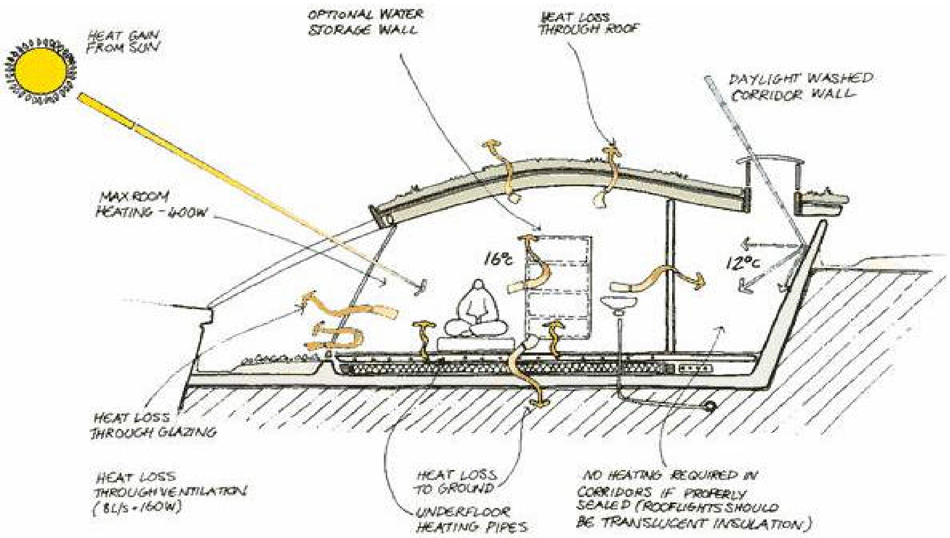
EMIRATES LUXURY RESORT
WOLGAN VALLEY, LITHGOW

INDOOR ENVIRONMENTAL CONTROL SYSTEMS



Mechanical Services

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Revision: Preliminary
Date: 29 July, 2005
DH/dh:5849dha1.doc

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Report №: 5849/1/Preliminary

Original Date of Issue: 29th July 2005

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Doc. Description:	Indoor Environmental Control Systems

REVISION/VERIFICATION HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY	
Preliminary	4/8/05	DJC		DH	

CLIENT APPROVAL SIGN-OFF

CLIENTS REPRESENTATIVE	DATE	SIGNATURE

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1.0 INTRODUCTION

The content of this report provides an outline description of the Indoor Environmental Control Systems which will be considered for the facilities at the Emirates Luxury Resort, Lithgow.

The indoor environmental systems have been considered in the following context:

- Occupant Environmental Interaction
- Ambience
- Acoustic Quality
- Flexibility
- Unobtrusive Equipment
- Ease of Maintenance
- Environmental Sustainability
- Passive Cooling

Mechanical ventilation and natural ventilation systems will be provided to serve Utility Rooms, Garbage Rooms, Workshops, Kitchens, etc.

The methods of pool heating have also been outlined for the pools in the Spa Building and the individual villas.

2.0 DEVELOPMENT

The Emirates Luxury Resort at Wolgan Valley near Lithgow comprises of a main reception/restaurant building, a conference centre building, a spa facility building, guest accommodation consisting of 40 individual villas and staff accommodation. The main building comprises of 3,500m^2 single story containing restaurants, lounges, kitchens and offices. The guest accommodation comprises 35 individual single story villas of approximately 90m^2 floor space each, 3 Royal Villas of 175m^2 floor space each and 2 Owners villas of 325m^2 floor space each. The Spa Facility building with a total floor space area of 1,100m^2 and 1,400m^2 for the conference building. The multi story Staff & Manager's accommodation of 6,200m^2 & 900m^2 floor space area respectively.

It is envisaged that the development will incorporate the many Ecologically Sustainable Design principles. These design initiatives include active and passive measure to reduce energy consumption as well as improve the overall usage efficiency.

3.0 SUSTAINABILITY

This report presents various strategies that will provide an ecologically sustainable design for the new Emirates Luxury Resort at Wolgan Valley. These strategies are aimed at minimising the usage of non-renewable energy. Energy reduction can be achieved through the implementation of two complementary strategies. These are the use of "clean" renewable energy production and smart building design to reduce energy consumption. Further reductions may be achieved through lifestyle modification of the end users.

