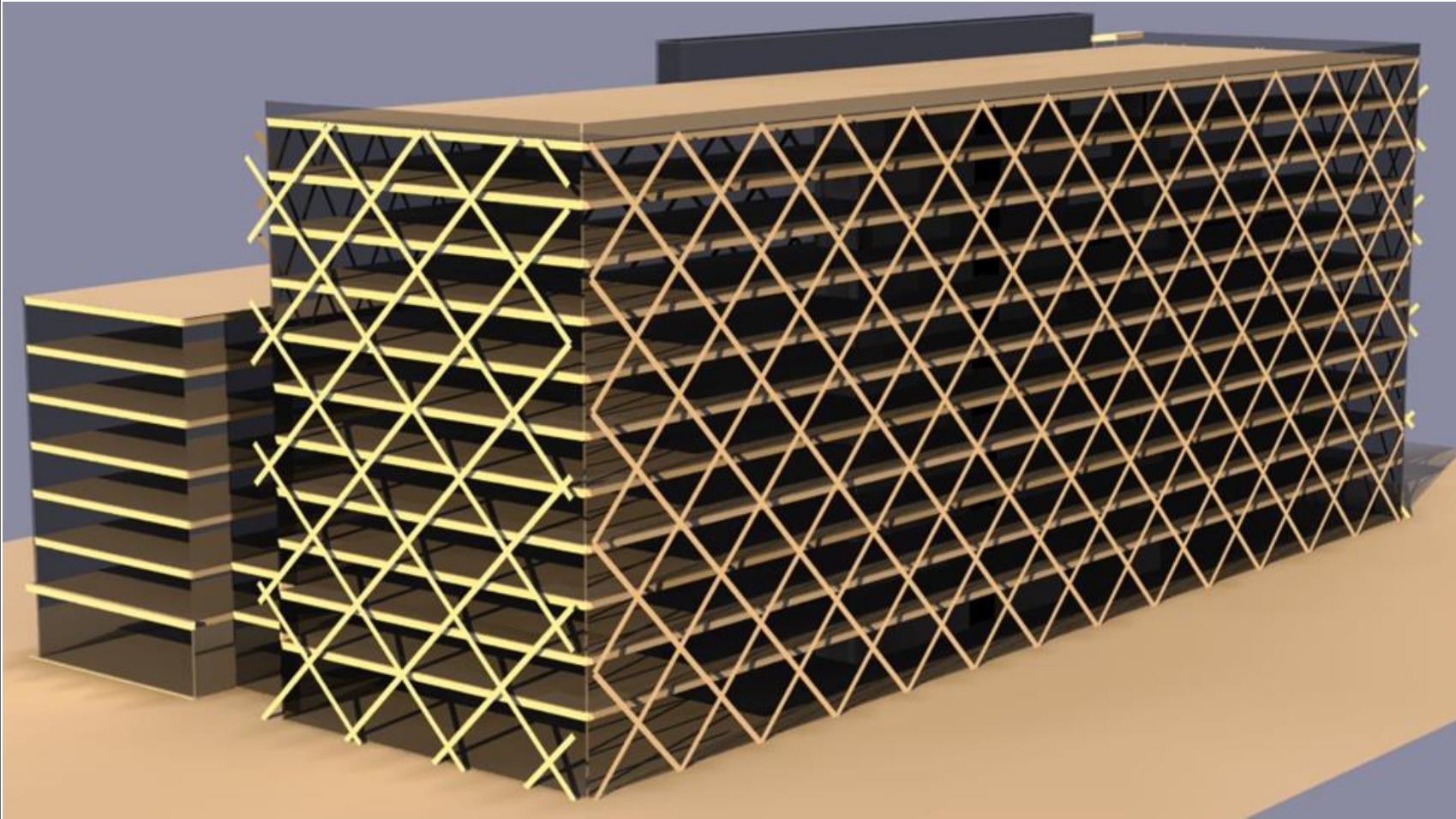
