0	0

1.3.2 Make-up Water Pump for Cooling Water Tower

From calculation above for cooling water pump

(a) Capacity

Flow rate of Cooling Tower 1 = 2,332 m³/h per tower
Differential Temp of Cooled Water = 7.78 °C

Evap & Drift & Blow Down loss are specified by supplier

Evaporative Loss per tower = 1.3% x 2332 m³/h = 30.3 m³/h
Drift Loss per tower = 0.005% x 2332 m³/h = 0.12 m³/h
Concentration Cycle = 6
Blow Down Loss per tower = Evaporative Loss / (Concentration cycle - 1) – Drift Loss = 4.21 m³/h

Formulation : Concentration cycle = Evap + Drift + Blow Down loss From ASHRAE Handbook, chap S36

Total Loss per tower = 36.36 m³/h (1.56%) loss

Total Cooling Tower Water Loss = 36.36 m³/h x 12
= **436.32 m³/h loss**

A total number of 2 pumps will be operating. Therefore, the required pump capacity:

Pump Capacity: = 436.32 m³/h / 2
≈ **218 m³/h**

(b) Pump Head

Pipe, Fittings, Valves	7 mAq
Safety Factor (10%)	0.7 mAq
Control Valves (Ball Float)	3 mAq
Y- Strainer	3 mAq
Equipment Pressure Drop	
Actual Head	17 mAq
FM Valve	0 mAq
TES	0 mAq
HEX	0 mAq
TOTAL	30.7 mAq
SELECTED	32 mAq

(c) **Specification**

Item	Description					
EQUIPMENT NO.	MPcw 1-2 (one Stand by)					
TYPE	Horizontal Split Case Pump					
SPECIFICATION	218 m³/h x 32 mAq x 22 kW					
MOTOR	3ø x 415V					
SHAFT SEAL	Mechanical Seal					
QUANTITY	Phase 1					
	2					

1.4 Side Stream Filtration Unit Selection

1.4.1 Side Stream Filtration Unit for Cooling Tower (SSFU 1)

NOT APPLICABLE TO BURJ DUBAI PROJECT.
Extracted from Woodlands Project

(a) **Capacity**

Total Flow Rate from Cooling Tower 1 – 4 = 4428 m^3/h

Requires 2% of total cooling water flow rate = 2% x 4428 m^3/h
= **88.56 m^3/h**

Selected = 89 m^3/h

(b) **Specification**

Item	**Description**		
EQUIPMENT NO.	SSFU 1		
TYPE	Centrifuge Filter Units		
SPECIFICATION	89 m^3/h		
MOTOR	3⌀ x 415V x 15kW		
SHAFT SEAL	Mechanical Seal		
QUANTITY	Stage 1	Stage 2	Stage 3
	1	-	-

1.4.2 Side Stream Unit for Chilled Water (SSF-DCP-1-3)

(a) **Capacity**

Requires 1 turn per 5 days of total system volume

$$\Rightarrow \dot{Q} = 12{,}096 m^3 \div 2\,days \div 24\,hours$$

$$\underline{\dot{Q} = 252\ m^3/h}$$

Selected = 252 m^3/h

(b) **Specification**

Item	**Description**		
EQUIPMENT NO.	SSF-DSP- 1-3		
TYPE	Centrifuge Filter Units		
SPECIFICATION	252 m^3/h		
MOTOR	3⌀ x 415V x 15kW		
SHAFT SEAL	Mechanical Seal		
QUANTITY	Stage 1		
	3		

1.5 Oil Pump Selection

NOT APPLICABLE TO BURJ DUBAI PROJECT. Extracted from Woodlands Project

1.5.1 Oil Pump for Gen- Set

(a) Flow Rate Calculation

[1]Gen- Set oil consumption = 0.885 m^3/h
Pump capacity is to cater for 2 Gen- sets.