Energy reduction measures include:

1. Sourcing of energy from 'clean' renewable or alternative energy sources, such as:

   - Solar Photovoltaic
   - Solar Thermal (such solar hot water)
   - Geothermal

2. Minimisation of energy usage through smart building design, such as:

- Building orientation
- Low energy heating, ventilation and air conditioning
- Façade construction materials with high thermal mass or high levels of thermal insulation
- Use of low embodied energy building materials (ie materials which are not energy intensive to manufacture)

4.0 BUILDING DESIGN

4.1 GENERAL

The Main Building, Conference Building and Staff/Managers Accommodation Building shall be designed with consideration given to a variety of passive energy concepts to help ensure the building requires minimal energy for heating and cooling. These passive techniques include:

- Building orientation and solar access
- Ventilation strategies
- Material Usage

4.2 ORIENTATION AND SOLAR ACCESS

Ideally, buildings should be orientated with living areas facing approximately 20 degrees east of north and have minimal window openings on western walls. Buildings should typically have aspect ratios of 1:1.6 to 1:2, the largest side having the northerly aspect. The Main Building, Conference Building, Spa Facility and Staff/Manager's Accommodation are oriented in a north south direction with the public access areas of the Main building to have North-easterly aspects. The Villas will typically oriented east west and the residences will typically have westerly aspects to capture views over the Wolgan valley. Therefore all buildings will require additional techniques to improve their thermal performance.

In order to minimise solar radiation heat gain through fenestrations in the summer, while allowing solar radiation heat gain in the winter, the shading overhangs shall be designed for optimum length. In summer the building windows shall be predominantly shaded, whilst in winter the solar radiation will enter the space and be absorbed by the thermal mass of the floor structure, thus adding passive heating. Figure 1 illustrates the main concept for ideal solar access during the summer and winter equinoxes. Extra benefits are obtained by using manually operable outside awnings.

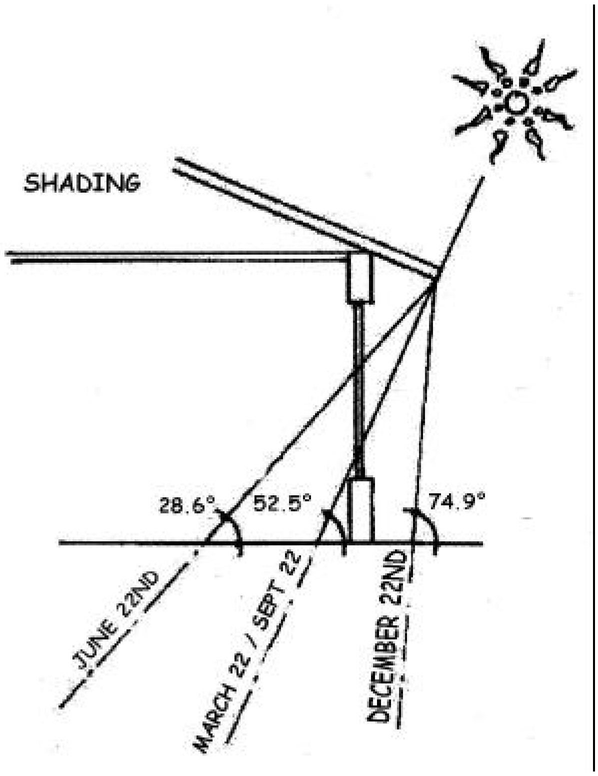


Figure 1: Graphic showing concept of ideal solar access and shading,

Rooms with southerly aspects may benefit from the use of a north facing clerestory window for natural lighting and solar gain during winter months and to aid natural ventilation, as shown in figure 2.