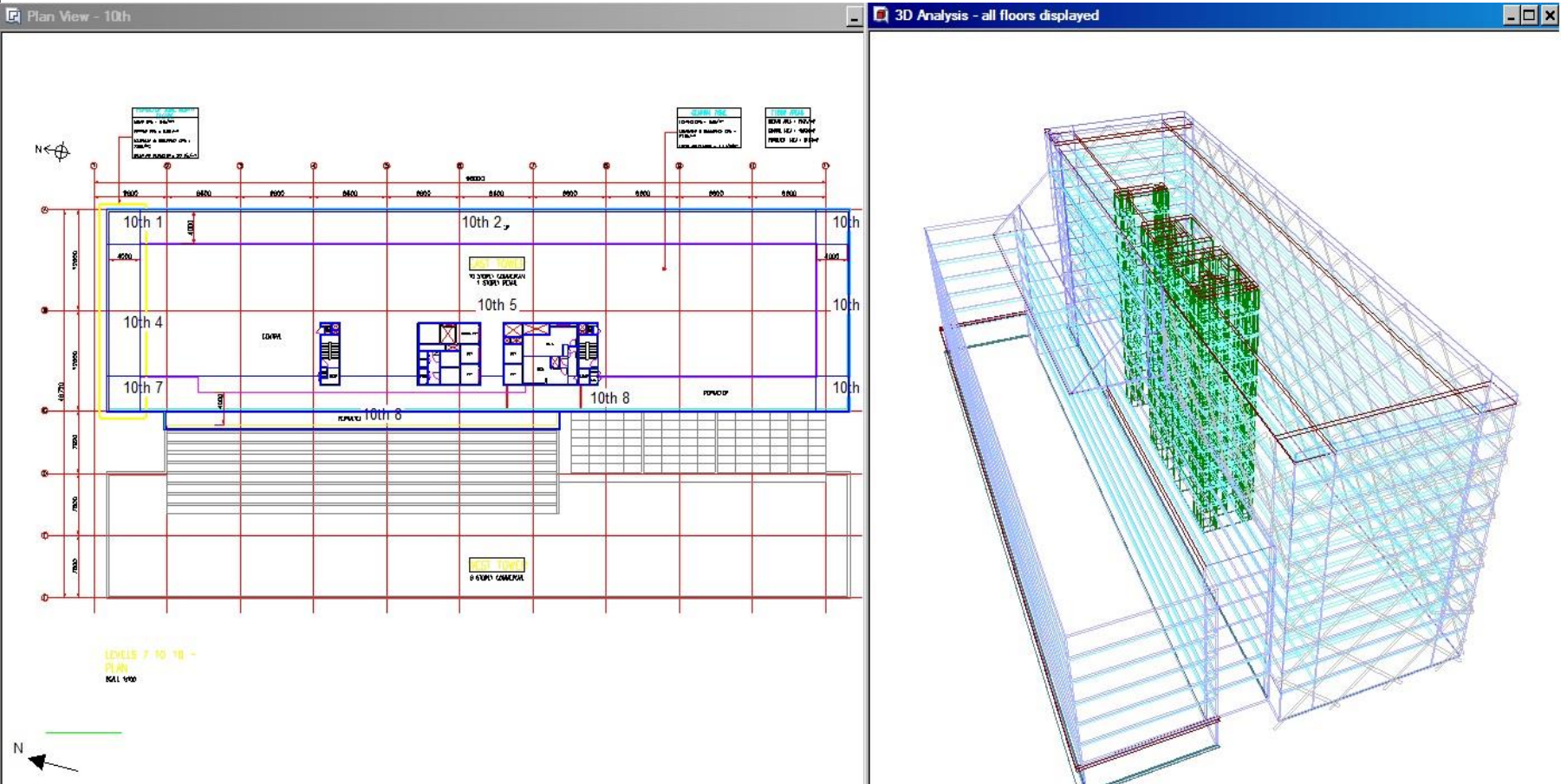


