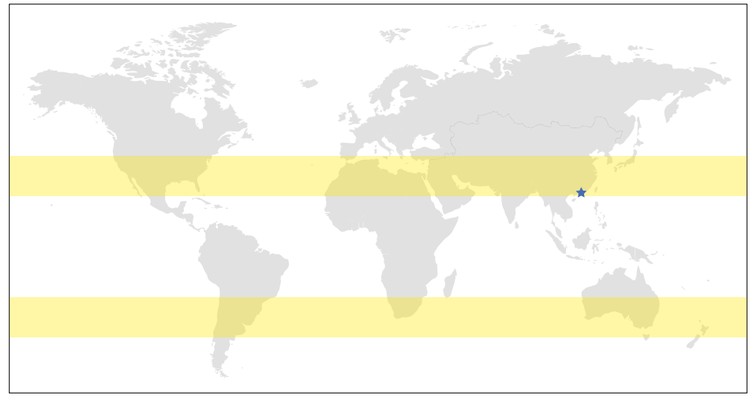
Hong Kong

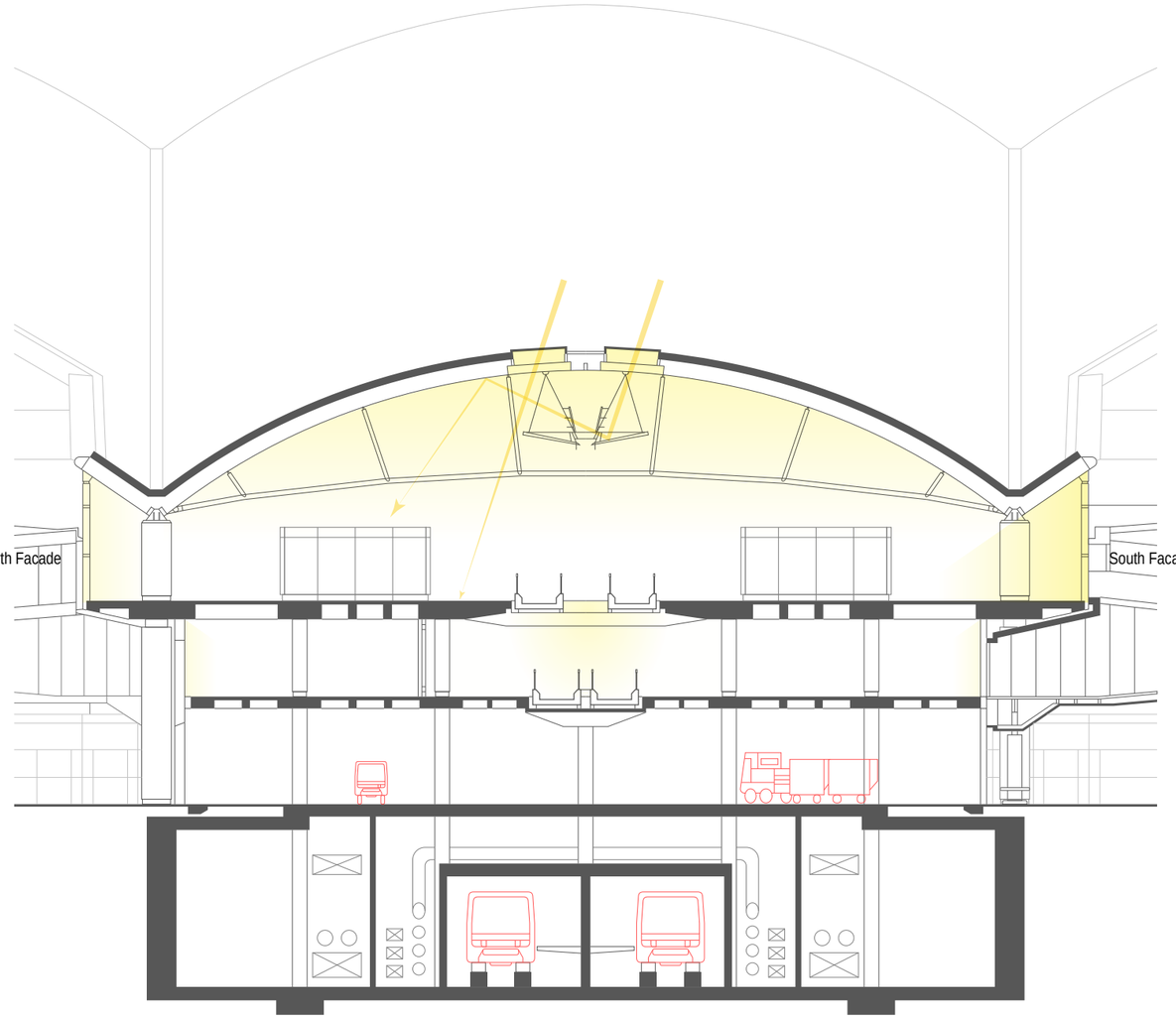
Hong Kong International Airport

Things to consider for design:

- Subtropical climate
- Humid & hot
- Tropical cyclones
- HVAC loads at large scale
- Daylight at lower floors

Subtropical Climate Locations

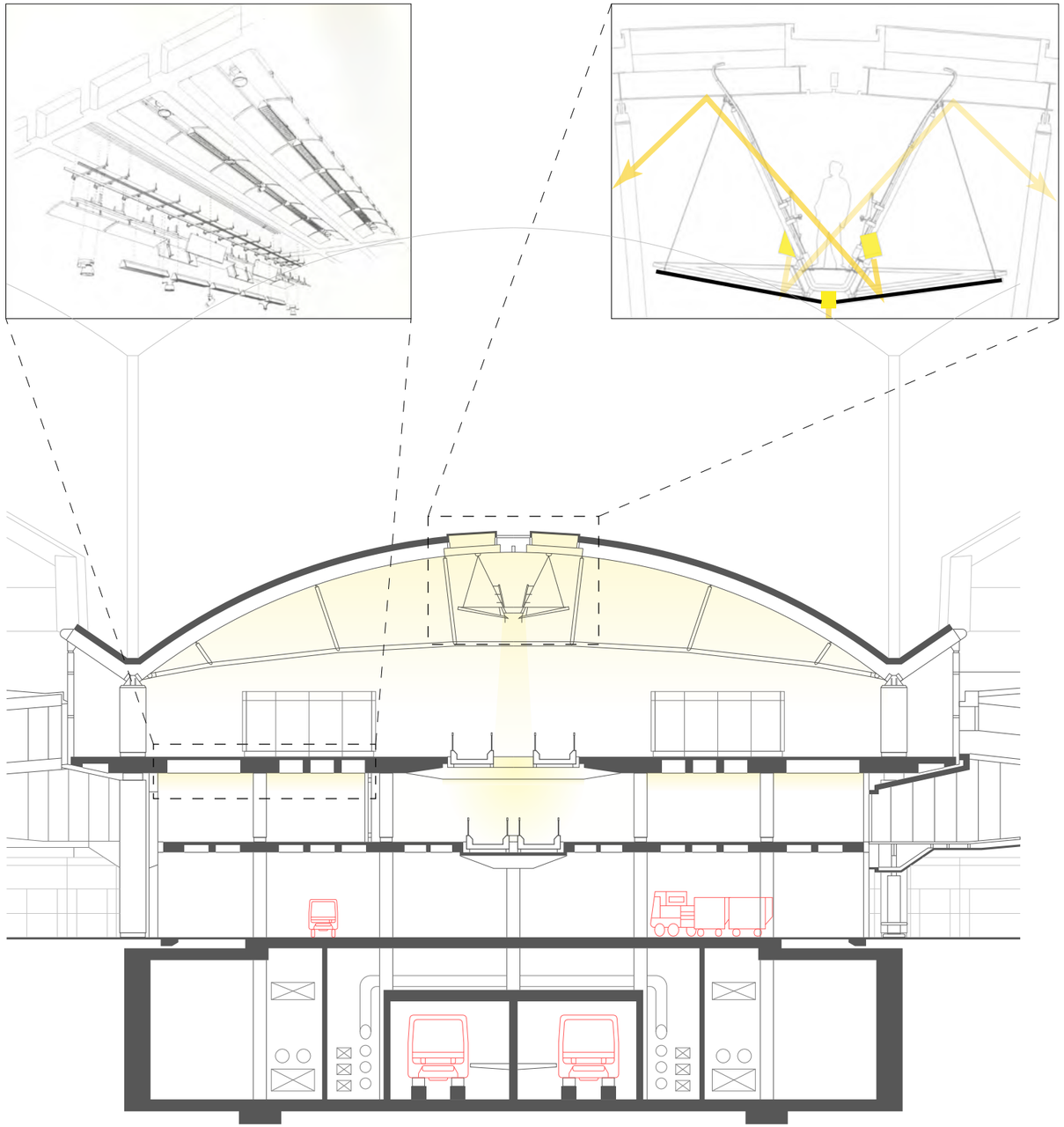




Reflectors along centre of roof to reflect diffused light into the space

Glazing between the two moving walkways to allow light to enter the arrivals concourse

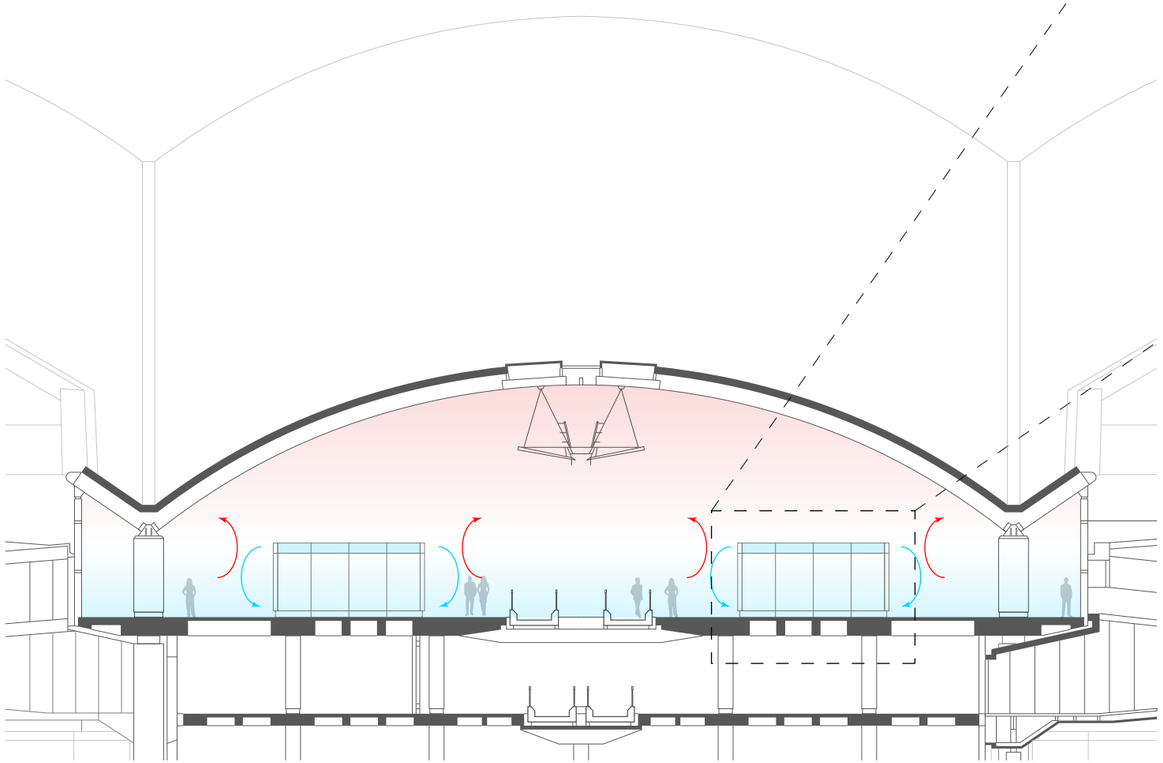
Daylight through skylights reflecting off reflectors & ceiling for comfortable indirect ambient light



Effect of the lights reflecting off of the reflectors and roof at night

Artificial lighting along border control (and for baggage claim)

Artificial uplighting reflecting off reflectors & ceiling for comfortable indirect ambient light



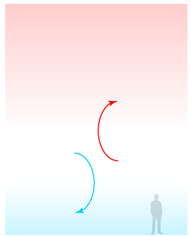
“Binnacle” detail

Drum louvers above at check-in islands

Jet nozzles at both ends of check-in islands

“Binnacle” with drum louvers

Stacked Ventilation



Hot air rises

Buffer Zone (right above passengers)

Cold air sinks

*Note: with this concept, if a fire were to occur in the airport, the smoke would rise up to the very high roof (well above the level that would harm occupants), which allows for adequate time for occupants to evacuate the building. Smaller compartments aren’t necessary.

