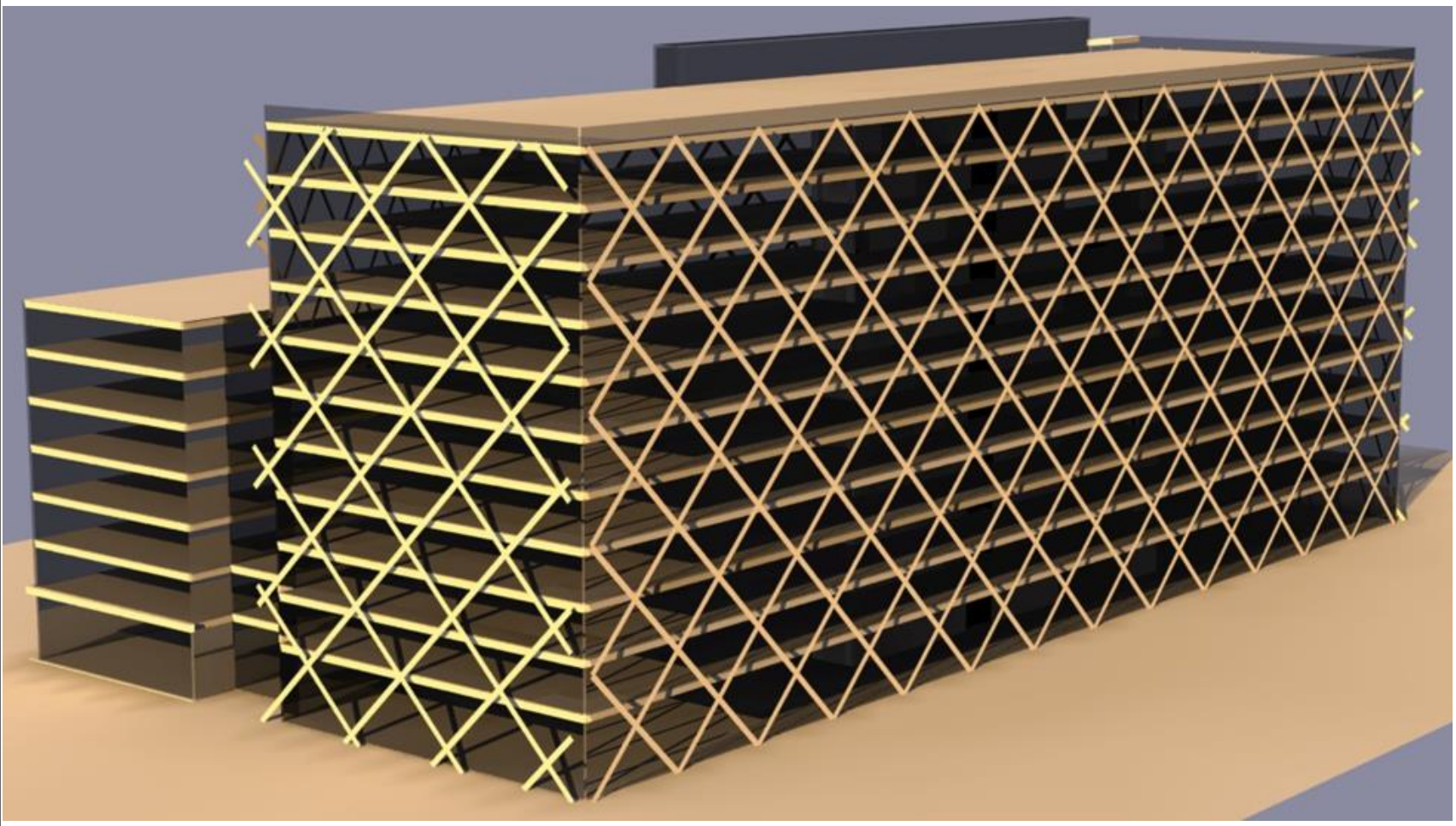
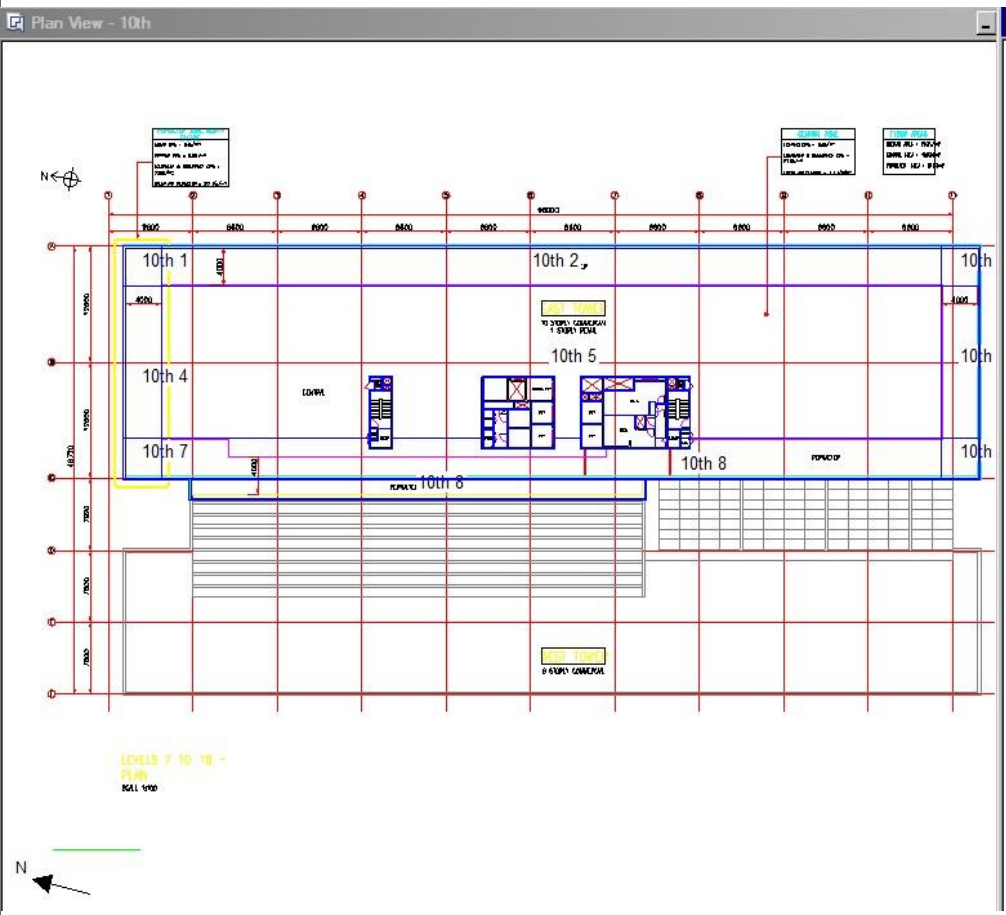
