GOONYELLA RIVERSIDE MINE

ADMINISTRATION BUILDING

Mechanical Building Services Report

For

BHP Mitsubishi Alliance

Prepared by:
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Date: March 2008
Revision: A

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SECTION 1.0.0 – Preliminaries

1.1.0 - Introduction

This report has been requested by Mr. Crispian Mallise, Senior Environmental Projects Engineer, BHP Mitsubishi Alliance.

This report was commissioned to provide a current overview of the air conditioning systems serving the Administration Building with a specific focus on standard of workmanship, compliance with required standards and to propose options for improvement

The scope of this report is to provide:

1. Audit of existing air conditioning systems and internal conditions on site and quality of workmanship.
2. General review of maintenance.
3. Compliance check with relevant Australian standards.
4. Develop options for rectification / improvement of the systems.

There have been concerns raised by staff as follows:

1. General internal temperature fluctuations.
2. Lack of ability to change set-points / control the systems.
3. Generally poor indoor environment.

1.2.0 – Methodology

This report has used the following methodology:

1. Collect existing data, drawings and "As Constructed" information for the site.
2. Conduct a walkthrough of the air conditioned areas.
3. Inspect the existing systems and plant .
4. Review installed plant capacity.
5. Prepare this report.

To assist in enabling an accurate assessment of the situation, the service refrigeration mechanic (Andrew) attended site during our inspection.

1.3.0 – General Description

The Mine Administration building is a single storey building of slab on ground construction, block walls with metal roof. The windows are tinted single glazed type and the windows to the club room are full height western glass. The ceilings are trafficable cold room type panels.

It is located approximately 40 kilometers North of Moranbah in central Queensland. The building is a Class 5 building for the purposes of the Building Code of Australia.

Gross floor area is approximately 2000 square metres. Air conditioned floor area is approximately 1550 square metres.

The building includes offices and training/meeting rooms, internal toilets areas and general office ancillary areas. The building is used on a 8-12 hrs basis.

The building is air conditioned using six (6) off, direct expansion, rooftop packaged air conditioning units. These units are located on the ground around the perimeter of the building to facilitate ease of maintenance. The centre corridor is not air conditioned but is cooled by spill air from the adjacent air conditioned spaces.

The building includes a smoke detection system.

1.4.0 – Original Design Brief

Ashburner Francis Consulting Engineers completed a design concept brief for the air conditioning of this building in 2005. This design brief was used for the ordering of plant and general zoning of the building. However, a formal final design does not seem to have been completed as nominated in the concept brief.

The majority of items nominated / recommended in the design concept brief have not been included in the installation and specific, required compliance issues have been disregarded.

The number of air conditioning units, areas served and base capacities have been generally complied with or exceeded, however, no outdoor air or nominated types / quality of air filtration were provided.

Specific zone control was nominated in the brief for the Meeting room, Training room, Lunch room and Accounts office. This has not been provided and these areas are areas of current complaints.

Duct insulation was nominated to be 50mm thick foil faced fibreglass. 25mm foil faced fibreglass has been installed externally to the ductwork within the building and internally in the duct outside the building. Exhaust ducts are not insulated.

Heating was proposed to be via electric duct heaters. The existing installation has heating via reverse cycle. However, the reverse cycle currently does not work on any unit apparently due to incorrect installation / selection of the controls systems.

Toilet exhaust systems have been provided as per the brief.

The concept brief recommended a small direct digital control system to monitor space temperatures, control individual units, control compressor loading and unloading, control electric duct heaters, start and stop the units and to provide an operator interface to enable adjustment and monitoring of temperatures throughout the building.

The controls systems that have been installed are simple electronic type individual unit controllers. Time clocks have been installed to start and stop some of the units. There is no operator interface external to the inside of the unit electrical panels and there is no run/fault indication to alert staff to a fault within the systems.

In general all of the air conditioning units are effectively significantly oversized for the application based on no outdoor air currently being introduced which presents problems for the units and directly results in AC-05 shutting down every day with low suction pressures.

We have calculated the required heat loads for the actual building with and without outdoor air introduction and details of the results are provided later in this report.

1.5.0 – Summary

The Administration building mechanical services installation was inspected to determine suitability for use and general compliance check, with a view to providing a guide to the works required to improve the systems installed.