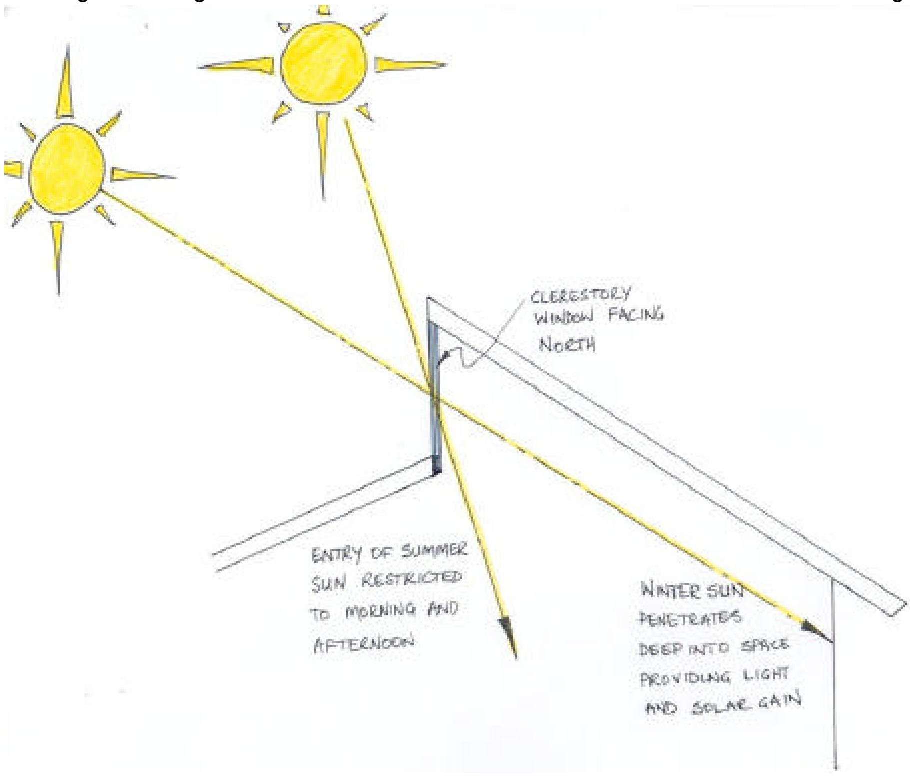


Figure 2: Concept of clerestory to allow winter sun to penetrate southern rooms providing natural light and solar gain

5.0 ACTIVE HEATING AND COOLING OPTIONS

As the residences will be well appointed it is expected that the occupants will want to have a high degree of control over their internal thermal comfort. The proposed air conditioning systems will be selected on the basis of:

- low environmental impact
- low noise for customer tranquillity
- interactive with the environment

Various options for these systems have been considered:

1. Water source reverse cycle heat pumps and ground source reverse cycle heat pumps for space heating and pool/spa heating.
2. High efficiency air source reverse cycle heat pumps with environmentally benign refrigerants (zero ozone depletion potential and low global warming potential).
3. Environmentally sustainable slow combustion heaters can supplement heating of the homes. Provided that the timber is sourced fom a sustainable plantation, these have a greenhouse gas emission coefficient of approximately 0.012kg/MJ compared to 0.15kg/MJ for an electric reverse cycle heat pump with a COP of 2.5 running off grid electricity. The chimney may also be used as a thermal and/or solar chimney in summer and a thermal chimney in winter to help promote natural ventilation of the space. Ceiling fans should be used wherever possible to move warm air from high level to low level and thereby assist heating.

6.0 INDOOR ENVIRONMENT CONTROL SYSTEMS

The following active and passive environmental control system shall be considered for each of the different facilities.

Main Building

- Cavity Floors or Labyrinths
- Solar Chimney
- Geothermal Ground Source Heat Pump
- Mixed Mode System / Air Conditioning & Natural Ventilation
- Mechanical Ventilation to kitchens, toilets and miscellaneous rooms
- Water features to provide passive evaporative cooling
- In-slab hydronic heating and cooling

Conference Building

- Cavity Floors or Labyrinths
- Solar Chimney
- Geothermal Ground Source Heat Pump
- Mixed Mode System / Geothermal Air Conditioning & Natural Ventilation
- Mechanical Ventilation to kitchens, toilets and miscellaneous rooms
- In-slab hydronic heating and cooling

Spa Facility Building

- Geothermal Heat Pump VS. Gas Heating
- Solar Pool Heating
- Geothermal Ground Source Heat Pump
- Mixed Mode System / Geothermal Air Conditioning & Natural Ventilation
- Mechanical Ventilation to kitchens, toilets and miscellaneous rooms