Flow Rate:

0.885 m^3/h x 2 x 10% = 1.947 m^3/h

Selected: 2.0 m^3/h

(b) Pump head

Pipe, Valves, Fittings	5 mAq
Safety Factor (10%)	0.5 mAq
Y- Strainer	3 mAq
Actual Head	10 mAq
TOTAL	18.5 mAq
SELECTED	2.0 kgf/cm^2 G

(c) Specification

Item	**Description**		
EQUIPMENT NO.	OSP 1		
TYPE	Oil Gear Pump		
SPECIFICATION	2.0 m^3/h x 2.0 kg f/cm^2 G x 0.75 kW		
MOTOR	3⌀ x 415V		
SHAFT SEAL	Mechanical Seal		
QUANTITY	Stage 1	Stage 2	Stage 3
	1	-	-

[1] KOHLER Power Systems Catalogue; Model 1000 ROZD

2. CHILLED WATER PRESSURE TANK CALCULATION

The total volume of an expansion tank, V_t is as follow:

$$V_t = V_g + V_w + V_{w1} \qquad [m^3]$$

Where:

V_t : Total volume of the expansion tank, m^3
V_g : Gas Pressurizing volume, m^3
V_w : Water volume, m^3
V_{w1}: Residual volume, m^3

Assumptions:

- Conditions in calculating the following values are assumed to be at maximum conditions.
- Supply and return temperature at all times are assumed constant.
- T_{supply} = 4.44°C ; T_{return} = 14.44°C
- Water temperature during start- up is 25°C

1.6 Determining Water Volume, V_w and Residual Volume, V_{w1} , Height

1.6.1 Expansion of chilled water, R_{normal} ,

$$R = \frac{\beta \times V \times H_m}{M} \qquad [m^3 / hr]$$

Where:

R_{normal} : Expansion of chilled water at normal time, m^3 / hr
β_{normal} : Volumetric coefficient of thermal expansion of water, °C^{-1}
V : Total volume of chilled water system, m^3 ≈ 12,100 m^3
H_m : Maximum cooling load, Mcal/hr = 30,240 Mcal/hr (assume starting with 2 chiller)
M : Total system heat capacity, kcal/°C

Calculated by (Pipe cross sect. Area * Length) for the whole chilled water system.

Chillers shall not be start up simultaneously to avoid sudden increase in electric supply and the max. expansion of water. (usually 2 by 2 until the water are chilled to the steady supply temp)

$$\beta_{normal} = \frac{\frac{1}{\rho_{ave}} - \frac{1}{\rho_{supply}}}{\frac{1}{\rho_{supply}} \times (T_{ave} - T_{supply})} [^{o}C^{-1}]$$

Obtained from Heating, ventilating, and Air-conditioning analysis and design (Mcquiston) APPENDIX A

CHW Temp.supply + CHW
emp.return)
2

Where:

T_{ave}	: Average temperature of chilled water, °C	= 9.44 °C
T_{supply}	: Supply temperature of chilled water, °C	= 4.44 °C
ρ_{ave}	: Density of average temperature of chilled water, kg/ m^3	= 999.65 kg/m^3
ρ_{supply}	: Density of supply temperature of chilled water, kg/m^3	= 999.90 kg/m^3

$$M = V \times 1000 kg/m^3 \times 1.0 kcal/kg.^{o}C \times (1.2 \sim 1.5) \quad [kcal/^{o}C]$$

(20%-50% of the heat load in piping and equipment is assumed to be the total system heat capacity)

Where:

1000 kg/m^3 is density of water
1.0 kcal/kg. °C is specific heat capacity of water

$$\therefore M = 12{,}000 m^3 \times 1000 kg/m^3 \times 1.0 kcal/kg.^{o}C \times 1.5 \quad [kcal/^{o}C]$$

$$M = 18.0 \times 10^3 \quad Mcal/^{o}C$$

$$\Rightarrow \beta_{normal} = \frac{\frac{1}{999.65} - \frac{1}{999.9}}{\frac{1}{999.9} \times (9.44 - 4.44)} \quad [^{o}C^{-1}]$$

$$\beta_{normal} = 0.00005 \ ^{o}C^{-1}$$

$$R_{normal} = \frac{0.00005^{o}C^{-1} \times 12{,}000 m^3 \times 30240 \ Mcal/hr}{18.0 \times 10^3 \ Mcal/^{o}C} [m^3/hr]$$

$$R_{normal} = 1.0084 \ m^3/hr$$

1.6.2 Maximum expansion rate of chilled water, R_{max},

T_{ave} = 14.72°C ; ρ_{ave}= 999.09 kg/ m^3

$\dfrac{\text{(CHW Temp Start up + CHW Temp Supply)}}{2}$

$$\beta_{\max} = \frac{\frac{1}{999.09} - \frac{1}{999.9}}{\frac{1}{999.9} \times (14.72 - 5.0)} \quad [{}^{o}C^{-1}]$$

