



Insight on the technology decisions at King Abdulaziz University Central Utility Plant #2

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Key Contacts

Designer

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Contractor

ARABIAN BEMCO CONTRACTING CO.LTD.
INDUSTRIAL and POWER PROJECTS
DEVELOPERS & CONTRACTORS.



Main Equipment List

- 5 Three-Stage Titan Chillers – Dual Duty. 3,600 Tons Chilled Water duty and 2,750 Tons Glycol duty. Total =
18,000 Tons water/13750 Tons Glycol
- 14 Two-Stage base CYK Chillers –
2,185 Tons Chilled Water Each.
30,520 Tons
- 6 Ice Storage Tanks – 21,150 Ton-Hr
Capacity Each. Total Stored cooling
capacity is: **126,900 Ton-HR**
- 60 Dry Coolers (120 Fans) 11,978,900
BTU/HR Each
700,000,000 BTU/HR Total



District Cooling Design Options

Typical District Cooling uses single stage centrifugal chillers with Cooling Towers and water storage system.

- Requires large amount of water. water quality is an issue.

Dry-Coolers

No water is lost!

- Typically water storage system

Ice Storage

- Reduces number of chillers and dry coolers

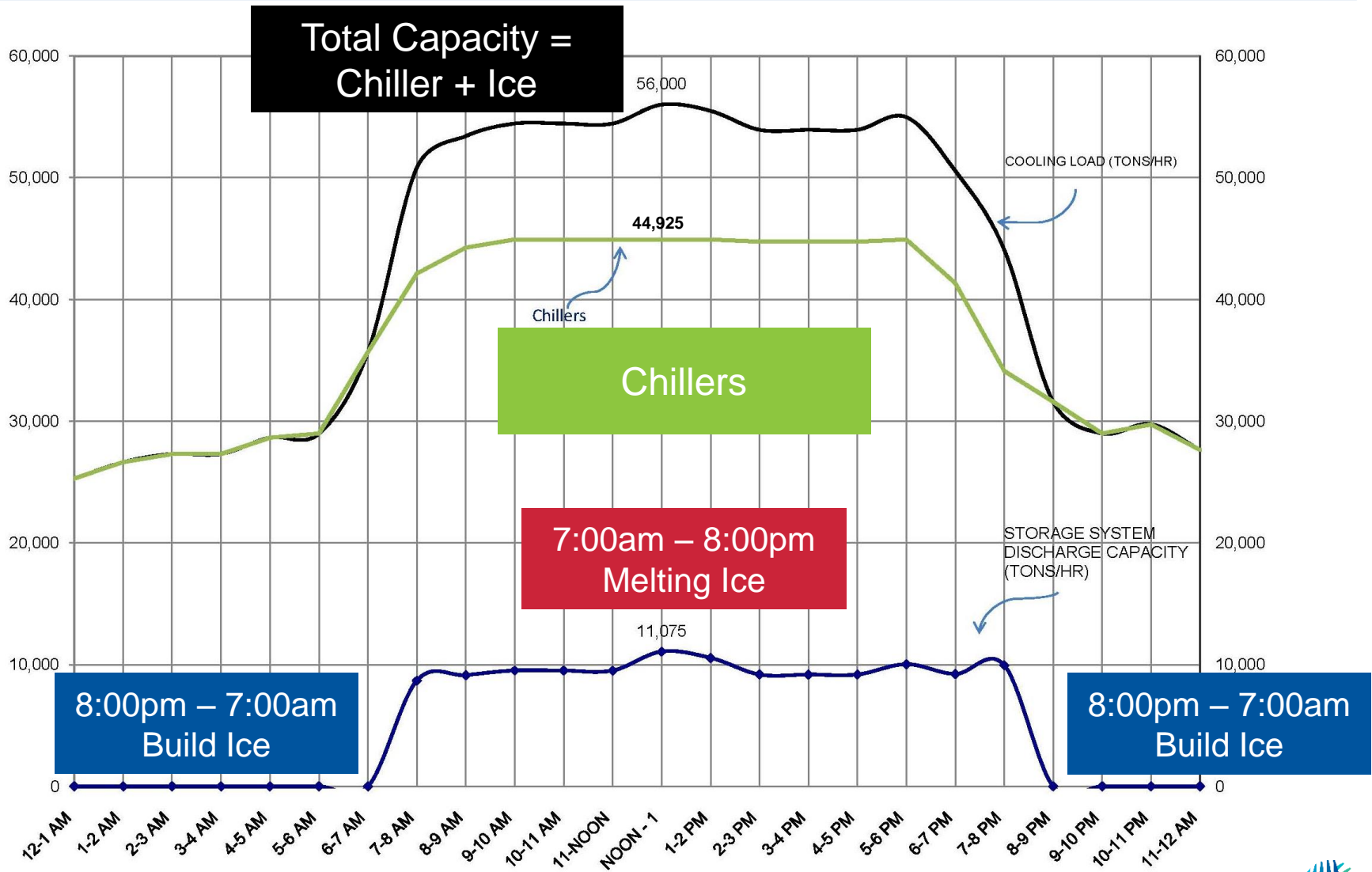
Additional Benefits

- Reduce peak demand, shift energy usage to non-peak hours.
- Reduce pump, pipes and air equipment sizes

