

		Doc No: L1-I.16.1270-A4-HCS-002
		Rev No. : 0
High Purity N-Heptane Project	HVAC Calculation for New MCC Room	Date of Issue : 25-May-2017
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HVAC Calculation for New MCC Room

0	Approved for Construction	23-May-2017	W.Y.Cho	N.Y.Kim	C.K. Song	J.G. Kim
A	Issued for Approval	11-Apr-2017	W.Y.Cho	N.Y.Kim	C.K. Song	J.G. Kim
Rev.	Description	Date	Prepared By	Checked By	Checked By	Approved By

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REVISION INDEX

Rev	Date	Revision History
A	11-Apr-2017	Issued for Approval
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ATTACHMENT

Attachment #1. HVAC Load Calculation Input & Output Data

Attachment #2. Heat Dissipation Data

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1.0 INTRODUCTION

This calculation defines the requirements for detail design and construction of Heating, Ventilating and Air Conditioning (hereinafter referred to as HVAC) system, which shall be applied to New MCC Room for High Purity N-Heptane Project.

2.0 OBJECTIVE

To determine the cooling and heating loads in New MCC Room and to size HVAC equipment to provide the suitable environmental conditions for personnel and equipment.

3.0 REFERENCE

3.1. International Codes and Standards

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineer
ANSI	American National Standards Institute
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers Associations
ASME	American Society of Mechanical Engineers
NEC	National Electrical Code
ASTM	American Society for Testing and Materials
UBC	Uniform Building Code

3.2. Domestic Codes and Standards

KS	Korean Industrial Standards
KBC	Korean Building Code

3.3. Hanwha Total Engineering Specifications

HTC-GE-001E	Engineering Specification for Basic Engineering Design Data
HTC-CA-105E	Engineering Specification for Building
HTC-CA-321E	Engineering Specification for Construction Building Work

4.0 LANGUAGE AND UNITS

Language : English
Unit : SI Unit

5.0 DESIGN CONDITIONS

5.1. Outdoor Site Design Conditions

Seasons	Dry Bulb Temp. (°C DB)	Wet Bulb Temp. (°C WB)	Relative Humidity (%RH)	Remark
Summer	31.1	25.8	66	
Winter	-9.6	-10.3	78	

Outdoor design condition for HVAC design will be selected according to the "Ministry of Land, Infrastructure and Transport of the 2015-1108, Building Design Standard for Energy Conservation in Table 7."

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5.2. Indoor Design Conditions

Room Name	Summer		Winter		Room Pressure (Pa)	Remark
	DB (°C)	RH (%)	DB (°C)	RH (%)		
New MCC Room	Max. 30	N.C	N.C	N.C	N.C	

Note :

DB: Dry Bulb

RH: Relative Humidity

N.C: Not Controlled

5.3. Design Calculations

The methods, coefficients and general engineering data used in load calculation shall be in accordance with the ASHRAE handbook fundamentals.

HVAC load calculation program:

Carrier Software E20-II Program – Windows Version (Hourly Analysis Program 4.61)

5.4. Heat gain from occupants of air conditioned spaces

Typical Application	Degree of Activity	Sensible Heat (W/Person)	Latent Heat (W/Person)	Remark
Office	Moderately Active Office Work	70	45	

Based on 2009 ASHRAE Handbook – Fundamentals Chapter 18 Table-1

5.5. Heat emission from lighting fixtures

Common Space Type	Lighting Fixtures (W/m ²)	Remark
Electrical / mechanical	16	

Based on 2009 ASHRAE Handbook – Fundamentals Chapter 18 Table-2

5.6. Heat emission from Equipment

Room Name	Electrical Heat Emission		Remark
	W	W/m ²	
New MCC Room	7,946	88.3	

Refer to Attachment #2 Heat Dissipation Data

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6.0 COOLING LOAD SUMMARY

6.1. Cooling Room Load Summary (Refer to Attachment #1)

Room Name	Floor Area (m ²)	Cooling Load (W)			Remark
		Sensible	Latent	Total	
New MCC Room	90.0	10,548	1,282	11,830	
Total	90.0	10,548	1,282	11,830	

