







	
DOC NUMBER: 569-DB7B-PRO-500-004		CLIENT NUMBER: PRD-MEC-CLC-009	
CLIENT: TAKEDA			
PROJECT BURITI EPCMV PROJECT			

COOLING WATER SYSTEM CALCULATION

0	30JUL2021	ISSUED FOR CONSTRUCTION	JRM	LFF	MSS
D	03MAY2021	90% DD ISSUE	JRM	CCO	MSS
C	16OCT2020	FINAL BD ISSUE	MPA	LFF	MSS
B	28AUG202	90% BD ISSUE	MPA	LFF	MSS
A	28AUG202	90% BD ISSUE	MPA	LFF	MSS
REV	DATE	DESCRIPTION	EXEC	CHECK	APPROV

 		 	
DOC NR: 569-DB7B-PRO-500-004		CLIENT NR: PRD-MEC-CLC-009	
TITLE: COOLING WATER SYSTEM CALCULATION			SHEET 2 of 9 REV.: 0

1.	REVISION HISTORY	3
2.	PURPOSE	3
3.	REFERENCE.....	3
4.	BASIC DATA AND PREMISES.....	3
5.	CALCULATION.....	4
	5.1 THERMAL LOAD	4
	5.2 PUMPS	5
	5.3 BALANCING VALVES.....	6
6.	RESULTS.....	8
	6.1 VISUAL REPORT	8
	6.2 OUTPUT	8
	6.3 PUMPS SELECTED.....	8

 		 	
DOC NR:	569-DB7B-PRO-500-004	CLIENT NR:	PRD-MEC-CLC-009
TITLE:			SHEET 3 of 9
COOLING WATER SYSTEM CALCULATION			REV.: 0

1. REVISION HISTORY

Rev	Reason for Change
A	90% BD ISSUE
B	90% BD ISSUE
C	FINAL BD ISSUE
D	FLOWRATES AND DIAMETERS HAVE BEEN UPDATED. AS WELL AS CALCULATIONS AND EQUIPMENT, ALL DATA WERE UPDATED ACCORDING DETAILMENT DESIGN.
0	ANSWERING TAKEDA COMMENTS – SUBMITAL 222.0

2. PURPOSE

This document aims to establish the main characteristics for sizing the Cooling Water System for Building 7A (Final Drug Product), intended to Buriti Project, located at Hemobrás site in Goiana - Pernambuco state, Brazil.

The calculation will be adjusted according to the PID during detailed design.

3. REFERENCE

The following documents were used as reference:

Item	Number	Title
1	7A-M-0-5-43	Chilled Water Generation System (HVAC)
2	7A-M-0-5-45	Chilled Water Generation System (Process)
3	7A-M-0-5-81	Compressed Air Generation System
4	7A-Z-0-2-31	Proc. Waste – Collect & Temp./ Lift Station, SK-8001





4. BASIC DATA AND PREMISES

The Cooling Water System supplies the Building 7A and this system includes 3 Cooling Towers (3 operating in parallel or two operating and the other stopped in case of maintenance) primary pumps (2 in operation and 1 stand by) all with variable speed.

For system sizing, the following conditions were considered:

- DESIGN CONDITION – Sizing Criterion for Cooling Towers - 100% of the capacity of all equipment and an oversizing of 20%. – 2 Cooling Towers operating and 1 stand-by (maintenance).
- MAXIMUM OPERATING CONDITION – 100% of the capacity of all equipment operating at the same time – 2 Cooling Towers operating and 1 stand-by (maintenance).
- MINIMUM OPERATING CONDITION – 100% of the capacity of all equipment operating at the same time – 3 Cooling Towers operating at the same time (minimum pressure drop of the system).

This system supplies 3 HVAC Chillers (2 operating and the other stand-by), 2 Process Chillers (1 operating and the other stand-by), 1 Proc. Waste Sump Cooler and 2 Air Compressors.

 		 	
DOC NR:	569-DB7B-PRO-500-004	CLIENT NR:	PRD-MEC-CLC-009
TITLE:			SHEET 4 of 9
COOLING WATER SYSTEM CALCULATION			REV.: 0

The pressure drop required for the cooling water is 0.22 bar, according to the tower manufacturer's information.

To guarantee a balancing and a good distribution, static balancing valves were considered throughout the system as indicated in the PID's.

The chemical dosing is carried out directly in the cooling towers basin.