Guest Villas

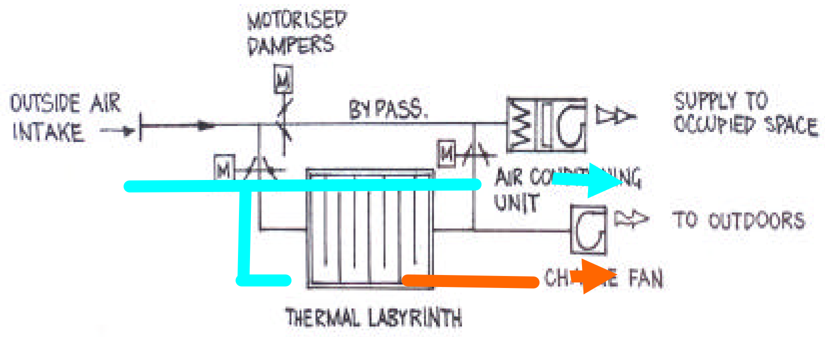
- Mixed Mode System / Geothermal Air Conditioning & Natural Ventilation
- Mechanical Ventilation to kitchens, toilets and miscellaneous rooms

Staff Accommodation Building

- Cavity Floors or Labyrinths
- Solar Chimney
- Geothermal Ground Source Heat Pump
- Mixed Mode System / Geothermal Air Conditioning & Natural Ventilation
- Mechanical Ventilation to kitchens, toilets and miscellaneous rooms

6.1 CAVITY FLOORS OR LABYRINTHS

Preheating or pre-cooling of outside air by channelling it through cavities in the floor slab. The high thermal mass of the slab draws heat out of the warm air in summer and can transfer heat to the cool air in winter, thus reducing the load requirements for heating and cooling.



6.2 SOLAR CHIMNEY

The use of solar chimneys on the northern side of buildings can be used to cool in summer and heat in winter. Solar radiation falls on the wall, warming the air in the space, which in turn produces a stack effect drawing fresh air through the building. In winter the warm airflow may be directed back into the occupied areas.

6.3 GEOTHERMAL GROUND SOURCE HEAT PUMP

Geothermal air-conditioning and heating systems provide space conditioning. The system works by moving heat from the space to or from the earth to provide cooling or heating. Every geothermal system has three sub-systems:

1. Geothermal heat pump
   The Geothermal heat pump move heat between the space and the fluid in the earth connection. The heat pump is typically packaged as a single unit and can be either concealed within a ceiling, underfloor or cupboard void. This unit consists of a refrigerant compressor, fluid-to-refrigerant heat exchanger and controls. The Heat pump is generally contained together with the air distribution system.

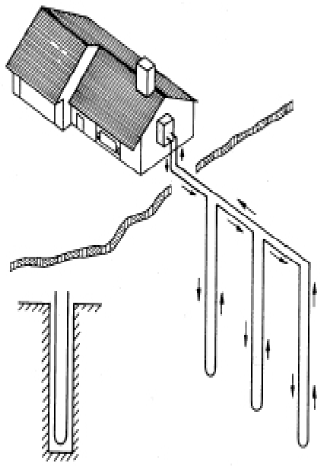
2. Earth connection
   The earth connection transfers heat between the fluid and the earth.

3. Air distribution system
   The air distribution system is used for delivering heating or cooling to the space.

Each system may also have a desuperheater to supplement the building's water heater to meet a portion of the building's hot water needs in the form of *free heating*.

The Geothermal Air-Conditioning system comprises of the following equipment:

- Floor or ceiling Mounted Water Source Geothermal Heat Pumps
- Geothermal Water Pipework system within the building
- Geothermal Primary Pumps
- Vertical Ground Loop Heat exchanger with all of the associated vertical ground loop piping



6.4 NATURAL VENTILATION/MIXED MODE VENTILATION STRATEGIES

The idea of a mixed mode ventilation system is to reduce the reliance on ventilation and air-conditioning plant resulting in reduced energy consumption and the associated energy costs. This operates by allowing outside air to flow through the building naturally when the outside conditions are favourable, instead of using mechanically assisted ventilation and cooling under all conditions. This involves utilising low and high level openings with associated dampers to allow fresh air to be naturally drawn into the space and then exhausted.

The flow of air occurs due to a combination of the stack effect (buoyancy driving the heated air to the top of the space) and the wind producing either:

- positive pressure at low level - wind blowing perpendicularly to façade, or
- negative pressure at high level - venturi effect sucking air out.