Design conditions for heating/cooling loads:

Summer space: 24°C ± 2°C DB, 55% RH
Winter space: 20°C ± 2°C DB
Outside air: 7.5 L s-1 per person

Chilled water provided at 7.0°C and returned at 13.5°C

Don’t try to cool the entire space! Supply cold close to the floor where people actually are.

Air-handling is decentralised in the Hong Kong International Airport. This allows for minimised horizontal ducting and the effects of breakdowns.

Air is distributed into the large volume areas of the airport through free standing rises called “binnacles”. Each binnacle consists of a series of long throw air outlets of either drum louvers or jet nozzles, all of which are situated above head height on the concourse instead of from the roof. The other method of air distribution is through cladding line distribution located in the Arrivals Concourse corridors and retail malls. The air is served from grilles and louvers located in cladding panels on the walls. Ductwork is run through the ceilign spaces of those areas.

Using binnacles to supply air and cooling while utilising stacked ventilation

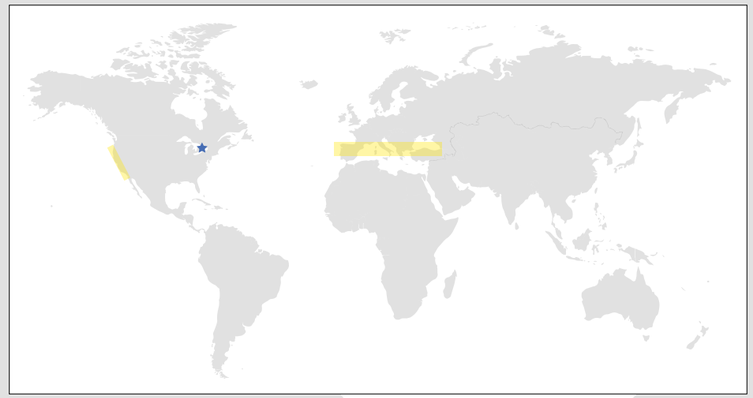
Madrid Barajas Airport - T4

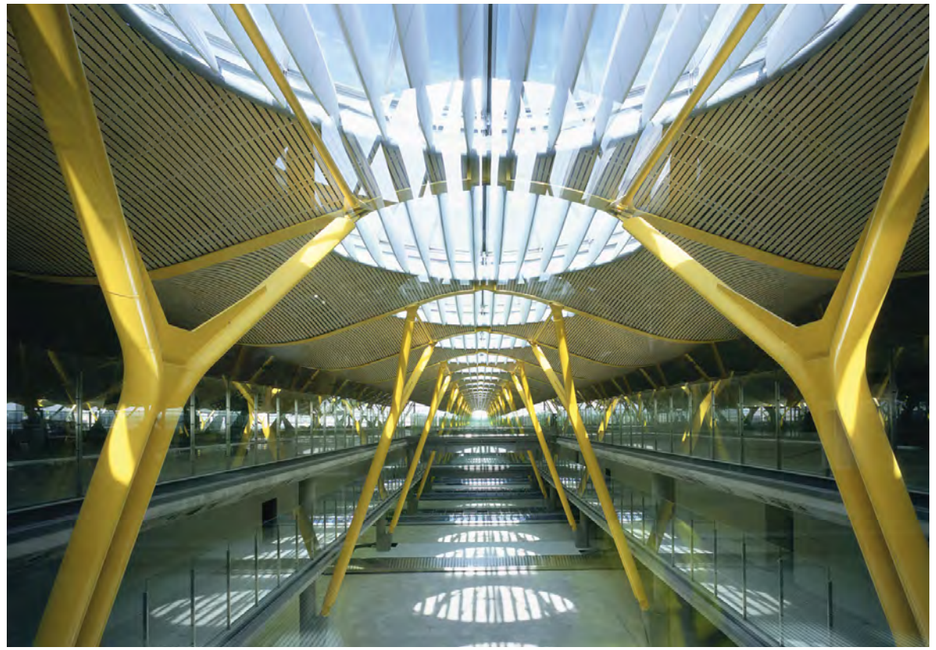
Things to consider for design:

- Summer cooling & extracting heat
- Minimising heat gain
- Illuminating multiple floors
- Maintaining dynamic roof undulation

Madrid

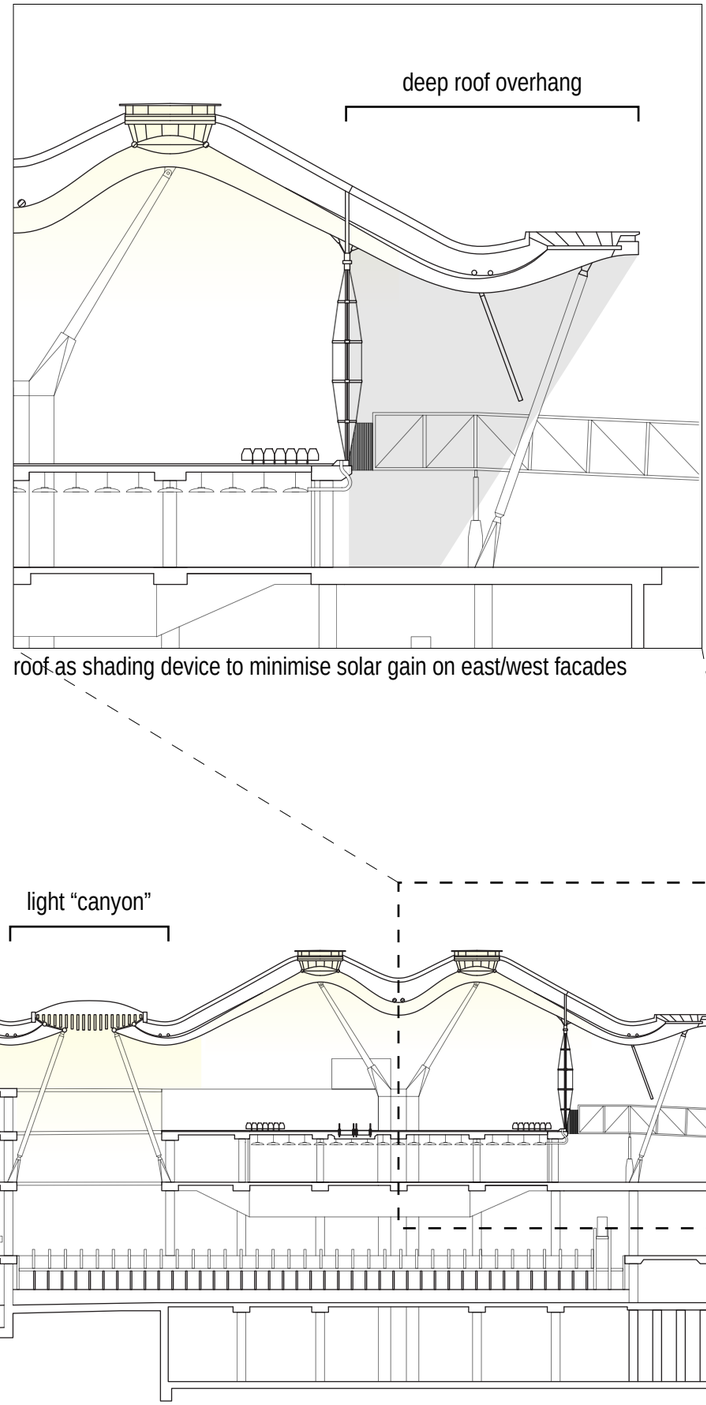
Mediterranean Climate Locations





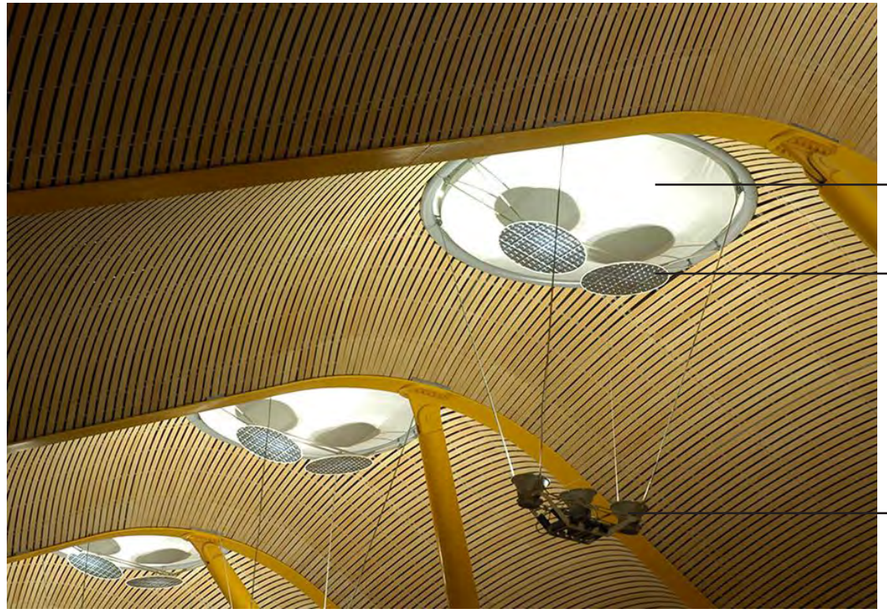
Light “canyons” with white louvers located at lower part of sinuous roof to illuminate the multi-level section and act as a locator in space

Daylight is diffused through the ETFE translucent layer



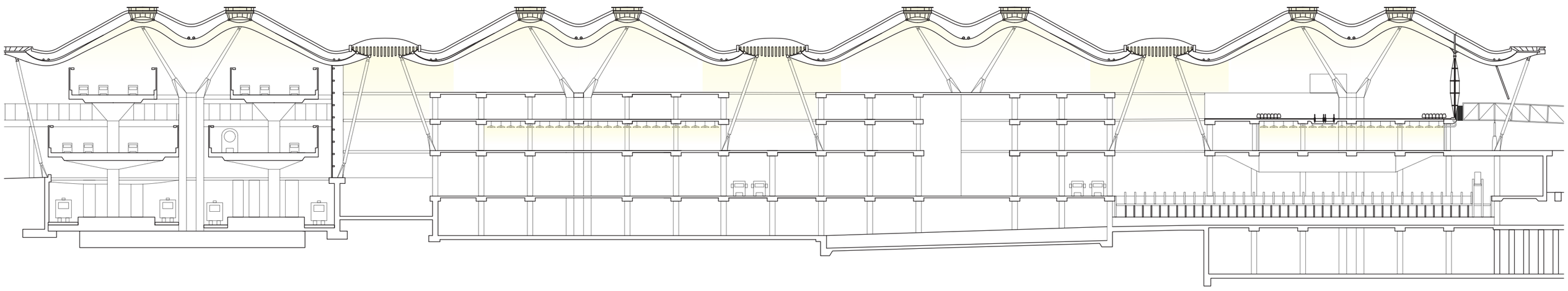
roof as shading device to minimise solar gain on east/west facades

Daylight through “lenses”



Mirror system located at upper parts of sinuous roof illuminates the space with rhythmic glow

Lower level areas are illuminated by “the wok”: provides downlighting, reflects light to distract from the concrete soffit/services and avoids need for suspended ceiling