Central Utility Plants Design Conditions

- Chilled water loop temperatures:
 - 7:00 am – 8:00 pm = 59°F/36°F (15°C/2.2°C)
 - All other times = 59°F/40°F (15°C/4.5°C)
- Water chillers and Ice Storage:
 - Chillers in plant #1 and #2 deliver 80% of peak load.
 - Ice storage system to provide 20%
- Return chilled water flows through chillers in plants #1 and #2 first, then combine and flow over the ice heat exchangers in the tanks.
- Condenser water loop temperatures:
 - 7:00 am – 8:00 pm = 130°F/140°F (54.4°C/60°C)
 - All other times = 130°F/138°F (54.4°C/59°C)

Chiller Plant CUP #2 Load Profile



Plant Energy Analysis – Ice on Coil Design Analysis Peak Day

Water Chiller Electric
=1075476 kW

+

Glycol Chiller Electric =
171991 kW

+

Air-Cooled Radiator
Fans = 97344 kW

+

Condenser Water
Pumps = 82654 kW

+

Distribution Pumps =
50114 kW

+

Primary Chiller Pumps=
17409 kW

+

Glycol Pumps =
12929 kW

+

Air Pump & Other Small
Motors = 5248 kW

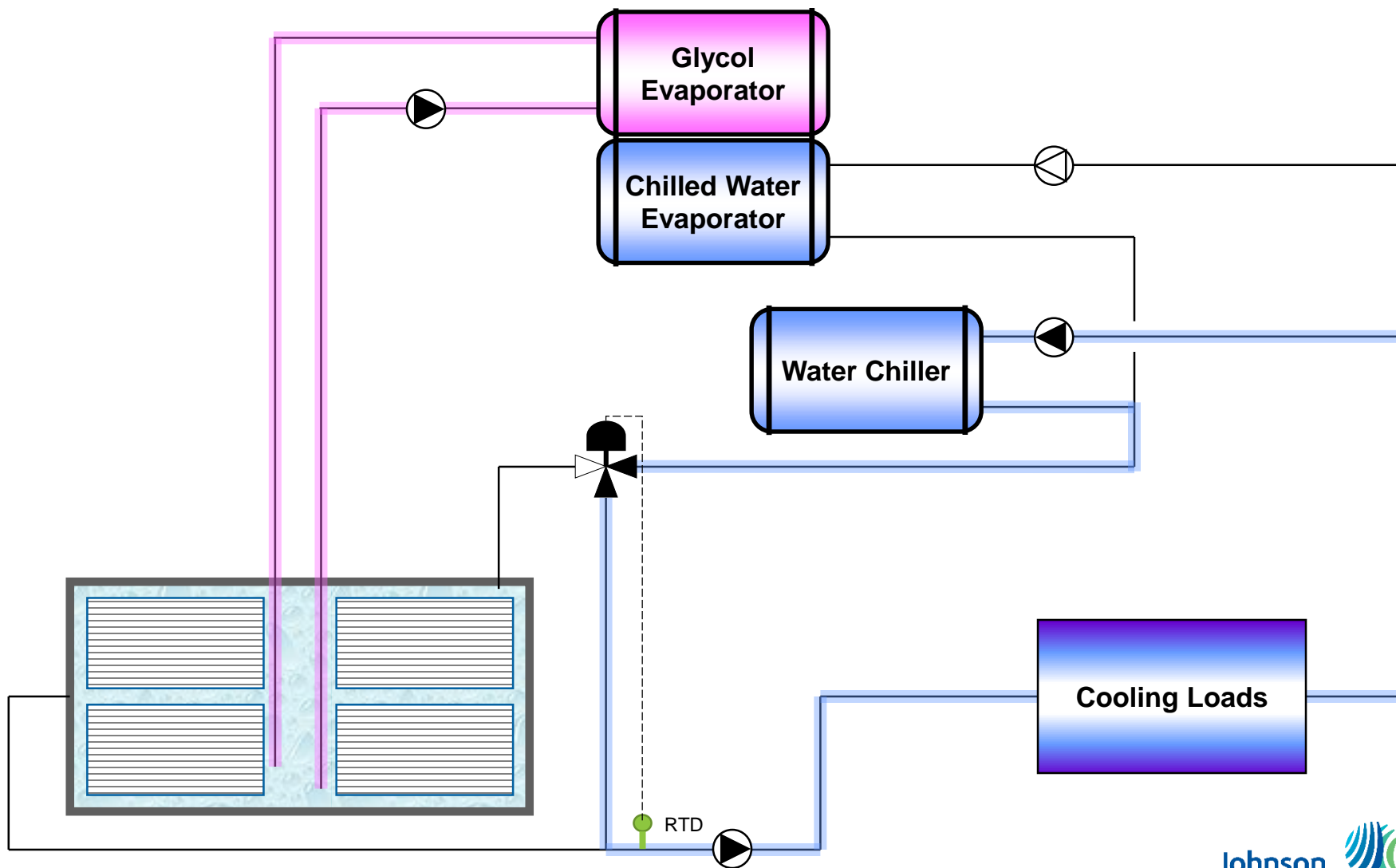
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Fans & Other Non-
Process Plant Electric
Loads = 6744 kW