7.0 SELECTION OF HVAC EQUIPMENT

7.1. Packaged Air Conditioner Unit (Split type air conditioner)

A) Packaged air conditioner for New MCC Room

Item		Remark
▪ Equipment No.	• L1-AC-701A/B	- Asterisk marked (*) item shall be determined by vendor data. - Refer to Attachment #1. Air System Sizing Summary - Air cooled condensing unit shall be operable at 35.0°C
▪ Quantity	• 2 Sets (100% x 2Sets, 1 Duty, 1 Stand-by)	
▪ Location	• New MCC Room	
▪ Type	• R-410a	
▪ Supply Fan	• 714 LPS	
▪ Cooling Coil	• Type : Direct expansion • Total Capacity : 12.3 kW • Room temp. : Max. 30°C	
▪ Condenser Type	• Air cooled, DX type	
▪ Condenser Fan	• 750 LPS x 2 EA	
▪ Total Input Power for Unit	• 4.99 Kw	
▪ Electric Source	• 440V / 3Ph / 60Hz	

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ATTACHMENT 1

HVAC LOAD CALCULATION INPUT & OUTPUT DATA(E20-II)



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1.0 HVAC LOAD CALCULATION INPUT DATA

1.1 Design Weather Parameters & MSHGs

Design Parameters:

City Name Seosan
 Location South Korea
 Latitude 35.6Deg.
 Longitude -126.2Deg.
 Elevation 36.0m
 Summer Design Dry-Bulb 31.1°C
 Summer Coincident Wet-Bulb 25.8°C
 Summer Daily Range 12.0°K
 Winter Design Dry-Bulb -9.6°C
 Winter Design Wet-Bulb -10.3°C
 Atmospheric Clearness Number 1.00
 Average Ground Reflectance 0.20
 Soil Conductivity 1.385W/(m·°K)
 Local Time Zone (GMT +/- N hours) -9.0hours
 Consider Daylight Savings Time No
 Simulation Weather Data noneN/A
 Current Data is User Modified
 Design Cooling Months January to December

Design Day Maximum Solar Heat Gains

(The MSHG values are expressed in W/m²)

Month	N	NNE	NE	ENE	E	ESE	SE	SSE	S
January	68.6	68.6	74.1	291.4	530.8	678.3	783.9	800.5	791.5
February	81.5	81.5	198.1	420.5	632.6	756.0	785.3	753.8	725.3
March	95.7	100.1	334.0	560.1	693.7	758.8	725.8	643.4	599.3
April	109.8	241.1	448.8	621.6	711.9	693.6	614.3	488.1	420.1
May	119.4	338.4	528.6	645.6	695.1	640.5	517.2	361.1	286.0
June	150.6	374.2	547.4	652.3	680.9	608.2	472.3	307.3	236.2
July	122.0	338.2	510.7	642.5	682.1	619.7	504.3	349.1	276.7
August	115.0	238.3	434.4	605.4	685.6	665.6	592.0	470.2	405.3
September	99.4	99.4	298.2	526.9	667.1	716.4	701.9	627.6	584.1
October	84.2	84.2	166.1	425.5	603.6	723.0	759.9	732.4	706.7
November	69.8	69.8	72.9	294.4	510.8	683.8	761.6	781.0	781.4
December	63.0	63.0	63.0	226.8	479.7	643.8	764.6	798.8	802.5
Month	SSW	SW	WSW	W	WNW	NW	NNW	HOR	Mult
January	798.0	772.4	695.2	508.4	307.0	68.6	68.6	494.3	1.00
February	757.0	789.8	739.6	637.3	437.3	182.2	81.5	630.4	1.00
March	649.5	731.2	755.7	705.7	546.6	338.5	100.5	754.1	1.00
April	488.9	613.9	698.8	710.8	614.6	457.9	238.1	829.6	1.00
May	361.2	516.5	641.6	693.9	642.3	530.6	337.1	858.9	1.00
June	307.4	469.1	611.7	675.2	653.7	553.7	369.6	860.9	1.00
July	349.7	500.5	628.1	675.0	638.5	526.1	331.9	847.0	1.00
August	471.9	592.2	674.0	685.6	594.2	445.2	235.8	813.2	1.00
September	626.1	700.2	720.6	663.4	528.4	305.8	99.4	730.6	1.00
October	728.3	755.4	729.5	603.4	413.3	188.5	84.2	621.1	1.00
November	786.1	769.7	675.0	521.0	275.3	77.0	69.8	493.3	1.00
December	795.5	762.2	652.4	477.6	223.6	63.0	63.0	436.6	1.00

Mult. = User-defined solar multiplier factor.