The inspection revealed that the installation was of a poor quality (high quality equipment was used but a very amateurish end result) and non-compliant with the Queensland Building Act, Building Code of Australia and referenced Australian Standards. The space general air quality was poor and odourous. There were significant levels of dust and dirt obvious.

The existing installation is a non-compliant air conditioning system. The system has not been adequately designed and the internal air quality is poor. Adequate temperature control cannot be provided by the systems and controls fitted.

There is a major issue with the complete disregard of the requirements of the Queensland Building Act - no outdoor air is provided to the building except by infiltration. There is no zone control, poor space temperature control, and poor air filtration.

The building air conditioning systems require a complete re-design which should include:

1. Review and document existing ductwork for possible modification or re-use including sizing, layout and installation including insulation thickness and application,

2. Outdoor air introduction at the air conditioning units,

3. Improved air filtration,

4. Revised zoning of the areas,

5. Improved controls,

6. Complete documentation and certification

7. Full commissioning of the systems

There are no quick fixes for these systems. The existing equipment can mostly be re-used but AC-05 and AC-06 require warranty repair prior to any re-use. Some minor repairs may be required if these have not been completed to date.

The existing electrical installation has not been evaluated, but a check should be carried out.

2.0 Existing Air Conditioning Systems

2.1 General

The focus of this report is on the existing air conditioning systems serving the Administration Building.

All units are manufactured by Carrier APAC and are considered to be high quality units. All units have dual refrigeration circuits and are reverse cycle units. Refrigerant used in these units is R407C

These units are as follows:

AC Unit	*Area Served*	*Model Number APAC*	*Nominal Capacity from manufacturer*	*Design Brief Estimated Capacity with OA - AFCE*	*Existing estimated Capacity No OA - ACDS*	*Required estimated Capacity with OA - ACDS*
AC-01	HR (South East)	P055	53.4 kWr @ 3000l/s	48.1 kWr @ 2240l/s, 450l/s OA	23.0 kWr @ 1450l/s, 0 l/s OA	40.6 kWr @ 1460l/s, 345l/s OA
AC-02	Large Training Rm, Accountants and Conference room (North East)	P096	90.7 kWr @ 5300l/s	90.2 kWr @ 2710l/s, 1275 l/s OA	28.9 kWr @ 1830l/s, 0 l/s OA	67.5 kWr @ 1860l/s, 750 l/s OA
AC-03	HSEC (North East)	P055	53.4 kWr @ 3000l/s	33.7 kWr @ 1780l/s, 210 l/s OA	26.1 kWr @ 1460l/s, 0 l/s OA	37.8 kWr @ 1695l/s, 240 l/s OA
AC-04	Admin (existing Bldg)	P046	42 kWr @ 2500l/s	41.4kWr @ 2160l/s, 280 l/s OA	28.9 kWr @ 1885l/s, 0l/s OA	46.9kWr @ 1775l/s, 365 l/s OA
AC-05	Tech Services room and offices (South zone)	P055	53.4 kWr @ 3000l/s	39.0 kWr @ 2020l/s, 255 l/s OA	46.4 kWr @ 3120l/s, 0l/s OA	68.9 kWr @ 3150l/s, 430 l/s OA
AC-06	Offices, Board room, Lunch room (west zone)	P055	53.4 kWr @ 3000l/s	39.0kWr @ 2020l/s, 255 l/s OA	23.6 kWr @ 1575l/s, 0l/s OA	36.9kWr @ 1550l/s, 275 l/s OA

The units installed match the initial rough heat load calculations by Ashburner Francis Consulting Engineers. Note that these were "preliminary only" heat loads and the consultants noted clearly that they required further calculation and design.

The actual installation did not include outdoor air introduction to the units as per the design brief, and the recalculated heat loads show that most of the time the existing compressors would short cycle due to low loads. Space conditions currently reflect this with wide variances in temperature.

Note that the original system design included electric duct heating for winter heat, this may also have been intended for zone reheat to maintain zone space temperatures.

The current estimated capacity with outdoor air does not include extra capacity to provide trim re-heat. Space conditions in areas that have different occupancy types off a single air conditioning unit would still fluctuate in temperature by around 2-4 degrees as illustrated in the attached heat load calculations. The correct zoning of air conditioning systems is essential to ensure that multiple spaces served by a single unit are all controlled to set point temperature – not just the one that has the sensor, or in the case of the existing on site, none of the spaces are specifically controlled.