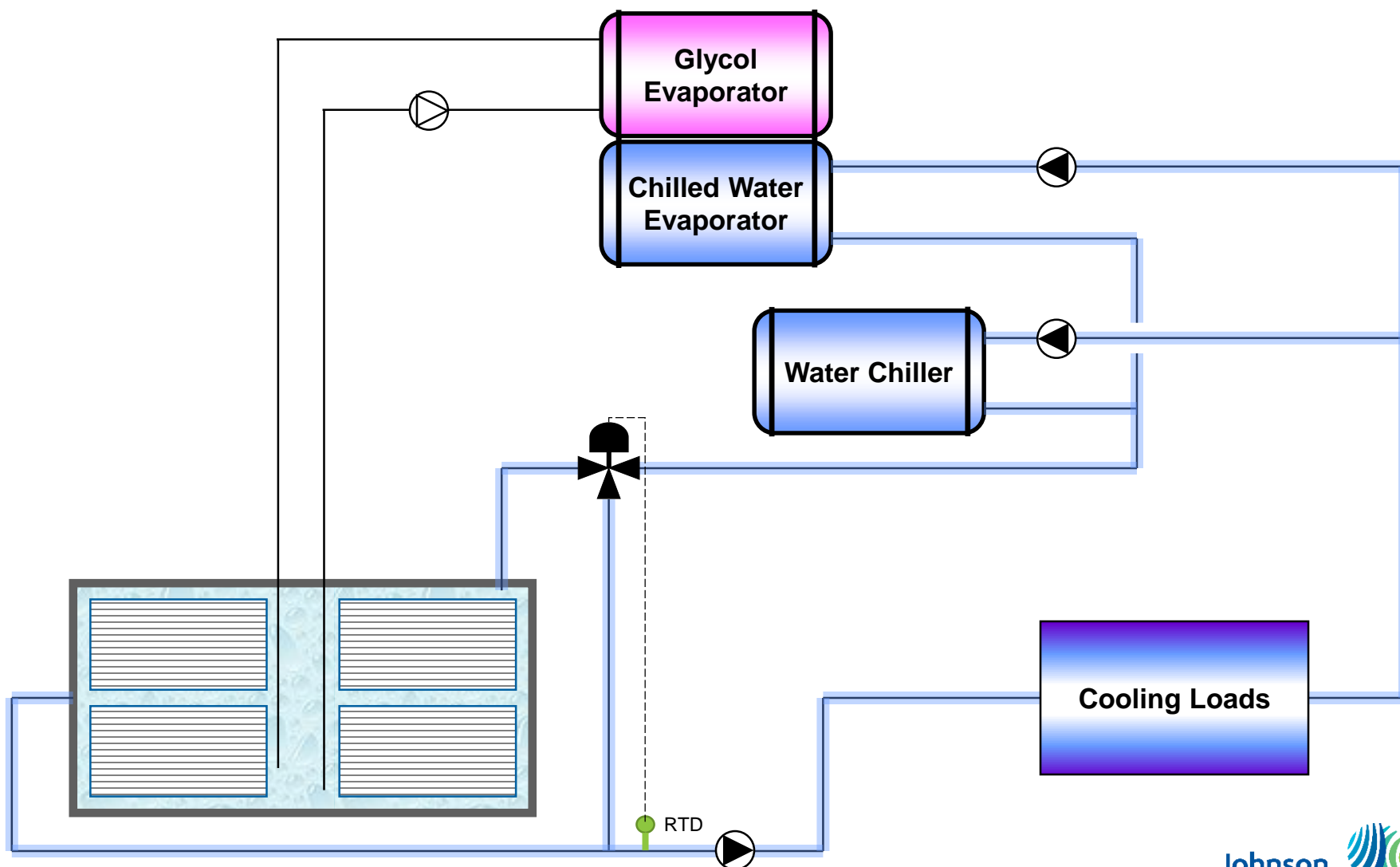
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Total Daily kW/h = 1,519,918
Daily kW/Ton at peak day = 1.67
Actual measured KW/Ton = 1.36