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1.2 Space Input Data

NEW MCC ROOM

1. General Details:

Floor Area.....**90.0m²**
 Avg. Ceiling Height**4.4m**
 Building Weight.....**341.8kg/m²**

1.1. OA Ventilation Requirements:

Space Usage **User-Defined**
 OA Requirement 1 **0.0L/s**
 OA Requirement 2 **0.00L/(s-m²)**
 Space Usage Defaults **ASHRAE Std 62.1-2007**

2. Internals:

2.1. Overhead Lighting:

Fixture Type..... **Recessed (Unvented)**
 Wattage **16.00W/m²**
 Ballast Multiplier..... **1.00**
 Schedule..... **Sample Schedule**

2.2. Task Lighting:

Wattage **0.00W/m²**
 Schedule..... **None**

2.3. Electrical Equipment:

Wattage **7946.0Watts**
 Schedule..... **Sample Schedule**

2.4. People:

Occupancy **0.0People**
 Activity Level **User defined**
 Sensible **75.0W/person**
 Latent **55.0W/person**
 Schedule **Sample Schedule**

2.5. Miscellaneous Loads:

Sensible **0W**
 Schedule **None**
 Latent **0W**
 Schedule **None**

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (m ²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
NW	32.1	0	0	1
NE	8.8	0	0	0
SE	8.8	0	0	0
SW	39.6	0	0	0

3.1. Construction Types for Exposure NW

Wall Type..... **W**
 Door Type **SD-1**

3.3. Construction Types for Exposure SE

Wall Type **W**
 Door Type **SD-2**

3.2. Construction Types for Exposure NE

Wall Type..... **W**

3.4. Construction Types for Exposure SW

Wall Type **W**

4. Roofs, Skylights:

Exp.	Roof Gross Area (m ²)	Roof Slope (deg.)	Skylight Qty.
H	90.0	0	0

4.1. Construction Types for Exposure H

Roof Type **R**

5. Infiltration:

Design Cooling **0.48ACH**
 Design Heating **0.00ACH**
 Energy Analysis **0.00L/s**
 Infiltration occurs at all hours.

6. Floors:

Type **Floor Above Unconditioned Space**
 Floor Area..... **90.0m²**
 Total Floor U-Value..... **0.328W/(m²-°K)**
 Unconditioned Space Max Temp. **31.1°C**
 Ambient at Space Max Temp. **31.1°C**
 Unconditioned Space Min Temp. **-9.6°C**
 Ambient at Space Min Temp. **-9.6°C**

7. Partitions:

7.1. 1st Partition Details:

Partition Type **Wall Partition**
 Area **86.7m²**
 U-Value **0.289W/(m²-°K)**
 Uncondit. Space Max Temp..... **31.1°C**
 Ambient at Space Max Temp..... **31.1°C**
 Uncondit. Space Min Temp..... **-9.6°C**
 Ambient at Space Min Temp..... **-9.6°C**

1.3 Equipment Input Data

1.3.1 L1-AC-701A/B

1. General Details:

Air System Name..... **L1-AC-701A/B**
 Equipment Type..... **Packaged Vertical Units**
 Air System Type **Single Zone CAV**
 Number of zones **1**

2. System Components:

Ventilation Air Data:

Airflow Control **Constant Ventilation Airflow**
 Ventilation Sizing Method..... **Sum of Space OA Airflows**
 Unocc. Damper Position **Closed**
 Damper Leak Rate..... **0%**
 Outdoor Air CO2 Level..... **400ppm**

Central Cooling Data:

Supply Air Temperature **18.0°C**
 Coil Bypass Factor..... **0.100**
 Cooling Source **Air-Cooled DX**
 Schedule..... **JFMAMJJASOND**
 Capacity Control **Cycled or Staged Capacity - Fan On**

Supply Fan Data:

Fan Type **Forward Curved**
 Configuration **Draw-thru**
 Fan Performance **1000Pa**
 Overall Efficiency **60%**
 Fan Control..... **1-speed fan, cooling and heating**