## Frenger "Radiant" chilled beam performance at 1 Shelly St - Sydney



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systems

## 3D Model Creation



1 Shelly St - Sydney

## Daylight Analysis

Tas 3D Modeller - shelley street-with shades

File Edit Building View Tools Window Workspace Analysis Daylight Help

Plan View - 10th

Daylight Factors (<)

- 0.100
- 0.300
- 0.500
- 1.000
- 1.500
- 2.000
- 2.500
- 3.000
- 3.500
- 4.000

Daylight Calculation <Current Calculation> ( 03/06/2013 13:10:15 )

Results for CIE Overcast sky on day 173 at hour 12:00

Name	Daylight Factor %	Maximum Factor	Minimum Factor	Average Lux	Maximum Lux	Minimum Lux	Uniformity (min/average)	Percentage above base
10th								
10th 1	16.221	34.919	5.768	4796.922	10326.056	1705.845	0.356	100.0
10th 2	8.766	20.968	2.861	2592.18	6200.565	846.196	0.326	100.0
10th 3	15.553	30.527	5.876	4599.201	9027.239	1737.595	0.378	100.0
10th 4	9.251	21.971	2.888	2735.578	6497.305	854.171	0.312	100.0
10th 5	1.106	4.494	0.232	326.936	1329.077	68.639	0.21	13.26
10th 6	9.161	20.087	3.197	2709.094	5940.157	945.374	0.349	100.0
10th 7	15.376	32.668	5.36	4546.887	9660.637	1584.985	0.349	100.0
10th 8	20.755	49.774	1.725	6137.452	14719.161	510.247	0.083	99.444
10th 9	16.059	32.886	5.757	4748.892	9725.08	1702.389	0.358	100.0

Base (for % above) 2.0

Daylight Calculations

Sky:  CIE  IESNA Overcast Day 21 Month June Hour 12

Use sky settings for building analysis

Calculation Areas

Working plane height 0.7m

Area margin from walls 0.5m

Display Grid Size 0.5m

Accuracy

Reflectance convergence for preview

Results

1 Shelly St - Sydney



## Comparison of the performance of various HVAC systems at 1 Shelly St, Sydney

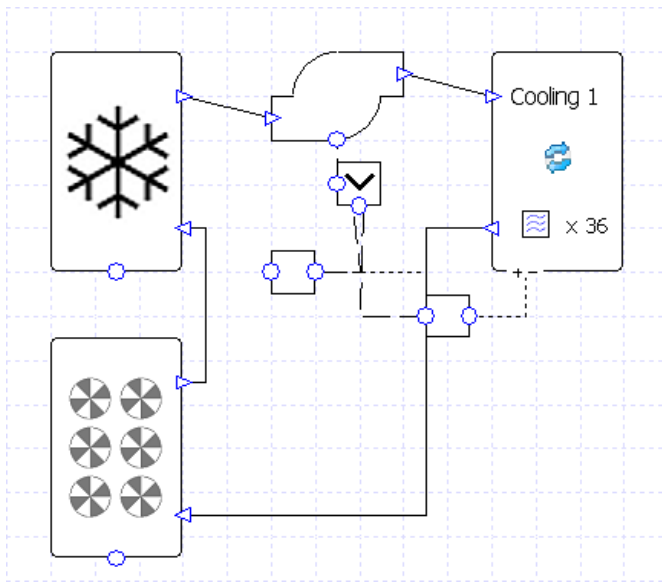
- VAV fancoil
- Active chilled beam
- Passive chilled beam (95% convective / 5% radiant absorption)
- Passive “Radiant” chilled beam (65% convective / 35% radiant absorption)
- Traditional VAV
- Modern VAV (temperature and CO2 control with “static reset”)

*1 Shelly St - Sydney*

## Systems Setup – Cooling Circuit

Cooling circuit (common to all air side systems)

Chiller has a COP of 4 (typical chiller performance based on flow of 6°C and return temp of 12°C). Addition of Dry Air Cooler for free cooling when available. DAC efficiency = 67%, SFP of fans = 0.4W/l/s

