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MEDUPI POWER STATION BASELINE REPORT OF

HVAC for Weight Bridge Gate House

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Compiled by:

H von Zwietring
C Prinsloo Pr. Eng.
Spoormaker & Partners
Consulting Engineers

Approved by:

Dr DT Claassen Pr. Eng.
Spoormaker & Partners
Consulting Engineers

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Contents

1 INTRODUCTION 1

2 DESCRIPTION OF BUILDING 1

2.1 ARCHITECTURAL DRAWINGS USED 1
2.2 AIR CONDITIONED & VENTILATED AREAS 1

3 DESIGN CRITERIA 2

3.1 DESIGN WEATHER PARAMETERS 2
3.2 COMPLIANCE TO CLIENT BRIEF/APPROVED CONCEPT 3
3.3 HVAC DESIGN CRITERIA 4
3.4 INTERNAL DESIGN HEAT GAINS 5
3.5 MECHANICAL VENTILATION 5
3.6 BUILDING THERMAL DESIGN 6

4 DESCRIPTION OF AIR-CONDITIONING SYSTEM 7

4.1 AIR-CONDITIONING UNITS 7
4.2 AIR DISTRIBUTION 7
4.3 HVAC ELECTRICAL SYSTEM 7
4.4 SMOKE VENTILATION SYSTEMS 7
4.5 HVAC NCP PANEL 7

5 BASELINE DRAWINGS 8

ADDENDUM A – REFERENCE EMAILS 9

ADDENDUM B – ACRONYMS 12

1 INTRODUCTION

This report is part of the HVAC design submission of Medupi Weight Bridge Gate House to Eskom for information purposes. It points out the important design features and assumptions for the HVAC system.

2 DESCRIPTION OF BUILDING

The Weigh Bridge Gate House consists of a ground level only. The ground floor has the following rooms: One passage, one kitchen, one store, one office, one control room and male and female ablution.

2.1 ARCHITECTURAL DRAWINGS USED

The report is based on architectural layout drawings received from WMS architects as follows:

DESCRIPTION	ESKOM	Sheet	DRAWING NUMBER	REV.
GENERAL ARRANGEMENT PLANS, SECTION & ELEVATIONS	0.84/50892	X	07015-X-XXXXX	X

2.2 AIR CONDITIONED & VENTILATED AREAS

2.2.1 Air-conditioned areas

Room name	Floor area [m²]
Control room	59.5
Equipment room	6.0
Tea kitchen	8.6

2.2.2 Ventilated areas

Room name	Floor area [m²]
Control room	59.5
Equipment room	6.0
Tea kitchen	8.6
Store	9.6
Passage	22.3
Male toilets	6.7
Female toilets	5.6

3 DESIGN CRITERIA

3.1 DESIGN WEATHER PARAMETERS

The proposed weather parameters for Lephalale (Ellisras), Limpopo province are as follows:

Description	Value	Reference
Altitude	902.25 m above mean sea level	As per e-mail from Frank Wessels to Cheshire Zdziarski on 28 August 2012, refer to Addendum A
Latitude	23°41' South	Obtained for South African Weather Service, document titled document titled 'Climate Data of South Africa WB 42 Climate Statistics 1961-1990, Number: 06743116 Name: Ellisras Period: 1982-1990
Longitude	27°41' East	Obtained for South African Weather Service, document titled document titled 'Climate Data of South Africa WB 42 Climate Statistics 1961-1990, Number: 06743116 Name: Ellisras Period: 1982-1990
Maximum design dry-bulb temperature	36 °C	Architectural Baseline Report 84CIVL007 Rev P07
Corresponding design wet-bulb temperature	20 °C	The architectural baseline report 84CIVL007 Rev P07
Minimum design dry-bulb temperature	4 °C	The architectural baseline report 84CIVL007 Rev P07
Corresponding winter wet-bulb temperature	0.1 °C	Assumed 50% RH, as is advised by the Carrier HAP load calculation software
Daily temperature swing	12.6°C For January month	Obtained for South African Weather Service, document titled document titled 'Climate Data of South Africa WB 42 Climate Statistics 1961-1990, Number: 06743116 Name: Ellisras Period: 1982-1990

3.2 COMPLIANCE TO CLIENT BRIEF/APPROVED CONCEPT

	Requirement	**Comply (y/n)**	**Note**
	Mechanical filtration on AHU 85% efficiency. Primary and secondary filtration used. Velocity over filters between 1.5 and 2.0 m/s, Standard Filter sizes (600x600)	N	Our specification requires 85% filters as the client wants. However on Medupi we were offered Filtration of G4/F5 (40-55%) due to space constraints. In addition a 600mmx300mm filter was employed instead of the normal 600x600 filters.
	No Redundancy required for a non process building.	Y	
	Fans installed at a level not higher than 2.4m affl.	N	The toilet exhaust fan is installed at a height of 3m affl in the ceiling void.
	Attenuation required	Y	

