HVAC
34 SAT UNIT SUBSTATION 34-SS-01
CALCULATION REPORT

REVISION CONTROL PAGE

MAIN DOCUMENT

REV.	DATE	DESCRIPTION	COMMENTS
O	23-Mar-2016	Issued For Approval	

ATTACHMENTS

DOCUMENT CODE	DESCRIPTION	REV.
NA		

TEMPLATES

DOCUMENT CODE	DESCRIPTION	REV.
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1. GENERAL NOTE

1.1 SCOPE

The scope of this calculation is the heating and cooling load evaluation, for HVAC system of the building "SUBSTATION 34-SS-01"of the Kuwait National Petroleum Company's New Refinery Project (KNPC-NRP) located at the Al-Zour site in Kuwait. Transmission Load Analysis is made with HAP- version 4.61 software by CARRIER.

1.2 REFERENCE DOCUMENTS

Design of HVAC system shall be in accordance and referenced to the documents listed below.

1.2.1 Applicable Codes

ASHRAE STD 62.1	Ventilation for Acceptable Indoor Air Quality
ASHRAE STD 52	Method of Testing General Ventilation Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE STD 52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE STD 55	Thermal Environmental Conditions for Human Occupancy
ASHRAE HANDBOOK	Fundamentals Handbook Fundamentals, Chapter 26 (Cooling Load) Handbook Fundamentals, Chapter 25 (Heating Load)
ASHRAE HANDBOOK	HVAC Applications
ASHRAE HANDBOOK	Systems and Equipment
EN 13779	Ventilation for non-residential buildings – Performance requirements ventilation and room-conditioning systems
EN 15241	Ventilation for buildings – Calculation methods for energy losses due to ventilation and infiltration in commercial buildings
EN-ISO 13789	Thermal Performance of Buildings – Transmission and ventilation heat transfer coefficients –Calculation method

EN 15242	Ventilation for buildings – Calculation methods for the determination of air flow rates in buildings including infiltration
EN 15243	Ventilation for buildings – Calculation of room temperatures and of load and energy for buildings with room conditioning systems
EN 15255	Energy Performance of Buildings – Sensible room cooling load calculation– General criteria and validation procedures
EN 12831	Heating systems in buildings. Method for calculation of the design heat load

1.2.2 Local Regulations

MEW/R-6/2014	Kuwait Ministry of Electricity & Water Energy Conversation Program
MEW/R-7	Kuwait Ministry of Electricity & Water Energy Rules and Regulations for the design of air-conditioning systems under Kuwait

1.2.3 Project and Engineering Practice (DEP)

DEP 31.76.10.11-Gen	Installation, Testing and Balancing, and Commissioning of HVAC Systems
DEP 00.00.20.10-Gen	The Use of SI Quantities and Units
DEP 31.10.00.31-Gen	Noise Control (amendments/supplements to ISO 15664)
DEP 34.17.00.32-Gen	Design and Engineering of Buildings
DEP 32.30.20.11-Gen	Fire, Gas and Smoke Detection Systems
DEP 34.17.10.33-Gen	Portable blast-resistant modules

1.2.4 NRP Project Specifications

P4049N.0000.BA30.DCN.0747	Basic Engineering Design Data (BEDD)
P4049NRP.00.10.64.008	**Electrical Specification for Packaged Substation**
P4049NRP.00.10.76.001	HVAC Design Criteria
P4001NRP.00.10.76.002	HVAC Installation Specification
P4001NRP.00.10.76.003	HVAC Packaged Air Conditioning Units
P4001NRP.00.10.76.008	HVAC Fans
P4001NRP.00.10.76.009	HVAC Chemical Filter Units
P4001NRP.00.10.76.010	HVAC Control Systems
P4001NRP.00.10.76.011	HVAC Equipment Numbering
P4001NRP.00.10.76.012	HVAC Instrumentation and Control Component Numbering

1.2.5 Project Variations

02.00.00.10-P4049NRP-00-PV	Preparation and Microfilming of Technical Documents
30.48.00.31-P4049NRP-00-PV	Painting and Coating of New Equipment
31.76.10.10-P4049NRP-00-PV	Heating, ventilation and air conditioning for Plant Buildings
32.30.20.11-P4049NRP-00-PV	Fire, gas and smoke detection systems
33.64.10.10-P4049NRP-00-PV	Electrical Engineering Guidelines
33.66.05.31-P4049NRP-00-PV	Electric Machines – Cage Induction Types
34.17.00.32-P4049NRP-00-PV	Design and Engineering of Buildings (Amendments/Supplements to IEC 60034-1 and IEC 60034-14)

34.17.10.33-P4049NRP-00-PV	Design of Blast Resisntan Onshore Buildings, Control Roomsand Field Auxiliary Rooms
80.00.10.10-P4049NRP-00-PV	Area Classification (Amendment/Supplements to IP15)

1.2.6 Reference Documents and Drawing

P055AZOR-00.10.76.001	HVAC DESIGN SPECIFICATION
P055AZOR-34-76-1-H001-M001	HVAC 34 SAT UNIT SUBSTATION 34-SS-01 FLOW & SIGNAL DIAGRAM
P055AZOR-34-76-0-H001-M002	HVAC 34 SAT UNIT SUBSTATION 34-SS-01 EQUIPMENT AND DUCT DISTRIBUTION LAYOUT

2. GENERAL COOLING AND HEATING CALCULATION

2.1 INTRODUCTION

Thermal calculation load and main equipment sizing have been carried out on the basis of the design condition, as per KNPC specification. P4049NRP.00.10.76.001 HVAC Design Criteria.