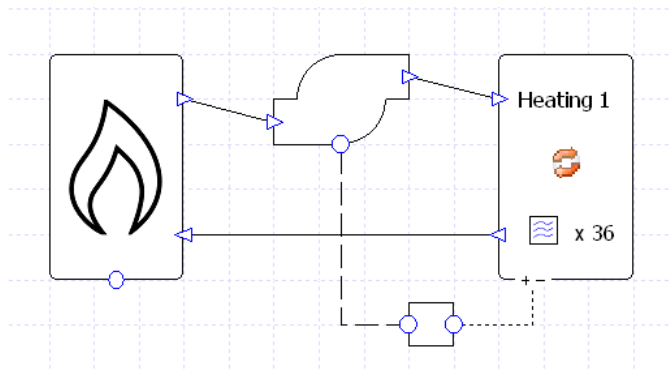


1 Shelly St - Sydney

## Systems Setup – Heating Circuit

Heating circuit (common to all air side systems)

Boiler has an efficiency of 90% and a flow set point of 65°C.  
DHWS also fed from this circuit.



1 Shelly St - Sydney

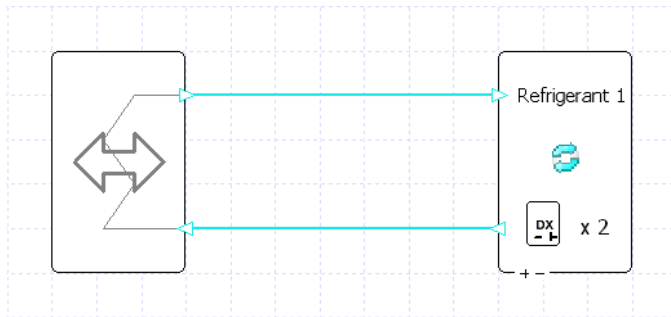
## Systems Setup – DX Circuit

DX circuit - common to all air side systems

Nominal heating energy input ratio 0.261 (COP = 3.83)

Nominal cooling energy input ratio 0.307 (COP = 3.26)

(Performance taken from typical Mitsubishi VRF heat recovery unit)



*1 Shelly St - Sydney*

## Systems Setup – VAV Fancoil

### VAV fancoil air side

A high efficiency chiller supplies chilled water at 6°C to the fan coils with a nominal return temperature of 12°C.

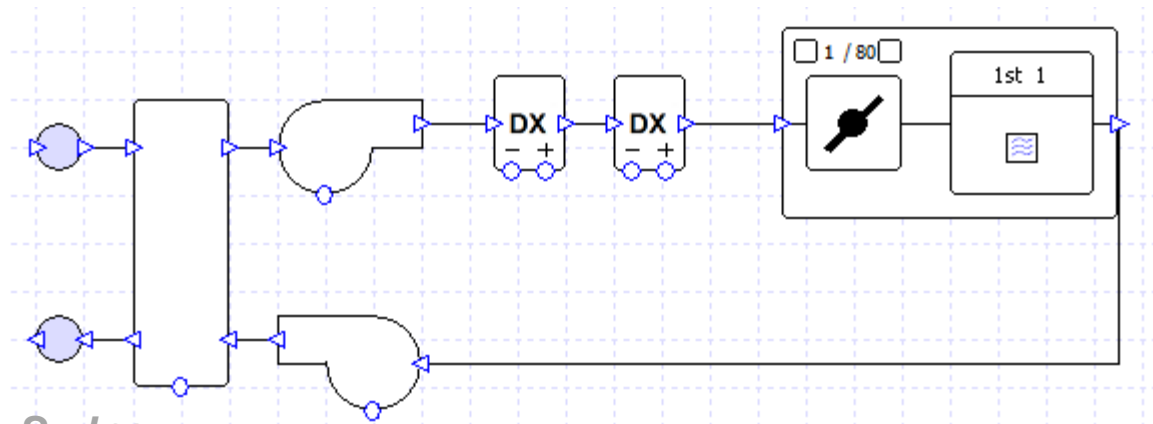
An air source heat pump supplies heating and cooling to the DX coils in the AHU

The AHU is based on a total SFP of 1.8 W/l/s and includes heat recovery at 75% efficiency and provides air to the fan coil units at 14°C.

The fresh air flow rate is 2.2 l/s/m<sup>2</sup> for perimeter zones and 1.1 l/s/m<sup>2</sup> for core zones.

The fan coil units include EC motors and VAV control and have an SFP of 0.25 W/l/s.

The fan coil units have a minimum flow turndown to 60% of the maximum flow rate.