Artificial lighting lights the crowns of the roof to provide a sense of rhythm without flattening the dynamic undulation

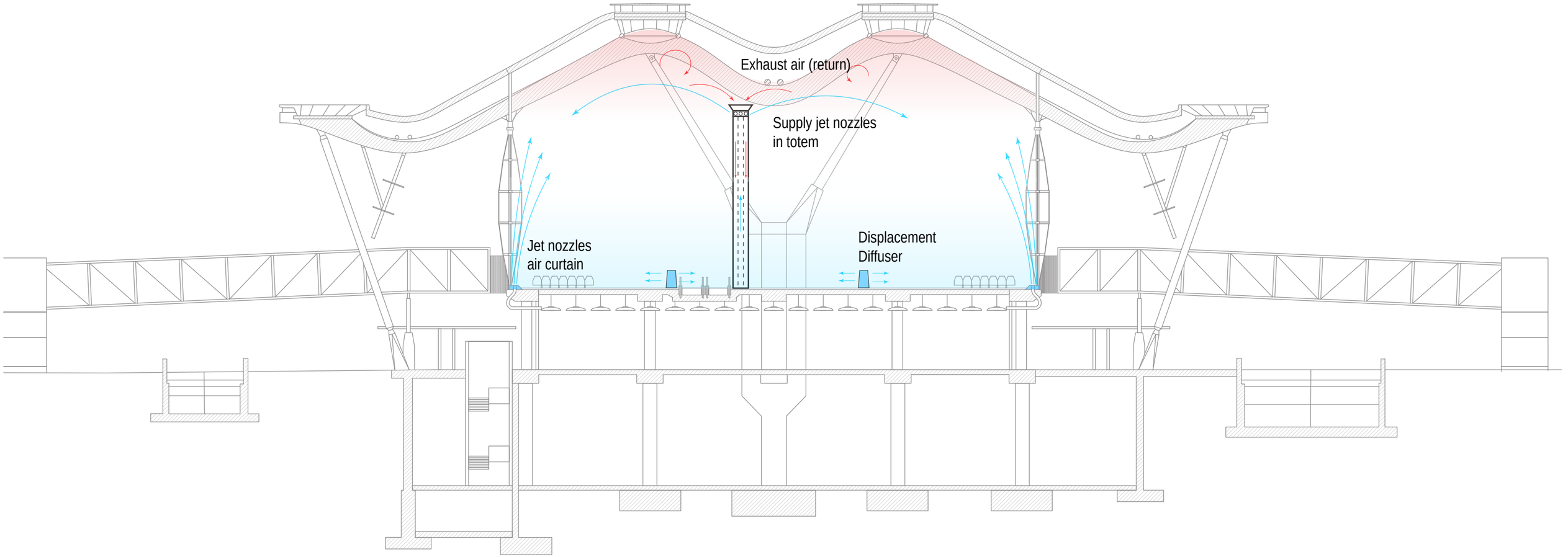
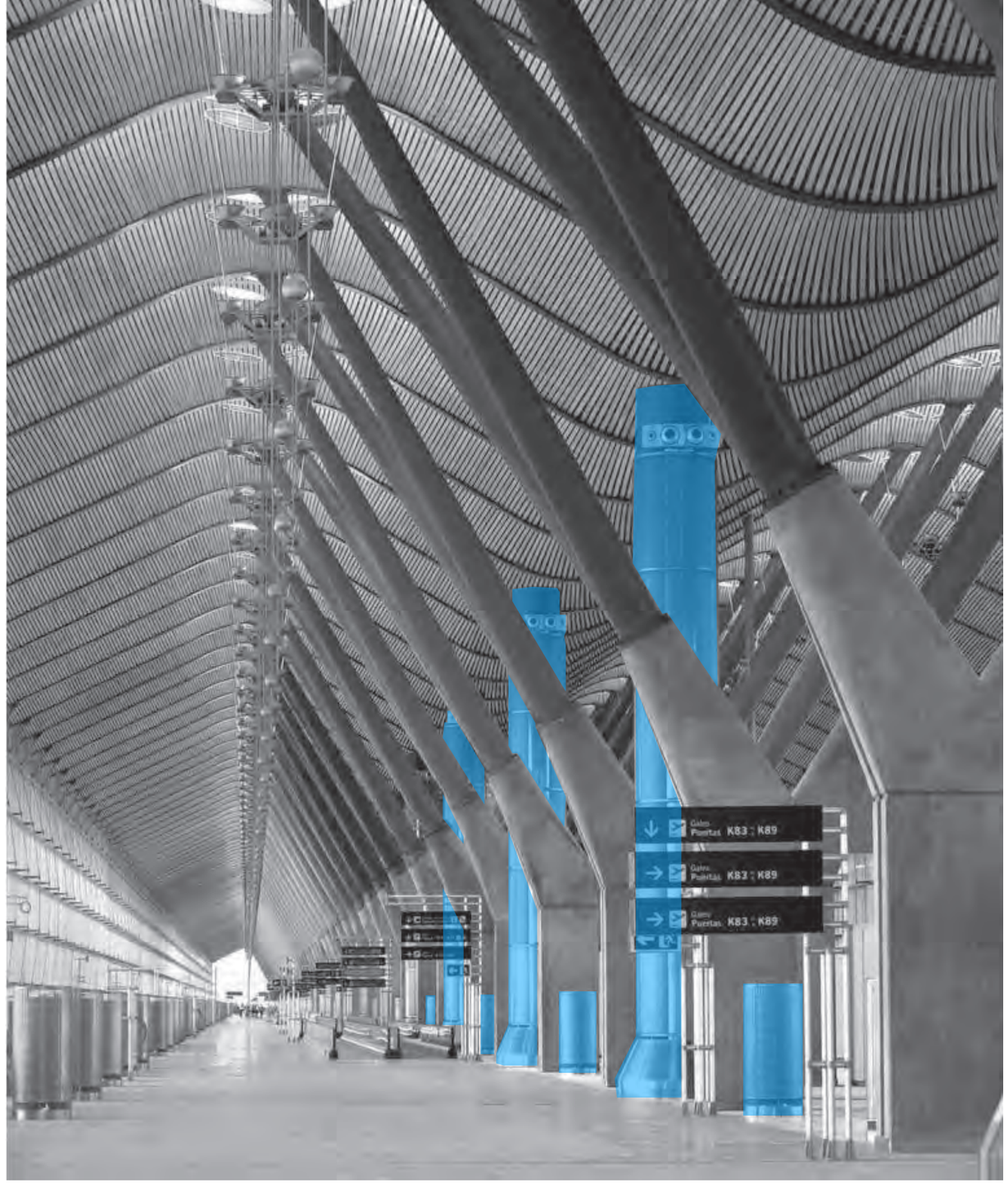


Diagram of stratefied (stacked) ventilation

Displacement flow diffusers are located at check-in, baggage claim and security areas, which helps prevent air turbulence and draughts

Displacement flow diffusers for high-velocity air ventilation & stratefied (stacked) cooling system that extracts warm, stale air out near the ceiling



Displacement diffuser and totem integrated into structural grid

Mechanical ventilation & cooling

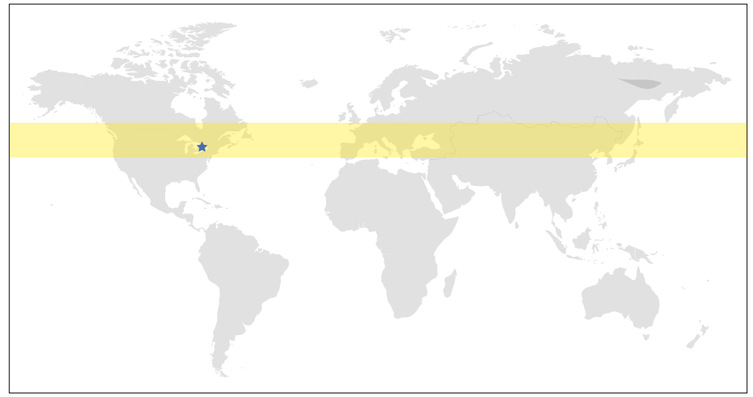
Toronto Pearson International Airport - T1

Toronto

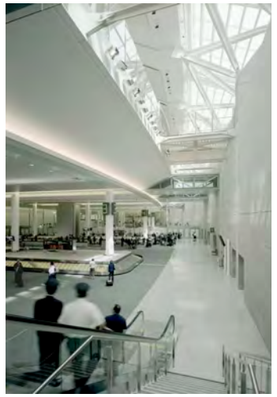
Things to consider for design:

- Snow loads
- Winter heating
- Summer cooling
- Location of skylights

Humid Continental Climate Locations

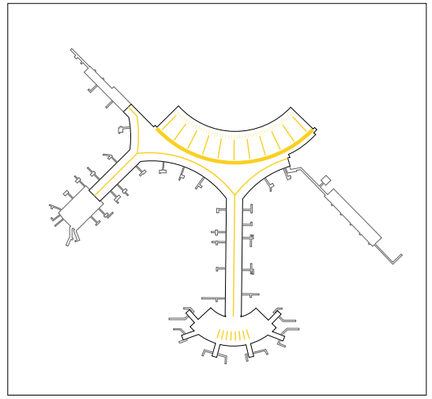


Daylighting for bridge from check-in to security (beneath is baggage claim)

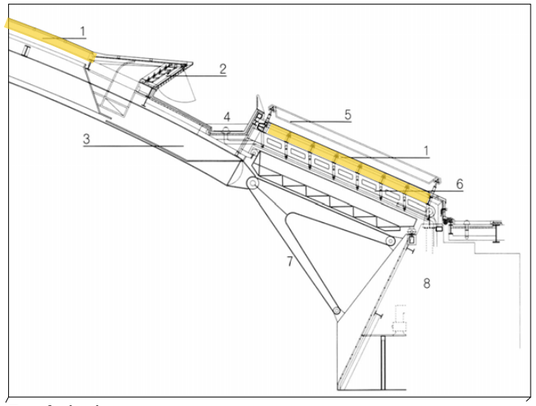


Skylight illuminates below to the baggage claim area

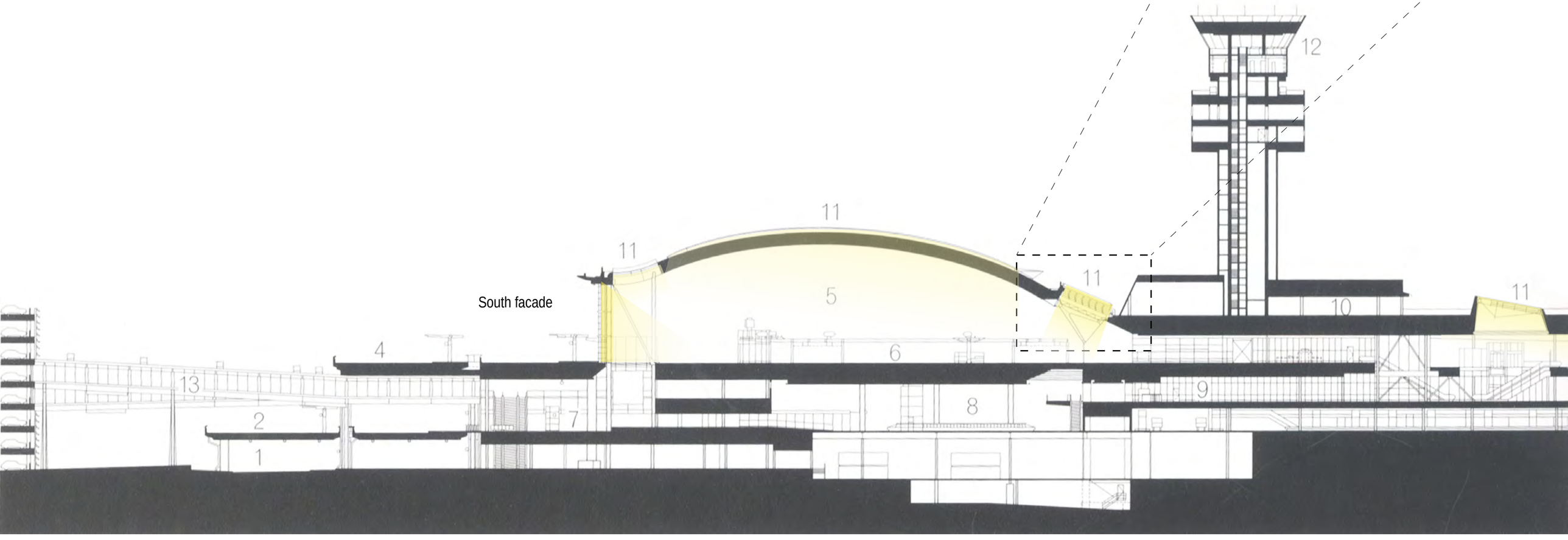
Uses skylights to not only illuminate the airport, but also as a method of spatial orientation and wayfinding