In summer, the presence of winds within the valley will assist cooling by providing a driving force for natural ventilation.

Other passive techniques include:

- Preheating or pre-cooling of outside air by channelling it through cavities in the floor slab. The high thermal mass of the slab draws heat out of the warm air in summer and can transfer heat to the cool air in winter, thus reducing the load requirements for heating and cooling.

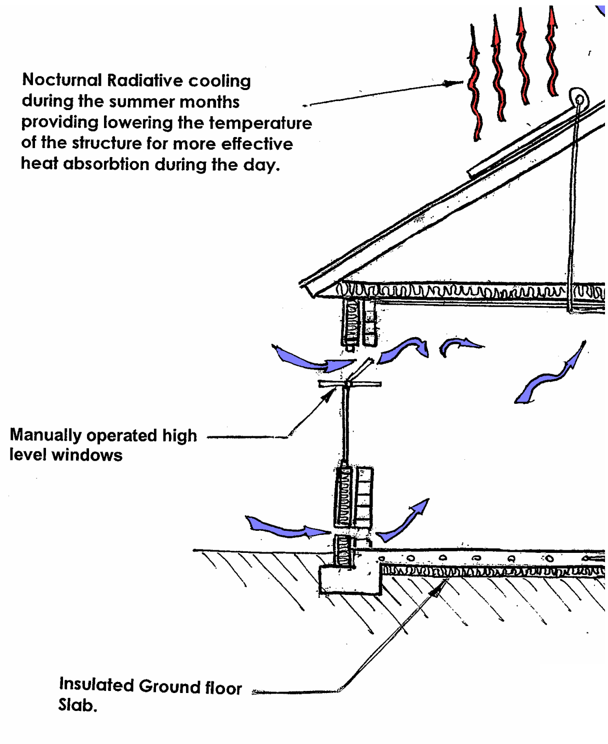


Figure 2: Concept of solar panels providing passive heating and cooling to thermally massive slab

- The use of solar air heaters to provide warm air during the day in winter to the slab cavity. This may be reversed for radiative night cooling in summer, whereby heat is lost to the night sky through the solar collector and cool air is drawn through the slab to remove heat collected during the day.
- The use of thermal mass in walls and floors to stabilise building temperatures.
- Where lightweight construction is desired and precludes the use of high thermal mass, thermal insulation should be used to stabilise thermal performance.
- Glazed areas should be double glazed as a minimum and fitted with heavy drapes and pelmets to prevent heat loss. Further advantage may be obtained by triple glazing with an internal sliding blind.

Figures 3 and 4 show natural ventilation and heating strategies.

