Workshop Session
Stream 1

High Efficiency Air Conditioning Systems: Approach, Design & Implementation
Synopsis
Designing efficient HVAC systems encompasses a holistic approach covering both the arts and science of HVAC as expounded by ASHRAE. However, the best designed and installed HVAC system will only last until the end of the Defects Liability Period if there is no proper commissioning, operation and maintenance regime in place.

Synopsis
This presentation aims to assist local HVAC designers, installers, commissioning specialists, operators and maintenance staff in their regular routines by highlighting some of the good and bad practices in the industry.
“Air Conditioning is the control of the humidity of air by either increasing or decreasing its moisture content. Added to the control of the humidity is the control of temperature by either heating or cooling the air, the purification of the air by washing or filtering the air and the control of the air motion and ventilation.”

- Willis H. Carrier

Without the need for thermal comfort, there will be no need for buildings
**HVAC - APPROACH**

**BUILDING HVAC LIFE SEQUENCE:**
- OWNER’S REQUIREMENT
- DESIGN incorporating Owner’s needs
- IMPLEMENTATION / INSTALLATION meeting functional needs
- TESTING - a continuous process during installation
- COMMISSIONING incorporating Training
- OPERATION
- MAINTENANCE including Servicing

**PORTION OF THE CONSTRUCTION PROCESS**

- install → progressive testing → 1st & 2nd fix
  - authority inspections
  - contractor’s own t&c
  - comprehensive t&c
  - DLP
  - training operators

- pre-handover inspection → integrated testing → Bomba inspection → completion & handover
• Do not work in isolation from the design team
• Design should always consider commissioning, serviceability and maintainability
• Design needs to take into account energy efficient operation at full AND at partial occupancy AND for after hours use

**DESIGN: The Science of HVAC**

1. Heat load (cooling) *ESTIMATE*
2. Static load calculations *PEAK LOAD*
3. Dynamic load calculations *PROFILE*
4. Softwares: E-20, Tracer 500 etc *COMPLEXITY*
5. GIGO concern
6. Accuracy to the last 2 decimal points?
7. HVAC engineer – Graduate, P.Eng.
8. HVAC TA, practitioner
9. Auditor – rule of thumb check figures?

**WHICH CATEGORY ARE YOU?**
8.1.1 Calculation procedures

Cooling design loads should be determined in accordance with the procedures described in ASHRAE Handbooks, or other equivalent publications.
TYPES OF AIR CONDITIONING SYSTEMS

Air Cooled Split Units

- Fan Coil Unit
- Condensing Unit
- Warm air (recirculating)
- Cool air
- Outdoor air
Air Cooled Split Units (ACSUs)

Both indoor and outdoor units are housed in robust casings. The outdoor unit is basically the same construction for all the various types of indoor units. The difference lies in the type of indoor unit.

Wall Mounted  
Floor Standing  
Cassette  
Ceiling Exposed

Air Cooled Split Units

Many Business Establishments are housed in Small Premises using ACSUs.

Office  
Restaurant
ACSUs Application

Shop Office

Air-cooled Ducted Units

Both Under Ceiling & Floor Standing
**Application**

- Residential
- Medium Commercial buildings
- Factories
- Government buildings

**Water-cooled Splits/Packaged Units**

**WC Split Units**
- Typ. Capacity range from 2.0 – 6 Hp
- Ducted/Under ceiling

**WC Packaged Units**
- Typ. Capacity range from 20 – 100 Hp
- Floor Standing

Typical kW / ton: around 1.0- 1.2 kW/ton
Variable Refrigerant System (VRS)/ Variable Refrigerant Flow (VRF)

On a single refrigerant pipe, many indoor units can be connected.

Variable Refrigerant System

Actual piping length 165 m
Variable Refrigerant Flow

Applications
• Offices
• Hotels
• Serviced Apts.
• Schools

Variable Refrigerant System

High external static pressure fan

78.4 Pa E.S.P.
VRS – Outdoor Units Installations

Air-Cooled Chillers
What factors to consider to determine the chiller configurations?

- Able to cater for peak load (not connected load)
  What about part loads? & how often is peak load? MS2449
- Must be energy efficient
  Peak chiller EE at what loading - 100% 90% 80% etc ?
- ARI rating is for **single** chiller
  How prevalent are installations with single chiller?
- Have standby chiller/s (redundancy)
  What about ancillary equipment viz pumps, CTs?
- Have different capacities to suit part load operation
  What about parts inventory and interchangeable ancillary equipment?
**DESIGN: The Science & Arts of HVAC**

- For an **existing** building, load profile is available to optimise chiller configuration
- A **new** building is not fully occupied on Day 1
- What about unscheduled partial completion of a high rise tower – say occupation of podium floor only due to sudden economic downturn?
- Siting of cooling towers on say 55th Floor – what is the implication?
- Primary-Secondary chw circuitry – when does this become necessary and advantageous?
- Why not VPF (Variable Primary Flow)?
- How about Primary-Secondary-Tertiary chw circuits?

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**Workshop Exercise 1**

- 3-storey office building; peak cooling load of 23.1 RT; office hours 52hrs/week; after hours operation expected.
- **What type of high efficiency HVAC system would you recommend? Explain your decision.**

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<thead>
<tr>
<th>12.0m</th>
<th>4.0m</th>
<th>18.0m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Room</td>
<td>3.0m</td>
<td>Typical Floor 216m²</td>
</tr>
<tr>
<td>4.0m</td>
<td>Office Room</td>
<td>3.0m</td>
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</tbody>
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Workshop Exercise 2

• 100-room 10-storey city budget hotel, one-20pax 24-hour coffee house.
• What type of high efficiency HVAC system would you recommend? Explain your decision.

Workshop Exercise 3

• 500-room 20-storey 5-star hotel.
• What type of high efficiency HVAC system would you recommend? Explain your decision.
Workshop Exercise 4

• A 20-storey office tower with a peak cooling load of 1,000RT. Typical floor GFA of 1,400m².
• What type of high efficiency HVAC system would you recommend? Explain your decision.

Ensure energy efficiency is optimised during part load operation of ac plant
HVAC - IMPLEMENTATION

- Do not install if you cannot maintain it
- Do not install if you cannot service it
- Do not install if you cannot commission it

TESTING during installation

- Trade contractors to carry out continuous and proper testing during construction
  - pressure and leakage tests for air and water systems
  - electric continuity tests, etc.
- Employ appropriate Inspector-of-Works to supervise proper installation and testing
COMMISSIONING

- Majority if not all HVAC contractors today are merely Management Contractors …..

- How to address this problem?

- Pre-Commissioning  Re-Commissioning
- Retro Commissioning  Post Commissioning

- Commissioning Authority
- Commissioning Agent
- Commissioning Specialist

OPERATION

- When do you employ and deploy your operational staff?

- Who qualifies as operational staff?

- What is the bare minimum staffing?

- How to monitor performance of outsourced services?
MAINTENANCE:

- What is the prevailing service maintenance cost?
- Is this realistic?
- What is the minimum standard of performance expectation?
- What is SUSTAINABLE MAINTENANCE?

Bad Practices
Good Practices
AHU Configurations

Location of thermostat
1st Class Infrastructure  
3rd Class mentality

The best designed and best installed building services will last until the end of the Defects Liability Period.

1 EE:

1 WATT SAVED IS MORE THAN 1 WATT PRODUCED
THANK YOU

www.greenbuildingindex.org
www.mgbc.org.my