An in-duct fan has been installed to attempt to rectify problems with control of the accountant's area. A significant amount of on-going adjustment to the system set-points will continue as the seasons change and an approximation of control will be all that can be achieved.

The original design brief called for specific zone control for some areas and this means that these areas should have a variable air flow to suit the specific area and possibly re-heat to ensure no areas are over cooled. This has not been provided and is necessary to provide adequate control of these types of areas. This applies primarily to AC-02 serving the training room and conference room and, to a lesser extent, units that serve lunch rooms and meeting rooms etc.

2.2 Air Conditioning Units

The air conditioning units have been installed over a period of time from 2005 to last year as the Administration building was developed in stages. All units are of Carrier APAC manufacture with the first four(AC-1 to AC-4) being supplied with the standard heresite condenser coil coating (black) and the last two having dipped Kirby cote condenser coils (blue).

The units are mounted on galvanized stands on concrete pads around the perimeter of the building.

Condensate drains are trapped un-insulated PVC to discharge directly in ground adjacent the units.

The units AC-1 to AC -4 are in a good condition. They were clean and were operating when inspected. AC-3 was advised as having a minor refrigerant leak on one of the two independent refrigeration circuits which requires repair. This unit was limited to 50% capacity at the time of the inspection.

AC 5 and AC 6 have both been significantly damaged during transit or installation. The top panels are damaged and compressing the main access panels to the electrical and compressor sections. Removal of the access panels is difficult and damage to the paint and is evident. This defect should have been addressed and new panels installed under warranty. As these units are less than 12 months old, warranty should be claimed and the panels replaced by the contractor.

Ductwork is directly connected to the units and no vibration isolation (flexible connections) have been used. These are normally used in this type of installation and their use is to minimize any vibration transmission to the building structure.

2.3 Air Filtration

All of the air conditioning units have been fitted with air filters these are nominally - panel type washable filter.

The filters are slide mounted and removal is difficult – access is by removal of screws and should have been sash type fasteners. There is indication of air bypass around the filters.

This type of air filter is associated with cheap commercial retail applications. They generally have the capacity to remove 50-80% of 3.0-15.0 micron particles. Coal dust and atmospheric duct commonly range from around 0.5 microns and the finer atmospheric coal duct on mine sites is found in relatively high concentrations.

The filters installed are not considered adequate for removal of atmospheric coal dust and are not considered appropriate for the application.

We recommend the installation of a separate filter plenum to each of the units fitted with deep bed type air filters. The media used should be selected to remove a significant proportion of the fine coal dust around the 0.5 -1.0 micron range.

The filter plenum also gives easier access for evaporator coil inspection and cleaning.

2.4 Sheet Metal Ductwork

The existing sheet metal ductwork installed into the ceiling space is considered to be of good quality. The ductwork is constructed using proprietary slip on flanges bolted at corners and with seals between each section of duct.

The ductwork connections to the connections on the air conditioning units do not have a flexible duct section as would be normal practice. In addition, the use of supply plenums indicates that the units were mounted too close to the buildings and the ducts site measured to suit afterwards. These 90 degree type bends close to a fan discharge induce significant turbulence and high static pressure losses. This generally results in poor fan performance. Normally larger motors and pulleys are fitted to suit the increased pressure drop in the system.

A quick check of the duct sizes for AC 5 and AC 6 (both 600x400) supply duct riser duct velocities, between the unit and the ducts in the ceiling space, are significantly higher than normal good practice and duct pressure losses would be around 3 times that of a standard consultant type design.

The entire duct systems require review and documentation to ensure reasonable sizing, confirm zoning and to provide an accurate “As Constructed” plan for future reference. This plan would be used to determine the suitability of the ductwork for the installation with regard air flows to the grilles is achieved without unnecessary energy losses in fan operation.

The ductwork is externally insulated where it runs within the ceiling space and internally insulated where it runs external to the building.

Insulation thickness is 25mm nominal foil faced fibre-glass insulation.

The relevant section of Australian Standard AS4254-1995 is attached and specific deficiencies in the installation for the externally insulated ductwork are as follows:

1. The duct insulation installation method does not prevent cold bridging as the externally insulated duct is installed on the ceiling and not supported from the roof structure above.

2. The insulation is compressed under the duct in places which would affect thermal performance.

Pre-insulated flexible ducts have been used to connect the ceiling grille to the sheet-metal ductwork.

