IEM
The Institution of Engineers, Malaysia
MECHANICAL ENGINEERING TECHNICAL DIVISION

PPK Malaysia
Malaysia Shopping Malls Association

SEMINAR ENGINEERING SHOPPING MALLS IV 2019

On

27th November 2019

At

Sime Darby Convention Centre

The challenge of perfect ACMV system for Tenants & Landlord

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1

Shopping Mall Occupants' Requirement on air-Conditioning & Mechanical Ventilation (ACMV):

1. **Air-conditioning**
2. **Kitchen Ventilation**
3. **Car Park Ventilation**
4. **Others…**

- **Are Shopping Mall ACMV operated at total full load from 10am – 10pm at same heat load profile always?**
- **How to address the AC part load concern if Tenants not opening & closing at the same time?**
- **What provision of ACMV system to cater for future Tenants?**
- **Others…**

Actually efficiency & effectiveness of ACMV depends on tenant mix, designer has to know… what type of mall is going to be built.

But then how many type of malls…?

Let's made reference to ICSC (International Council of Shopping Centers) whether it suit local context:

2

U.S. Shopping-Center Classification and Characteristics

Specialized-Purpose Centers	
Power Center	Category-dominant anchors, including discount department stores, off-price stores, wholesale clubs, with only a few small tenants.
Lifestyle	Upscale national-chain specialty stores with dining and entertainment in an outdoor setting.
Factory Outlet	Manufacturers' and retailers' outlet stores selling brand-name goods at a discount.
Theme/Festival	Leisure, tourist, retail and service-oriented offerings with entertaiment as a unifying theme. Often located in urban areas, they may be adapted from older--sometimes historic--buildings and can be part of a mixed-use project.
Limited-Purpose Property	
Airport Retail	Consolidation of retail stores located within a commercial airport

3

General-Purpose Centers	
Super-Regional Mall	Similar in concept to regional malls, but offering more variety and assortment.
Regional Mall	General merchandise or fashion-oriented offerings. Typically, enclosed with inward-facing stores connected by a common walkway. Parking surrounds the outside perimeter.
Community Center ("Large Neighborhood Center")	General merchandise or convenience- oriented offerings. Wider range of apparel and other soft goods offerings than neighborhood centers. The center is usually configured in a straight line as a strip, or may be laid out in an L or U shape, depending on the site and design.
Neighborhood Center	Convenience oriented.
Strip/Convenience	Attached row of stores or service outlets managed as a coherent retail entity, with on-site parking usually located in front of the stores. Open canopies may connect the store fronts, but a strip center does not have enclosed walkways linking the stores. A strip center may be configured in a straight line, or have an "L" or "U" shape. A convenience center is among the smallest of the centers, whose tenants provide a narrow mix of goods and personal services to a very limited trade area.

4

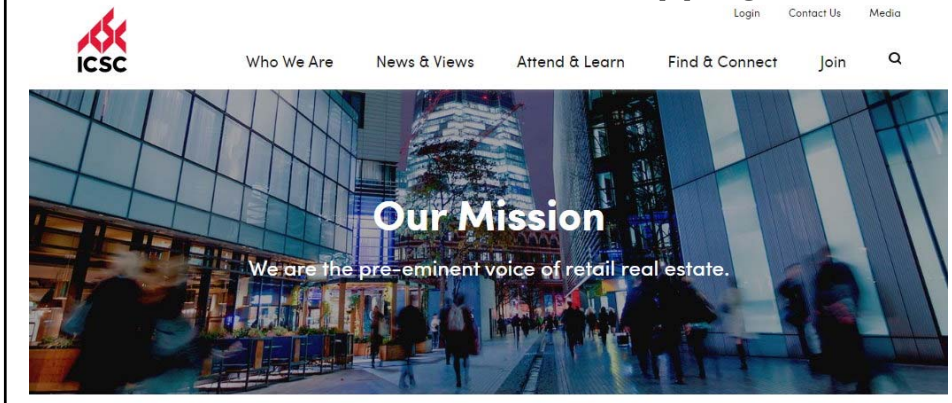
U.S. Shopping-Center Classification and Characteristics