3.3 HVAC DESIGN CRITERIA

The indoor climate is to be controlled according to the design criteria as tabulated below:

Application	Criteria Classification	Indoor Temperatures	Indoor Relative Humidity	Fresh/ Outside Air (ACH)	Noise Level	Filtration Standards	A+B Power Supply	Redundancy /Standby	Operating Hours	Pressurization
Control Room	Air Conditioning	22.5 ºC ±2.5ºC, controlled	Uncontrolled	2.92	NC40	G4/F5 on the fresh air unit	No	nil	Office Hours	Positive
Equipment Room	Air Conditioning	22.5 ºC ±2.5ºC, controlled	Uncontrolled	4.80	NC40	G4/F5 on the fresh air unit	Yes	N+1	Cont.	Positive
Tea kitchen	Air Conditioning	22.5 ºC ±2.5ºC, controlled	Uncontrolled	10.88	NC50	G4/F5 on the fresh air unit	No	nil	Office Hours	Neutral
Store	Ventilation only	Uncontrolled	Uncontrolled	3.00	NC50	G4/F5 on the fresh air unit	No	nil	Office Hours	Positive
Passage	Ventilation only	Uncontrolled	Uncontrolled	4.52	NC50	G4/F5 on the fresh air unit	No	nil	Office Hours	Positive
Male toilets	Ventilation only	Uncontrolled	Uncontrolled	27.73	NC50	G4/F5 on the fresh air unit	No	nil	Office Hours	Negative
Female toilets	Ventilation only	Uncontrolled	Uncontrolled	33.17	NC50	G4/F5 on the fresh air unit	No	nil	Office Hours	Negative

3.4 INTERNAL DESIGN HEAT GAINS

Room name	People (m^2/person)	Equipment (W/m^2)	Lighting (W/m^2)	Reference
Control room	15	50	15	Spoormaker assumption, typical value for office environment
Equipment room	0	300	15	Spoormaker assumption, typical value for office environment
Tea kitchen	4	15	25	Spoormaker assumption, typical value for office environment

3.5 MECHANICAL VENTILATION

Room name	Floor area [m^2]	Outside Air [ℓ/s]	Outside Air [ACH]	Note
Control room	59.5	120	2.92	≥ 7.5 l/s per person, as per NBR
Equipment room	6.0	20	4.80	≥ 7.5 l/s per person, as per NBR
Tea kitchen	8.6	65	10.88	≥ 50 l/s, as per NBR
Store	9.6	20	3.00	≥ 3 ACH
Passage	22.3	70	4.52	≥ 7.5 l/s per person, as per NBR
Male toilets	6.7	129	27.73	≥ 20 l/s per fitting, as per NBR
Female toilets	5.6	129	33.17	≥ 20 l/s per fitting, as per NBR

3.6 BUILDING THERMAL DESIGN

3.6.1 Building shape and orientation

See architectural drawings

3.6.2 Roof constructions

The roof construction is a pitched sheet metal roof on wooden trusses. The roof has 100mm mineral wool insulation. The U-value of the whole roof construction is 0.456 W/m^{2}K

Roof Details

Outside Surface Color	**Medium**	
Absorptivity	**0.675**	
Overall U-Value	**0.456**	W/(m^2-°K)

Roof Layers Details (Inside to Outside)

Layers	Thickness mm	Density kg/m^3	Specific Ht. kJ / (kg - °K)	R-Value (m^2-°K)/W	Weight kg/m^2
Inside surface resistance	0.000	0.0	0.00	0.11000	0.0
75mm board insulation	75.000	32.0	0.92	1.87500	2.4
Air space	0.000	0.0	0.00	0.16026	0.0
22 gage steel deck	0.853	7833.0	0.50	0.00002	6.7
Outside surface resistance	0.000	0.0	0.00	0.05000	0.0
Totals	**75.853**	**-**		**2.19528**	**9.1**

3.6.3 Wall constructions

Double brick cavity wall with face brick on the outside and plaster on the inside. The U-value of the walls is 2.590 W/m^{2}K.