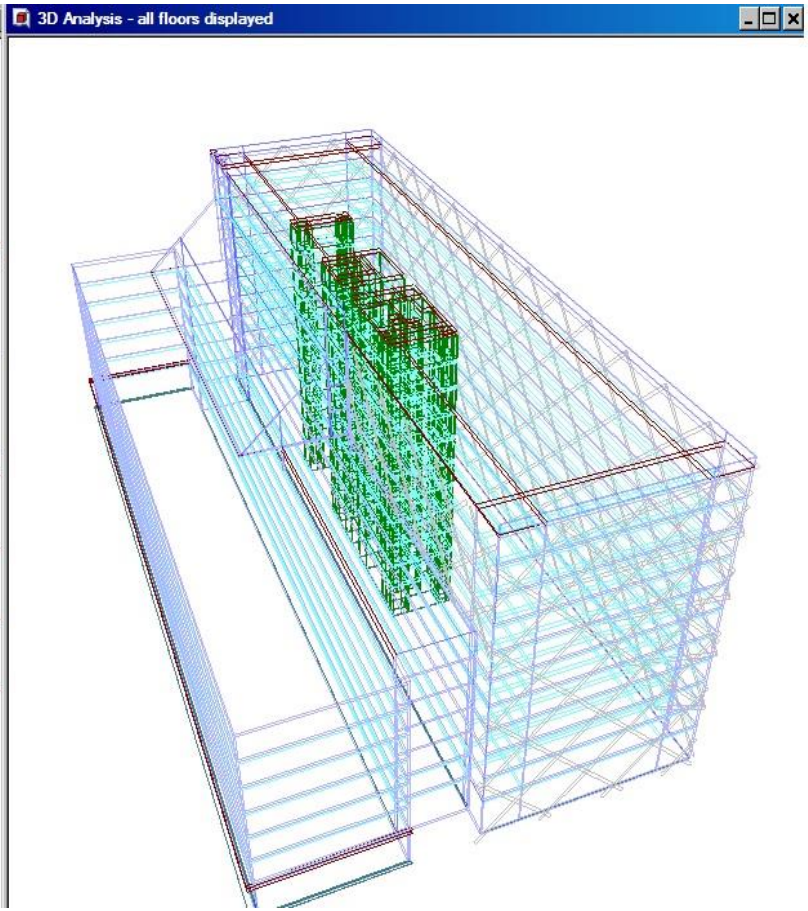
Frenger “Radiant” chilled beam performance at 1 Shelly St - Sydney



