Mechanical Services in Tall Residential Buildings
Melbourne is a hot spot in terms of approvals, design and construction of tall residential buildings
## Current Experience – Murchie Consulting

### Projects
- Aurora, Latrobe St
- EQ Tower
- 466 Collins St
- 54 A’Beckett St
- 160 Spencer St
- Victoria One
- Lighthouse
- Tower Melbourne
- 600 Collins St
- 111 A’Beckett St
- 478 Elizabeth Street
- WRAP, Southbank
- 380 Lonsdale St
- Altus, Docklands
- Sunday Apartments

### Peer Review
- The Guild
- A’Beckett Tower
- 63 Exhibition St
- Lucia
- Yarra House
- 3-9 Claremont St
- Phoenix
- M Docklands
- Lacrosse
- R5, Docklands
- 65 Clarke Street, Southbank
- Tram Road, Doncaster
- 240 Lygon Street
- 158 City Rd – Hanover House, Southbank
- Australia 108
- 170 Victoria Street
- 36 Spring St
- Abode
- MY80
- Empire
Residential buildings are different
Mechanical Services design needs to recognise the special requirements of this class of building

- **Amenity**
  - O/A makeup air to apartments
  - Heating/cooling
  - Bathroom ventilation
  - Kitchen rangehood ventilation
  - Public area ventilation
  - Carpark ventilation
  - Plantroom ventilation

- **Life Safety**
  - Smoke management
  - Lobby / corridor ventilation
  - Fire refuge ventilation
Today, we will mainly talk about the what is “special” about the Services required for **Tall Residential Buildings**

1. What is special about tall and super tall residential buildings

2. Provision in the Mechanical Design of these Buildings
1. What is Special About Tall and Super Tall Residential Buildings?

a. Wind Effects – are significant
b. Stack Effect – less significant than wind effects
c. Building Spatial Efficiency – floor plates, floor - floor heights
d. Façade openings – windows, Balcony Doors
e. Planning Regulations – ESD, new ResCode
f. Staged Construction Completion – is now the norm
g. Building Codes – do not adequately consider requirements of these buildings.
a. Wind Effects
Building Pressure in Perspective

- 110N Door Force
- Lift Door Limit
- Standard Partition
Building Pressure in Perspective

- 110N Door Force
- Lift Door Limit
- Standard Partition
- 1000 Year Return
- 1 Year Return
- 1 Week Return

Pressure (Pa) vs. Height (m) graph showing various pressure levels and their corresponding heights at different return periods.
Wind With Height – Urban Boundary Layer
Façade Pressures – Two 60 Storey Towers
Building Height and Pressure Magnitude

Average of Two 60 Storey Buildings - 1 Year Peak

- 30 Storeys
- Tunnel 60
- 90 Storeys
b. Stack Effect

Not significant in Melbourne’s climate.

While it does show itself to exceed 50 Pa over 60 levels, wind effects are far more significant.
c. Building Spatial Efficiency

Current towers are far more efficient than previous generations of buildings:

- Floor Plates: greater efficiency
- Floor-floor heights: 3.0m or less
- Plantrooms: Tighter, still tight floor-floor
- Structures: Heavy, deep, can tolerate limited penetrations.
d. Façade Openings

- Operable windows demanded by the market
- “Snap Shut” windows widely used, but are not a complete solution.
- Wintergardens widely adopted, but some developments still have balconies to lower levels
- “Uncontrolled” ventilation openings should be avoided at all levels.
e. Planning Regulations

- In Melbourne, approvals have been readily given for building scale and category that is not fully understood by planners.

- ESD benchmark requirements – are demanding greater energy and water efficiency.

- Likely ResCode changes intended to improve occupant amenity will further challenge services design.
  - e.g. More natural and cross-flow ventilation
  - More natural light
f. Staged Construction

- Lifts and cores take precedence

- Heat Rejection – a large consideration in staged completion strategies

- Ventilation systems – can be combined around staged completion requirements.
g. Building Codes

Extracted from International Building Code IBC 2012

909.4.3 Wind effect.

“The design [of smoke control systems] shall consider the adverse effects of wind.”

Commentary

“Wind exerts a load upon a building. The loads are looked at as windward (positive pressure) and leeward (negative pressure). These pressures alter the operation of fans, thus altering the pressure differences and airflow direction in the building. There is not an easy solution to dealing with these effects. In fact, little research has been done in this area.”
2. Provisions in Mechanical Design
a. O/A Makeup Air

- Is necessary – modern facades are well sealed
- Uncontrolled openings in façade should be avoided – transmit wind effects
- Central Mechanical makeup air is suitable
- Corridor plenum supply via uncontrolled openings to apartments should be avoided
- Several approaches being used:
  - central system ducted to apartment
  - motorised dampers in corridor/apartment wall penetrations
  - “controlled” devices introducing O/A via the facade
b. Heating/Cooling

Split Systems
- Split system are always the low cost option where balconies are provided
- Most tall buildings now have wintergardens instead of balconies
- Planning permits are now discouraging balcony units
- “Central” system options are now required

VRF Systems
- Water cooled VRF offers flexibility
- Power billing to apartments needs to be arranged with the embedded network or retail supplier
- Location of cooling towers and vent exchanges is important – especially for staged completion
- Air cooled options can be used in building of limited height.
Water Cooled Ducted System

- Have been used for many years
- Electricity billing is more simple than VRF
- Biggest drawback is the limited floor-floor height in these modern towers

3000mm F/F
200mm Structure
500mm HVAC unit zone
200mm acoustic ceiling zone
c. Bathroom and Kitchen Exhaust

- Options are horizontal discharge via façade, or central riser system
- Horizontal system can be selected based on wind tunnel façade data and wind return data (similar to how we select HVAC systems)
- Facade penetration details are critical elements for the builders
- Vertical systems perceived as reliable
- Vertical systems occupy sellable area and require additional plantrooms.
d. Smoke Management

- Key subject, considering design requirements relative to external wind effects
- Different Fire Engineers are adopting differing strategies e.g. – Stair pressurisation
  – Corridor pressurisation
  – Lift /Stair lobbies
- Operation of lifts as part of the evacuation strategy is becoming common – hence the lift shaft or lift lobby needs to be protected
- Current codes describe outcomes (e.g. AS1668), but not how to get those outcomes in this class of building
- This could become a serious “Safety in Design” issue for designers and builders, given the lack of adequate code.
Conclusion

- Lack of code – presents a risk
- There is no shortage of expert data on every job:
  - Wind Engineer
  - Fire Engineer
  - Façade Engineer
  - Building Surveyor
  - Architect
  
However, their inputs are often in silos.

- The **mechanical engineer** is uniquely placed in 2 ways:
  - The **mechanical engineer** can usually understand all these expert inputs
  - The **mechanical engineer** is the one responsible to make the systems work