1 Shelly St - Sydney



## Systems Setup – Active Chilled Beam

### Active chilled beam air side

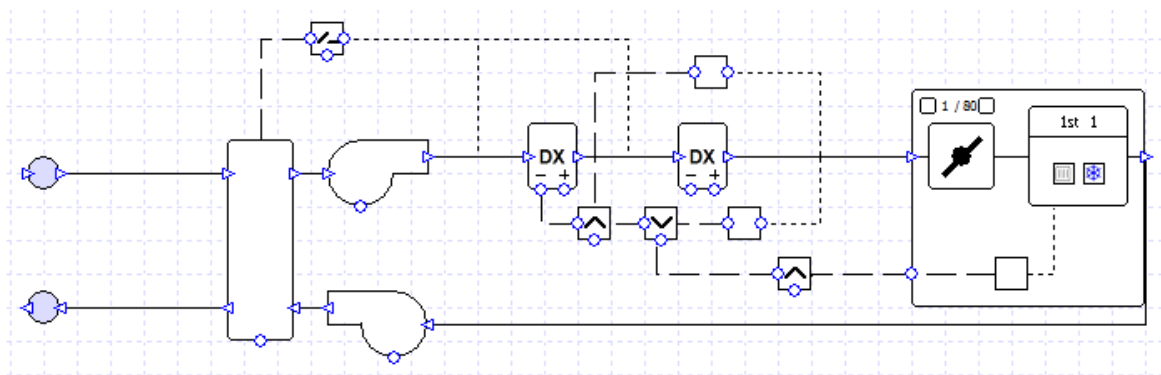
A dedicated high efficiency chiller supplies 14°C water to the chilled beams; the chiller incorporates a "Free Cooling" circuit so that when the outdoor conditions permit the chiller can turn off. During other times the free cooling runs in conjunction with the chiller to further reduce energy usage.

The pump speed is varied to ensure the chilled water return is 3K higher than the supply.

A DX cooling coil provides the conditioned air at 16°C but also provides sufficient dehumidification of the supply air, to ensure latent gains within the space are controlled and maintains the dew point at 1.0°C lower than the chilled water flow temperature onto the beams.

A DX heating coil provides the conditioned air at 13°C and supplies reheat during dehumidification. The AHU is based on a total SFP of 1.8 W/l/s and includes heat recovery at 75% efficiency.

The fresh air flow rate is 2.2 l/s/m<sup>2</sup> for perimeter zones and 1.1 l/s/m<sup>2</sup> for core zones.



1 Shelly St - Sydney

## Systems Setup – Passive Chilled Beam

### Passive chilled beam air side system (common to both radiant and / convective)

Two passive chilled beam systems were modelled; one with a 5% radiant proportion and one with a 35% radiant proportion. The room thermostat setpoint for cooling was increased by 1°C for the 35% radiant case, to compensate for the lower resultant temperatures.

A dedicated high efficiency chiller supplies 15°C water to the chilled beams; the chiller incorporates a "Free Cooling" circuit so that when the outdoor conditions permit the chiller can turn off. During other times the free cooling runs in conjunction with the chiller to further reduce energy usage.

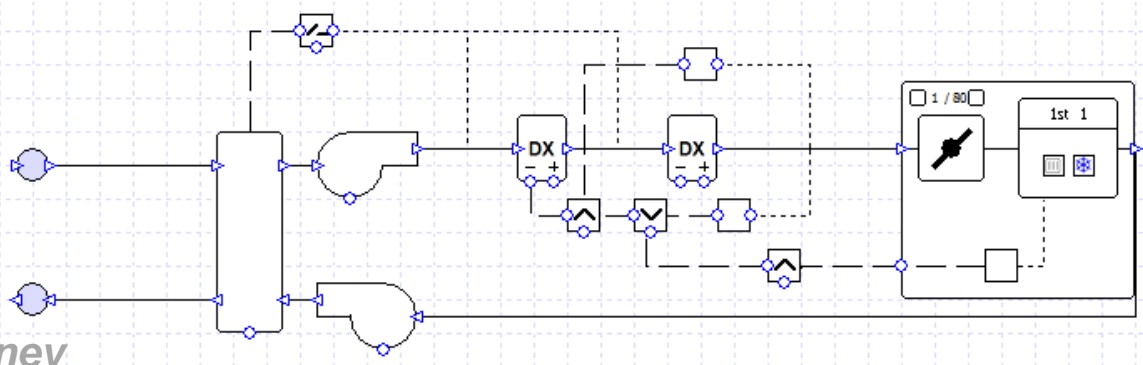
The pump speed is varied to ensure the chilled water return is 3K higher than the supply.