FRENGER® systems

3D Model Creation

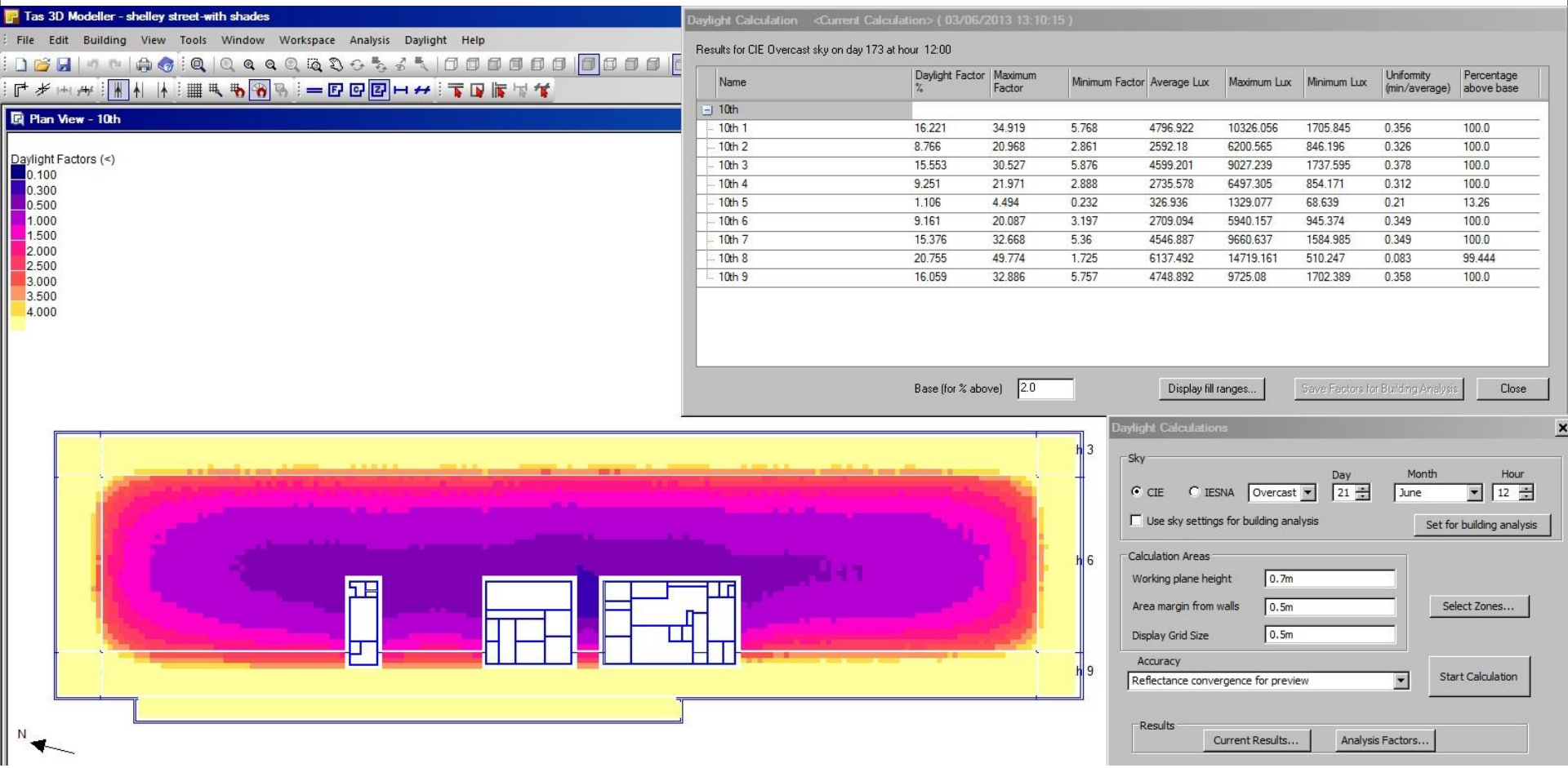




1 Shelly St - Sydney

FRENGER systems

Daylight Analysis



1 Shelly St - Sydney

FRENGER systems

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

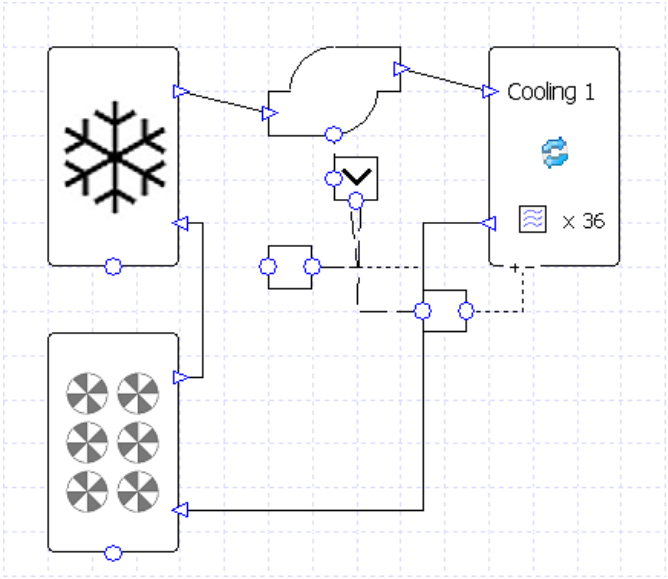
- VAV fancoil
- Active chilled beam
- Passive chilled beam (95% convective / 5% radiant absorption)
- Passive “Radiant” chilled beam (65% convective / 35% radiant absorption)