The existing flexible ductwork is connected to the sheet metal ductwork via proprietary spigots complete with dampers for air balancing. The installation of the spigots has been via approximately 4 screws. A small sample of spigots was checked and all were leaking supply air around the spigot flange – no sealant was evident. The amount of leakage was considered to be significant and this should be addressed to ensure energy wastage is minimized and the design air flows are achieved in the occupied spaces.

2.5 Controls

The existing air conditioning unit controls are basic electronic type Innotech IMT5022 packaged unit controllers. These controls use a sensor in the return air duct near the unit to control the staging of the compressors and (if wired up correctly) change over of the reversing valve for winter heating. We were advised by the maintenance technician that the heating did not work on any units as the units were incorrectly wired up.

The location of the sensor is important as it controls the unit. The current location and poor insulation on the ductwork means that the sensor is registering a few degrees higher than what the spaces are operating at. The avoid overcooling the spaces the Technician has adjusted set-point in a number of units to achieve the desired internal temperatures.

Whist this is not desirable, it will work most of the time. That is, when the set point has been adjusted for summer (higher heat load in the roof space, it will be OK until the ambient temperature starts to drop in autumn / winter and the set-point adjustment will be required again by the technician otherwise the system may begin to under cool the space.

The preferred solution is to measure the space where we want to control temperature by installing remote sensor either on the wall or at the return air grille.

The controls systems do not include any operator interface to adjust temperature set points or to indicate a fault condition on any system.

The preferred system for this sized facility would be a small Innotech Maxim III DDC system, which could be set up to monitor space temperatures and then control on actual space conditions and be able to be monitored for performance. This system would provide a detailed user interface and system monitoring, computer type operator interface and could provide alarms remotely to the service technician via email or paging system. The system could be remotely interrogated if necessary to faults, reset set-points or review log data to optimize performance. This type of

system is preferred where separate zone control is required (training rooms, conference rooms etc).

An in between solution would be to replace the existing electronic controls with individual controllers with a user interface in the space, such as the Innotech MTC-03 which provides start stop on time clock function, fault indication and space temperature read out on a Clipsal type wall mounted panel (similar to a light switch panel). These also monitor system run hours and permit users to change set-points. These could be located either in a group in reception or in the areas served.

SECTION 3.0.0 – Conclusions and Recommendations

3.1.0 - Conclusions

The Administration building mechanical services installation was inspected to determine suitability for use and general compliance check, with a view to providing a guide to the works required to improve the systems installed.

The inspection revealed that the installation was of a poor quality (high quality equipment was used but a very amateurish end result) and non-compliant with the Queensland Building Act, Building Code of Australia and referenced Australian Standards. The space general air quality was poor and odourous. There were significant levels of dust and dirt obvious.

There is no indication of certification of the mechanical services design or certification that the installation complies with a certified design can be provided and there are no design drawings or design calculations available from BMA. This indicates that the design and documentation has not been completed by the contractor for this project and certification has not been provided by a competent person.

This means that the building does not satisfy the basic building requirements and if it was located in a major town, the local authority would not have permitted occupation or use of the building.

There are a number of items requiring rectification to make the building compliant and to provide reasonably consistent internal temperatures and reasonable indoor air quality:

1. Provide outdoor air in accordance with AS1668 Part 2-1991- Mechanical ventilation for Acceptable indoor air quality

2. Provide zoning of the systems to reduce temperature fluctuations.

3. Provide a suitable control systems and user interface with run and fault indication.

4. Provide air filtration that will remove the majority of dust in the internal spaces.

5. Replace / upgrade ductwork insulation to minimize energy loss and to meet minimum requirements for this location.

6. Repair the physical damage to the new air conditioning units to permit maintenance.

The above will require extensive modification of the existing systems and considerable disruption to the operation of the building. Costs will be significant.

A re-design of the systems by a competent registered professional engineer is required and full documentation to ensure that the most economical, compliant and practical outcome is achieved that can be programmed to suit the operable building.

Note that certain house–keeping requirements will be needed if the building is to be occupied during the interim period. This is meet Code requirements and to improve the internal air quality in the short term. Temporary filtered outdoor air systems may be necessary either supplying direct to the space or into the return air ducts. This would prevent the unwanted dust ingress if windows and doors were left open as a natural ventilation option.

Currently the building is under a slight negative pressure due to the toilet exhaust systems which increases the ingress of dust and dirt into the building. The amount of outdoor air infiltration due to the toilet exhaust is far short of the required outdoor air rates and would not be classed as an alternative to provision of outdoor air via the air conditioning systems.