A DX cooling coil provides the conditioned air at 16°C but also provides sufficient dehumidification of the supply air, to ensure latent gains within the space are controlled and maintains the dew point at 1.0°C lower than the chilled water flow temperature onto the beams.

A DX heating coil provides the conditioned air at 16°C and supplies reheat during dehumidification.

The AHU is based on a total SFP of 1.8 W/l/s and includes heat recovery at 75% efficiency.

The fresh air flow rate is 2.2 l/s/m<sup>2</sup> for perimeter zones and 1.1 l/s/m<sup>2</sup> for core zones.



1 Shelly St - Sydney

## Systems Setup – Traditional VAV

### Traditional VAV air side

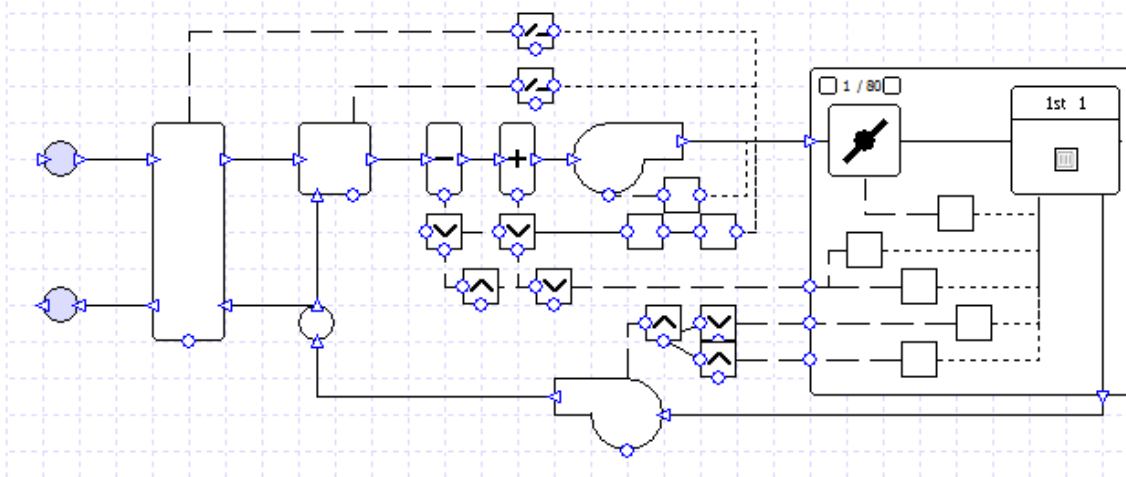
A high efficiency chiller supplies chilled water at 6°C to the cooling coil with a nominal return temperature of 12°C.

The VAV system is based on a total SFP of 1.8 W/l/s and includes heat recovery at 75% efficiency and provide air to the zones to meet the heating and cooling demands.

The fresh air flow rate is 2.2 l/s/m<sup>2</sup> for perimeter zones and 1.1 l/s/m<sup>2</sup> for core zones.

The zone dampers are set up to control air flow based on zone temperature requirements.

The supply fan is controlled to maintain a constant static pressure.