$$\underline{\beta_{\max} = 0.0000789\ {}^{o}C^{-1}}$$

$$R_{\max} = \frac{0.0000789^{o}C^{-1} \times 12{,}000 m^{3} \times 30{,}240 Mcal/hr}{18.0 \times 10^{3} Mcal/{}^{o}C} [m^{3}/hr]$$

$$\underline{R_{\max} = 1.59\ m^{3}/hr}$$

1.6.3 Make-Up Water Flow Rate

Assumptions: Make- up water flow rate is at a steady flow rate, hourly, i.e 0.05% of total system flow rate

Volume flow rate

$$\dot{Q}_{make-up} = \frac{60{,}000 RT \times 3.024 Mcal/hr.RT \times 0.0005}{10.0^{o}C} [m^{3}/hr]$$

Total Chillers capacity

Temp Diff. Between CHWS AND CHWR

$$\underline{\dot{Q}_{make-up} = 9.072\ m^{3}/hr}$$

q = m * Cp * TD

= Q * density * Cp * TD

Density* Cp = 1.00 Mcal °C

$\text{Q} = \dfrac{\text{(q * conversion factor * normal)}}{\text{TD}}$

1.6.4 Total Variation of Flow Rate

Assumptions: Taking at maximum condition, i.e at start up:

$$\dot{Q}_{\text{var}} = R_{\max} + \dot{Q}_{make-up} \qquad [m^{3}/hr]$$

$$\dot{Q}_{\text{var}} = 1.59 + 9.072 \qquad [m^{3}/hr]$$

$$\underline{\dot{Q}_{\text{var}} = 10.66\ m^{3}/hr}$$

1.6.5 Water Height, H_w

Assumptions: Water volume, V_w to be **10-20** minutes of maximum total variation flow rate of chilled water. Additional **10%** allowance is considered for residual volume, V_{w1}.

$$V_w = \dot{Q}_{\text{var}} \times t_{storage}\ [m^3]$$

$$V_{w1} = V_w \times 0.1\, [m^3]$$

$$H_w = \frac{4 \times (V_w + V_{w1})}{\pi \times D^2} \quad [m]$$

Where:

H_w : Height of water side, m
V_w : Water volume, m^3
V_{w1} : Residual volume, m^3
$t_{storage}$: Water storage time (10~20 minutes), taking 20 minutes
D : Diameter of expansion tank, m

$$D = \sqrt{\frac{4 \times \dot{Q}_{\text{var}} \times t_1}{\pi \times H_{buffer}}} \quad [m]$$

Where:

t_1 : Stability period, minute (2~3 minutes), taking **3 minutes**
H_{buffer} : buffer zone for expansion and contraction **(0.1~0.15m)**

$$D = \sqrt{\frac{4 \times 7.42\ m^3/hr \times 0.05hr}{\pi \times 0.15m}} \quad [m]$$

$$D = 2.13\ m$$
$$\underline{D \approx 2.1\ m}$$

$$\Rightarrow V_w = 10.66 m^3/hr \times \frac{20}{60} hr \quad [m^3]$$
$$\underline{V_w = 3.553\ m^3}$$

$$\Rightarrow V_{w1} = 3.553 \times 0.1 \quad [m^3]$$
$$\underline{V_{w1} = 0.3553\ m^3}$$

$$\Rightarrow H_w = \frac{4 \times (3.553 + 0.3553)}{\pi \times 2.13^2} \quad [m]$$

$$\underline{H_w = 1.097\ m}$$

1.7 Determining Gas Volume, V_g

- GAS VOLUME, V_g

<u>Assumptions</u>: Assume that maximum variation volume is **<u>2~3 minutes</u>** of the total variation of chilled water flow rate, $Q_{var,}$ taking into account stability period of distribution pumps.