- Traditional VAV
- Modern VAV (temperature and CO2 control with “static reset”)

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

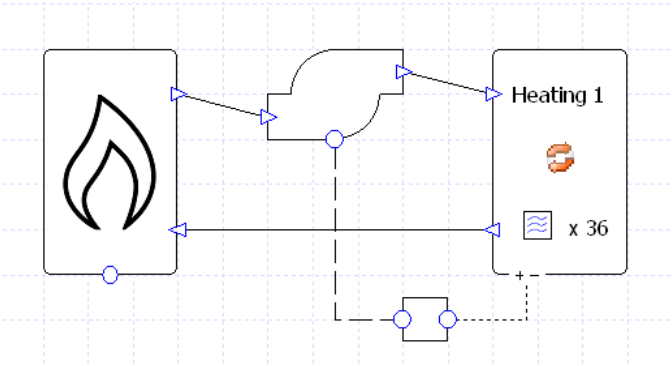


1 Shelly St - Sydney

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.

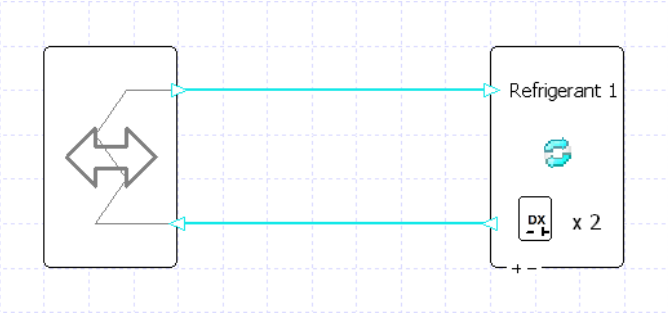


1 Shelly St - Sydney

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)