Wall Details

Outside Surface Color	**Dark**	
Absorptivity	**0.900**	
Overall U-Value	**2.590**	W/(m^2-°K)

Wall Layers Details (Inside to Outside)

Layers	Thickness mm	Density kg/m^3	Specific Ht. kJ / (kg - °K)	R-Value (m^2-°K)/W	Weight kg/m^2
Inside surface resistance	0.000	0.0	0.00	0.11000	0.0
102mm face brick	12.000	2000.0	1.09	0.01000	24.0
Air space	101.600	1922.2	0.84	0.13977	195.3
Face brick	101.600	2002.3	0.92	0.07624	203.4
Outside surface resistance	0.000	0.0	0.00	0.05000	0.0
Totals	**215.200**	**-**		**0.38601**	**422.7**

4 DESCRIPTION OF AIR-CONDITIONING SYSTEM

4.1 AIR-CONDITIONING UNITS

Direct Expansion (DX) heat pump type mid wall units are employed for the control room, electrical equipment room as well as the tea kitchen. Each office has a dedicated thermostat and remote control.
The air-conditioning outdoor units are located on the building outside wall

4.2 AIR DISTRIBUTION

The outdoor air is distributed by means of uninsulated rectangular ducts in the ceiling void, supply grilles in ceiling serve as outdoor air outlets.
The toilets exhaust is through ceiling disk valves and exhaust ducting is above the ceiling.

4.3 HVAC ELECTRICAL SYSTEM

A wall mounted, weatherproof control panel is required for the fresh air unit.

The electrical motor rating of the unit is 0.75kW, 400V, 3 phase. The control panel will include short circuit and over load protection. The controls will include the following:

- Fire interlock
- Local / remote selector switch, with stop/start buttons on the local selection for testing and commissioning
- The remote switching will be by means of a remote stop start switch that is located in the control room
- Visual Run/Trip indication

The fault level rating of the control panel will be 10kA.

The Electrical sub-contractor will supply a cable to a local isolator next to the fresh air unit control panel.

All split units, toilet fans and kitchen fan will be supplied from the main electrical board in this building.

4.4 SMOKE VENTILATION SYSTEMS

No smoke exhaust systems provided.

4.5 HVAC NCP PANEL

CBMS AND NCP INTERFACE
The NCP interfaces with the CBMS. The CBMS only monitors the points on the NCP, no control of the HVAC system is done from the CBMS. The communication protocol between the NCP and CBMS is BACNet.

5 BASELINE DRAWINGS

See the drawings that are part of the HVAC design submission.

Drawing Title	Eskom drawing Series no.	Sheet No.	Rev.	Consultant doc. No.
Medupi Power Station Weigh Bridge Gate House HVAC Plan Layout	0.84/50892	1	2	08073-WGB-4GF
Medupi Power Station Weigh Bridge Gate House MCC HVAC Electrical Single Line	0.84/50892	2	0	10268-WGB-110-ME

ADDENDUM A – REFERENCE EMAILS

Date sent	From	Subject
2012-08-28	Frank Wessels	FW: HVAC Design Parameter for Aux Bay

From: Frank Wessels
Sent: 28 August 2012 08:15 AM
To: Cheshire Zdziarski
Cc: Bonginkosi Mathe
Subject: FW: HVAC Design Parameters for Aux Bay

Cheshire, I find these HVAC design parameters in a report from Spoormaker. Can you confirm that these are correct. I disagree with the elevation which should be 902.25 m.

Have you reviewed any other design reports by Spoormaker for Medupi i.e. SSB, Aux Bay U6.

Regards

Frank

3 DESIGN PARAMETERS
3.1 DESIGN WEATHER DATA
The proposed weather parameters for Lephalale, Limpopo province are as follows:
Altitude 849m above mean sea level

Background: 849 m is the height according to the Ellisras weather station climate date (see attached sheet). This is the height on which we did our heat load calculations. We tested the effect of changing the height from 849 m to 902.25 m in our heat load calculations for Aux Bay Unit 6. Depending on the specific air handling unit it causes a difference of between 1.4% reduction in total cooling up to an increase of 0.5% on total cooling. In other words the height change has a negligible effect.
Recommendation: We will change the height to 902.25 m in our report for all Medupi Aux Bays and change the height to 902.25 m for all remaining Aux Bay heat load calculations (unit 1 to 3). We will put the following reference in our report: "As per e-mail from Frank Wessels to Cheshire Zdziarski on 28 August 2012".

Longitude 27.4° South
Background: This should actually read 27.4° East (as per the Ellisras weather station climate data). Our heat load calculations were done on a longitude of 27.4°C East which is correct.
Recommendation: We will correct our reports for all Medupi Aux Bays to read 27.4° East. We will reference the "Ellisras climate statistics 1961-1990" in baseline our report.
Latitude 23.4° East
Background: This should actually read 23.4° South (as per the Ellisras weather station climate data). Our heat load calculations were done on a latitude of 23.4°C South which is correct.
Recommendation: We will correct our reports for all Medupi Aux Bays to read 23.4° South. We will reference the "Ellisras climate statistics 1961-1990" in our baseline report.