1 Shelly St - Sydney

## Systems Setup – Modern VAV

### Modern VAV air side

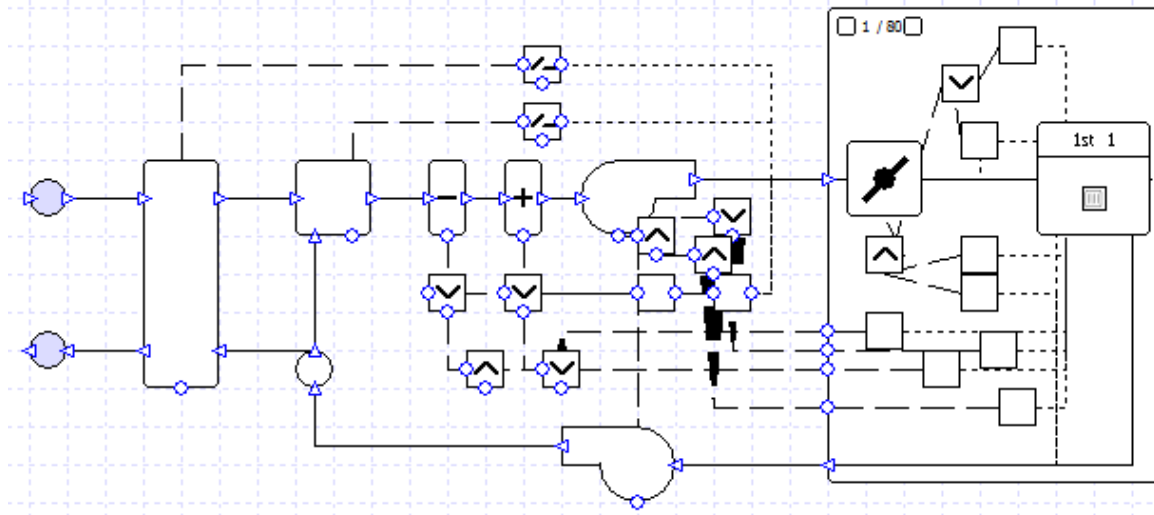
A high efficiency chiller supplies chilled water at 6°C to the cooling coils with a nominal return temperature of 12°C.

The VAV system is based on a total SFP of 1.8 W/l/s and includes heat recovery at 75% efficiency and provide air to the zones based on heating and cooling demand.

The fresh air flow rate is 2.2 l/s/m<sup>2</sup> for perimeter zones and 1.1 l/s/m<sup>2</sup> for core zones.

The zone dampers are set up to control air flow based on zone temperature requirements and CO<sub>2</sub> levels.

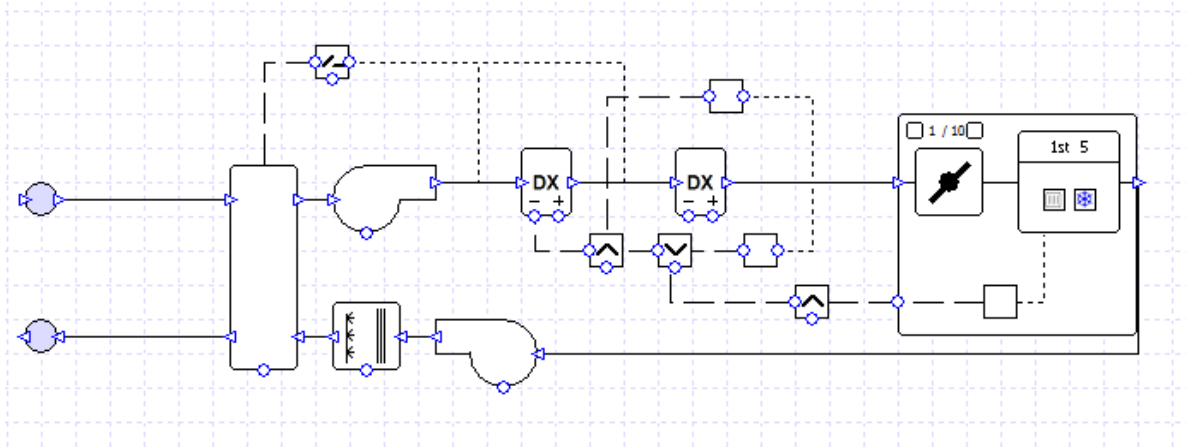
The supply and return fans are controlled to give “static pressure reset” as described in Ashrae 90.1.



1 Shelly St - Sydney

## Systems Setup – Frenger ‘Radiant’ Chilled Beam (A)

Passive chilled (65% convective / 35% radiant absorption) beam air side  
Evaporative cooling of exhaust air before heat recovery.