Duct System Data:

Supply Duct Data:

Duct Heat Gain **0%**
 Duct Leakage..... **0%**

Return Duct or Plenum Data:

Return Air Via **Ducted Return**

3. Zone Components:

Space Assignments:

Zone 1: Zone 1	
NEW MCC ROOM	x1

Thermostats and Zone Data:

Zone **All**
 Cooling T-stat: Occ. **30.0°C**
 Cooling T-stat: Unocc. **30.0°C**
 Heating T-stat: Occ. **5.0°C**
 Heating T-stat: Unocc. **5.0°C**
 T-stat Throttling Range **0.83°K**
 Diversity Factor..... **100%**
 Direct Exhaust Airflow..... **0.0L/s**
 Direct Exhaust Fan kW **0.0kW**
 Thermostat Schedule **Sample Schedule1**
 Unoccupied Cooling is **Available**

Supply Terminals Data:

Zone **All**
 Terminal Type..... **Diffuser**
 Minimum Airflow **0.00L/s/person**

Zone Heating Units:

Zone **All**
 Zone Heating Unit Type **None**
 Zone Unit Heat Source..... **Electric Resistance**
 Zone Heating Unit Schedule **JFMAMJJASOND**

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4. Sizing Data (Computer-Generated):

System Sizing Data:

Cooling Supply Temperature..... **18.0°C**
 Supply Fan Airflow..... **731.3L/s**
 Ventilation Airflow **0.0L/s**

Hydronic Sizing Specifications:

Chilled Water Delta-T..... **5.6°K**
 Hot Water Delta-T **11.1°K**

Safety Factors:

Cooling Sensible..... **10%**
 Cooling Latent..... **10%**
 Heating **0%**

Zone Sizing Data:

Zone Airflow Sizing Method **Sum of space airflow rates**
 Space Airflow Sizing Method..... **Individual peak space loads**

Zone	Supply Airflow (L/s)	Zone Htg Unit (kW)	Reheat Coil (kW)	- (L/s)
1	731.7	-	-	



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2.0 HVAC LOAD CALCULATION OUTPUT DATA

2.1 LA-AC-701A/B

2.1.1 Air System Sizing Summary

Air System Information

Air System Name **L1-AC-701A/B**
Equipment Class **PKG VERT**
Air System Type **SZCAV**

Number of zones **1**
Floor Area **90.0m²**
Location **Seosan, South Korea**

Sizing Calculation Information

Zone and Space Sizing Method:

Zone L/s **Sum of space airflow rates**
Space L/s **Individual peak space loads**

Calculation Months **Jan to Dec**
Sizing Data **Calculated**

Central Cooling Coil Sizing Data

Total coil load **12.3kW**
Sensible coil load **11.2kW**
Coil L/s at Jul 1400 **714L/s**
Max block L/s **714L/s**
Sum of peak zone L/s **714L/s**
Sensible heat ratio **0.906**
m²/kW **7.3**
W/m² **137.0**
Water flow @ 5.6 °K rise **N/A**
Load occurs at **Jun 1500**

OA DB / WB **30.5 / 25.8°C**
Entering DB / WB **30.9 / 21.5°C**
Leaving DB / WB **17.8 / 17.0°C**
Coil ADP **16.4°C**
Bypass Factor **0.100**
Resulting RH **44%**
Design supply temp. **18.0°C**
Zone T-stat Check **1 of 1OK**
Max zone temperature deviation **0.0°C**

Supply Fan Sizing Data

Actual max L/s **714L/s**
Standard L/s **711L/s**
Actual max L/(s-m²) **7.93L/(s-m²)**

Fan motor BHP **1.50BHP**
Fan motor kW **1.19kW**
Fan static **1000Pa**

Outdoor Ventilation Air Data

Design airflow L/s **0L/s**
L/(s-m²) **0.00L/(s-m²)**

L/s/person **0.00L/s/person**

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2.1.2 Space Design Load Summary