2.2 OUTDOOR DESIGN CONDITIONS

The following ambient condition shall be used when computing the heating and cooling load requirements of HVAC system.

Seasons	**Summer**	**Winter**
Dry Bulb Temperature (ºC)	47.4 ºC	4.5 ºC
Wet Bulb Temperature (ºC)	31.8 ºC	2 ºC
Daily Range (ºC)	13.3 ºC	13.3 ºC

Packaged Air Cooled Conditioning Units (RFT) will be installed outdoors over concrete pads and surrounded with a protective wall.

Materials shall be suitable for corrosive atmosphere and dust presence and shall comply with all the requirements of project documentation.

2.3 INDOOR DESIGN CONDITIONS

Indoor requirements and heat dissipation to be considered in each area are summarize in next table, as indicated in reference document Building HVAC Condition Parameters.

SUBSTATION

Room	**Normal DB Temp.**		**Normal RH**		**Over-Pressure (Pa)**	**Max Noise level HVAC dB(A)**	**Dissipated Load [W/(m² floor)]** (Note1)	**Number of Persons**	**Remarks**
	Winter (°C) (Note 2)	**Summer (°C)** (Note 2)	**Min. (%)**	**Max. (%)**					
SWG/MCC Room	> 18	< 27	35	75	25	40-45	300	NA	
Battery Room	> 18	< 27	35	75	SP1	45-55	150	NA	
Airlock	> 18	< 27	35	75	25	40-45	-	NA	

Note 1: The "Dissipated Load" from above tables will be used, if the heat dissipation will be not obtained by electrical department or instrumentation department. The real value will be used in HAP program for calculation.

Note 2: The Control Point (= Set point) shall be adjustable within the “normal” temperature range stated. The Control Point is normally set at 22±2°C; the Control Point Tolerance shall not exceed

SP1: The room to be maintained by a Slightly Positive pressure (approx. 25 Pa) comparing with an ambient, but it is actually a slight negative pressure comparing with an adjacent room.

2.4 BUILDING TRANSMISSION COEFFICEINT

The overall heat transmission coefficients for buildings requiring heating, air conditioning or ventilation shall comply with DEP 34.17.00.32-Gen, point 4.5. The different U values for this building shall be:

External Wall	
Outside Surface Color	Medium
Absorptivity	0.675
Overall U-Value W/(m^2·ºK)	0.598

Roof	
Outside Surface Color	Medium
Absorptivity	0.675
Overall U-Value W/(m^2·ºK)	0.435

3. CALCULATION MODEL

Cooling and heating loads and equipment sizing calculation of this building is performed using Carrier's Hourly Analysis Program (HAP), version 4.61.
HAP uses the ASHRAE-endorsed transfer function method for cooling and heating loads calculation. Refer to ASHRAE Fundamentals Handbook.
Fresh air quantities are established in accordance with minimum requirements/recommend for acceptable indoor air quality for occupants, ventilation and also to provide space overpressure.
Calculation is performed using ASHRAE Leakage Function through effective air leakage areas of external walls and doors of each considered room (refer to ASHRAE Fundamentals Handbook).

4. THERMAL LOAD CALCULATION HAP SOFTWARE OUTPUT REPORTS

Find attached *Addendum 1 "HAP Reports"* with the results obtained from HAP Software.

5. ADDENDUM 1 HAP REPORTS

In this addendum are included next reports from HAP:

- Design Weather Parameters & MSHGs
- Space Input Data
- Air System Sizing Summary

- Zone Sizing Summary
- Ventilation Sizing Summary
- Space Design Load Summary
- Psychometric Chart and data tables

Design Parameters:

City Name	**Al-Zour**	
Location	**Kuwait**	
Latitude	**29.2**	Deg.
Longitude	**-48.0**	Deg.
Elevation	**9.62**	m
Summer Design Dry-Bulb	**47.4**	°C
Summer Coincident Wet-Bulb	**31.8**	°C
Summer Daily Range	**13.3**	°K
Winter Design Dry-Bulb	**4.5**	°C
Winter Design Wet-Bulb	**2.0**	°C
Atmospheric Clearness Number	**1.00**	
Average Ground Reflectance	**0.33**	
Soil Conductivity	**0.800**	W/(m-°K)
Local Time Zone (GMT +/- N hours)	**-3.0**	hours
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	114.4	114.4	114.4	370.9	602.5	739.9	825.7	817.6	790.4
February	132.6	132.6	245.1	490.7	695.8	795.3	808.8	751.7	705.3
March	150.6	150.6	395.9	601.1	738.1	790.2	725.4	623.0	558.7
April	165.6	261.4	508.4	671.2	735.8	711.3	606.9	451.7	367.4
May	177.9	364.1	573.6	696.4	719.1	641.1	504.4	321.9	248.0
June	183.0	404.9	594.9	697.4	699.9	610.1	456.4	272.0	214.2
July	180.1	371.7	569.7	682.4	696.9	632.6	489.5	310.6	241.2
August	169.5	265.9	498.1	647.6	703.3	690.1	583.6	434.6	354.7
September	153.3	153.3	371.2	579.3	698.2	752.9	705.7	608.4	549.4
October	135.4	135.4	234.6	484.8	649.5	771.5	779.2	728.6	692.1
November	116.3	116.3	118.6	355.7	588.2	745.7	805.2	798.0	785.7
December	106.9	106.9	106.9	307.7	558.6	714.4	816.1	826.7	813.9
Month	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**HOR**	**Mult**
January	817.7	825.7	741.7	601.7	372.3	114.4	114.4	592.3	1.00
February	750.5	807.0	798.1	694.2	485.0	247.9	132.6	714.3	1.00
March	626.3	730.7	789.9	744.9	590.3	393.7	150.6	817.1	1.00
April	450.9	603.1	717.3	740.1	655.5	504.2	276.9	867.9	1.00
May	320.5	496.9	651.6	717.1	680.8	570.8	378.8	879.2	1.00
June	271.1	450.4	617.9	696.0	686.6	593.3	413.9	873.8	1.00
July	308.9	485.1	636.2	697.3	674.7	567.8	377.1	864.2	1.00
August	434.6	581.4	692.4	715.1	635.7	491.7	276.0	848.3	1.00
September	611.4	709.7	743.8	714.0	578.7	351.4	153.3	795.4	1.00
October	729.9	781.5	769.4	655.3	486.7	230.8	135.4	707.8	1.00
November	801.8	800.5	746.2	579.2	367.9	116.3	116.3	595.9	1.00
December	826.7	809.0	727.0	534.5	323.3	106.9	106.9	543.6	1.00

Mult. = User-defined solar multiplier factor.

100-SWITCHGEAR ROOM

1. General Details:

Floor Area ..... **358.8** m²
Avg. Ceiling Height..... **5.8** m
Building Weight ..... **341.8** kg/m²

1.1. OA Ventilation Requirements:

Space Usage..... **User-Defined**
OA Requirement 1 ..... **578.0** L/s
OA Requirement 2 ..... **0.0** L/s
Space Usage Defaults ..... **ASHRAE Std 62.1-2007**

2. Internals:

2.1. Overhead Lighting:

Fixture Type ..... **Recessed (Unvented)**
Wattage..... **20.00** W/m²
Ballast Multiplier..... **1.00**
Schedule ..... **SUBSTATION**

2.2. Task Lighting:

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

2.3. Electrical Equipment:

Wattage..... **300.00** W/m²
Schedule ..... **SUBSTATION**

2.4. People:

Occupancy ..... **0.0** Person
Activity Level ..... **Office Work**
Sensible..... **71.8** W/person
Latent ..... **60.1** W/person
Schedule ..... **None**

2.5. Miscellaneous Loads:

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

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (m²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
N	202.8	0	0	0
E	55.8	0	0	1
S	181.8	0	0	0
W	28.8	0	0	1

3.1. Construction Types for Exposure N

Wall Type ..... **W-1(SUBSTATION)**

3.2. Construction Types for Exposure E

Wall Type ..... **W-1(SUBSTATION)**
Door Type ..... **D-2(SWITCHGEAR ROOM)**

3.3. Construction Types for Exposure S

Wall Type ..... **W-1(SUBSTATION)**

3.4. Construction Types for Exposure W

Wall Type ..... **W-1(SUBSTATION)**
Door Type ..... **D-2(SWITCHGEAR ROOM)**

4. Roofs, Skylights:

Exp.	Roof Gross Area (m²)	Roof Slope (deg.)	Skylight Qty.
H	358.8	0	0

4.1. Construction Types for Exposure H

Roof Type..... **R-1(SUBSTATION)**

5. Infiltration:

Design Cooling..... **0.00** L/s
Design Heating..... **0.00** L/s
Energy Analysis ..... **0.00** L/s
Infiltration occurs only when the fan is off.

6. Floors:

Type ..... **Floor Above Unconditioned Space**
Floor Area ..... **358.8** m²
Total Floor U-Value ..... **0.328** W/(m²-°K)
Unconditioned Space Max Temp. ..... **47.4** °C
Ambient at Space Max Temp. ..... **47.4** °C
Unconditioned Space Min Temp. ..... **4.5** °C
Ambient at Space Min Temp. ..... **4.5** °C

7. Partitions:

(No partition data).