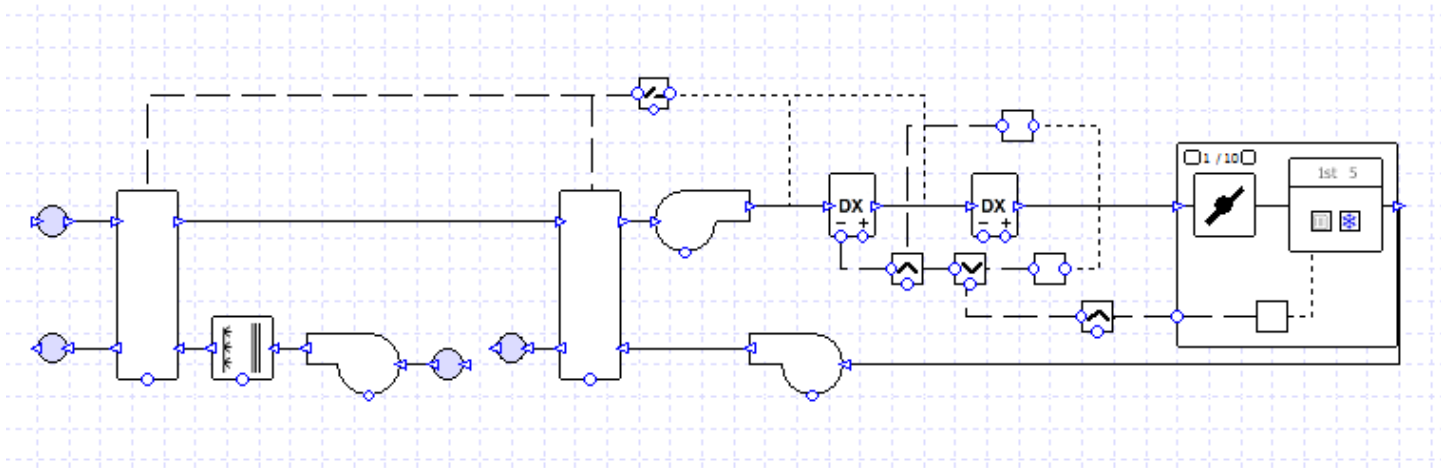


1 Shelly St - Sydney

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## Systems Setup – Frenger ‘Radiant’ Chilled Beam (B)

Passive chilled (65% convective / 35% radiant absorption) beam air side  
Evaporative cooling and sensible heat recovery on fresh air.



1 Shelly St - Sydney

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## Results of the various different air conditioning systems modelled for 1 Shelly St building, Sydney.

	Heating (kWh)	Cooling (kWh)	Auxiliary (kWh)	Total (kWh)
VAV fancoil	84,504.39	541,862.09	252,238.47	878,604.95
Active beam	84,468.56	529,660.69	203,059.41	817,188.66
Passive Beam (95% Convective / 5% Radiant absorption)	87,021.97	509,811.69	206,553.40	803,387.06
Frenger "Radiant" Passive Beam (65% Convective / 35% Radiant absorption)	86,836.56	454,034.25	203,257.08	744,127.89
Traditional VAV	365,106.69	663,804.59	389,736.06	1,418,647.34
Modern VAV	86,167.17	609,406.33	276,391.29	971,964.79

From the above results the Frenger "Radiant" passive beam system consumes the least energy for the building modelled.

	Heating (kWh)	Cooling (kWh)	Auxiliary (kWh)	Total (kWh)
Frenger "Radiant" Passive Beam (65% Convective / 35% Radiant absorption)	86,836.56	454,034.25	203,257.08	744,127.89

By applying evaporative cooling on the exhaust air further energy savings can be achieved, however when applied to the fresh air system additional energy would be consumed.

	Heating (kWh)	Cooling (kWh)	Auxiliary (kWh)	Total (kWh)
Evaporative cooling on exhaust air	88,454.71	411,994.34	209,178.74	709,178.93
Evaporative cooling on fresh air	88,319.67	383,777.83	282,394.64	754,491.95

1 Shelly St - Sydney

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