TABLE 1.1.A. COMPONENT LOADS FOR SPACE " NEW MCC ROOM " IN ZONE " Zone 1 "						
	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1600 COOLING OA DB / WB 30.7 ° C / 25.6 ° C OCCUPIED T-STAT 30.0 ° C			HEATING DATA AT DES HTG HEATING OA DB / WB -9.6 ° C / - 10.3 ° C OCCUPIED T-STAT 5.0 ° C		
		Sensible	Latent		Sensible	Latent
SPACE LOADS	Details	(W)	(W)	Details	(W)	(W)
Window & Skylight Solar Loads	0 m ²	0	-	0 m ²	-	-
Wall Transmission	80 m ²	-23	-	80 m ²	338	-
Roof Transmission	90 m ²	41	-	90 m ²	197	-
Window Transmission	0 m ²	0	-	0 m ²	0	-
Skylight Transmission	0 m ²	0	-	0 m ²	0	-
Door Loads	10 m ²	-23	-	10 m ²	294	-
Floor Transmission	90 m ²	-34	-	90 m ²	431	-
Partitions	87 m ²	-29	-	87 m ²	366	-
Ceiling	0 m ²	0	-	0 m ²	0	-
Overhead Lighting	1440 W	1440	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	7946 W	7946	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	47	995	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	10% / 10%	936	100	0%	0	0
>> Total Zone Loads	-	10301	1095	-	1625	0

TABLE 1.1.B. ENVELOPE LOADS FOR SPACE " NEW MCC ROOM " IN ZONE " Zone 1 "						
				COOLING	COOLING	HEATING
	Area	U-Value	Shade	TRANS	SOLAR	TRANS
	(m ²)	(W/(m ² -° K))	Coeff.	(W)	(W)	(W)
NW EXPOSURE						
WALL	25	0.290	-	-15	-	104
DOOR	8	2.100	-	-18	-	230
NE EXPOSURE						
WALL	9	0.290	-	2	-	37
SE EXPOSURE						
WALL	7	0.290	-	4	-	28
DOOR	2	2.100	-	-5	-	64
SW EXPOSURE						
WALL	40	0.290	-	-13	-	168
H EXPOSURE						
ROOF	90	0.150	-	41	-	197

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ATTACHMENT 2

Heat Dissipation Data

■ Size & Weight Data sheet

- Customer : HANWHA TOTAL PETROCHEMICAL CO., LTD.

- Project Name : High Purity N-Heptane

FOR APPROVAL

Group name	Item	Q'ty	Unit (mm)			Total (mm)			Unit (kg)	Total (kg)	Load	100%	Rev.A
			Wide	Depth	Height	Wide	Depth	Height			Unit (kW)	Total (kW)	
									Weight	Weight	Heat Loss	Heat Loss	Remark
460V 65kA 3200A LV SWGR (Main LV SWGR & MCC)	INC/BC	3	800	1,450	2,350	2,400	1,450	2,350	1,100	3,300	1.053	3.160	
	Bus Joint	-	-	-	-	-	-	-	-	-	-	-	
	FED - 630A	2	800	1,450	2,350	1,600	1,450	2,350	1,000	2,000	0.282	0.564	
	MCC	8	900	1,100	2,350	7,200	1,100	2,350	1,000	8,000	0.299	2.392	
	Connection	4	600	1,100	2,350	2,400	1,100	2,350	800	3,200	0.282	1.127	
SUB TOTAL		17				13,600				16,500		7.243	
460V 65kA 800A LV SWGR (Emergency ATS PNL & MCC)	INC/BC	1	1,200	1,450	2,350	1,200	1,450	2,350	1,100	1,100	0.329	0.329	
	Bus Joint	-	-	-	-	-	-	-	-	-	-	-	
	FED - 630A	-	-	-	-	-	-	-	-	-	-	-	
	MCC	2	900	1,100	2,350	1,800	1,100	2,350	900	1,800	0.178	0.357	
SUB TOTAL		3				3,000				2,900		0.686	
460V 65kA 800A LV SWGR (DB PNL)	INC/BC	-	-	-	-	-	-	-	800	-	-	-	
	Bus Joint	-	-	-	-	-	-	-	300	-	-	-	
	FED - 630A	-	-	-	-	-	-	-	800	-	-	-	
	DB PNL	1	800	1,450	2,350	800	1,450	2,350	900	900	0.017	0.017	
SUB TOTAL		1				800				900		0.017	
TOTAL		21				17,400				20,300		7.946	