101-BATTERY ROOM

1. General Details:

Floor Area ..... **23.0** m²
Avg. Ceiling Height..... **5.9** m
Building Weight ..... **341.8** kg/m²

1.1. OA Ventilation Requirements:

Space Usage..... **User-Defined**
OA Requirement 1 ..... **226.0** L/s
OA Requirement 2 ..... **0.0** L/s
Space Usage Defaults ..... **ASHRAE Std 62.1-2007**

2. Internals:

2.1. Overhead Lighting:

Fixture Type ..... **Recessed (Unvented)**
Wattage..... **20.00** W/m²
Ballast Multiplier..... **1.00**
Schedule ..... **SUBSTATION**

2.2. Task Lighting:

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

2.3. Electrical Equipment:

Wattage..... **150.00** W/m²
Schedule ..... **SUBSTATION**

2.4. People:

Occupancy ..... **0.0** Person
Activity Level ..... **Office Work**
Sensible..... **71.8** W/person
Latent ..... **60.1** W/person
Schedule ..... **None**

2.5. Miscellaneous Loads:

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

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (m²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
W	25.8	0	0	1
S	37.8	0	0	0

3.1. Construction Types for Exposure W

Wall Type ..... **W-1(SUBSTATION)**
Door Type ..... **D-4(BATTERY RM.)**

3.2. Construction Types for Exposure S

Wall Type ..... **W-1(SUBSTATION)**

4. Roofs, Skylights:

Exp.	Roof Gross Area (m²)	Roof Slope (deg.)	Skylight Qty.
H	23.0	0	0

4.1. Construction Types for Exposure H

Roof Type..... **R-1(SUBSTATION)**

5. Infiltration:

Design Cooling..... **0.00** L/s
Design Heating..... **0.00** L/s
Energy Analysis ..... **0.00** L/s
Infiltration occurs only when the fan is off.

6. Floors:

Type ..... **Floor Above Unconditioned Space**
Floor Area ..... **23.0** m²
Total Floor U-Value..... **0.328** W/(m²-°K)
Unconditioned Space Max Temp. ..... **47.4** °C
Ambient at Space Max Temp..... **47.4** °C
Unconditioned Space Min Temp. ..... **4.5** °C
Ambient at Space Min Temp..... **4.5** °C

7. Partitions:

(No partition data).

102-AIRLOCK-1

1. General Details:

Floor Area ..... **4.2** m²
Avg. Ceiling Height..... **3.0** m
Building Weight ..... **341.8** kg/m²

1.1. OA Ventilation Requirements:

Space Usage..... **User-Defined**
OA Requirement 1 ..... **88.0** L/s
OA Requirement 2 ..... **0.0** L/s
Space Usage Defaults ..... **ASHRAE Std 62.1-2007**

2. Internals:

2.1. Overhead Lighting:

Fixture Type ..... **Recessed (Unvented)**
Wattage..... **20.00** W/m²
Ballast Multiplier..... **1.00**
Schedule ..... **SUBSTATION**

2.2. Task Lighting:

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

2.3. Electrical Equipment:

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

2.4. People:

Occupancy ..... **0.0** Person
Activity Level ..... **Office Work**
Sensible..... **71.8** W/person
Latent ..... **60.1** W/person
Schedule ..... **None**

2.5. Miscellaneous Loads:

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

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (m²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
W	9.9	0	0	1

3.1. Construction Types for Exposure W

Wall Type ..... **W-1(SUBSTATION)**
Door Type ..... **D-3(AIRLOCK)**

4. Roofs, Skylights:

Exp.	Roof Gross Area (m²)	Roof Slope (deg.)	Skylight Qty.
H	4.2	0	0

4.1. Construction Types for Exposure H

Roof Type..... **R-1(SUBSTATION)**

5. Infiltration:

Design Cooling..... **0.00** L/s
Design Heating..... **0.00** L/s
Energy Analysis ..... **0.00** L/s
Infiltration occurs only when the fan is off.

6. Floors:

Type ..... **Floor Above Unconditioned Space**
Floor Area ..... **4.2** m²
Total Floor U-Value..... **0.328** W/(m²-°K)
Unconditioned Space Max Temp. ..... **47.4** °C
Ambient at Space Max Temp. ..... **47.4** °C
Unconditioned Space Min Temp. ..... **4.5** °C
Ambient at Space Min Temp. ..... **4.5** °C

7. Partitions:

(No partition data).