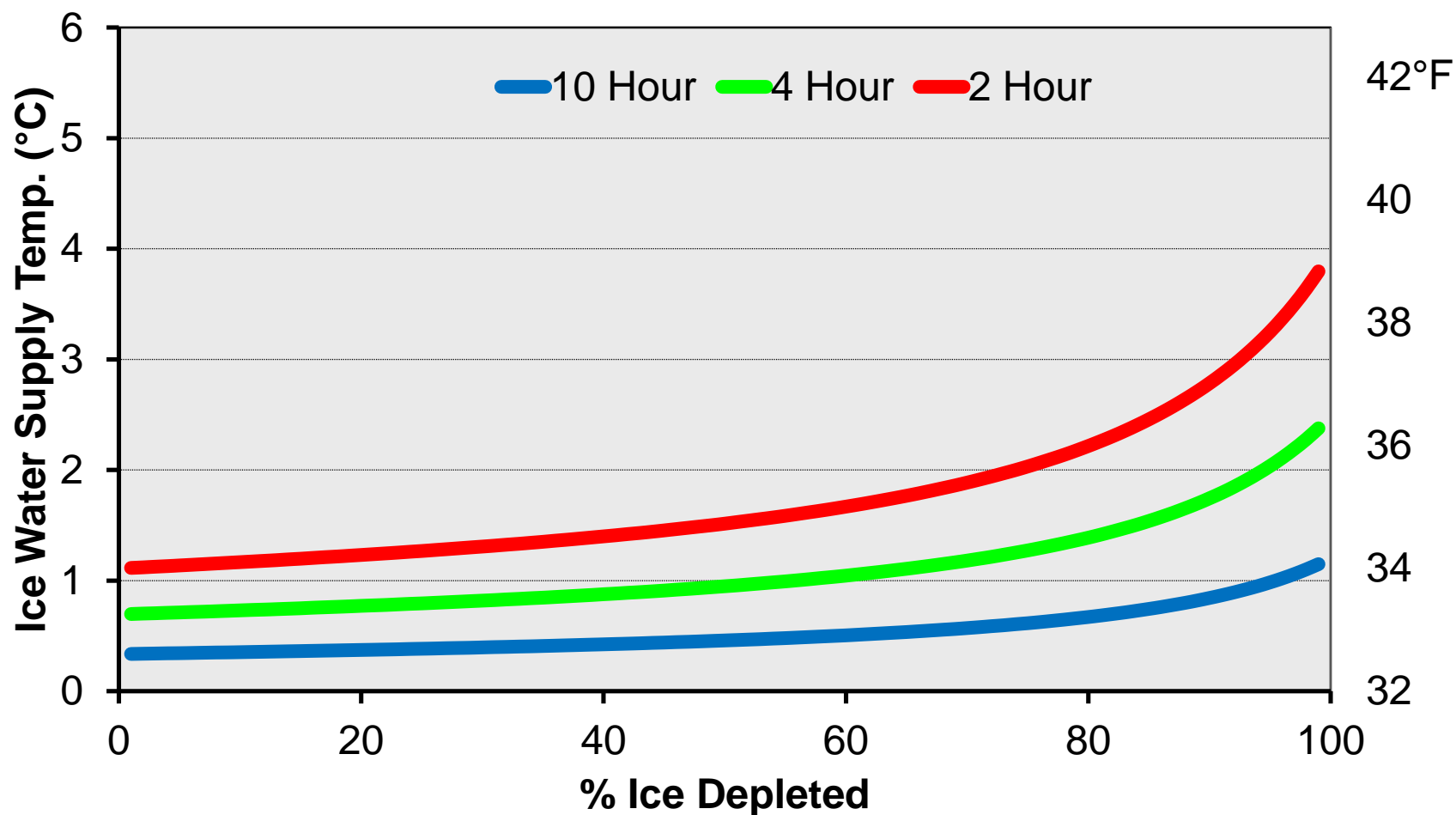
Ice Build with Water Chilling



Ice Melt with Water Chilling



External Melt Supply Temperatures