Location of skylights



Roof glazing



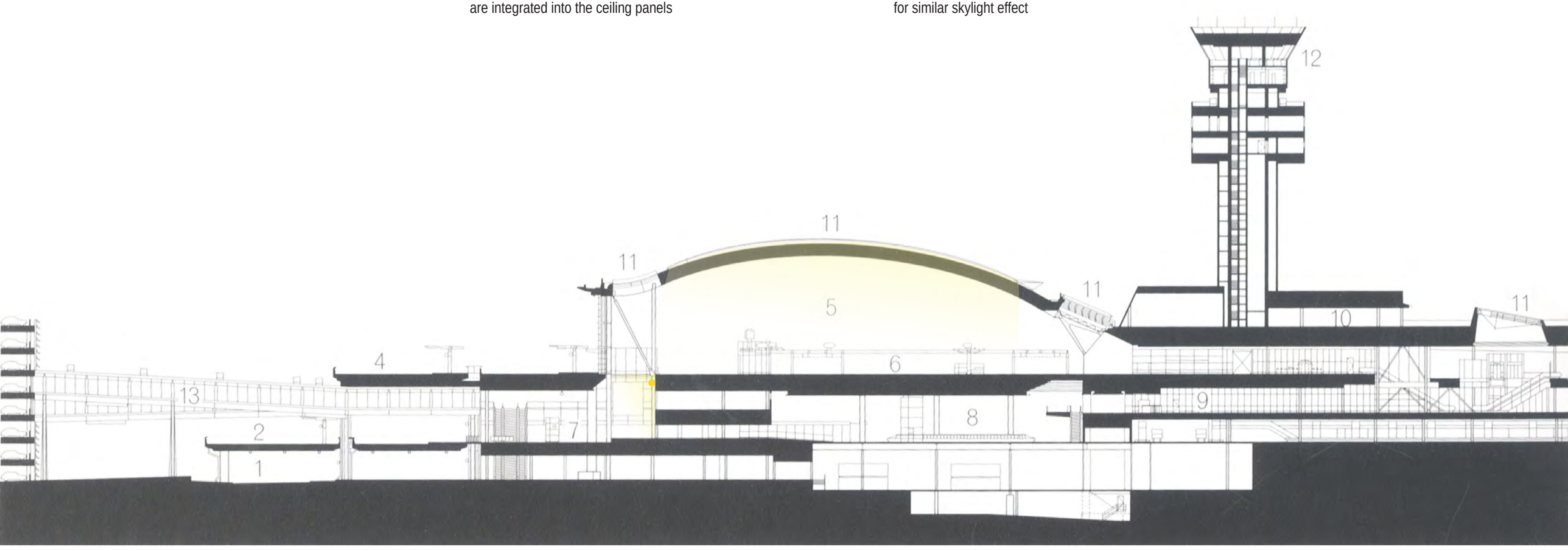
Daylight through Skylights

LED lighting/skylights along the centre of the check-in aisles

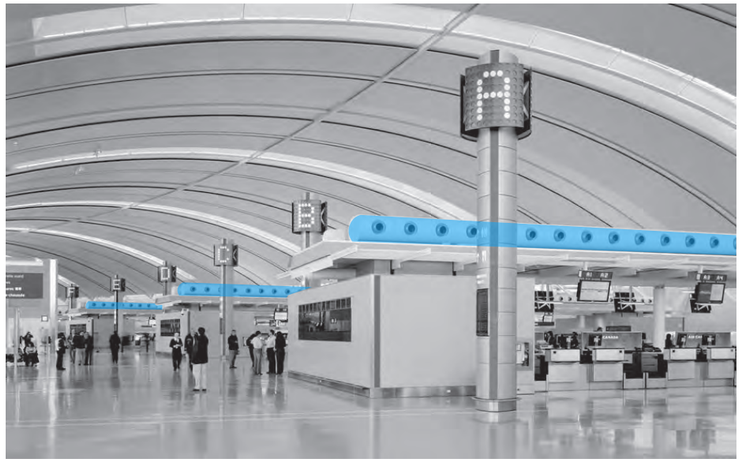
Uplighting fixtures are hidden in the roof, whereas smaller downlighting are integrated into the ceiling panels

Lighting along edge of check-in floor for similar skylight effect

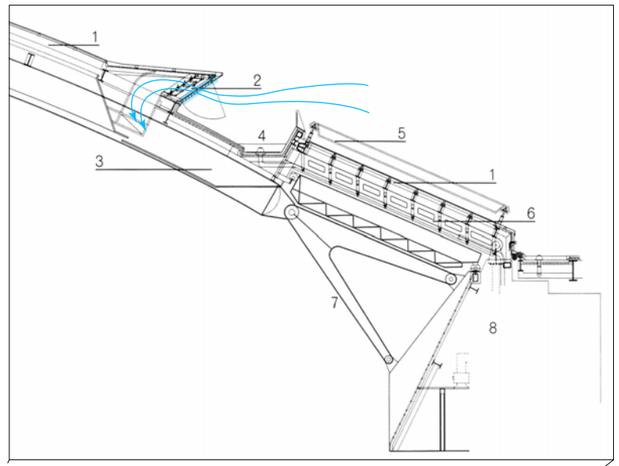
Uplighting integrated into structural columns



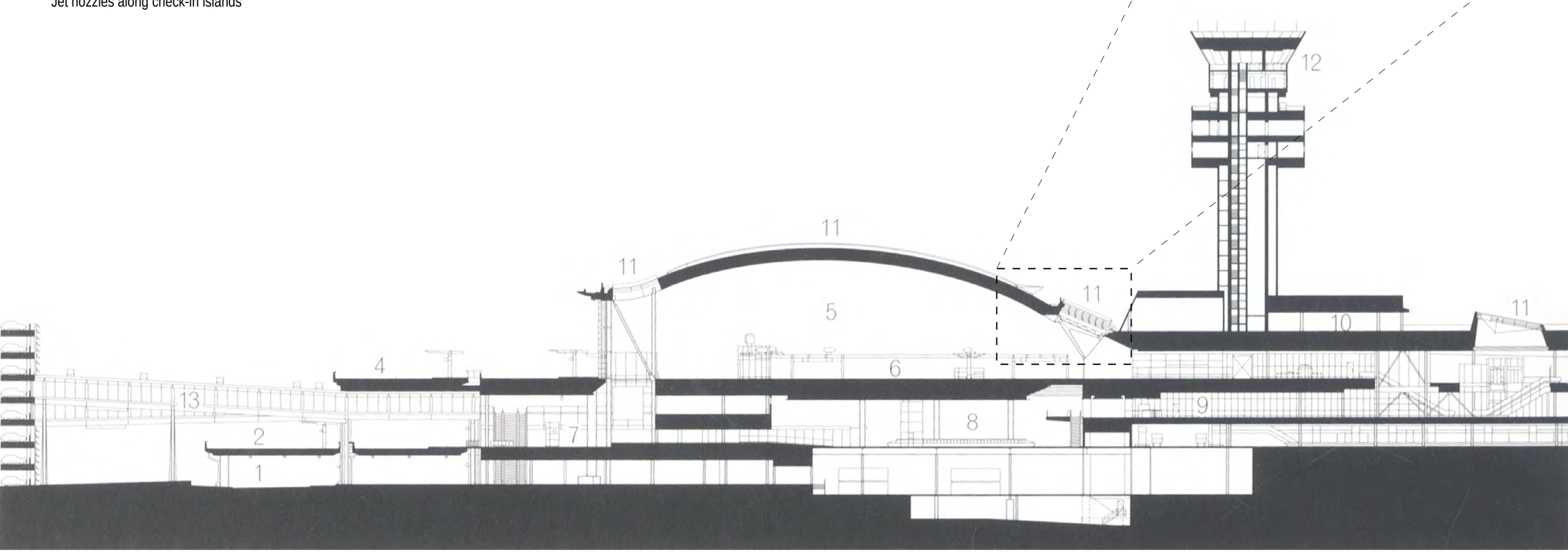
Artificial LED lighting along skylights to provide similar effect as day time