Maximum summer dry-bulb temperature 36 °C
Background: We proposed a summer design temperature of 35°C at the design review meetings in 2008. However we were requested to change this to 36°C. I unfortunately don't have records of that comment but 36°C seems to agree with the architectural baseline report (see attached). I must also state that as far as I remember we did not give input in the architectural baseline report nor were we instructed to adhere to it. Please also note that we specified the ambient temperature for the air-cooled chillers 40°C in the chiller specifications.
Recommendation: We will keep the maximum summer dry-bulb design temperature 36°C on all the baseline reports and all the heat load calculations and the ambient temperature for the air-cooled chillers 40°C. We will reference "Architectural Baseline Report 84CIVL007 Rev P07" in our baseline report.

Resultant maximum outdoor air temperature at roof intake level due to heat rise from boiler house 46 °C

Background On 12 Feb 2009 we did a site measurement at Matimba power station. We found that the air intake temperature at the Aux Bay Roof was about 10°C higher than the ambient temperature, probably due to the heat from the boiler houses.
Recommendation: We will keep the maximum outdoor air temperature at roof intake level due to heat rise from boiler house 46°C. We will put the following reference in our report: "On 12 Feb 2009 Spoormaker & Partners did a site measurement at Matimba power station. It was found that the air intake temperature at the Aux Bay Roof was about 10°C higher than the ambient temperature, probably due to the heat from the boiler houses. Therefore the summer design intake air temperature at the roofs of the Aux Bays will be taken as 46°C"

Corresponding summer wet-bulb temperature 22.7 °C
Background: We worked on 20°C wet bulb due to comments we have received during the design review process in 2008. I unfortunately don't have records of that comment but 20°C seems to agree with the architectural baseline report (see attached). We later increased this figure to 22.7°C. This ensures that the absolute humidity (in g/kg dry air) is the same at 36/20 as at 46/22.7.
Recommendation: We will keep the corresponding summer wet-bulb design temperature 22.7°C on all the Aux Bay baseline reports and all the heat load calculations. We will put the following reference in our baseline report "The architectural baseline report 84CIVL007 Rev P07 requires a wetbulb temperature of 20°C. This temperature was increased to 22.7°C to ensure that the absolute humidity (in g/kg dry air) is the same at 36/20 as at 46/22.7".

Minimum winter dry-bulb temperature 3.9 °C
Background: We worked on 4°C wet bulb due to comments we have received during the design review process in 2008. I unfortunately don't have records of that comment but 4°C seems to agree with the architectural baseline report (see attached). Recommendation: We will keep the minimum dry-bulb temperature 4°C on all the baseline reports of all Medupi buildings and in all the heat load calculations for these buildings. We will put the following reference in our baseline report "The architectural baseline report 84CIVL007 Rev P07".

Corresponding winter wet-bulb temperature 0.1 °C
Background. It is based on an assumption of 50% RH, as is advised by the Carrier HAP load calculation software (see attachment). This figure is only used for humidifying calculations. There is only one humidifier in Aux Bay unit 6 namely for the C&I room. I tested the effect of changing the wet-bulb temperature from 0.1°C to 3°C but it had no effect on the required humidifier capacity.
Recommendation: We will keep the corresponding wet-bulb temperature 0.1°C on all the baseline reports of Aux Bay Unit 6 and in the heat load calculations for this building. We will put the following reference in our baseline report "Assumed 50% RH, as is advised by the Carrier HAP load calculation software"

Daily temperature variation 9 °C
Background. It is based on the default daily range for Pretoria (the closest city to Lephalale) in the HAP software. According to the Ellisras weather data this range is actually 12.6° in January. Our assumption of 9°C is conservative. By increasing the range to 12.6°C the heat loads drop by around 1% for all the air handling units.
Recommendation: We will change the daily temperature variation from 9°C to 12.6°C on the baseline reports of all Aux Bays and in the heat load calculations for these building which we have not completed yet (units 1 to 3). We will put the following reference in our baseline report "Ellisras climate statistics 1961-1990"

Frank Wessels
Lead Discipline Engineer (Acting)
Low Pressure Services
Medupi Power Station Project
ESKOM Group Technology
Sannhill Park, Building 2, First Floor, 1 Eglin Rd, Sunninghill
Tel: +27 11 800 4953
Cell:+27 083 633 6545
Frank.Wessels@eskom.co.za


ADDENDUM B – ACRONYMS

Acronym	Definition
ACH	Air Changes per Hour
AHU	Air Handling Units
HVAC	Heating, Ventilation and Air-Conditioning
NC	Noise Criteria
NCP	Network Control Panel
OBD	Opposed Blade Dampers
CBMS	Consolidated Building Management System