5. CALCULATION

5.1 Thermal load

The Cooling Water System has the following consumers in the Building 7A for the Maximum Operating Condition:

Item	Equipment	Tag	Diversity	Volumetric Flowrate		Mass Flowrate (kg/h)	Temp Inicial (°C)	Temp Final (°C)
				(m³/h)	(lpm)			
1	HVAC Chiller	CH-7A-1	Y	365.0	6,083.3	363,286.9	31.5	37.0
2	HVAC (stand-by)	CH-7A-2	N	-	-	-	31.5	37.0
3	HVAC Chiller	CH-7A-3	Y	365.0	6,083.3	363,286.9	31.5	37.0
4	Process Chiller	PCH-7A-1	Y	104.0	1,733.3	103,511.9	31.5	37.0
5	Process Chiller (stand-by)	PCH-7A-2	N	-	-	-	31.5	37.0
3	Process Waste Sump Lift Station	TC-8001	Y	114.6	1,910.0	114,062.1	31.5	37.0
4	Compressor	COMP-7A-1	Y	5.4	90.0	5,374.7	31.5	41.5
5	Compressor	COMP-7A-2	Y	5.4	90.0	5,374.7	31.5	31.5
TOTAL				959.4	15,990.0	954,897.2	31.5	36.99

Notes:





- Compressor – stand-by the cooling water is kept recirculating without thermal load.

Maximum Thermal Load Required = 5,246,560 kcal/h

Design Condition: Based on the Maximum Operating Condition, the manufacturer have selected 3 cooling towers operating at the same time, but in case of maintenance, two of them have the capacity to operate with the same required thermal load.

Cooling Towers Selected:

Cooling Tower	Flowrate m³/h	Flowrate (lpm)	Thermal Load kcal/h
1	495.0	8,250.0	2,718,608.0
2	990.0	16,500.0	5,437,215.0
3	1485.0	24,750.0	8,155,823.0

 		 	
DOC NR:	569-DB7B-PRO-500-004	CLIENT NR:	PRD-MEC-CLC-009
TITLE:			SHEET 5 of 9
COOLING WATER SYSTEM CALCULATION			REV.: 0

Each cooling tower has the thermal load of 2,718,608 kcal/h, with a flow rate of 495 m³/h.

Two cooling towers operating at the same time, the thermal load is 5,437,215.3 kcal/h, with a flow rate of 990 m³/h.

At the maximum operating condition, the thermal load required is 5,246,560 kcal/h, with a flow rate of 959.4 m³/h.

For design condition, the total flow rate is 990 m³/h. The flow rate in excess (30.6 m³/h) is diverted to tie-in (future expansion).

5.2 Pumps





The pumps were sized for the Design Condition, Maximum Operating Condition and Minimum Operating Condition, according to the tables shown below.

a) Design Condition – 2 Cooling Towers and 2 Pumps are operating at the same time.

EQUIPMENT	TAG	DIVERSITY (Y/N)	SIMULT. FLOWRATE (m ³ /h)	SIMULT. FLOWRATE (lpm)	SIMULT. FLOWRATE (kg/h)	NOTES
HVAC Chiller	CH-7A-1	Y	365.0	6,083.3	363,286.9	
HVAC (stand-by)	CH-7A-2	N	-	-	-	
HVAC Chiller	CH-7A-3	Y	365.0	6,083.3	363,286.9	
Process Chiller	PCH-7A-1	Y	104.0	1,733.3	103,511.9	
Process Chiller (stand-by)	PCH-7A-2	N	-	-	-	
Process Waste Sump Lift Station	TC-8001	Y	114.6	1,910.0	114,062.1	
Compressor	COMP-7A-1	Y	5.4	90.0	5,374.7	
Compressor	COMP-7A-2	Y	5.4	90.0	5,374.7	
Tie-in	-	Y	30.6	510.0	30,456.3	
TOTAL		-	990.0	16,500.0	985,353.5	

b) Maximum Operating Condition – 2 Cooling Towers and 2 Pumps are operating at the same time without the future expansion. See table below:

EQUIPMENT	TAG	DIVERSITY (Y/N)	SIMULT. FLOWRATE (m ³ /h)	SIMULT. FLOWRATE (lpm)	SIMULT. FLOWRATE (kg/h)	NOTES
HVAC Chiller	CH-7A-1	Y	365.0	6,083.3	363,286.9	
HVAC (stand-by)	CH-7A-2	N	-	-	-	
HVAC Chiller	CH-7A-3	Y	365.0	6,083.3	363,286.9	
Process Chiller	PCH-7A-1	Y	104.0	1,733.3	103,511.9	
Process Chiller (stand-by)	PCH-7A-2	N	-	-	-	