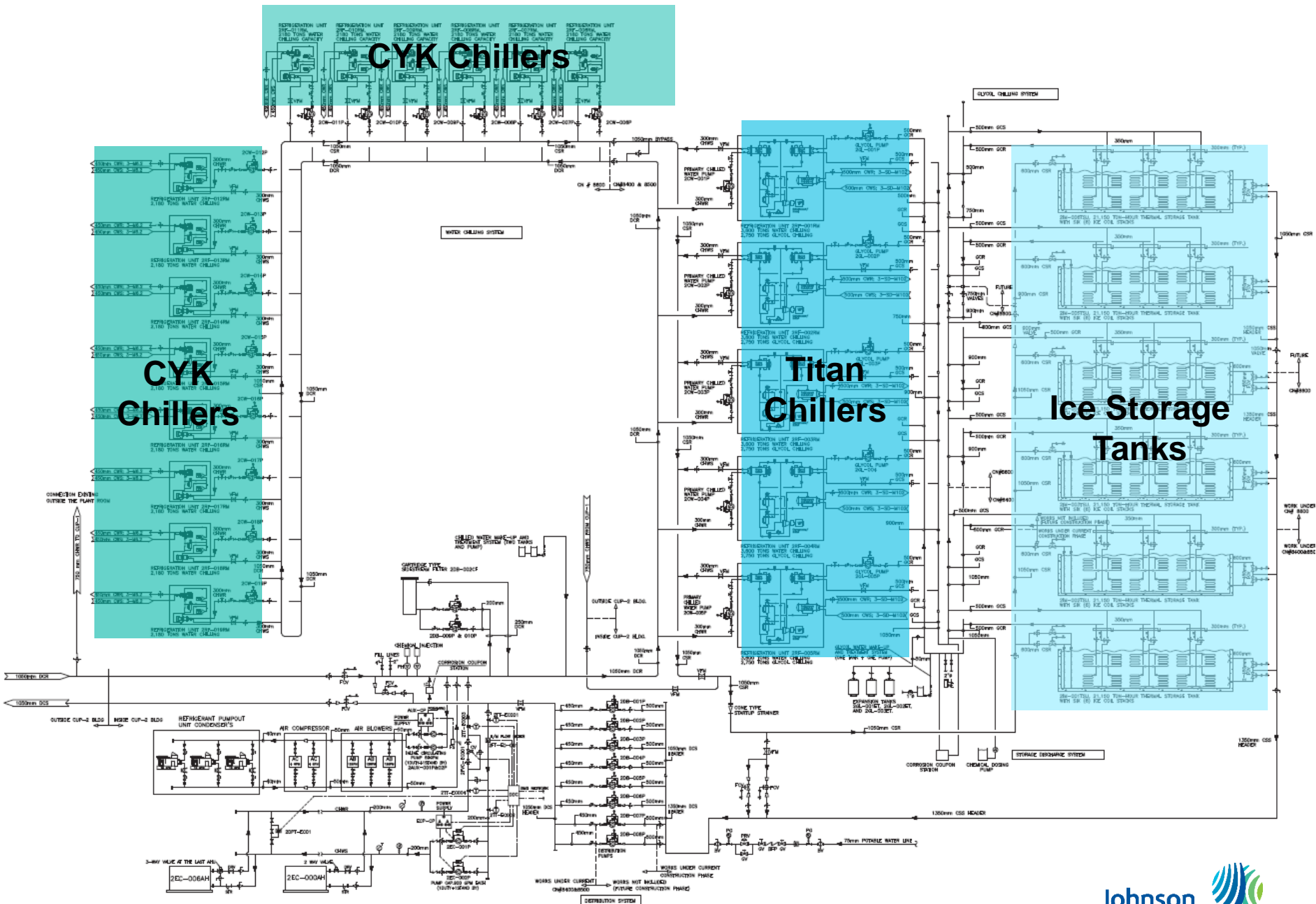


CYK Chillers

CYK Chillers

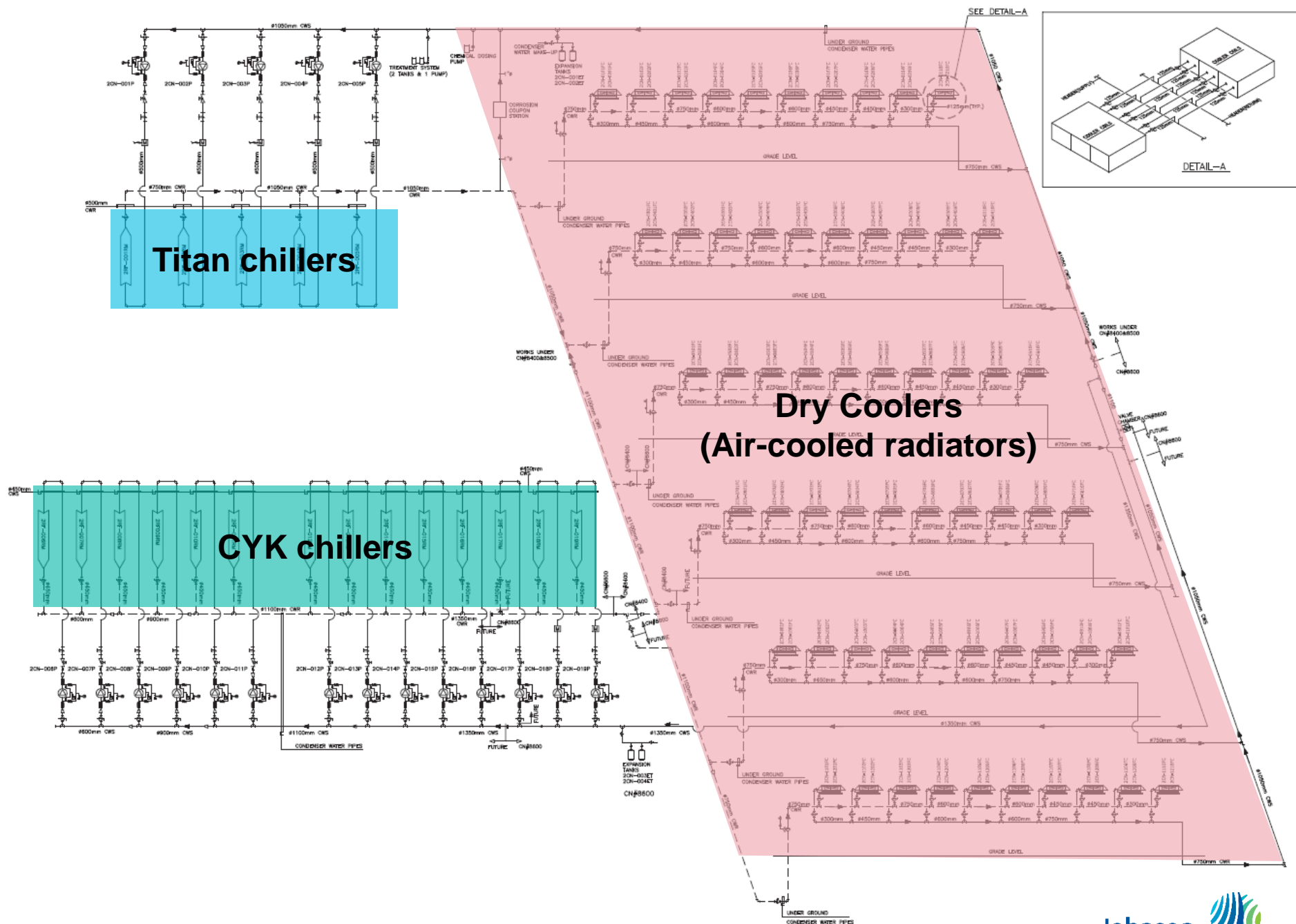
Titan Chillers

Ice Storage Tanks









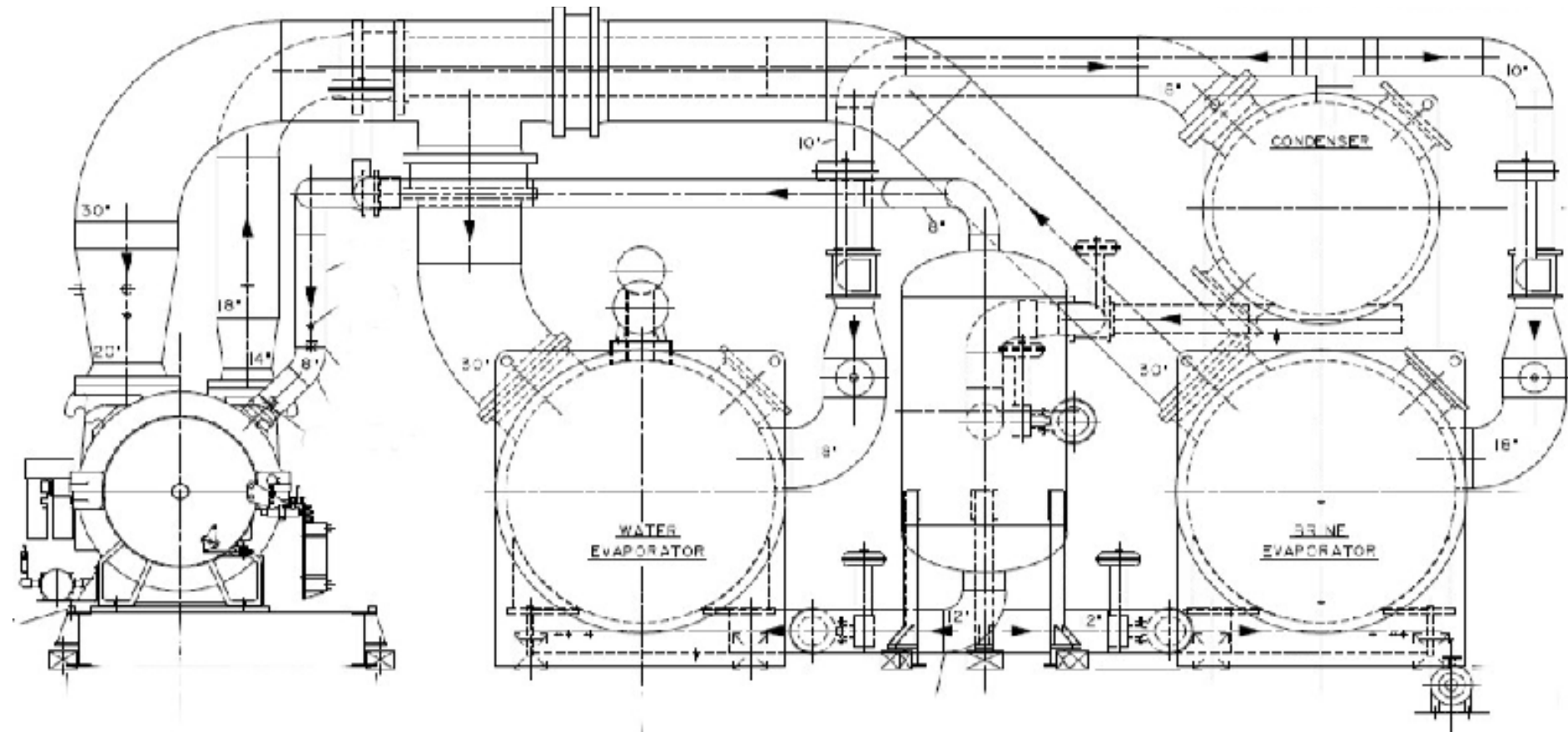