103-AIRLOCK-2

1. General Details:
Floor Area ..... **4.4** m²
Avg. Ceiling Height..... **3.0** m
Building Weight ..... **341.8** kg/m²

1.1. OA Ventilation Requirements:
Space Usage..... **User-Defined**
OA Requirement 1 ..... **92.0** L/s
OA Requirement 2 ..... **0.0** L/s
Space Usage Defaults ..... **ASHRAE Std 62.1-2007**

2. Internals:
2.1. Overhead Lighting:
Fixture Type ..... **Recessed (Unvented)**
Wattage..... **20.00** W/m²
Ballast Multiplier..... **1.00**
Schedule ..... **SUBSTATION**

2.2. Task Lighting:
Wattage..... **0.00** W/m²
Schedule ..... **None**

2.3. Electrical Equipment:
Wattage..... **0.00** W/m²
Schedule ..... **None**

2.4. People:
Occupancy ..... **0.0** Person
Activity Level ..... **Office Work**
Sensible..... **71.8** W/person
Latent ..... **60.1** W/person
Schedule ..... **None**

2.5. Miscellaneous Loads:
Sensible..... **0** W
Schedule ..... **None**
Latent ..... **0** W
Schedule ..... **None**

3. Walls, Windows, Doors:

Exp.	Wall Gross Area (m²)	Window 1 Qty.	Window 2 Qty.	Door 1 Qty.
N	10.6	0	0	0
E	8.7	0	0	1

3.1. Construction Types for Exposure N
Wall Type ..... **W-1(SUBSTATION)**

3.2. Construction Types for Exposure E
Wall Type ..... **W-1(SUBSTATION)**
Door Type ..... **D-3(AIRLOCK)**

4. Roofs, Skylights:

Exp.	Roof Gross Area (m²)	Roof Slope (deg.)	Skylight Qty.
H	4.4	0	0

4.1. Construction Types for Exposure H
Roof Type..... **R-1(SUBSTATION)**

5. Infiltration:
Design Cooling..... **0.00** L/s
Design Heating..... **0.00** L/s
Energy Analysis ..... **0.00** L/s
Infiltration occurs only when the fan is off.

6. Floors:
Type ..... **Floor Above Unconditioned Space**
Floor Area ..... **4.4** m²
Total Floor U-Value..... **0.328** W/(m²-°K)
Unconditioned Space Max Temp. ..... **47.4** °C
Ambient at Space Max Temp. ..... **47.4** °C
Unconditioned Space Min Temp. ..... **4.5** °C
Ambient at Space Min Temp. ..... **4.5** °C

7. Partitions:
(No partition data).

Air System Sizing Summary for SS1(34-SS-01)REV0

Project Name: 0322-Unit 34 SUBSTATION SS-01 03-22-2016
Prepared by: HEC 02:37

Air System Information

Air System Name ..... **SS1(34-SS-01)REV0**
Equipment Class ..... **PKG ROOF**
Air System Type ..... **CAV/RH**

Number of zones **4**
Floor Area ..... **390.4** m²
Location ..... **Al-Zour**

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	**271.4**	kW	Load occurs at	**Jul 1600**
Sensible coil load	**208.4**	kW	OA DB / WB	**47.0 / 31.7** °C
Coil L/s at Jul 1600	**9228**	L/s	Entering DB / WB	**29.1 / 18.8** °C
Max block L/s	**9228**	L/s	Leaving DB / WB	**10.4 / 9.5** °C
Sum of peak zone L/s	**9228**	L/s	Coil ADP	**8.3** °C
Sensible heat ratio	**0.768**		Bypass Factor	**0.100**
m²/kW	**1.4**		Resulting RH	**35** %
W/m²	**695.1**		Design supply temp.	**12.5** °C
Water flow @ 5.6 °K rise	**N/A**		Zone T-stat Check	**4 of 4** OK
			Max zone temperature deviation	**0.0** °K

Central Heating Coil Sizing Data

No central heating coil loads occurred during this calculation.

Humidifier Sizing Data

Max steam flow at Jul 1800	**25.10**	kg/hr	Air mass flow	**39864.68** kg/hr
Airflow Rate	**9228**	L/s	Moisture gain	**.00063** kg/kg

Supply Fan Sizing Data

Actual max L/s	**9228**	L/s	Fan motor BHP	**19.94** BHP
Standard L/s	**9217**	L/s	Fan motor kW	**15.82** kW
Actual max L/(s-m²)	**23.64**	L/(s-m²)	Fan static	**1200** Pa

Return Fan Sizing Data

Actual max L/s	**9228**	L/s	Fan motor BHP	**9.07** BHP
Standard L/s	**9217**	L/s	Fan motor kW	**7.20** kW
Actual max L/(s-m²)	**23.64**	L/(s-m²)	Fan static	**390** Pa

Outdoor Ventilation Air Data

Design airflow L/s	**984**	L/s	L/s/person	**0.00** L/s/person
L/(s-m²)	**2.52**	L/(s-m²)		

Zone Sizing Summary for SS1(34-SS-01)REV0

Project Name: 0322-Unit 34 SUBSTATION SS-01 03-22-2016
Prepared by: HEC 02:37

Air System Information

Air System Name ..... **SS1(34-SS-01)REV0**
Equipment Class ..... **PKG ROOF**
Air System Type ..... **CAV/RH**
Number of zones **4**
Floor Area ..... **390.4** m²
Location ..... **Al-Zour**

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**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (kW)	Design Air Flow (L/s)	Minimum Air Flow (L/s)	Time of Peak Load	Maximum Heating Load (kW)	Zone Floor Area (m²)	Zone L/(s-m²)
Zone 1	145.1	8299	8299	Jul 1900	8.9	358.8	23.13
Zone 2	5.9	338	338	Aug 2000	0.9	23.0	14.68
Zone 3	0.4	88	88	Jul 1900	0.2	4.2	20.95
Zone 4	0.5	226	226	Jul 1800	0.3	4.4	51.36

Zone Terminal Sizing Data

No Zone Terminal Sizing Data required for this system.