3.2.0 - Recommendations

Recommendations for immediate action:

1. Provide temporary outdoor air to each of the units / areas.

Recommendations for rectification:

2. Complete documentation of the existing equipment and ductwork to permit redesign.

3. Re-design and document the modifications to the air conditioning systems, generally in line with the original design brief from Ashburner Francis consulting Engineers Pty Ltd.

4. Co-ordinate the rectification works to suit the operation of the building.

A rough estimate of the costs of rectification is around $100,000 excluding GST but this would not include any mine specific training or inductions and does not include building works, slab extensions or consultant fees for the re-design and documentation.

Professional fees for the redesign are estimated to be in the order of $15,000-$20,000 excluding GST.

Goonyella Riverside
ADMINISTRATION BUILDING
DX APAC Plant Heat load Check

```
INPUT FILE NAME ~
C:/CAMEL509/DATA/RIVERSIDE ADMIN.DAT
OUTPUT FILE NAME~
C:/CAMEL509/DATA/RIVERSIDE ADMIN.OUT

CALCULATION BUILD NUMBER 5.00.9AP

OUTDOOR DESIGN CONDITIONS ~ with ACADS WEATHER DATA FILE for CRITICAL DESIGN
Location 35019   CLERMONT                              QLD Latitude -22.8 DEG(SOUTH)
Daily Range 12.1  Building Rotation  0.0
Elevation   267.0 m

WINTER OUTDOOR DESIGN   5.5 CDB  80.0 RH

TOTAL FLOOR AREA IS   4167.0 m2
FLOOR AREA SERVED BY CHILLER IS      0.0 m2
```

COOLING OUTDOOR DESIGN TEMPERATURES (C)

(DB – DRY BULB WB – WET BULB)

		JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
6AM	DB	31.1	29.0	28.5	25.2	21.4	19.3	19.3	22.4	25.7	29.0	30.0	32.6
	WB	27.2	23.1	24.8	19.9	19.4	17.2	16.4	15.9	18.4	20.3	24.4	25.9
7AM	DB	31.6	29.5	29.0	25.7	21.9	19.8	19.8	22.9	26.2	29.5	30.5	33.1
	WB	27.3	23.2	24.9	20.1	19.5	17.3	16.6	16.1	18.6	20.4	24.6	26.0
8AM	DB	31.6	29.5	29.0	25.7	21.9	19.8	19.8	22.9	26.2	29.5	30.5	33.1
	WB	27.3	23.2	24.9	20.1	19.5	17.3	16.6	16.1	18.6	20.4	24.6	26.0
9AM	DB	32.6	30.5	30.0	26.7	22.9	20.8	20.8	23.9	27.2	30.5	31.5	34.1
	WB	27.6	23.5	25.1	20.4	19.8	17.7	16.9	16.4	18.9	20.7	24.8	26.3
10AM	DB	34.0	31.9	31.4	28.1	24.3	22.2	22.2	25.3	28.6	31.9	32.9	35.5
	WB	27.9	23.8	25.5	20.8	20.3	18.2	17.4	16.9	19.4	21.1	25.2	26.6
11AM	DB	35.0	32.9	32.4	29.1	25.3	23.2	23.2	26.3	29.6	32.9	33.9	36.5
	WB	28.1	24.1	25.8	21.1	20.6	18.5	17.8	17.3	19.7	21.4	25.5	26.9
NOON	DB	36.0	33.9	33.4	30.1	26.3	24.2	24.2	27.3	30.6	33.9	34.9	37.5
	WB	28.4	24.4	26.0	21.4	20.9	18.8	18.1	17.6	20.0	21.7	25.7	27.1
1PM	DB	37.4	35.3	34.8	31.5	27.7	25.6	25.6	28.7	32.0	35.3	36.3	38.9
	WB	28.7	24.8	26.4	21.8	21.3	19.3	18.6	18.1	20.4	22.1	26.1	27.5
2PM	DB	38.4	36.3	35.8	32.5	28.7	26.6	26.6	29.7	33.0	36.3	37.3	39.9
	WB	28.9	25.0	26.6	22.1	21.6	19.6	18.9	18.4	20.7	22.4	26.3	27.7
3PM	DB	39.4	37.3	36.8	33.5	29.7	27.6	27.6	30.7	34.0	37.3	38.3	40.9
	WB	29.2	25.3	26.9	22.4	21.9	19.9	19.2	18.8	21.0	22.7	26.6	28.0
4PM	DB	38.4	36.3	35.8	32.5	28.7	26.6	26.6	29.7	33.0	36.3	37.3	39.9
	WB	28.9	25.0	26.6	22.1	21.6	19.6	18.9	18.4	20.7	22.4	26.3	27.7
5PM	DB	37.4	35.3	34.8	31.5	27.7	25.6	25.6	28.7	32.0	35.3	36.3	38.9
	WB	28.7	24.8	26.4	21.8	21.3	19.3	18.6	18.1	20.4	22.1	26.1	27.5
6PM	DB	37.0	34.9	34.4	31.1	27.3	25.2	25.2	28.3	31.6	34.9	35.9	38.5
	WB	28.6	24.7	26.3	21.7	21.2	19.1	18.4	18.0	20.3	22.0	26.0	27.4