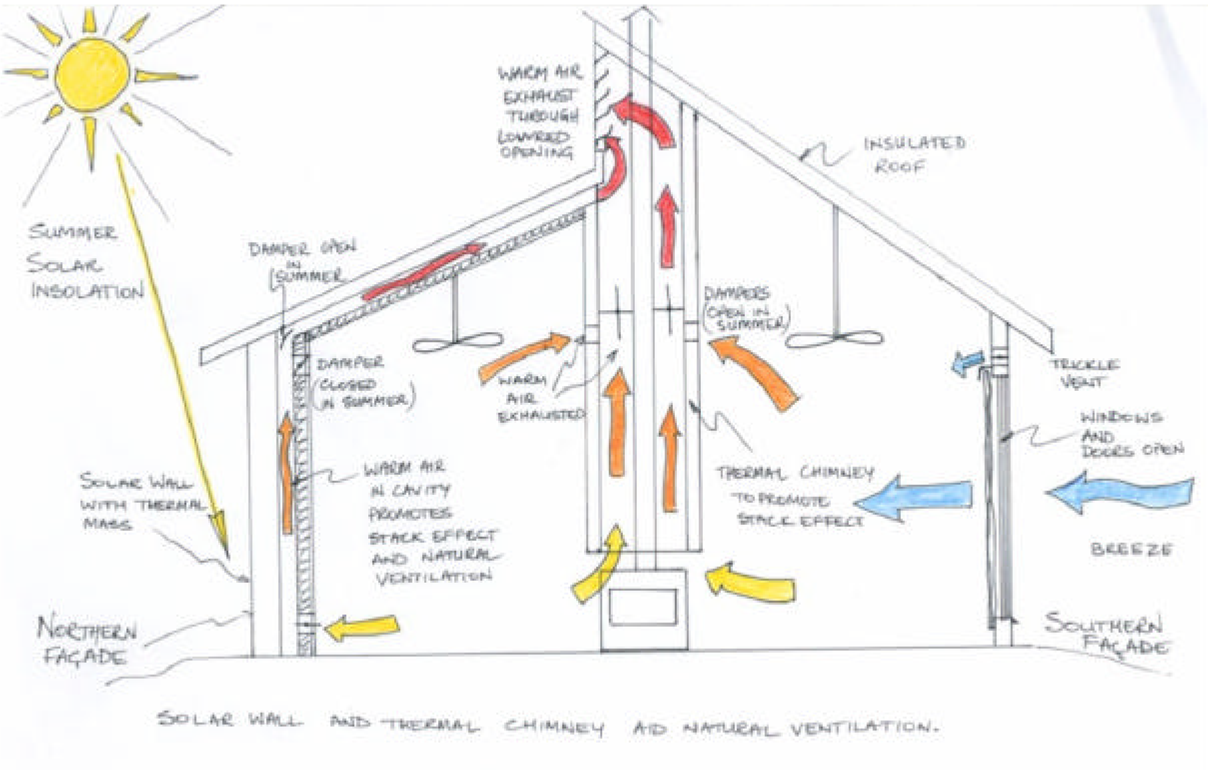


Figure 3: Natural ventilation strategies for summer

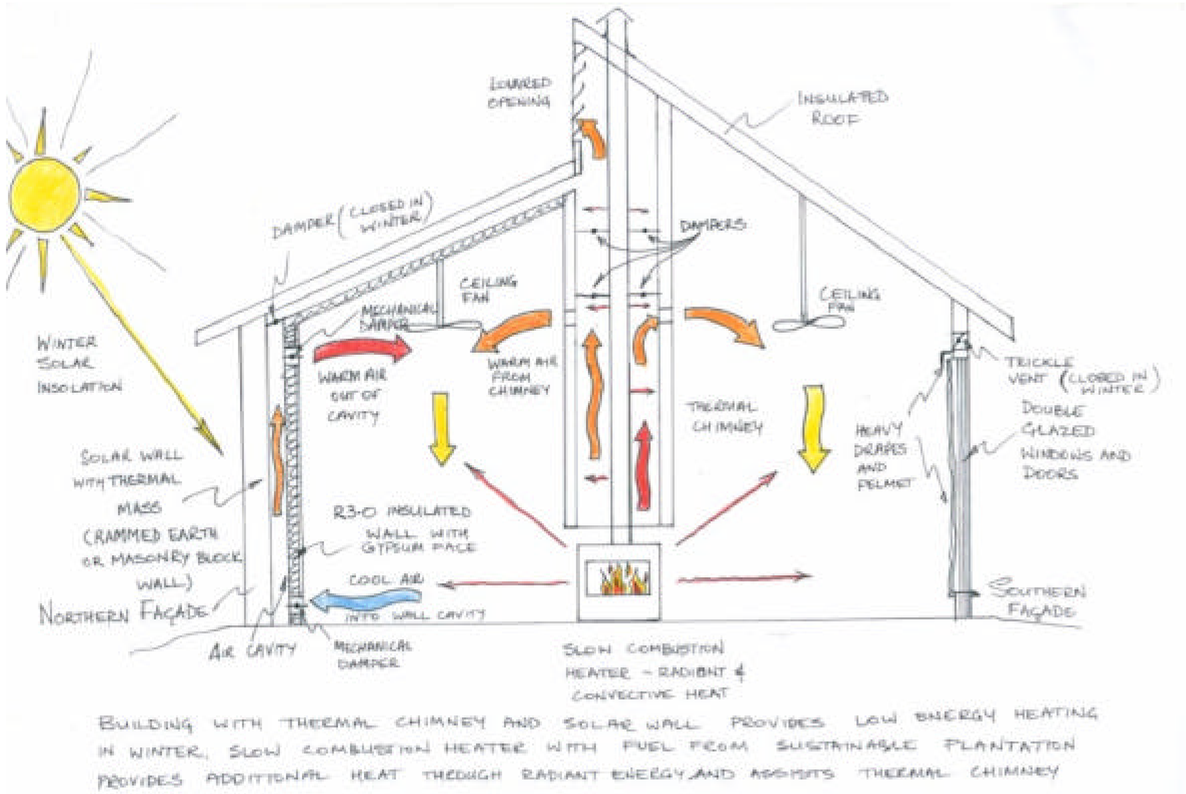


Figure 4: Natural heating and ventilation strategies for winter

It is recommended that corridors and other transit spaces be naturally ventilated only. The use of Trombe walls or solar chimneys on the northern side of buildings can be used to cool in summer and heat in winter. Solar radiation falls on the wall, warming the air in the space, which in turn produces a stack effect drawing fresh air through the building. In winter the warm airflow may be directed back into the occupied areas. (See figures 4 and 5).

The general design aspects of the residential apartments are shown in Figure 5 for different internal spaces. In summary the façade should been designed to open to allow the optimum amount of airflow while still remaining practical. Internal flows can be maximised by using full height doors that allow the flow of warm air out of the rooms and into the thermal chimney. Similarly, planter boxes with greenery can be used for shading and cooling of air before entering the space.

For the residential allotments, similar techniques should be employed in the house design.