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (kW)	Time of Load	Air Flow (L/s)	Heating Load (kW)	Floor Area (m²)	Space L/(s-m²)
Zone 1							
100-SWITCHGEAR ROOM	1	145.1	Jul 1900	8299	8.9	358.8	23.13
Zone 2							
101-BATTERY ROOM	1	5.9	Aug 2000	338	0.9	23.0	14.68
Zone 3							
102-AIRLOCK-1	1	0.4	Jul 1900	88	0.2	4.2	20.95
Zone 4							
103-AIRLOCK-2	1	0.5	Jul 1800	226	0.3	4.4	51.36

Ventilation Sizing Summary for SS1(34-SS-01)REV0

Project Name: 0322-Unit 34 SUBSTATION SS-01 03-22-2016
Prepared by: HEC 02:37

1. Summary

Ventilation Sizing Method..... **Sum of Space OA Airflows**
Design Ventilation Airflow Rate..... **984** L/s

2. Space Ventilation Analysis Table

Zone Name / Space Name	Mult.	Floor Area (m^2)	Maximum Occupants	Maximum Supply Air (L/s)	Required Outdoor Air (L/s/person)	Required Outdoor Air (L/(s-m^2))	Required Outdoor Air (L/s)	Required Outdoor Air (% of supply)	Uncorrected Outdoor Air (L/s)
Zone 1									
100-SWITCHGEAR ROOM	1	358.8	0.0	8299.4	0.00	0.00	578.0	0.0	578.0
Zone 2									
101-BATTERY ROOM	1	23.0	0.0	337.6	0.00	0.00	226.0	0.0	226.0
Zone 3									
102-AIRLOCK-1	1	4.2	0.0	88.0	0.00	0.00	88.0	0.0	88.0
Zone 4									
103-AIRLOCK-2	1	4.4	0.0	226.0	0.00	0.00	92.0	0.0	92.0
Totals (incl. Space Multipliers)				**8951.0**					**984.0**

TABLE 1.1.A. COMPONENT LOADS FOR SPACE " 100-SWITCHGEAR ROOM " IN ZONE " Zone 1 "						
	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1900 COOLING OA DB / WB 42.9 °C / 30.9 °C OCCUPIED T-STAT 27.0 °C			HEATING DATA AT DES HTG HEATING OA DB / WB 4.5 °C / 2.0 °C OCCUPIED T-STAT 18.0 °C		
		Sensible	Latent		Sensible	Latent
SPACE LOADS	**Details**	**(W)**	**(W)**	**Details**	**(W)**	**(W)**
Window & Skylight Solar Loads	0 m²	0	-	0 m²	-	-
Wall Transmission	451 m²	5198	-	451 m²	3642	-
Roof Transmission	359 m²	3860	-	359 m²	2105	-
Window Transmission	0 m²	0	-	0 m²	0	-
Skylight Transmission	0 m²	0	-	0 m²	0	-
Door Loads	18 m²	499	-	18 m²	437	-
Floor Transmission	359 m²	1814	-	359 m²	1589	-
Partitions	0 m²	0	-	0 m²	0	-
Ceiling	0 m²	0	-	0 m²	0	-
Overhead Lighting	7176 W	7176	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	107640 W	107635	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	15% / 15%	18927	0	15%	1166	0
>> Total Zone Loads	**-**	**145109**	**0**	**-**	**8939**	**0**

TABLE 1.1.B. ENVELOPE LOADS FOR SPACE " 100-SWITCHGEAR ROOM " IN ZONE " Zone 1 "						
				COOLING	COOLING	HEATING
	Area	U-Value	Shade	TRANS	SOLAR	TRANS
	(m²)	(W/(m²-°K))	Coeff.	(W)	(W)	(W)
N EXPOSURE						
WALL	203	0.598	-	2237	-	1637
E EXPOSURE						
WALL	47	0.598	-	642	-	378
DOOR	9	1.800	-	250	-	219
S EXPOSURE						
WALL	182	0.598	-	2045	-	1468
W EXPOSURE						
WALL	20	0.598	-	275	-	160
DOOR	9	1.800	-	250	-	219
H EXPOSURE						
ROOF	359	0.435	-	3860	-	2105