Type of Shopping Center	Concept	Center Count	Aggregate GLA (Sq. Ft.)	% Share of Industry GLA	Average Size (Sq. Ft.)	Typical GLA Range (Sq. Ft.)	Acres	# of Anchors	% Anchor GLA	Typical Number of Tenants	Typical Type of Anchors	Trade Area Size
General-Purpose Centers		**112,520**										
Super-Regional Mall	Similar in concept to regional malls, but offering more variety and assortment.	620	778,336,548	10.2%	1,255,382	800,000+	60-120	3+	50-70%	NA	Full-line or junior department store, mass merchant, discount department store and/or fashion apparel store.	5-25 miles
Regional Mall	General merchandise or fashion-oriented offerings. Typically, enclosed with inward-facing stores connected by a common walkway. Parking surrounds the outside perimeter.	600	353,795,548	4.7%	589,659	400,000-800,000	40-100	2+	50-70%	40-80 stores	Full-line or junior department store, mass merchant, discount department store and/or fashion apparel store.	5-15 miles
Community Center ("Large Neighborhood Center")	General merchandise or convenience- oriented offerings. Wider range of apparel and other soft goods offerings than neighborhood centers. The center is usually configured in a straight line as a strip, or may be laid out in an L or U shape, depending on the site and design.	9,776	1,930,849,736	25.4%	197,509	125,000-400,000	10-40	2+	40-60%	15-40 stores	Discount store, supermarket, drug, large-specialty discount (toys, books, electronics, home improvement/furnishings or sporting goods, etc.)	3-6 miles
Neighborhood Center	Convenience oriented.	32,588	2,340,711,371	30.8%	71,827	30,000-125,000	3-5	1+	30-50%	5-20 stores	Supermarket	3 miles
Strip/Convenience	Attached row of stores or service outlets managed as a coherent retail entity, with on-site parking usually located in front of the stores. Open canopies may connect the store fronts, but a strip center does not have enclosed walkways linking the stores. A strip center may be configured in a straight line, or have an "L" or "U" shape. A convenience center is among the smallest of the centers, whose tenants provide a narrow mix of goods and personal services to a very limited trade area.	68,936	911,202,922	12.0%	13,218	< 30,000	<3	Anchor-less or a small convenience-store anchor.	NA	NA	Convenience store, such as a mini-mart.	<1 mile
Specialized-Purpose Centers		**3,275**										
Power Center	Category-dominant anchors, including discount department stores, off-price stores, wholesale clubs, with only a few small tenants.	2,258	990,416,667	13.0%	438,626	250,000-600,000	25-80	3+	70-90%	NA	Category killers, such as home improvement, discount department, warehouse club and off-price stores	5-10 miles
Lifestyle	Upscale national-chain specialty stores with dining and entertainment in an outdoor setting.	491	164,903,247	2.2%	335,852	150,000-500,000	10-40	0-2	0-50%	NA	Large format upscale specialty	8-12 miles
Factory Outlet	Manufacturers' and retailers' outlet stores selling brand-name goods at a discount.	367	87,368,113	1.2%	238,060	50,000-400,000	10-50	NA	NA	NA	Manufacturers' and retailers' outlets	25-75 miles
Theme/Festival	Leisure, tourist, retail and service-oriented offerings with entertainment as a unifying theme. Often located in urban areas, they may be adapted from older--sometimes historic--buildings and can be part of a mixed-use project.	159	23,498,769	0.3%	147,791	80,000-250,000	5-20	Unspecified	NA	NA	Restaurants, entertainment	25-75 miles
Limited-Purpose Property		**62**										
Airport Retail	Consolidation of retail stores located within a commercial airport	62	15,452,860	0.2%	249,240	75,000-300,000	NA	NA	NA	NA	No anchors; retail includes specialty retail and restaurants	NA
Total Industry		**115,857**										
Total Industry	**Traditional + Specialty + Special Purpose**	**115,857**	**7,596,535,781**	**100.0%**	**65,568**							

Sources: ICSC Research and CoStar Realty Information, Inc . (www.costar.com) January 2017