Air-Cooled Radiator – Dry Coolers



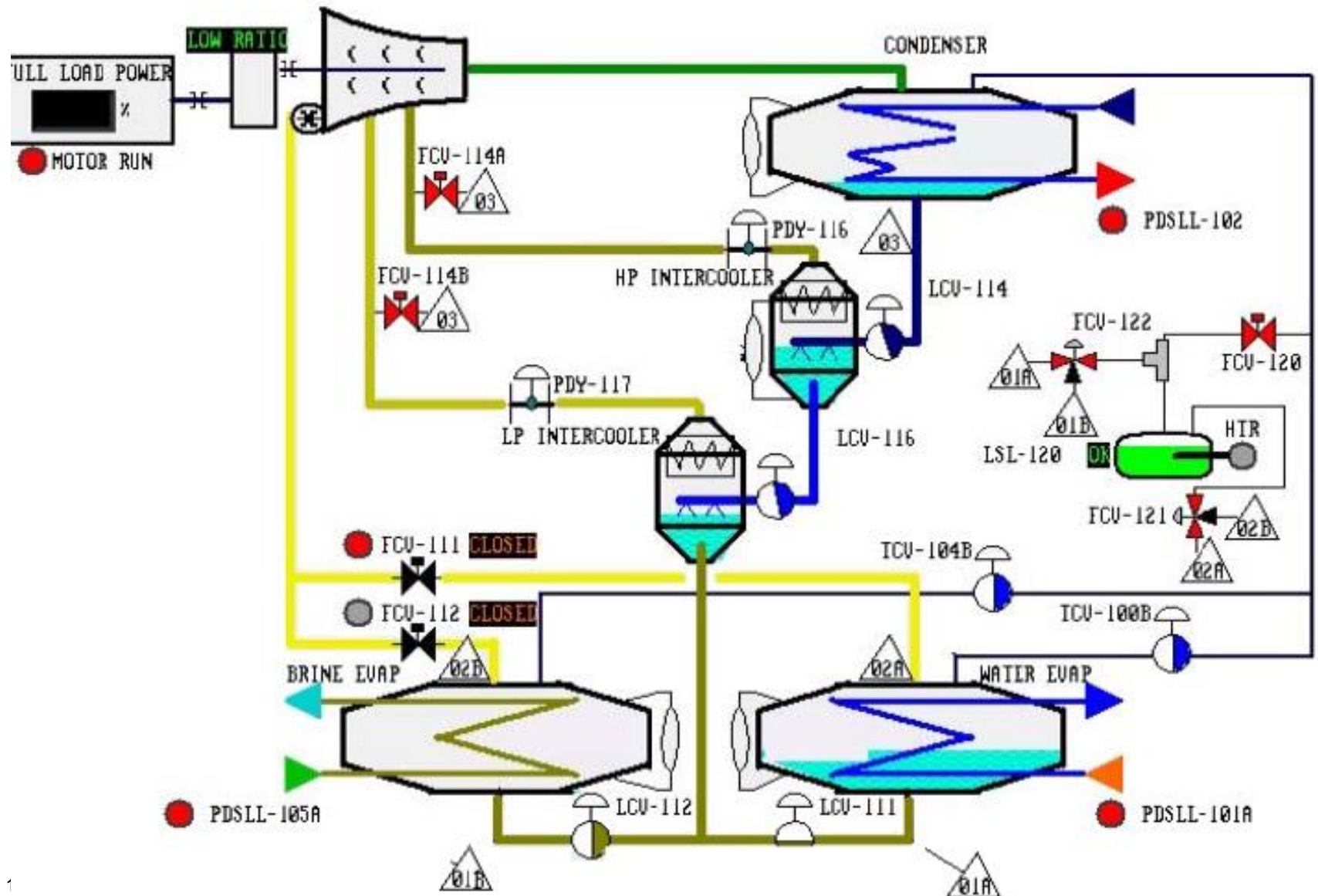
Titan OM Chillers – 3600 Tons Chilling Duty – 2750 Tons Ice Duty