TABLE 2.1.A. COMPONENT LOADS FOR SPACE " 101-BATTERY ROOM " IN ZONE " Zone 2 "						
	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 2000 COOLING OA DB / WB 41.1 °C / 30.6 °C OCCUPIED T-STAT 27.0 °C			HEATING DATA AT DES HTG HEATING OA DB / WB 4.5 °C / 2.0 °C OCCUPIED T-STAT 18.0 °C		
		Sensible	Latent		Sensible	Latent
SPACE LOADS	**Details**	**(W)**	**(W)**	**Details**	**(W)**	**(W)**
Window & Skylight Solar Loads	0 m²	0	-	0 m²	-	-
Wall Transmission	61 m²	795	-	61 m²	489	-
Roof Transmission	23 m²	244	-	23 m²	135	-
Window Transmission	0 m²	0	-	0 m²	0	-
Skylight Transmission	0 m²	0	-	0 m²	0	-
Door Loads	3 m²	77	-	3 m²	73	-
Floor Transmission	23 m²	108	-	23 m²	102	-
Partitions	0 m²	0	-	0 m²	0	-
Ceiling	0 m²	0	-	0 m²	0	-
Overhead Lighting	460 W	460	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	3450 W	3450	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	15% / 15%	770	0	15%	120	0
>> Total Zone Loads	**-**	**5903**	**0**	**-**	**919**	**0**

TABLE 2.1.B. ENVELOPE LOADS FOR SPACE " 101-BATTERY ROOM " IN ZONE " Zone 2 "						
				COOLING	COOLING	HEATING
	Area	U-Value	Shade	TRANS	SOLAR	TRANS
	(m²)	(W/(m²-°K))	Coeff.	(W)	(W)	(W)
W EXPOSURE						
WALL	23	0.598	-	324	-	184
DOOR	3	1.800	-	77	-	73
S EXPOSURE						
WALL	38	0.598	-	470	-	305
H EXPOSURE						
ROOF	23	0.435	-	244	-	135

TABLE 3.1.A. COMPONENT LOADS FOR SPACE " 102-AIRLOCK-1 " IN ZONE " Zone 3 "						
	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1900 COOLING OA DB / WB 42.9 °C / 30.9 °C OCCUPIED T-STAT 27.0 °C			HEATING DATA AT DES HTG HEATING OA DB / WB 4.5 °C / 2.0 °C OCCUPIED T-STAT 18.0 °C		
		Sensible	Latent		Sensible	Latent
SPACE LOADS	Details	(W)	(W)	Details	(W)	(W)
Window & Skylight Solar Loads	0 m²	0	-	0 m²	-	-
Wall Transmission	8 m²	108	-	8 m²	63	-
Roof Transmission	4 m²	45	-	4 m²	25	-
Window Transmission	0 m²	0	-	0 m²	0	-
Skylight Transmission	0 m²	0	-	0 m²	0	-
Door Loads	2 m²	58	-	2 m²	51	-
Floor Transmission	4 m²	21	-	4 m²	19	-
Partitions	0 m²	0	-	0 m²	0	-
Ceiling	0 m²	0	-	0 m²	0	-
Overhead Lighting	84 W	84	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	15% / 15%	48	0	15%	24	0
>> Total Zone Loads	-	365	0	-	181	0

TABLE 3.1.B. ENVELOPE LOADS FOR SPACE " 102-AIRLOCK-1 " IN ZONE " Zone 3 "						
				COOLING	COOLING	HEATING
	Area	U-Value	Shade	TRANS	SOLAR	TRANS
	(m²)	(W/(m²-°K))	Coeff.	(W)	(W)	(W)
W EXPOSURE						
WALL	8	0.598	-	108	-	63
DOOR	2	1.800	-	58	-	51
H EXPOSURE						
ROOF	4	0.435	-	45	-	25

TABLE 4.1.A. COMPONENT LOADS FOR SPACE " 103-AIRLOCK-2 " IN ZONE " Zone 4 "						
	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1800 COOLING OA DB / WB 44.6 °C / 31.3 °C OCCUPIED T-STAT 27.0 °C			HEATING DATA AT DES HTG HEATING OA DB / WB 4.5 °C / 2.0 °C OCCUPIED T-STAT 18.0 °C		
		Sensible	Latent		Sensible	Latent
SPACE LOADS	**Details**	**(W)**	**(W)**	**Details**	**(W)**	**(W)**
Window & Skylight Solar Loads	0 m²	0	-	0 m²	-	-
Wall Transmission	17 m²	204	-	17 m²	139	-
Roof Transmission	4 m²	46	-	4 m²	26	-
Window Transmission	0 m²	0	-	0 m²	0	-
Skylight Transmission	0 m²	0	-	0 m²	0	-
Door Loads	2 m²	62	-	2 m²	51	-
Floor Transmission	4 m²	24	-	4 m²	19	-
Partitions	0 m²	0	-	0 m²	0	-
Ceiling	0 m²	0	-	0 m²	0	-
Overhead Lighting	88 W	88	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	0 W	0	-	0	0	-
People	0	0	0	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	15% / 15%	64	0	15%	35	0
>> Total Zone Loads	**-**	**488**	**0**	**-**	**270**	**0**