$$V_g = \frac{\dot{Q}_{var} \times t_1}{\frac{\Delta P}{P}} \quad [m^3]$$

Where:

t_1 : Taking as 3 minutes
ΔP : Variation of gas- pressure during expansion, kgf/cm^2 G
P : Initial gas pressure, kgf/cm^2 G, taking **<u>P = 3.0 kgf/cm^2</u>**
$\Delta P/P$: Variation of gas pressure during expansion is assumed to be 1~5% of the initial gas pressure. Normally is assumed to be **<u>5% of the initial gas pressure.</u>**

$$\Rightarrow V_g = \frac{10.66 m^3 / hr \times 0.05 hr}{\frac{0.15 kgf / cm^2\ G}{3.0 kgf / cm^2\ G}} \quad [m^3]$$

$$\underline{V_g = 10.66\ m^3}$$

- GAS HEIGHT

$$H_g = \frac{4 \times V_g}{\pi \times D^2} \quad [m]$$

$$\Rightarrow H_g = \frac{4 \times 10.66 m^3}{\pi \times 2.13^2\ m^2} \quad [m]$$

$$\underline{H_g = 2.99\ m}$$

1.8 Determining Total Volume of Expansion Tank, V_t

- EXPANSION TANK HEIGHT, H_t

$$H_t = H_g + H_w \quad [m]$$

$$\Rightarrow H_t = 2.99 + 1.097 \quad [m]$$
$$H_t = 4.087\ m$$
$$\underline{H_t \approx 4.1m}$$

- EXPANSION TANK VOLUME, V_t

$$V_t = \frac{\pi \times D^2 \times H_t}{4} \quad [m^3]$$

$$\Rightarrow V_t = \frac{\pi \times 2.13^2 \times 4.1}{4} \quad [m^3]$$
$$V_t = 14.58\ m^3$$
$$\underline{V_t \approx 14.6\ m^3}$$

1.9 Determining Pressure Variation

$$PV^n = Cons\tan t$$
$$P_1 \times (V_g)^n = P_2 \times (V_{g1})^n$$

Where:

P_1 : Pressure during normal operation, kgf/cm^2
P_2 : Pressure during expansion, kgf/cm^2
n : 1.0 ~ 1.4 for nitrogen gas, taking n= 1.4.

Thus, pressure variation would be the difference between P_1 and P_2.

<u>Assumptions:</u>V_{g1} is the gas volume minus he volume of the buffer zone for expansion and contraction.

V_{g1} has the following relationship:

$$V_{g1} = \frac{\pi \times D^2}{4} \times \left(H_g - \frac{H_{buffer}}{2} \right) \quad [m^3]$$

$$\Rightarrow V_{g1} = \frac{\pi \times 2.13^2}{4} \times \left(3.0 - \frac{0.15}{2} \right) \quad [m^3]$$
$$\underline{V_{g1} = 10.39\ m^3}$$

$$\Rightarrow 3.0 \times (10.66)^{1.4} = P_2 \times (10.39)^{1.4}$$
$$P_2 = 3.11 kgf / cm^2$$

$$\therefore P_2 - P_1 = 0.11 kgf / cm^2$$

Specification:

<table>
<tr><th>Item</th><th colspan="6">Description</th></tr>
<tr><td>EQUIPMENT NO.</td><td colspan="6">PT-1</td></tr>
<tr><td>TYPE</td><td colspan="6">Steel Sheet Cylindrical Tank</td></tr>
<tr><td>CONTENTS</td><td colspan="6">Nitrogen</td></tr>
<tr><td>CAPACITY</td><td colspan="6">15 m^3</td></tr>
<tr><td>DIMENSION</td><td colspan="6">3,000Φ x 4,100 H</td></tr>
<tr><td>PRESSURE</td><td colspan="6">3.0 kgf/cm^2G (working) 8.0 kgf/cm^2G (max)</td></tr>
<tr><td rowspan="2">QUANTITY</td><td>Phase 1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

3. Make- Up Water Tank (MWT 1 – 2)

(a) **Tank Volume Calculation**

Total make up water flow rate:

Total Chilled Water Loss= 36.4 m^3/h
Total Cooling Water Loss = 415.56 m^3/h

Total Make- Up Water Loss = 451.96 m^3/h

Required Make-Up Tank holding capacity for 6 hours operation:

451.96 m^3/h x 6 hours = 2711.76 m^3

Selected Tank Capacity = 2712 m^3

(b) **Specification:**

Item	**Description**		
EQUIPMENT NO.	MWT-1-2 (complete with internal partition)		
TYPE	Concrete water Tank		
EFFECTIVE CAPACITY	2712 m^3		
DIMENSION	24 mL x 25 mW x 5 mH		
QUANTITY	Stage 1	Stage 2	Stage 3
	2	-	-