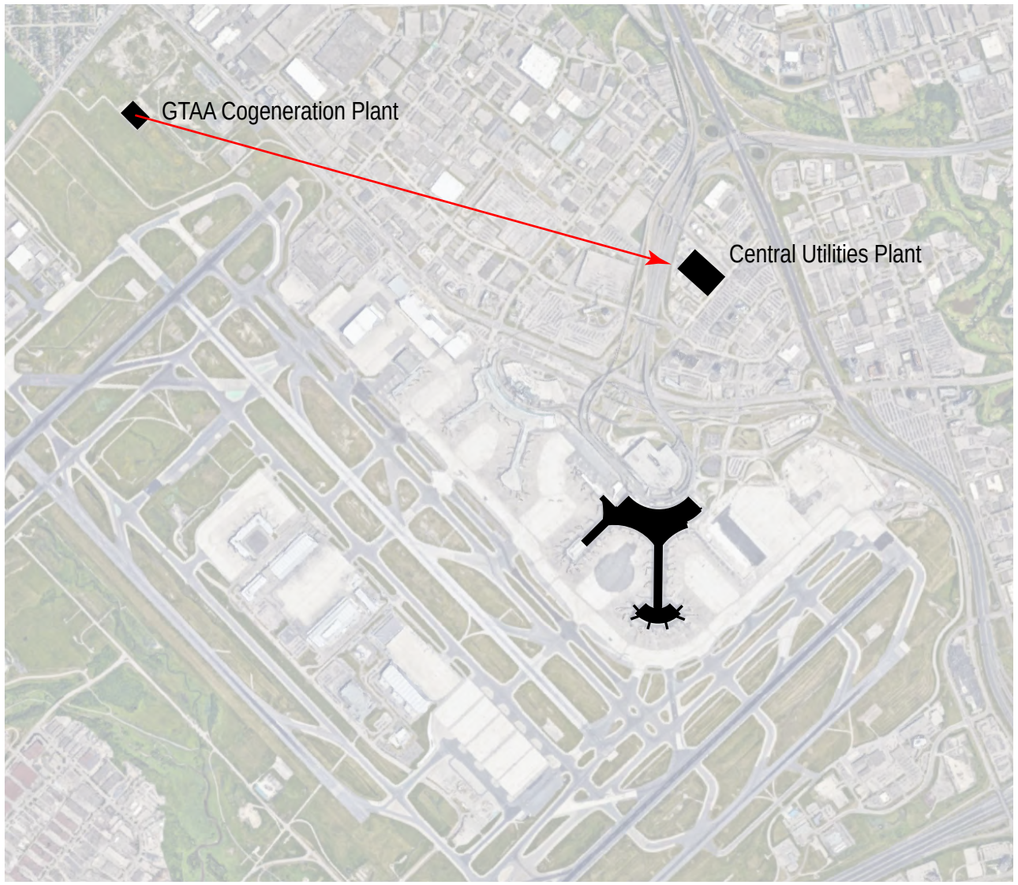
Jet nozzles along check-in islands



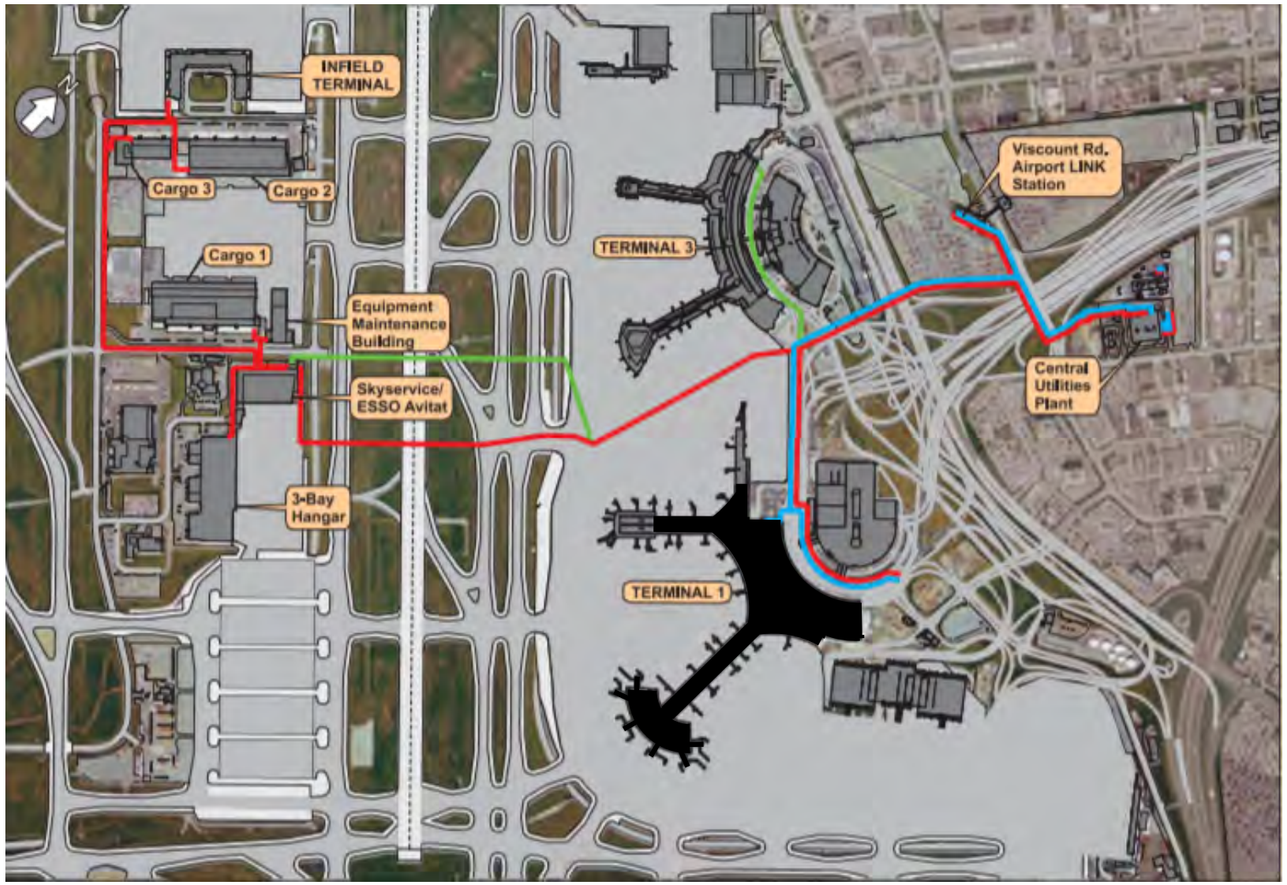
Ventilation louvers for smoke and heat exhaust



Ventilation



Cogeneration Plant is a combined cycle natural gas and steam power station that supplies power and steam. Steam from the cogeneration plant feeds into the Central Utilities Plant to produce heated and chilled water.



Chilled water (blue) is provided from the central utilities plant through pipes to the air-handing units inside the terminal. The heating water pipes (red) are located next to the chilled water pipes.

Use of heated and chilled water to heat and cool the terminal

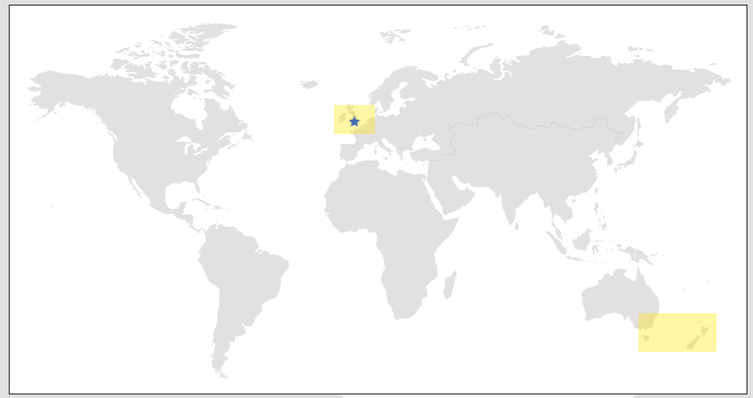
London

Heathrow Airport - T2

Things to consider for design:

- Dealing with often overcast weather
- Minimising heat gain
- Designing for carbon neutral

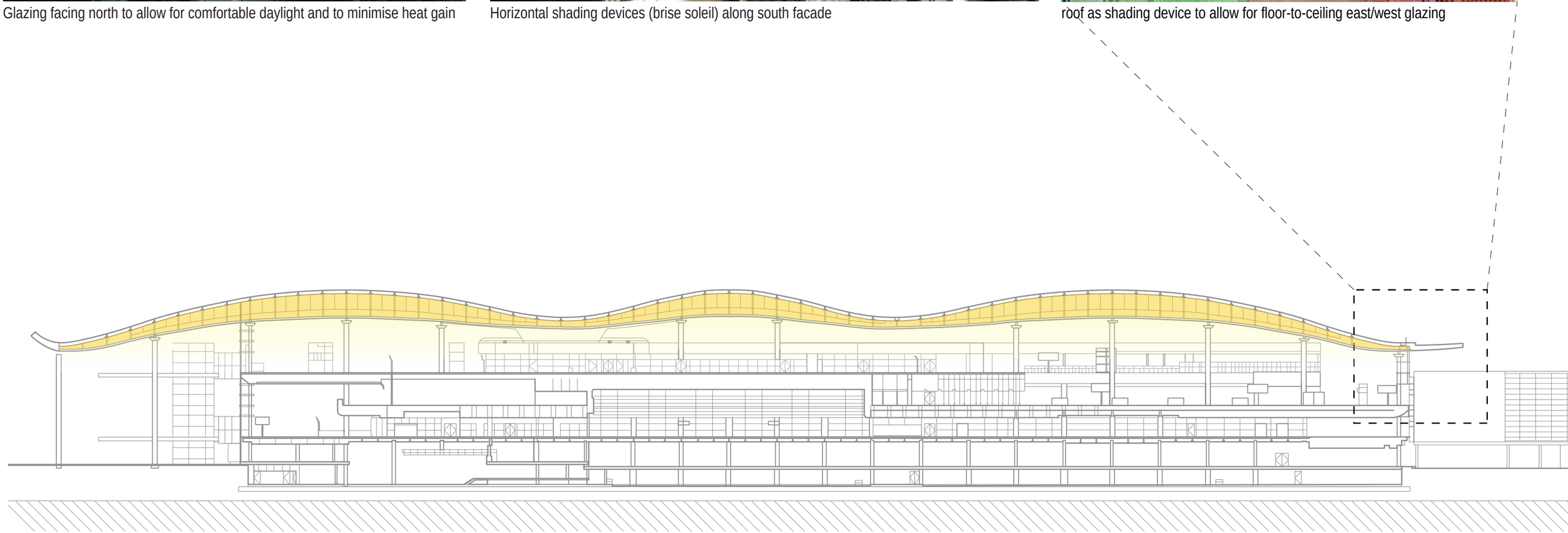
Oceanic Climate Locations



Glazing facing north to allow for comfortable daylight and to minimise heat gain

Horizontal shading devices (brise soleil) along south facade

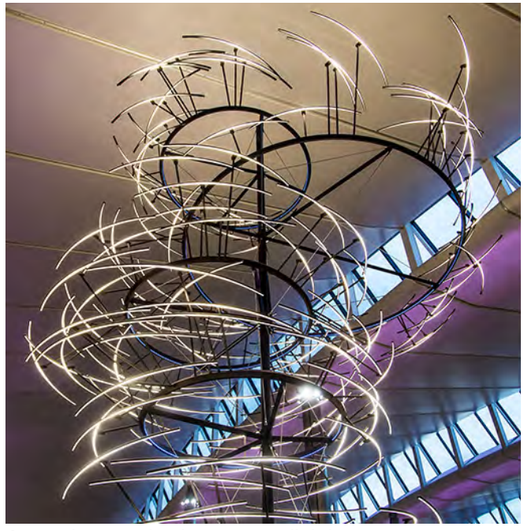
roof as shading device to allow for floor-to-ceiling east/west glazing

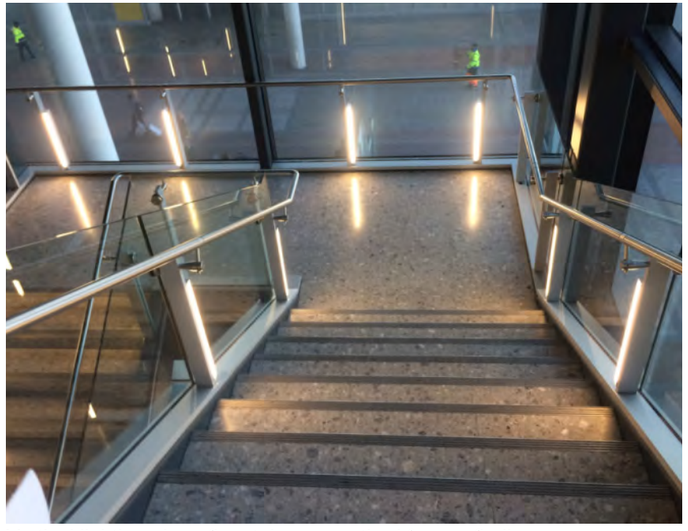


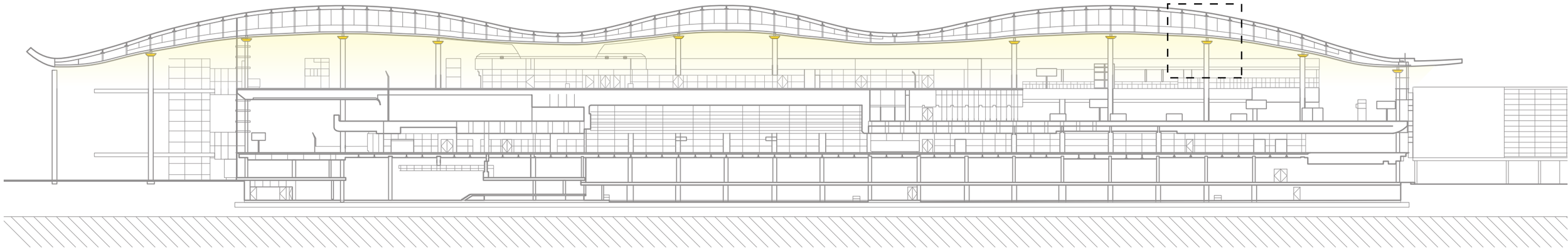
Daylight through roof form with north facing glazing