AHU SUMMARY - COOLING

At Time of Peak Grand Total Heat (GTH)

TITLE	NO. OFF	S/A l/s	OUT/AIR l/s	OUT/AIR %	GTH kW	GTSH kW	COIL ENT CDB	COIL ENT CWB	COIL LVG CDB	COIL LVG CWB
AC-01-HR	1	1456	345	24	40.6	26.1	27.3	20.0	12.0	11.4
AC-02	1	1858	750	40	67.5	38.4	30.0	22.4	12.4	11.9
AC-03-HSEC	1	1692	241	14	37.8	27.3	25.7	18.4	11.9	11.3
AC-04-Admin	1	1776	366	21	46.9	31.7	26.8	19.5	11.6	11.3
AC-05Tech	1	3150	427	14	68.9	50.1	25.5	18.3	11.9	11.3
AHU6	1	1548	275	18	36.9	25.2	25.9	18.8	11.9	11.4

AHU SUMMARY COOLING SUPPLEMENTARY DATA

Note 1: at time of peak AHU adjusted sensible heat
2: increased air quantity or reduced leaving coil CDB are alternatives

Title	Time Peak GTH	Adj Sens kW	Time Peak Adj Sens	Adj Sens kW	GTH kW	REVISED AQ l/s	REVISED % var	REVISED Lvg CDB	REVISED Diff CDB
AC-01-HR	3pm Jan	18.8	2pm Dec	19.3	38.5	1495	2.7	11.7	0.3
AC-02	3pm Jan	23.2	3pm Dec	23.8	63.7	1904	2.4	12.1	0.3
AC-03-HSEC	3pm Jan	22.0	3pm Dec	22.6	37.0	1741	2.9	11.6	0.3
AC-04-Admin	3pm Jan	23.8	4pm Dec	24.5	44.9	1823	2.7	11.3	0.3
AC-05Tech	2pm Jan	41.0	3pm Dec	41.2	67.1	3169	0.6	11.8	0.1
AHU6	6pm Jan	20.1	6pm Dec	20.7	35.9	1598	3.2	11.6	0.4

ZONES AND ROOMS COOLING RESULTS

(excluding Outside Air and Return Duct Gains)