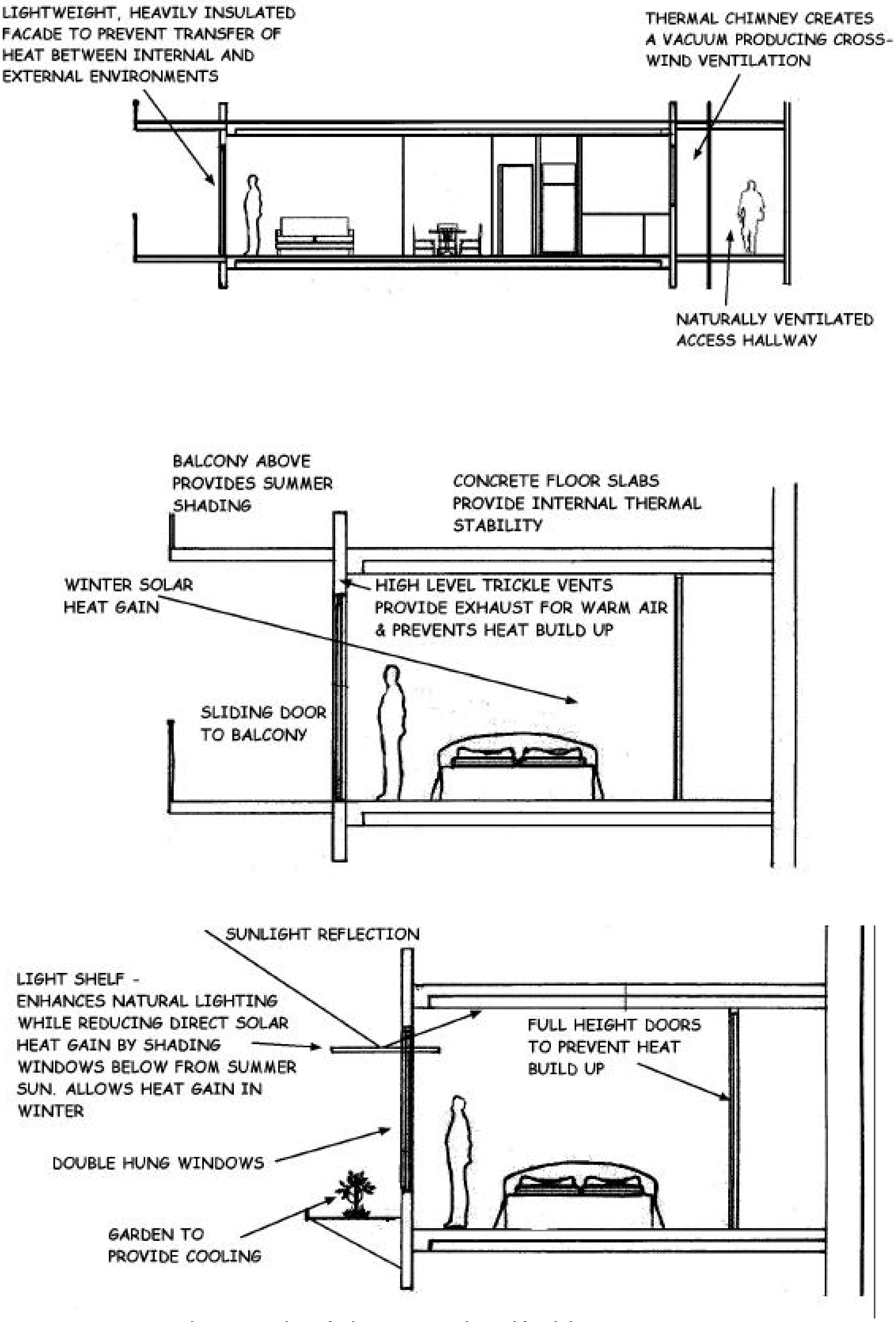


Figure 5: Various design concepts for residential apartments

7.0 POOL HEATING

7.1 Solar Pool Heating

Pools are to be installed in the spa facilities and in each of the 40 villas. Solar water heaters for pool heating are recommended. Placed on the roof of the spa facility of the villas it will provide enough hot water to keep the pool at a temperature of 25°C for about half the year.

For the pool to be used in winter months, backup heating is required. Either an electric heat pump or a gas heater can be used for this purpose.

7.2 Geothermal Pool Heating

In the same manner as providing geothermal air conditioning, heat pumps can be employed to provide energy efficient heating to the Spa Facility Pool. A dedicated in-ground loop would be provided to obtain heat from the ground and transfer it to the pool water.

8.0 TOILET EXHAUST SYSTEM

Mechanical exhaust shall be provided to serve any additional toilet facilities complete with fan, ductwork, fire dampers, volume control dampers and all necessary controls and equipment and discharge via the southern façade a minimum of 6 metres away from the nearest outside air intake.

9.0 KITCHEN EXHAUST

Mechanical kitchen exhaust shall be provided to serve the kitchen in the Main Building complete with fan, ductwork, fire dampers, volume control dampers and all necessary controls and equipment and discharge via the southern façade a minimum of 6 metres away from the nearest outside air intake

10.0 DESIGN CRITERIA

Design Conditions

The air conditioning systems to satisfy the following criteria under the most adverse combination of external solar loading and the following conditions:
Outside Design Conditions:

Summer: 35.0°C DB, 25.0°C WB
Winter: -1.5°C DB

Internal Design Conditions:

Area Served	Internal Design Conditions		Normal Operating Hours	Maximum Noise Level (NR)
	°C DB	% RH		
Main Building				
Offices	22 ± 2	(1)	12	40
Restaurant	22 ± 2	(1)	12	35
Conference Building				
Seminar Room	22 ± 2	(1)	12	35
Offices	22 ± 2	(1)	12	40
Spa Building				
Spa Facility	22 ± 2	(1)	12	40
Offices	22 ± 2	(1)	12	40
Guest Villa Buildings				
Living Areas	22 ± 2	(1)	12	35
Staff Accommodation Buildings				
Living Areas	22 ± 2	(1)	12	35

(1) Denotes no direct humidity control will be provided however inherent psychrometric characteristics will generally limit relative humidity to below 65% under most operating conditions.

(2) No humidity control.

Select plant to provide the specified performance suitable for an elevation of 565 metres.

Load Allowances

Area Served	Equipment Load W/m²	Lighting Load W/m²	Occupancy m² Per Person	Outdoor Air l/s Per Person
Offices	20	15	10	7.5
Restaurant	30	15	3	15
Seminar Room	20	15	1	15
Spa Facility	20	15	3	15
Guest Villa Living Areas	5	15	10	7.5
Staff Living Areas	5	15	10	7.5

Note: Filtration requirements to be met under AS 1668.2 otherwise higher levels required.

Facade and Structure Criteria (details to be confirmed with Architectural specification).

Material	Description Existing Glass	Parameter
Glass		Shading coefficient SC= 0.4
Walls.	Insulated external walls	Thermal coefficient U = 0.5
Floors	Concrete slab with carpet	Thermal coefficient U = 0.5
Roof	Light weight with insulation	Thermal coefficient U = 0.5