In addition to artificial lighting, FIDS provide lighting as well


Artificial lighting at every column of the structural grid


Art works can also incorporate lighting


Vertical lighting along fire stair as a method for wayfinding

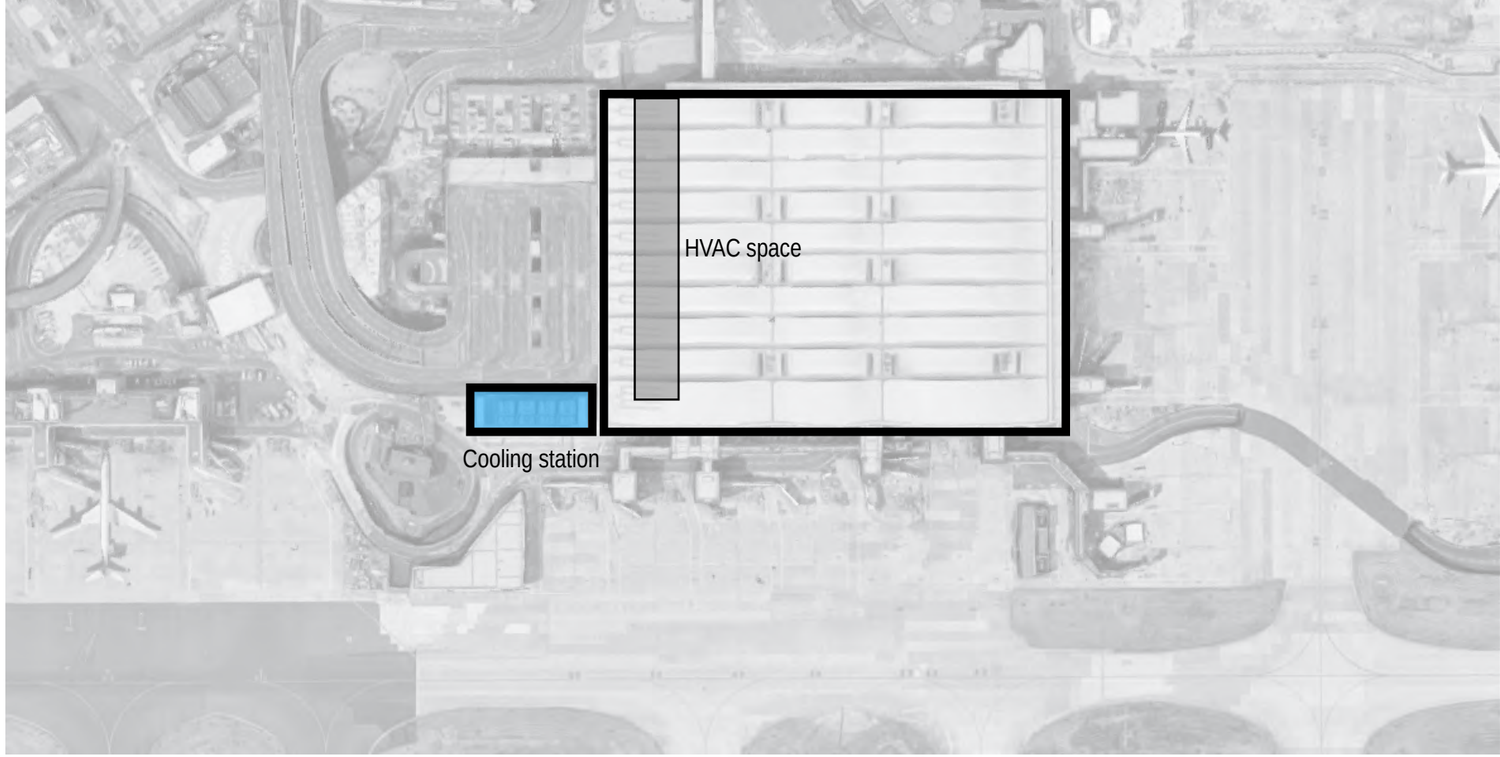


Artificial lighting on columns

Cooling station with equipments on roof

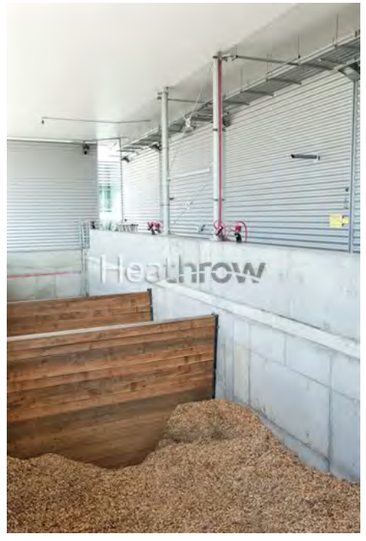
Duct supplying atmospheric air
(denoted green on white)

Pipe supplying atmospheric air (denoted green on white)



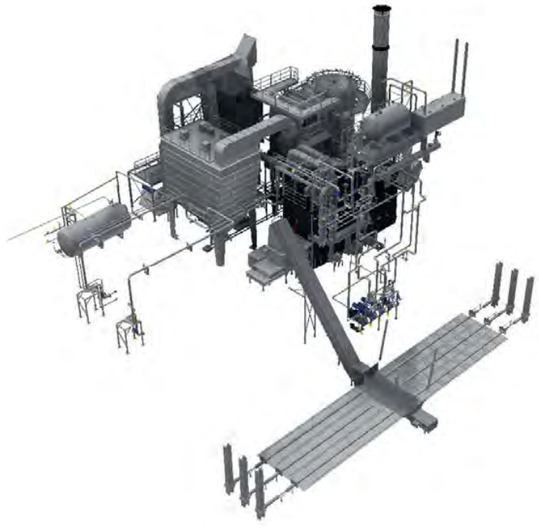
Duct supplying atmospheric air
(denoted green on white)

Cooling station regulates and controls the flow of chilled water

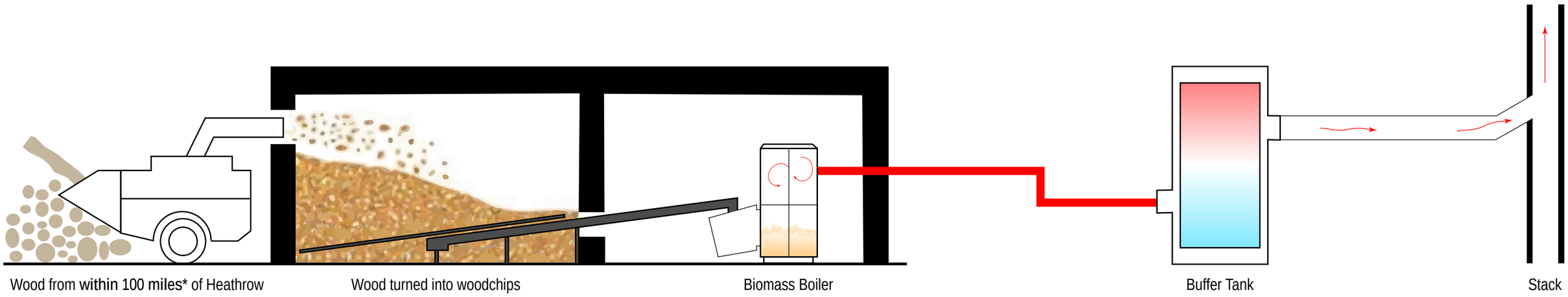


Woodchip storage

Biomass boiler



Biomass boiler system at Heathrow



*needs to be carefully sourced & local, otherwise becomes not sustainable

Combined Heat & Power (CHP) Biomass Boiler to create closed carbon cycle (carbon neutral)

Biomass takes carbon out of the atmosphere while it is growing and returns it as it is burned. To maintain on a sustainable basis, the wood should be a constantly replenished crop that can be harvested, which means it becomes a renewable resource. The use of woodchip is estimated to save 13,000 tonnes of CO2 every year.

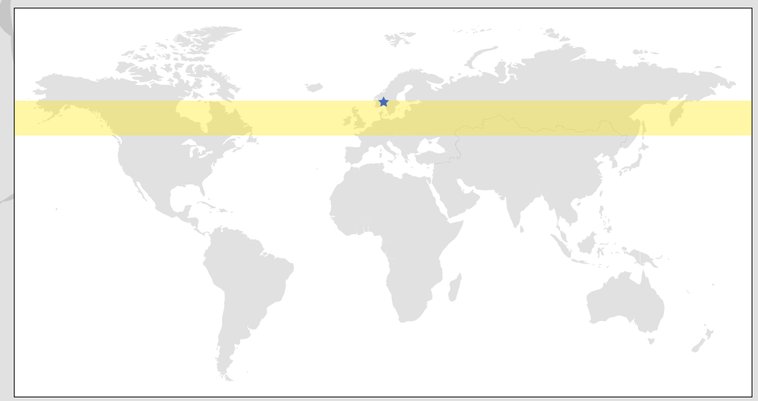
Oslo

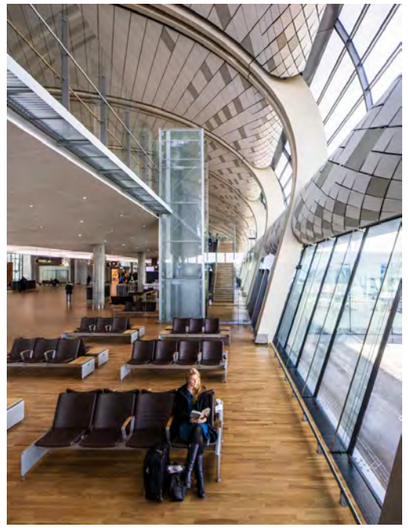
Oslo Airport

Things to consider for design:

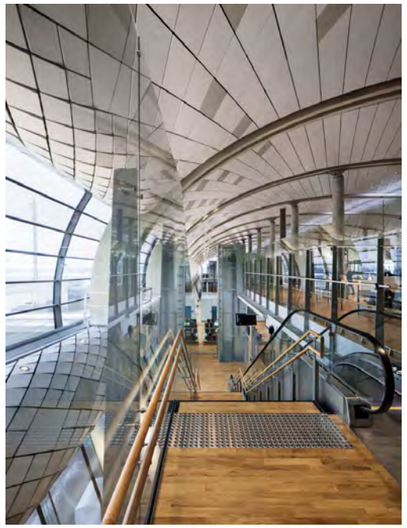
- Dealing with excess snow
- Winter heating
- Maximising daylight while minimising glare
- Maintaining sustainable means of HVAC