AHU NO	ZON NO	TITLE	NO. OFF #	ADJUSTED SENS kW	ADJUSTED LAT kW	S/A l/s	VAV TURN DWN%	O/A l/s	RE-HEAT kW	ROOM COND DB MIN	ROOM COND DB MAX	ROOM COND % RH
1		**AC-01-HR**	**1**	**18.8**	**2.28**	**1456**		**345**		**23.0**		**50**
	1		1	19.3	2.28	1456		345				
		Centr Offices	1	4.42	0.43	329		78		22.3	24.1	49
		Offices - east	**1**	**1.18**	**0.06**	**97**		**23**		**20.8**	**23.9**	**51**
		General Office	1	5.77	0.36	436		103		21.8	23.6	49
		Meeting Room	1	3.32	0.71	248		59		22.7	23.6	52
		Lunch Room	1	4.65	0.71	346		82		22.3	24.6	51
2		**AC-02**	**1**	**23.2**	**3.20**	**1858**		**750**		**23.0**		**52**
	1		1	23.8	3.20	1858		750				
		Large Trg Rm	1	15.4	2.26	1208		488		22.9	23.1	51
		Mine Accountants	**1**	**3.80**	**0.29**	**297**		**120**		**21.9**	**23.3**	**49**
		Conference Rm	1	4.51	0.65	353		143		22.3	23.9	51
3		**AC-03-HSEC**	**1**	**22.0**	**1.73**	**1692**		**241**		**23.0**		**48**
	1		1	22.6	1.73	1692		241				
		East Offices	1	5.92	0.28	446		64		21.2	24.2	47
		Centre Offices	1	13.1	0.98	979		140		22.2	23.5	48
		Lunch Rm	**1**	**3.55**	**0.48**	**266**		**38**		**23.0**	**26.3**	**50**
4		**AC-04-Admin**	**1**	**23.8**	**2.33**	**1776**		**366**		**23.0**		**50**
	1		1	24.5	2.33	1776		366				
		Filing	1	5.03	0.06	361		74		22.3	23.6	47
		Interview	1	3.27	0.24	247		51		19.1	23.6	51
		Reception	1	1.39	0.12	101		21		22.5	25.0	50
		Waiting	1	3.40	0.59	246		51		21.6	23.7	52
		Manager	**1**	**2.52**	**0.18**	**182**		**38**		**21.7**	**25.1**	**49**
		Contract Admin	1	2.86	0.24	207		43		22.4	25.3	50
		Int Offices	1	2.51	0.18	182		37		22.4	23.7	49
		Lunch Rm	1	3.48	0.71	249		51		23.1	27.1	53
5		**AC-05Tech**	**1**	**41.0**	**3.34**	**3150**		**427**		**23.0**		**48**
	1		1	41.2	3.34	3150		427				
		Offices internal	1	31.9	2.83	2434		330		22.8	23.8	48
		Offices S zone	**1**	**9.33**	**0.50**	**716**		**97**		**20.3**	**23.8**	**48**
6		**AHU6**	**1**	**20.1**	**1.78**	**1548**		**275**		**23.0**		**49**
	1		1	20.7	1.78	1548		275				
		Media Rm	**1**	**5.99**	**1.19**	**459**		**81**		**22.6**	**24.4**	**52**
		Club Room	1	14.7	0.59	1089		193		22.4	23.2	47

Note 1~ The room S/A is proportion of the zone air quantity at zone peak
Note 2~ The ROOM MIN/MAX is a rough estimate of the room temperature variation.
Note 3~ The ROOM maximum sensible heat may be greater than the AHU sensible heat.

Extracts from AS4354 –Ductwork for air-handling systems in buildings

2.7.2 Insulation for rigid ducts Materials applied to the outside of ductwork, for sound absorption and thermal stability, shall comply with the following requirements:

(a) Bulk insulation shall have a smoke developed index not greater than '3' and spread of flame index not greater than '0' when separately tested in accordance with AS 1530.3. Both faces of the insulation shall be tested.

(b) Bulk insulation assembled on a duct system, i.e. the assembled final product, shall have a smoke developed index not greater than '3' and spread of flame index not greater than '0' when tested in accordance with AS 1530.3. Prior to testing, reflective facing and lining materials shall be blackened and all facing and lining materials shall be scored in accordance with the recommendations of AS 1530.3.
The exposed face of the insulation shall be tested.

(c) Bulk insulation assembled on a duct system, i.e. the assembled final product, shall pass the UL 181 burning test. The test shall be carried out in accordance with the qualifications of Clause 2.8.2.

The insulation material shall be fixed to the exterior surfaces of the duct in a manner that—

(i) prevents cold bridging;

(ii) **maintains vapour barrier**;

(iii) **does not compress the insulation to the point where thermal performance is affected**;
and

(iv) ensures that the surface of the insulation is in contact with the duct surface.

NOTE: For details on insulation for flexible ductwork, see Clause 2.8.

2.8 FLEXIBLE DUCTWORK

2.8.1 Construction Flexible ductwork shall be constructed in accordance with one of the following methods:

(a) *Metal* The ductwork may comprise either—

(i) corrugated duct, helically wound with lockseam capable of being bent or set by hand without spring back and without deforming the circular section; or

(ii) single or multiple layers of strip formed into corrugations and wound in helical or annular form, without an obvious seam or joint.

Strip thickness shall be not less than 0.127 mm.

(b) *Reinforced fabric* The ductwork may comprise either—

(i) tough, flexible laminate; or

(ii) tough, tear-resistant, airtight material liner and cover incorporating a reinforcing former to retain circular section and permit flexibility with minimal spring back
when formed to the required shape.