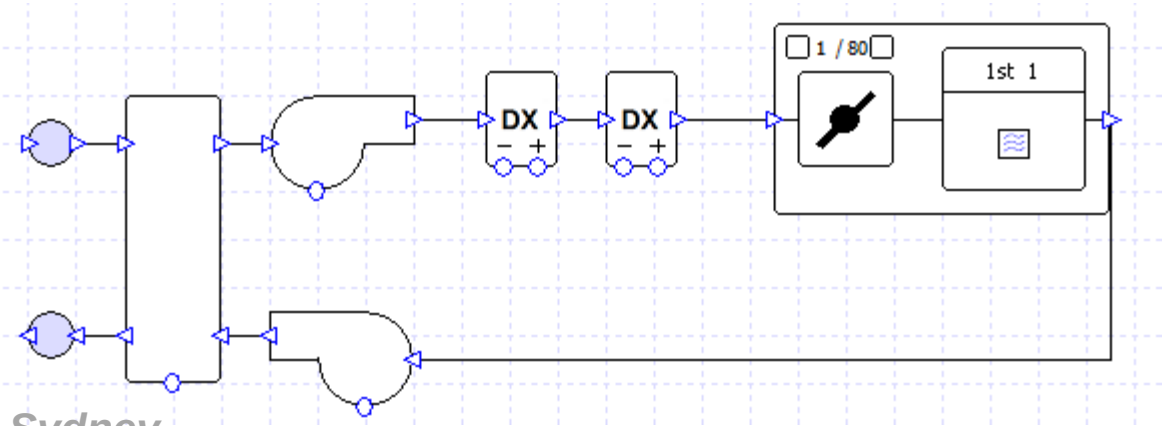


1 Shelly St - Sydney

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^2 for perimeter zones and 1.1 l/s/m^2 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.

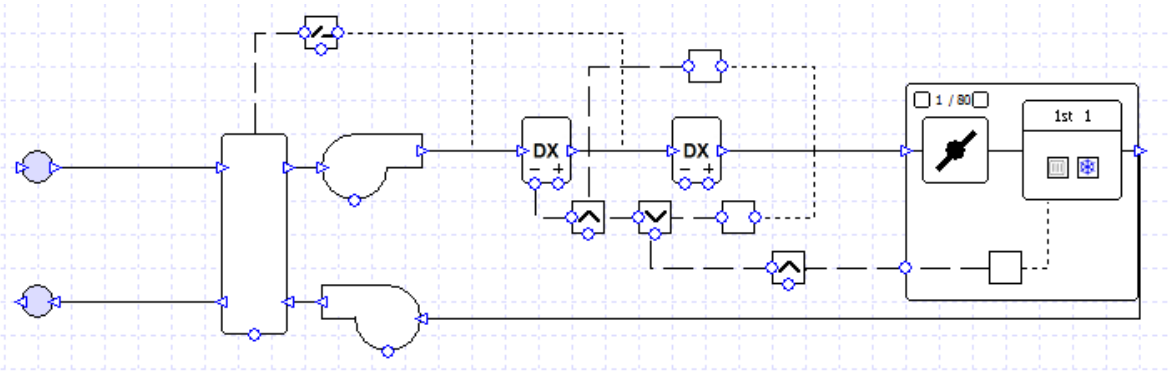


1 Shelly St - Sydney

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^2 for perimeter zones and 1.1 l/s/m^2 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.

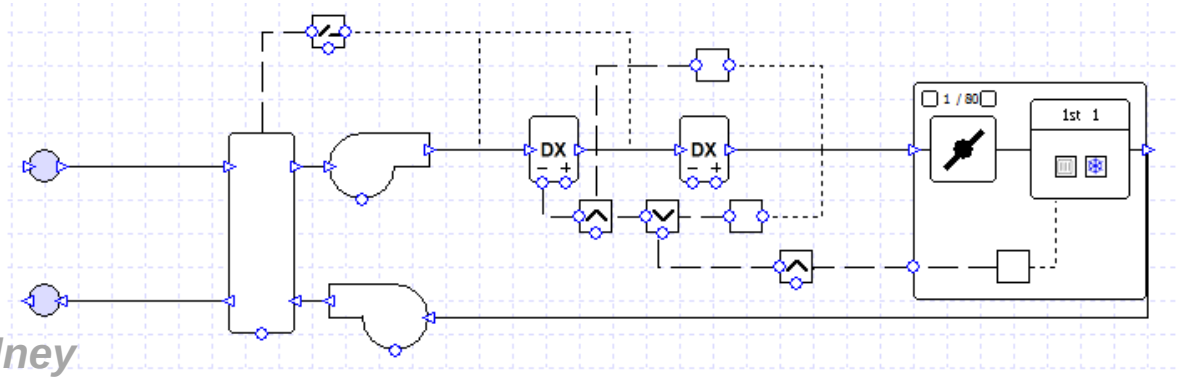
The pump speed is varied to ensure the chilled water return is 3K higher than the supply.