Humid Continental Climate Locations

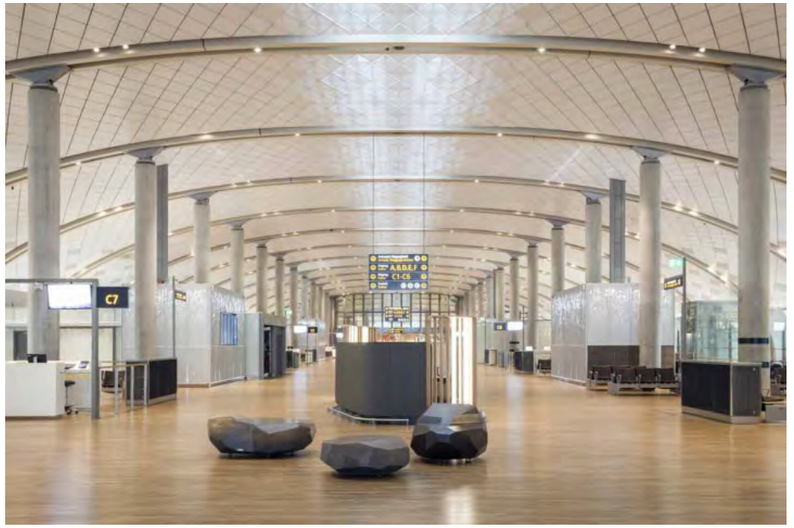




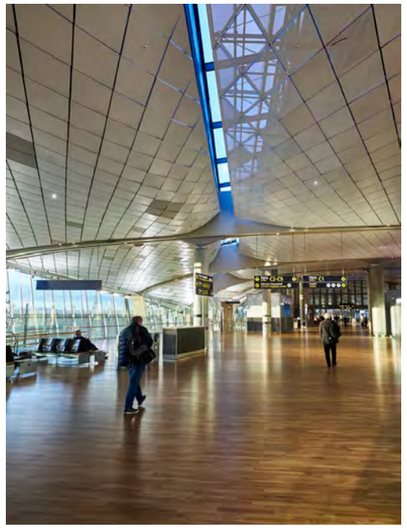
Glazing along concourse



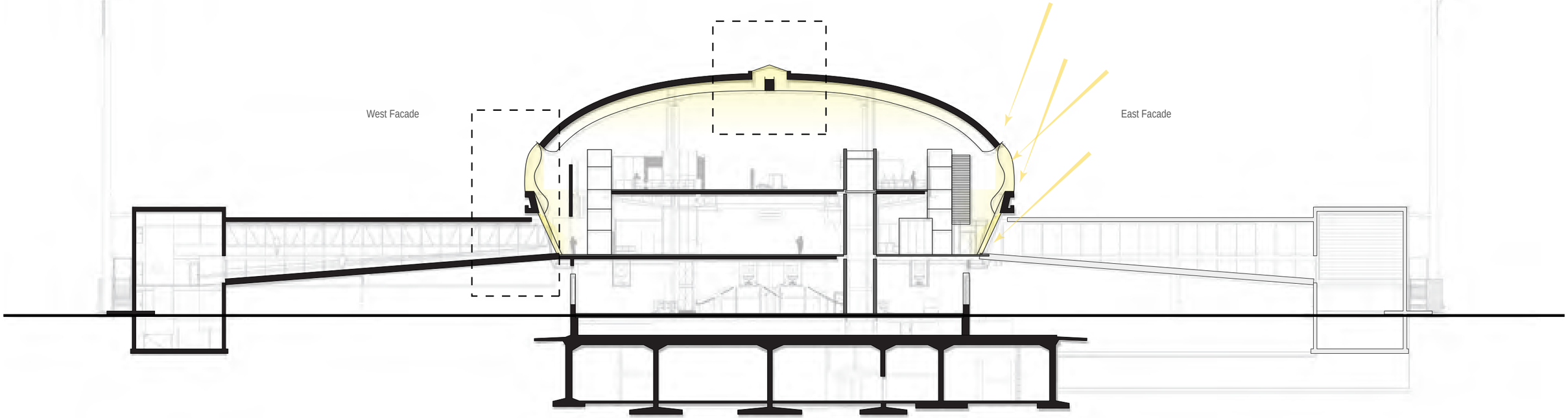
Circulation and seating along facades



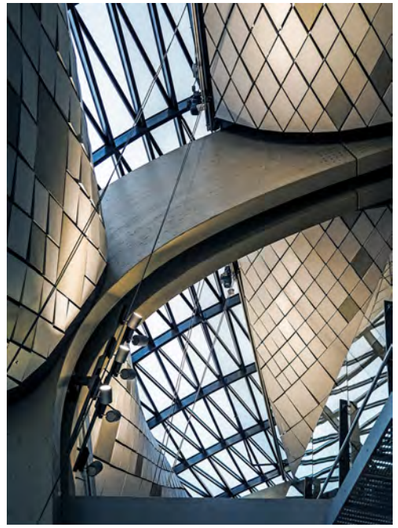
Skylights with translucent panels beneath to diffuse daylight



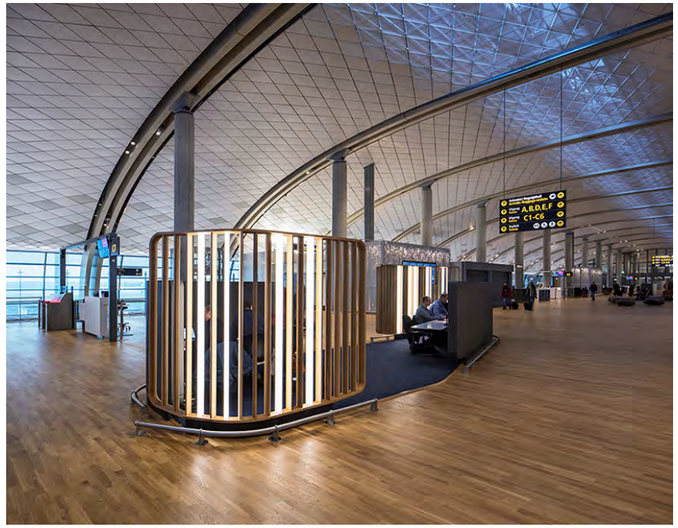
Skylights



Daylight through skylights

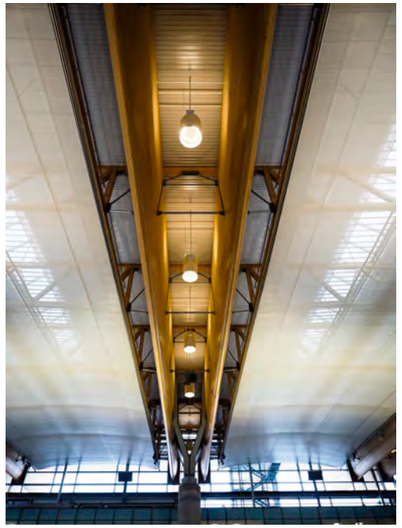


Smart lighting that can auto-adjust based on daylight

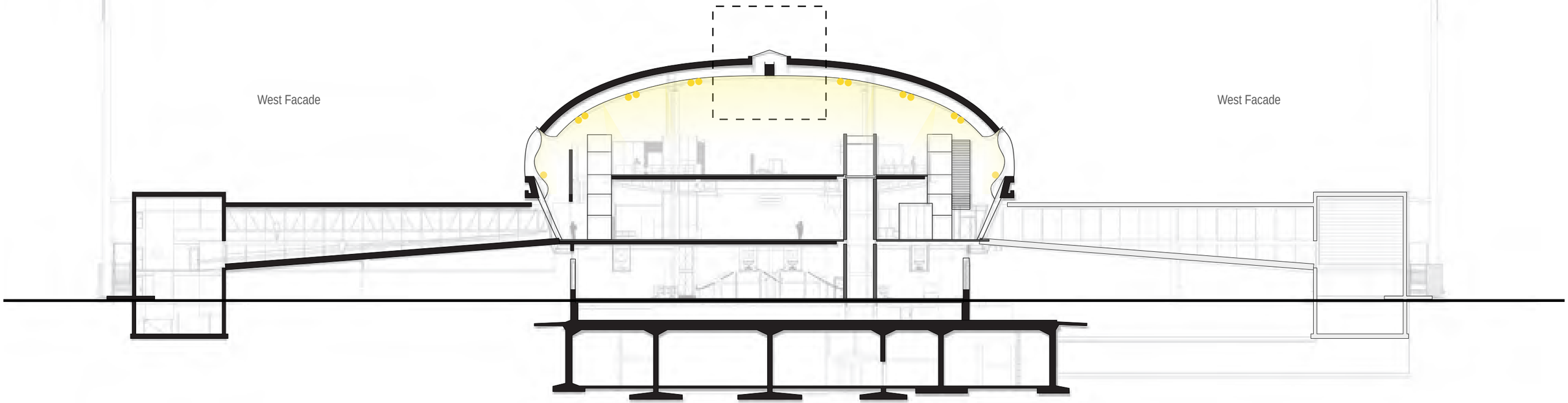


Vertical lighting in furniture to provide more lighting for reading/working

Artificial lights along roof structure

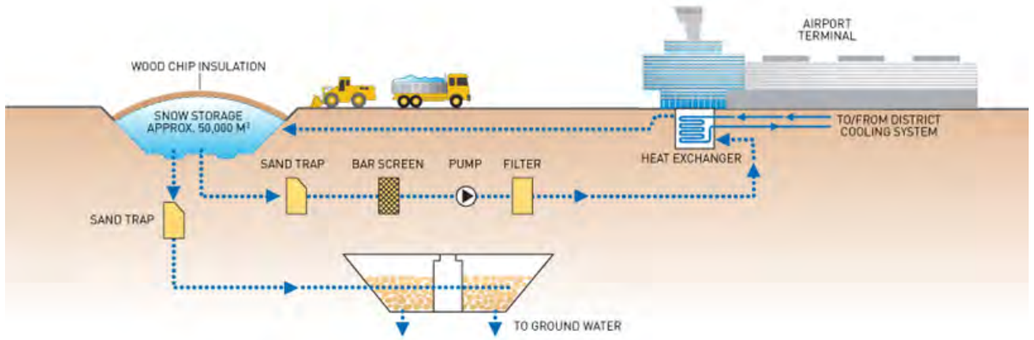


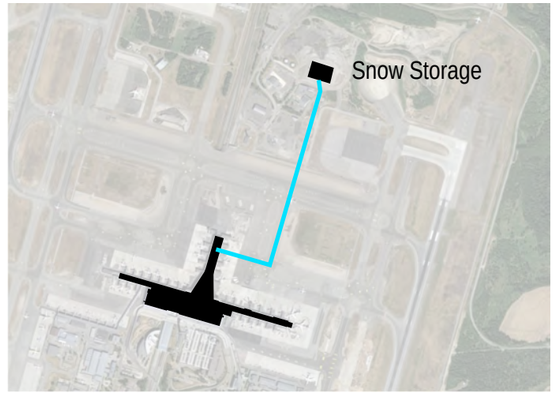
Lights along roof structure of head house

