Sustainable Design & Maintenance

(Emphasis on M&E System)

Jack Chan
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Sky Hotel, Kota Kinabalu
Question:

What is the most expensive cost in a building life cycle?

a. Construction costs
b. Design fees
c. Financing costs
d. Operation costs
TOTAL COST OF OWNERSHIP – 40 Years

- Initial Cost of Construction: 20%
- Operational Cost (Maintenance, Repairs, Utilities, janitorial, Capital Reserve): 71%
- Design and CM Fees: 3%
- Cost of Money/Financing: 6% if paid off in 7 years
What is Sustainability?

“meeting the needs of the present without compromising the ability of future generations to meet their own needs”

(United Nations)
Sustainable Development

Sustainable Design → Enhanced Commissioning → Sustainable Maintenance → Measurement & Verification
Sustainable Design
Traditional vs Sustainable Design

- **Traditional**
  - Safe & Workable
  - First cost
  - Manual static calculations
  - Discreet function
  - Good till Hand-over

- **Sustainable**
  - Safe & Efficient
  - Life cycle cost
  - Complex system modelling
  - Interactive function
  - Cradle to grave
New Design Guide

New guides considers;
- Energy
- Indoor Air Quality
  - CO2
  - TVOC
  - Formaldehyde
- Indoor Environmental Quality
  - Thermal Comfort
  - Daylighting
  - Noise Level
  - External views
Green Design Guides

Green Building Index

Non-Residential New Construction (NRNC)
Design Reference Guide & Submission Format

LEED

LEED 2009 for New Construction and Major Renovations

For Public Use and Display
LEED 2009 for New Construction and Major Renovations Rating System
USGBC Member Approved November 2008
Energy Guides

ASHRAE 90.1

Energy Standard for Buildings Except Low-Rise Residential Buildings
I-P Edition

MS 1525
Thermal Comfort

ASHRAE 55

ANSI/ASHRAE Standard 55-2010
(Supersedes ANSI/ASHRAE Standard 55-2004)
Includes ANSI/ASHRAE addenda listed in Appendix I

MS 1525

MALAYSIAN STANDARD
CODE OF PRACTICE ON ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY FOR NON-RESIDENTIAL BUILDINGS (FIRST REVISION)


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DEPARTMENT OF STANDARDS MALAYSIA

1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

1941-1945
Telephone: 0963-626-6553 or 012-11981-49
Fax: 0963-626-6552

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Indoor Air Quality

DOSH CP IAQ

ASHRAE IAQ GUIDE

ASHRAE 62.1
Daylighting

IES DAYLIGHTING GUIDE
Design Tips

Sustainable Energy System
- VAV and VSD fan system to reduce fan speed low air-cond load
- Automatic duct static pressure reset to optimize operating pressure
- CO2 modulates fresh air dampers allows minimal supply of fresh air
- VPF hydronic system lowering pumping cost
Design Tips

Sustainable Energy System
- Highly efficient chiller
- Large cooling towers to reduce condenser temperature
- Photocell switch-off perimeter lighting when daylight is sufficient
- Efficient lighting (use T5 or LED)
- Solar cell installation
Design Tips

Sustainable Environment System
- Monitoring room temperature with digital display
- Ensure outdoor air monitoring
- Recycling of condensate water
Sustainable Maintenance

Maintenance Mindset

- **Corrective maintenance** - detects anomalies & restores to normal condition
- **Preventive maintenance** – carried out at predetermined interval according to prescribed criteria
- **Risk-Based maintenance** – integrating analysis, measurement & periodic tests
- **Condition-Based maintenance** – performance monitoring & corrective action
Energy Metering
Sound Level Measurement
IAQ Measurement

- TVOC: 647 ppb
- Carbon Dioxide: 832 ppm
- Carbon Monoxide: 3.8 ppm
- Ozone: 0.01 ppm
- Temperature: 75.1 °F
- Relative Humidity: 26.5 %RH
Thermal Infrared Scan
Vibration Analysis
Building Performance Statistics

kW, CO2, Fresh Air, Temp, RH etc

Periodic Report
Monitoring Based Cx/Maintenance
Monitoring Based Cx/Maintenance

Chiller Plant Power kW (Apr 2014)

- 530kW
- 450kW

AHU Power kW (Apr 2014)

- 225kW
- 175kW
Monitoring Based Cx/Maintenance
Monitoring Based Cx/Maintenance
Monitoring Based Cx/Maintenance
DISCUSSION