DESIGN OPERATING CONDITIONS		Water Chilling	Brine Chilling
Chiller:	Design Load	3600 Tons	2750 Tons
	Efficiency (w/o liquid injection)	1.26 kW/Ton	1.50 kW/ton
	Efficiency (with liquid injection)	1.28 kW/Ton	1.54 kW/ton
Evaporator:	Water Ent. & Lvg. Temperatures	59.0 °F to 40.0 °F	32.0 °F to 24.7 °F
	Water Flow	4547 gpm	9795 gpm
	Water Diff. Press. (nozzle – nozzle)	27.8 ft. water	44.6 ft. water
	Tubeside Fouling Factor	0.00010 ft ² -h-°F/Btu	0.00010 ft ² -h-°F/Btu
	Refrigerant Temperature	38.8 °F	20.7 °F
	Refrigerant Pressure	48.6 psia	33.6 psia
Condenser:	Water Ent. & Lvg. Temperatures	130.0 °F to 140.5 °F	130.0 °F to 138.4 °F
	Water Flow	10,800 gpm	10,800 gpm
	Water Diff. Press. (nozzle – nozzle)	27.8 ft. water	27.8 ft. water
	Tubeside Fouling Factor	0.00025 ft ² -h-°F/Btu	0.00025 ft ² -h-°F/Btu
	Refrigerant Temperature	142.4 °F	139.9 °F
	Refrigerant Pressure	251.7 psia	243.6 psia
	Subcooler leaving refrigerant temp	132.9 °F	132.2 °F
Compressor:	Suction & Discharge Temperatures	38.4 °F to 167.1 °F	20.5 °F to 167.8 °F
	Full Load Rotational Speed	4379 rpm	4682 rpm
	Shaft Power (w/o liquid injection)	5661 HP	5153 HP
Gear:	Input Power (w/o liquid injection)	5841 HP	5333 HP
Motor:	Input Elect. Power (w/o liquid injection)	4532 kW	4138 kW
	Electrical Requirements	13,800 V / 3 Ph / 60 Hz	13,800 V / 3 Ph / 60 Hz

Titan OM Chiller Design



Titan OM Chiller Schematic



Installation Photo – Titan OM Chiller



CYK Two Stage Chiller – Two Externally Compounded Compressors

ISSUE DATE: 04/14
PROJECT - 14-4021
SALES ENGINEER - AMAR FARJO/ARIF H
CUSTOMER - KAAU CUPRII

PROGRAM: LTC
REV: v1.135.yau
DATE: 06/24/14
PAGE: 1 OF 1

MODEL CYKSSSSK4U2-DJDJG
(MOTOR LS SPECIFIED BY USER)
RATED CAPACITY (TONS) 2185
REFRIGERANT (LB 134A) 7408
OPTISOUND CONTROL-LS YES
INPUT POWER-LS (KW) 1516
INPUT POWER-HS (KW) 1281
TOTAL INPUT POWER (KW) 2797
TOTAL FULL LOAD (KW/TON) 1.280
VOLTAGE/HZ-LS 13800/60
VOLTAGE/HZ-HS 13800/60
ECONOMIZER YES (48IN)

(MOTOR HS SPECIFIED BY USER)
SPECIFIED CAPACITY (TONS) 2185
OPTISOUND CONTROL-HS YES
GEAR CODE-LS PY (SPEC)
GEAR CODE-HS EB (SPEC)
FLA-LS 73
FLA-HS 73
LRA-LS 471
LRA-HS 471

LS-STARTER TYPE (0)
HS-STARTER TYPE (0)

	EVAPORATOR WATER	CONDENSER WATER
FLUID TUBE	273*	262*
PASSES	3*	2*
FOUL FACTOR	0.00010*	0.00025*
FLUID ENT TEMP (F)	59.00	130.00*
FLUID LEV TEMP (F)	40.00*	140.00
FLUID FLOW (GPM)	2751.0*	7174.0*
FLUID PRDROP (FT)	31.4	36.9
REFRIGERANT INTERMEDIATE TEMP (F)	94.00	