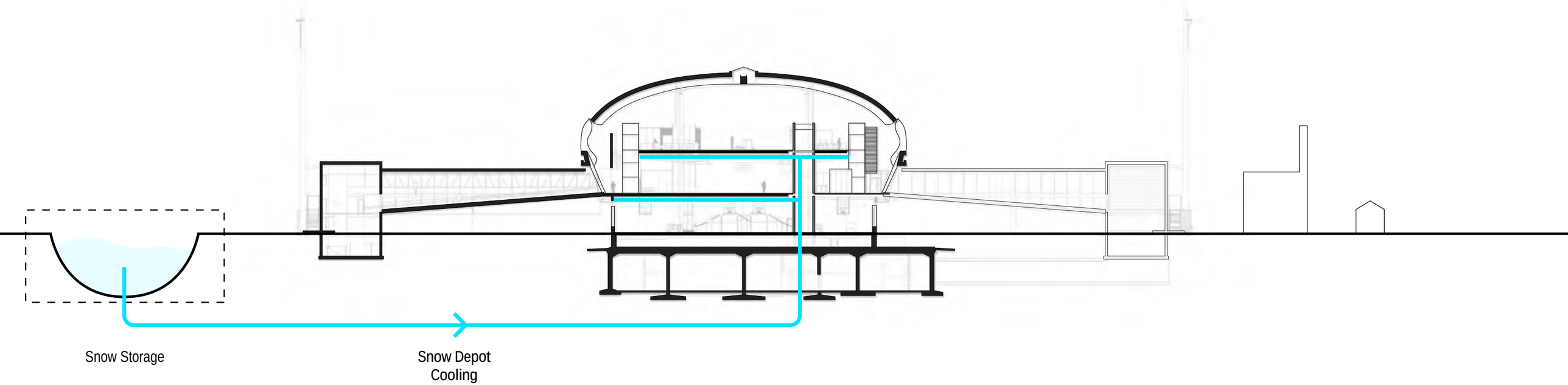


Smart artificial lighting along roof structure

Snow Storage: snow will be covered with wood chip insulation once full



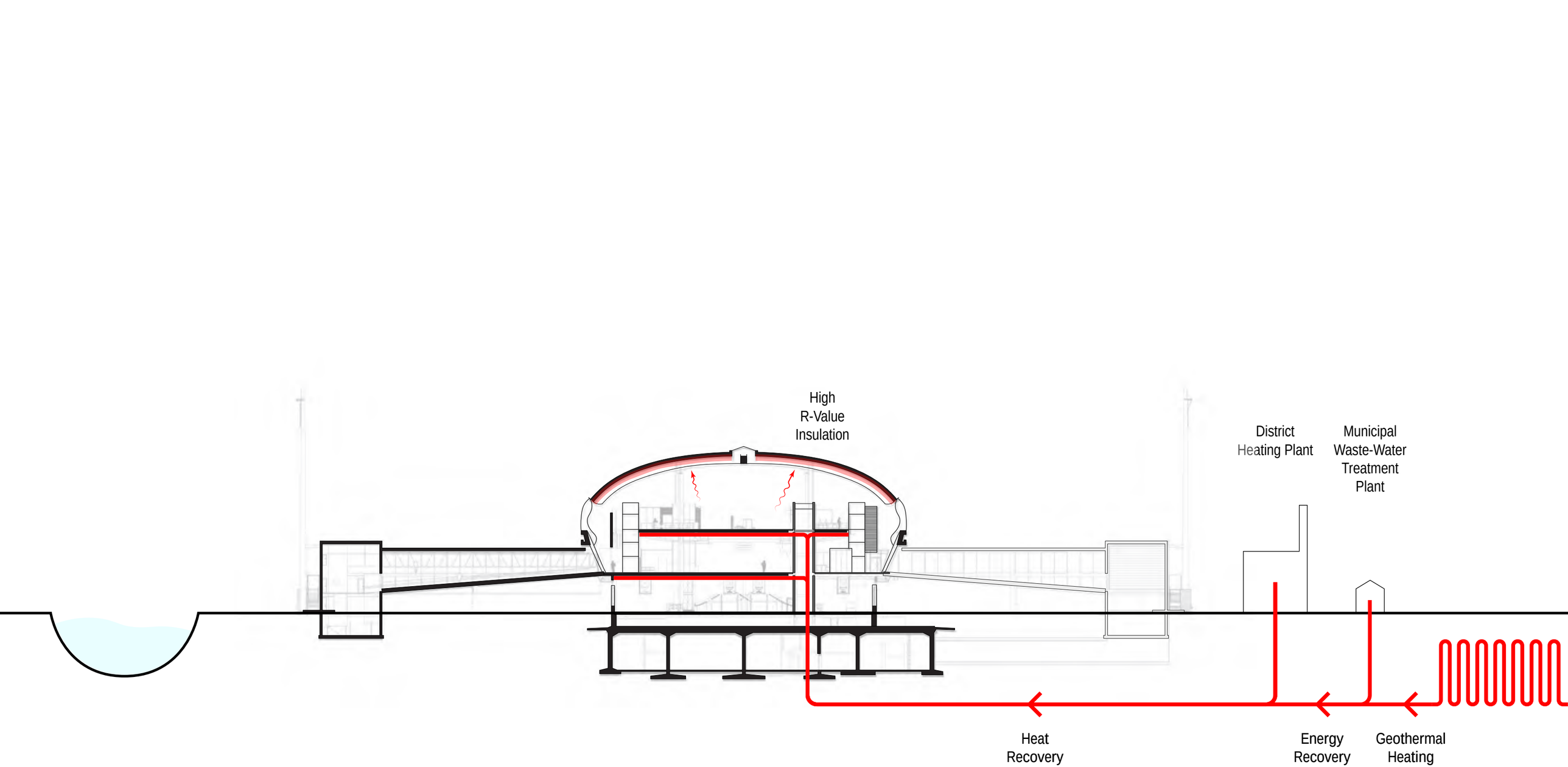




Summer Cooling

Benefits of Snow Cooling (2017 data)

Energy required by conventional cooling to deliver same amount of cooling		450,000 kWh
Energy used for snow cooling	-	90,000 kWh
Energy saved due to free cooling	=	**360,000 kWh**
Cooling delivered by snow cooling plant		1,200,000 kWh



Winter Heating

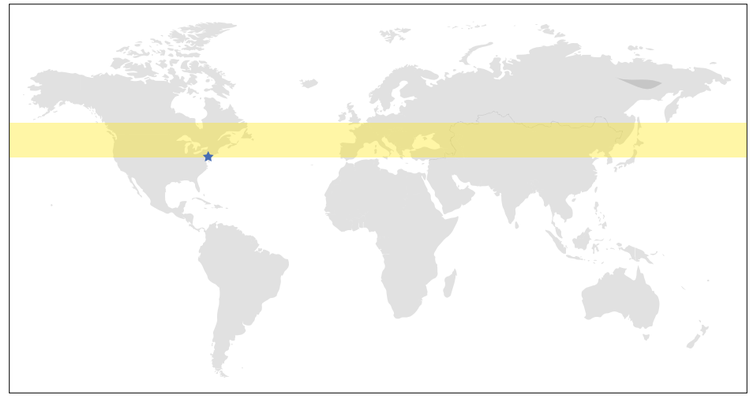
John F. Kennedy International Airport - T4

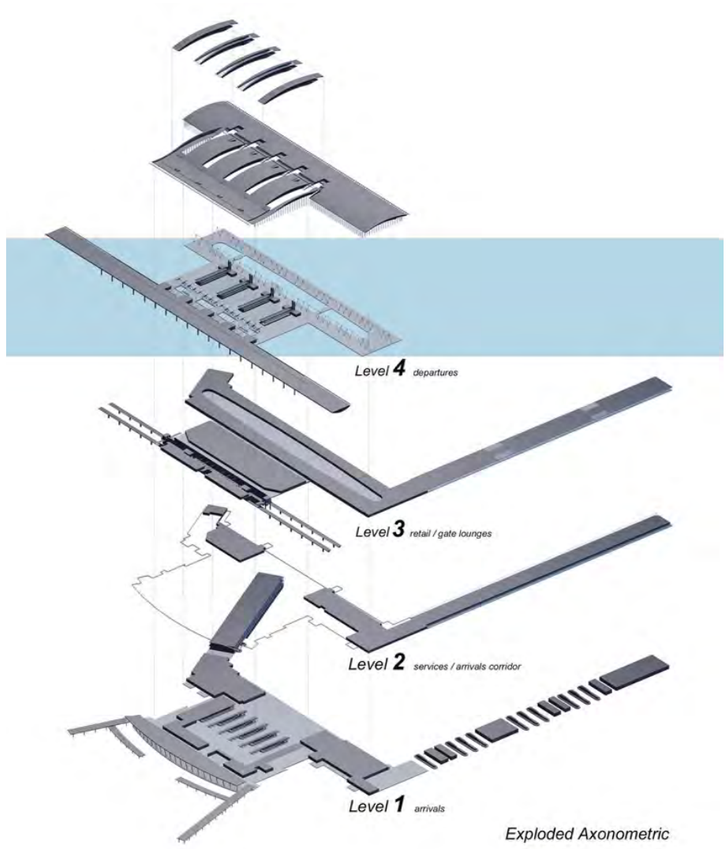
Things to consider for design:

- Snow loads
- Winter heating
- Summer cooling

New York City

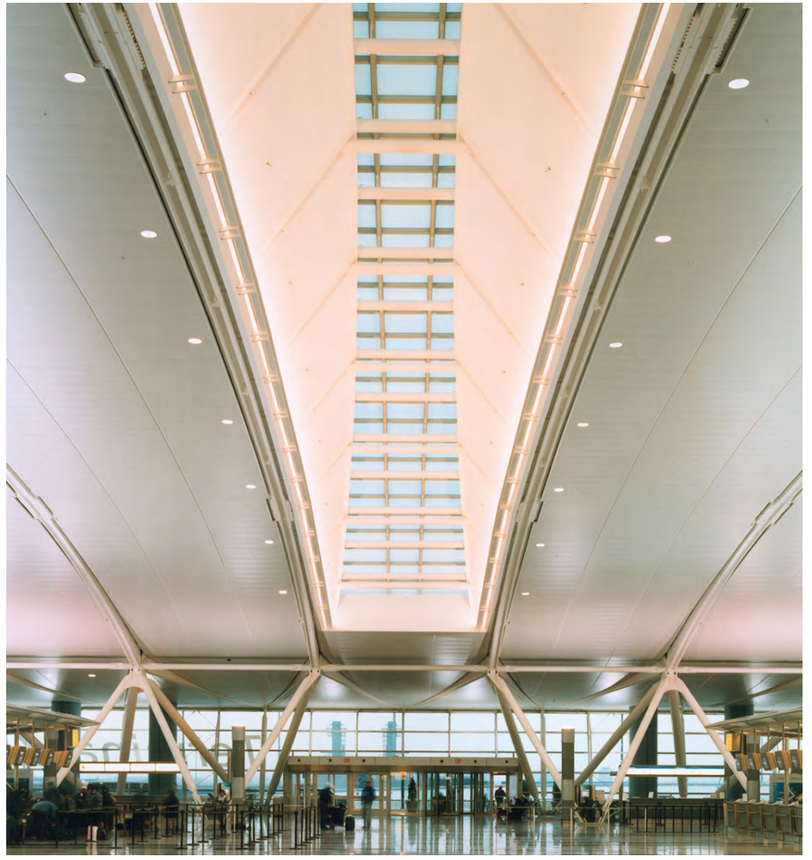
Humid Continental Climate Locations





Exploded Axonometric

Five total skylights that also penetrate a bit into the concourse


Skylights are wide and deep, allowing light to be diffused comfortably along the two sides before illuminating the space


Skylights with structure/pipes running across at intervals

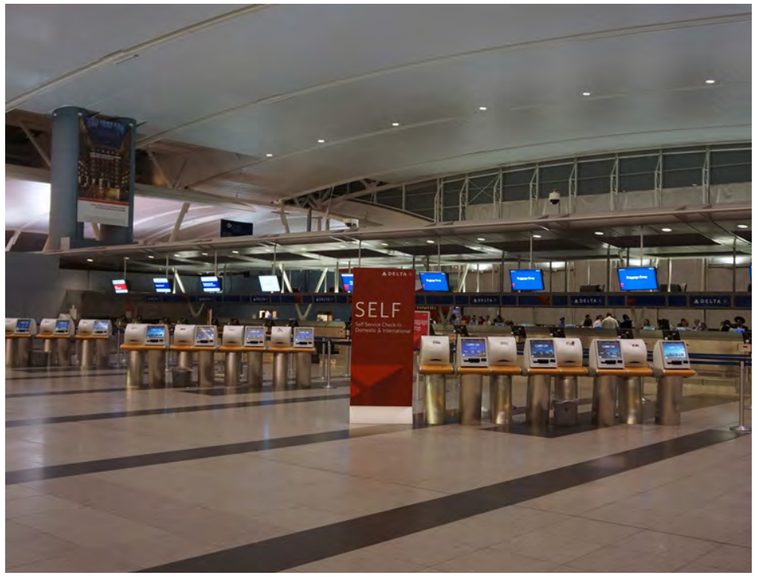

Skylights are located in the aisles, between the check-in islands

Perforated panels above security check-point that diffuses the light from clerestory


Clerestory allows for light to enter the concourse
Skylight from head house penetrates into the concourse (roof at back left)

Daylight through skylights

Cove lights along skylights and downlight



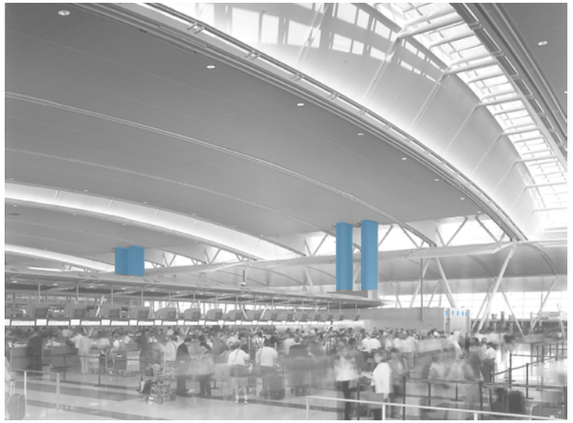
Effect of artificial light at night

Artificial lighting underneath the bridge

Combination of downlight recessed in undulating ceiling panels as well as hidden fixtures around structural columns

Combination of artificial lighting and daylighting from skylights/east facade

Artificial light



HVAC integrated into structural columns (?)

HVAC integrated into lighting columns (?)

Drum louvers above check-in counters that ventilate (low speed, high volume)

Jet nozzles along mezzanine edge of the concourse (high speed, low volume)

Drop ceiling grille along extension of concourse B

Air ducts along ceiling of baggage claim

Vents along edge of facade as well as on ceiling

Kennedy International Airport Power Plant located in Jamaica, NY
A gas-fired cogeneration facility that generates electricity and thermal energy for chilled and hot water

Ventilation