 		 	
DOC NR:	569-DB7B-PRO-500-004	CLIENT NR:	PRD-MEC-CLC-009
TITLE:			SHEET 6 of 9
COOLING WATER SYSTEM CALCULATION			REV.: 0

EQUIPMENT	TAG	DIVERSITY (Y/N)	SIMULT. FLOWRATE (m³/h)	SIMULT. FLOWRATE (lpm)	SIMULT. FLOWRATE (kg/h)	NOTES
Process Waste Sump Lift Station	TC-8001	Y	114.6	1,910.0	114,062.1	
Compressor	COMP-7A-1	Y	5.4	90.0	5,374.7	
Compressor	COMP-7A-2	Y	5.4	90.0	5,374.7	
Tie-in	-	N	-	-	-	
TOTAL		-	959.4	15,990.0	954,897.2	

Notes:

- 2 Cooling Towers operating and 1 stand-by (maintenance).

c) Minimum Operating Condition

For Minimum Operating Condition, the pumps are operating with 3 cooling towers (minimum pressure drop of the system) and without the future expansion.

EQUIPMENT	TAG	DIVERSITY (Y/N)	SIMULT. FLOWRATE (m³/h)	SIMULT. FLOWRATE (lpm)	SIMULT. FLOWRATE (kg/h)	NOTES
HVAC Chiller	CH-7A-1	Y	365.0	6,083.3	363,286.9	
HVAC (stand-by)	CH-7A-2	N	-	-	-	
HVAC Chiller	CH-7A-3	Y	365.0	6,083.3	363,286.9	
Process Chiller	PCH-7A-1	Y	104.0	1,733.3	103,511.9	
Process Chiller (stand-by)	PCH-7A-2	N	-	-	-	
Process Waste Sump Lift Station	TC-8001	Y	114.6	1,910.0	114,062.1	
Compressor	COMP-7A-1	Y	5.4	90.0	5,374.7	
Compressor	COMP-7A-2	Y	5.4	90.0	5,374.7	
Tie-in	-	N	-	-	-	
TOTAL		-	959.4	15,990.0	954,897.2	

Notes:





- 3 Cooling Towers operating at the same time.

5.3 Balancing Valves

To ensure the correct flow distribution in the installation, the following balancing valves were installed.

a) Static Balancing valves at the pump discharge

Static balancing valves were considered at the pump discharge, as shown in the table below:

 			 		
DOC NR: 569-DB7B-PRO-500-004			CLIENT NR: PRD-MEC-CLC-009		
TITLE:				SHEET 7 of 9	
COOLING WATER SYSTEM CALCULATION				REV.: 0	

ITEM	VALVE	PUMP	FLOWRATE		P in (barG)	P out (barG)	ΔP (bar)	CV (Calculated)
			(m³/h)	(LPM)				
21	BV-940049	PC-7A-3	494.6	8,244.0	2.4	2.3	0.12	1,641.7
x24	BV-940050	PC-7A-2	494.6	8,244.0	2.5	2.4	0.12	1,641.7
27	BV-940051	PC-7A-1	495.4	8,256.0	2.4	2.3	0.12	1,641.7

b) Static Balancing valves at the cooling water return (inlet of each tower)

Static balancing valves were considered at the inlet of each Tower, as shown in the table below:





ITEM	VALVE	COLLING TOWER	FLOWRATE		P in (barG)	P out (barG)	ΔP (bar)	CV (Calculated)
			(m³/h)	(LPM)				
63	BV-940072	CT-7A-1	495.9	8,265.5	0.3	0.3	0.06	2,341.0
x65	BV-940073	CT-7A-2	495.9	8,265.5	0.3	0.3	0.03	3,302.0
67	BV-940074	CT-7A-3	495.9	8,265.5	0.3	0.3	0.04	2,940.5

c) Static Balancing valves at the inlet/ outlet of Equipment

Static balancing valves were considered for each Equipment, as shown in the table below:

ITEM	VALVE	EQUIPMENT	FLOWRATE		P in (barG)	P out (barG)	ΔP (bar)	CV (Calculated)
			(m³/h)	(LPM)				
108	BV-980056	PCH-7A-1	104.2	1,736.7	1.1	0.8	0.26	233.7
x111	BV-980057	PCH-7A-2	104.2	1,736.7	1.1	0.8	0.25	240.9
209	BV-960062	CH-7A-1	365.7	6,094.8	1.2	0.9	0.30	772.6
x212	BV-960064	CH-7A-2	365.7	6,094.8	1.2	0.9	0.27	817.6
215	BV-960066	CH-7A-3	365.7	6,094.8	1.2	0.9	0.27	808.2
305	BV-840018	COMP-7A-2	5.4	90.0	3.6	3.5	0.05	27.3
308	BV-840017	COMP-7A-1	5.4	90.0	3.6	3.5	0.05	27.1
311	BV-940091	TC-8001	114.6	1,910.0	3.6	3.5	0.09	447.5

The Cooling Water System was sized based on flowrate and diversity indicated above, using the software Fathom version 10.0 and PID 7A-M-0-5-42 for this system was elaborated based on these calculations.

 		 	
DOC NR:	569-DB7B-PRO-500-004	CLIENT NR:	PRD-MEC-CLC-009
TITLE:			SHEET 8 of 9
COOLING WATER SYSTEM CALCULATION			REV.: 0

6. RESULTS

6.1 VISUAL REPORT

Design Condition



Visual Report -
Design Condition.pdf

Maximum Operating Condition



Visual Report -
Maximum Operating

Minimum Operating Condition



Visual Report -
Minimum Operating

6.2 OUTPUT

Design Condition



Output - Design
Condition.pdf

Maximum Operating Condition



Output - Maximum
Operating Condition

Minimum Operating Condition



Output - Minimum
Operating Condition

6.3 PUMPS SELECTED

a) DESIGN CONDITION

Jct	Results Diagram	Name	Vol. Flow (m3/hr)	dH (meters)	Ideal Power (hp)	Overall Efficiency (Percent)	Overall Power (hp)	Speed (Percent)	NPSHA (meters)	P Static Suction (barG)	P Static Disc. (barG)	dP (bar)
20	Show	PC-7A-3	495	25,6	46,1	86,4	53,4	100	10,5	0,0518	2,50	2,50
X23	Show	PC-7A-2 (Stand-by)	0	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
26	Show	PC-7A-1	495	25,6	46,1	86,4	53,4	100	10,6	0,0542	2,50	2,50

PC-7A-1/2/3 – The pump head will be rounded to 26 m.

b) MAXIMUM OPERATING CONDITION

Jct	Results Diagram	Name	Vol. Flow (m3/hr)	dH (meters)	Ideal Power (hp)	Overall Efficiency (Percent)	Overall Power (hp)	Speed (Percent)	NPSHA (meters)	P Static Suction (barG)	P Static Disc. (barG)	dP (bar)
20	Show	PC-7A-3	479,7	25,46	44,40	86,30	51,45	99,03	10,59	0,05704	2,487	2,485
X23	Show	PC-7A-2 (Stand-by)	0,0	N/A	N/A	N/A	N/A	0,00	N/A	N/A	N/A	N/A
26	Show	PC-7A-1	479,7	25,44	44,36	86,30	51,40	99,00	10,62	0,05942	2,487	2,483

c) MINIMUM OPERATING CONDITION

Jct	Results Diagram	Name	Vol. Flow (m3/hr)	dH (meters)	Ideal Power (hp)	Overall Efficiency (Percent)	Overall Power (hp)	Speed (Percent)	NPSHA (meters)	P Static Suction (barG)	P Static Disc. (barG)	dP (bar)
20	Show	PC-7A-3	479,7	24,91	43,44	86,33	50,31	98,51	10,79	0,07617	2,452	2,431
23	Show	PC-7A-2 (Stand-by)	479,7	24,94	43,49	86,33	50,38	98,56	10,89	0,08563	2,464	2,434
X26	Show	PC-7A-1	0,0	N/A	N/A	N/A	N/A	0,00	N/A	N/A	N/A	N/A

DOC NR: **569-DB7B-PRO-500-004**

CLIENT NR:

PRD-MEC-CLC-009

TITLE:

SHEET
9 of 9

COOLING WATER SYSTEM CALCULATION

REV.:
0

Pumps (PC-7A-1, PC-7A-2 and PC-7A-3)

Meganorm 200-150-250, 1750 rpm