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^2 for perimeter zones and 1.1 l/s/m^2 for core zones.

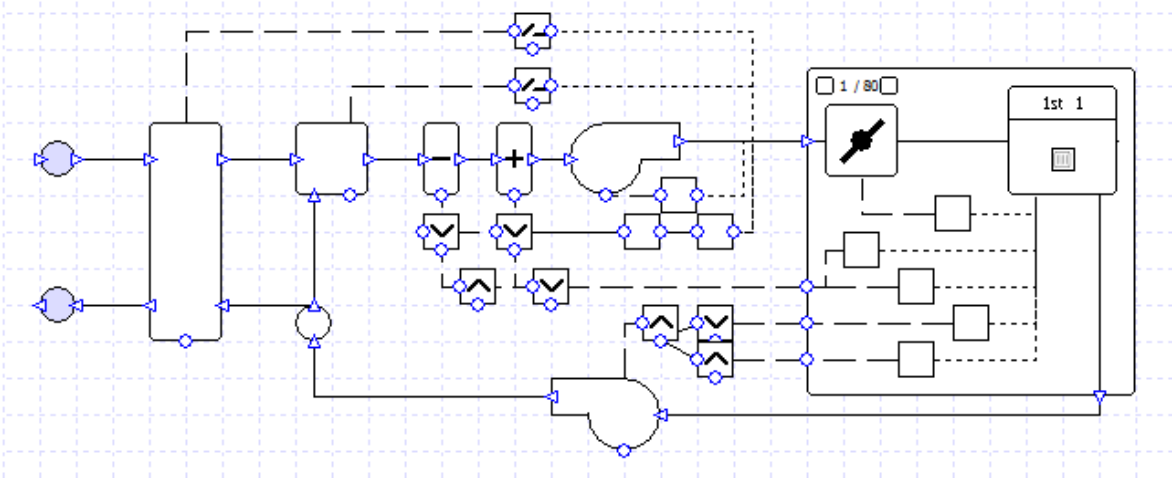


1 Shelly St - Sydney

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^2 for perimeter zones and 1.1 l/s/m^2 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.

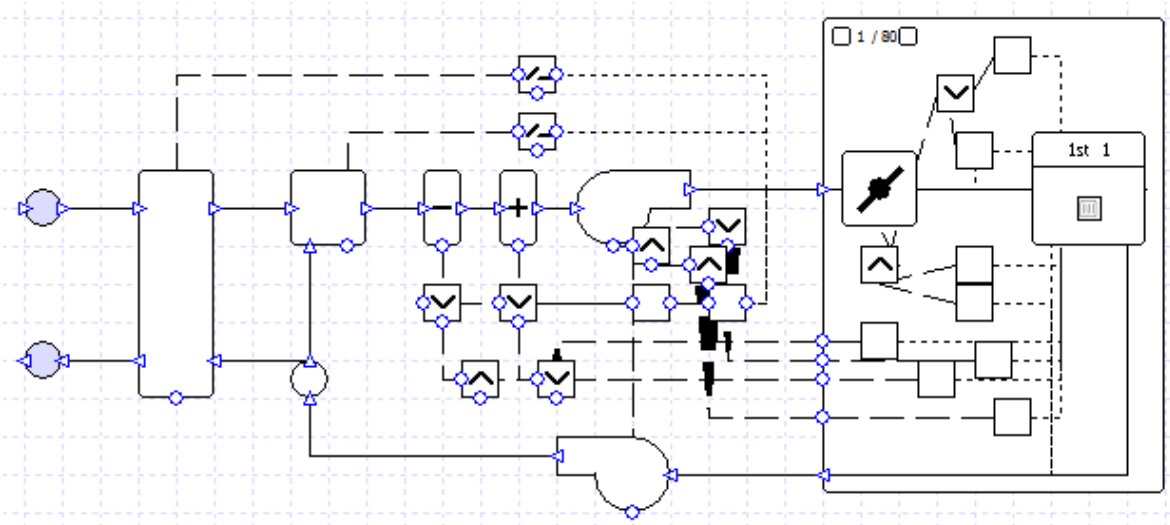


1 Shelly St - Sydney

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^2 for perimeter zones and 1.1 l/s/m^2 for core zones.
The zone dampers are set up to control air flow based on zone temperature requirements and CO_2 levels.
The supply and return fans are controlled to give “static pressure reset” as described in Ashrae 90.1.