(*) DESIGNATES SPECIFIED INPUT
(LS) DESIGNATES LOW STAGE COMPRESSOR
(HS) DESIGNATES HIGH STAGE COMPRESSOR

PART LOAD PERFORMANCE:
(ELFT & EVAP FLOW + CEFT & COND FLOW are Constant)
OPERATING MACH = 1.353

% LOAD	CAP (TONS)	% POWER	INPUT (KW)	ELFT (F)	ELFT (F)	CEFT (F)	CLFT (F)	PERF (KW/TON)	VGD (COP) EFF	HeatRejec (TONS)
100.0	2185.0	100.0	2797	59.00	40.00	130.00	140.00	1.280	2.75	2948.2
90.0	1966.5	88.3	2468	57.10	40.00	130.00	138.96	1.255	2.80	2640.3
80.0	1748.0	77.3	2180	55.20	40.00	130.00	137.95	1.247	2.82	2342.9
70.0	1529.5	67.5	1909	53.29	40.00	130.00	136.95	1.249	2.92	2049.6
60.0	1311.0	58.8	1665	51.39	40.00	130.00	135.98	1.270	2.77	1763.0
50.0	1092.5	50.9	1480	49.49	40.00	130.00	135.06	1.355	2.60	1492.8
40.0	874.0	43.5	1263	47.59	40.00	130.00	134.12	1.445	2.43	1213.3
30.0	655.5	34.5	1013	45.69	40.00	130.00	133.13	1.545	2.28	924.1
20.0	437.0	26.5	767	43.79	40.00	130.00	132.16	1.755	2.00	636.3
19.1	417.2	25.9	745	43.62	40.00	130.00	132.07	1.786	1.97	610.1

RATINGS < 65 DEG. F CEFT ARE OUTSIDE THE SCOPE OF AHRI STD. 550/590-2011 (IP),
ALL OTHER LOAD POINTS ARE RATED IN ACCORDANCE WITH THE STANDARD.

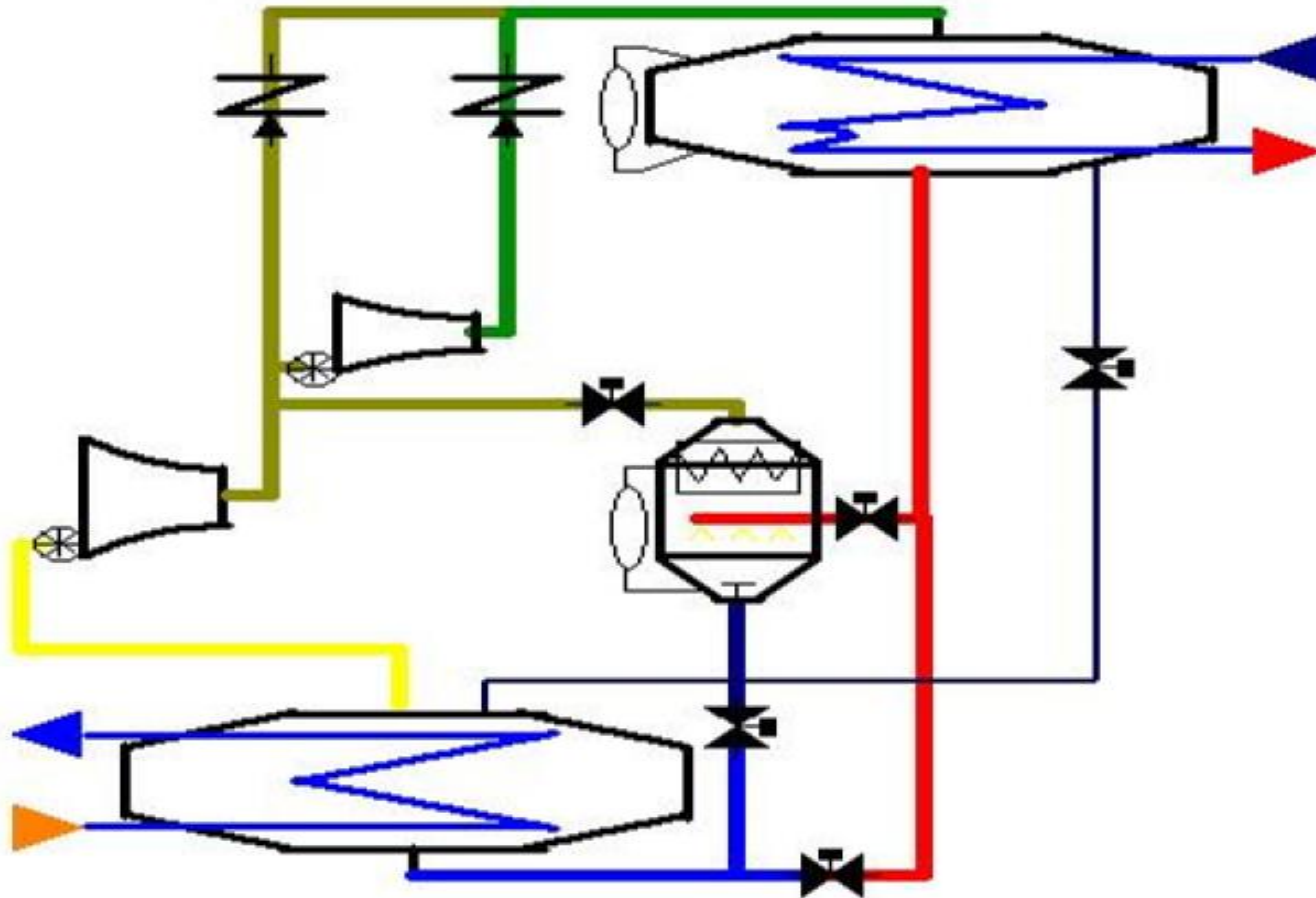
AUXILIARY COMPONENTS INCLUDED IN TOTAL KW - CHILLER CONTROLS.

MATERIALS AND CONSTRUCTION PER MECHANICAL SPECIFICATIONS - FORM 160.82-EG1.

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CYK Chiller Schematic



Installation Photo – CYK Chiller



Thank you