TABLE 4.1.B. ENVELOPE LOADS FOR SPACE " 103-AIRLOCK-2 " IN ZONE " Zone 4 "						
				COOLING	COOLING	HEATING
	Area	U-Value	Shade	TRANS	SOLAR	TRANS
	(m²)	(W/(m²-°K))	Coeff.	(W)	(W)	(W)
N EXPOSURE						
WALL	11	0.598	-	114	-	86
E EXPOSURE						
WALL	7	0.598	-	90	-	53
DOOR	2	1.800	-	62	-	51
H EXPOSURE						
ROOF	4	0.435	-	46	-	26

July DESIGN COOLING DAY, 1600

TABLE 1: SYSTEM DATA

Component	Location	Dry-Bulb Temp (°C)	Specific Humidity (kg/kg)	Airflow (L/s)	CO2 Level (ppm)	Sensible Heat (W)	Latent Heat (W)
Ventilation Air	Inlet	47.0	0.02357	984	400	27147	46031
Vent - Return Mixing	Outlet	29.1	0.00937	9228	483	-	-
Central Cooling Coil	Outlet	10.4	0.00705	9228	483	208405	62961
Central Heating Coil	Outlet	10.4	0.00705	9228	483	0	-
Supply Fan	Outlet	11.8	0.00705	9228	483	15820	-
Humidifier	Outlet	11.8	0.00768	9228	483	-	16930
Cold Supply Duct	Outlet	12.5	0.00768	8951	483	-	-
Zone Air	-	26.8	0.00768	8951	492	151246	0
Zone Direct Exhaust	Outlet	26.8	0.00768	805	492	-	-
Return Plenum	Outlet	26.8	0.00768	8146	492	0	-
Duct Leakage Air	Outlet	11.8	0.00768	277	483	-	-
Return Duct	Outlet	26.3	0.00768	8423	492	-	-
Return Fan	Outlet	27.0	0.00768	8423	492	6633	-

Air Density x Heat Capacity x Conversion Factor: At sea level = 1.207; At site altitude = 1.206 W/(L/s-K)
Air Density x Heat of Vaporization x Conversion Factor: At sea level = 2947.6; At site altitude = 2944.2 W/(L/s)
Site Altitude = 9.6 m

TABLE 2: ZONE DATA

Zone Name	Zone Sensible Load (W)	T-stat Mode	Zone Cond (W)	Zone Temp (°C)	Zone Airflow (L/s)	CO2 Level (ppm)	Terminal Heating Coil (W)	Zone Heating Unit (W)
Zone 1	144582	Deadband	144335	26.9	8299	492	0	0
Zone 2	5773	Deadband	5761	26.7	338	492	0	0
Zone 3	354	Deadband	464	16.9	88	492	0	0
Zone 4	482	Deadband	686	15.0	226	492	0	0

WINTER DESIGN HEATING

TABLE 1: SYSTEM DATA

Component	Location	Dry-Bulb Temp (°C)	Specific Humidity (kg/kg)	Airflow (L/s)	CO2 Level (ppm)	Sensible Heat (W)	Latent Heat (W)
Ventilation Air	Inlet	4.5	0.00335	984	400	-8732	0
Vent - Return Mixing	Outlet	11.8	0.00335	9228	483	-	-
Central Cooling Coil	Outlet	11.1	0.00335	9228	483	6971	0
Central Heating Coil	Outlet	11.1	0.00335	9228	483	0	-
Supply Fan	Outlet	12.5	0.00335	9228	483	15820	-
Humidifier	Outlet	12.5	0.00335	9228	483	-	0
Cold Supply Duct	Outlet	12.5	0.00335	8951	483	-	-
Zone Air	-	11.9	0.00335	8951	492	-6234	0
Zone Direct Exhaust	Outlet	11.9	0.00335	805	492	-	-
Return Plenum	Outlet	11.9	0.00335	8146	492	0	-
Duct Leakage Air	Outlet	12.5	0.00335	277	483	-	-
Return Duct	Outlet	12.0	0.00335	8423	492	-	-
Return Fan	Outlet	12.6	0.00335	8423	492	6633	-

Air Density x Heat Capacity x Conversion Factor: At sea level = 1.207; At site altitude = 1.206 W/(L/s-K)
Air Density x Heat of Vaporization x Conversion Factor: At sea level = 2947.6; At site altitude = 2944.2 W/(L/s)
Site Altitude = 9.6 m

TABLE 2: ZONE DATA

Zone Name	Zone Sensible Load (W)	T-stat Mode	Zone Cond (W)	Zone Temp (°C)	Zone Airflow (L/s)	CO2 Level (ppm)	Terminal Heating Coil (W)	Zone Heating Unit (W)
Zone 1	-8939	Deadband	-5448	12.0	8299	492	0	0
Zone 2	-919	Deadband	-517	11.2	338	492	0	0
Zone 3	-181	Deadband	-105	11.5	88	492	0	0
Zone 4	-270	Deadband	-164	11.9	226	492	0	0

Location: Al-Zour, Kuwait
Altitude: 9.6 m.
Data for: July DESIGN COOLING DAY, 1600