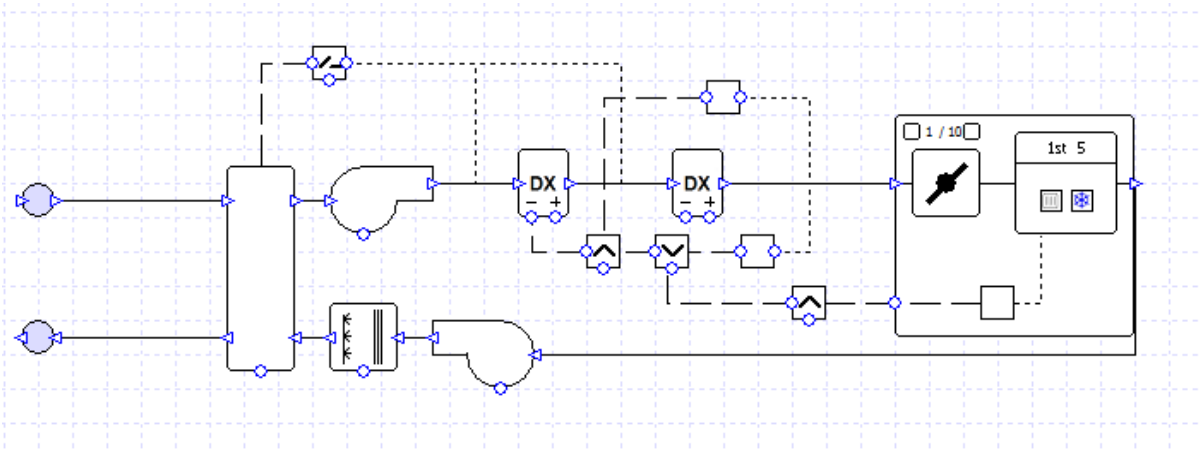


1 Shelly St - Sydney

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.



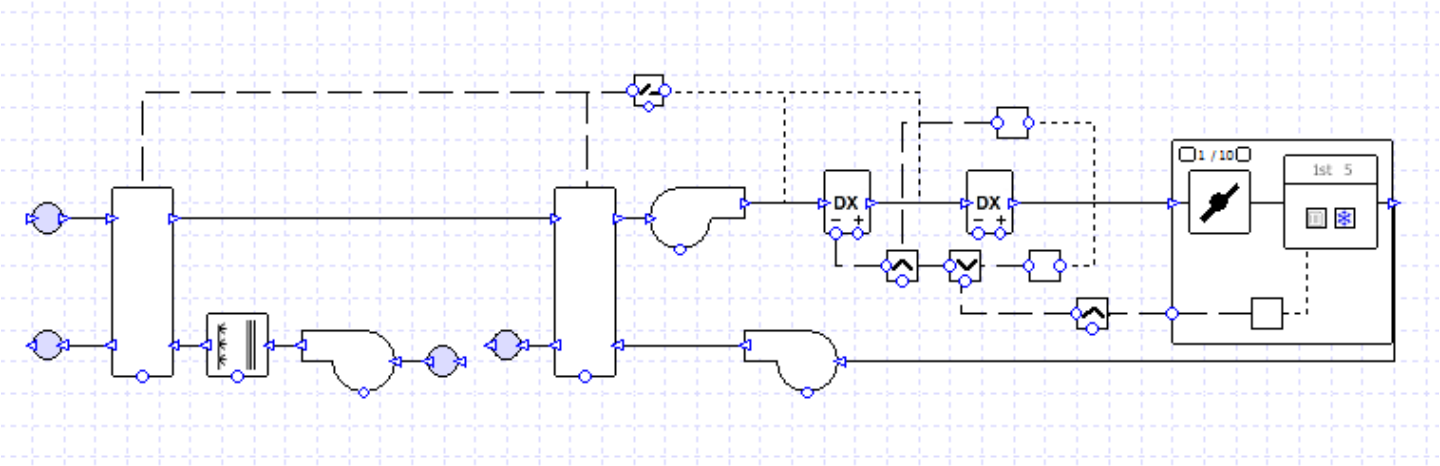
1 Shelly St - Sydney

FRENGER systems

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

FRENGER systems

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

FRENGER systems