5

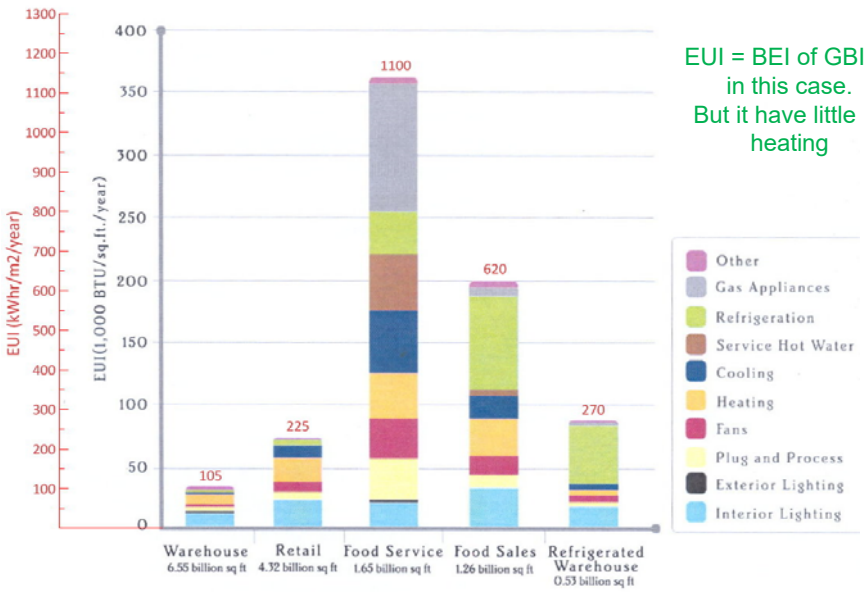
ICSC: International Council of Shopping Centers



Our mission is to ensure the retail real estate industry is broadly recognized for the integral role it plays in the social, civic and economic vibrancy of communities across the globe. Founded in 1957, today we are a 70,000-member network joined together in one vibrant global community.

6

Energy use of typical tenants defined by ICSC, affecting ACMV loads



EUI = BEI of GBI in this case. But it have little heating

Energy use in retail stores varies dramatically by end-use and type of activity, as shown by the annual energy use index (EUI). Source: www.nrel.gov/docs/fy08osti/41956.pdf

7

Example of Tenant Mix:

The profile can affect building heat load & operation of chillers:

SUB AREAS	Floor percentage	EUI
Warehouse	5%	105
Retail	60%	225
Food services	10%	1,100
Food Sales	15%	620
Refrigerated Warehouse	10%	270
	100%	
Overall EUI for the above floor proportions:		370

8

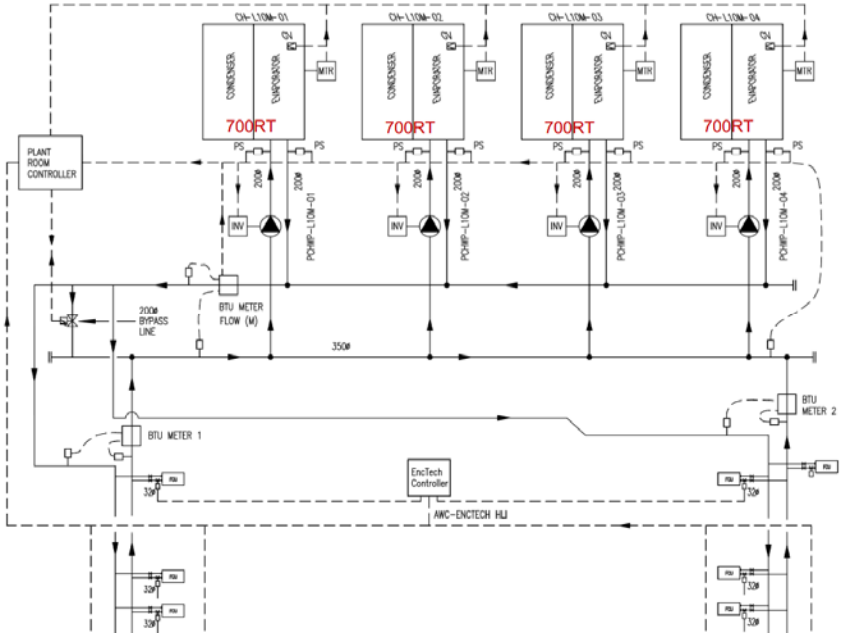
Example of Tenant Mix: Building Information of a Mall in PJ

Level	Floor Area (m2)	Floor Area Mgt (m2)			Floor Area under ICSC Classification (m2)				
		Sold area	Retain-ed area	Comm-on area	Ware-house	Retail	Food Service	Food Sales	Refri. Sales
Basement 2	6,778		6,274						2,131
Basement 1	10,107		6,605			1,623	1,329		
Ground Flr	11,252	2,509	3,648	2,908		1,350			
First Flr	9,828	3,454	3,587	2,908		1,392			
Upper first	3,116	1,140							
	41,081	7,103	20,114	5,816	0	4,364	1,329	0	2,131

Design of energy systems depends on characteristics of building

9

A shopping mall in KL with 4 nos. of 700RT constant speed chiller



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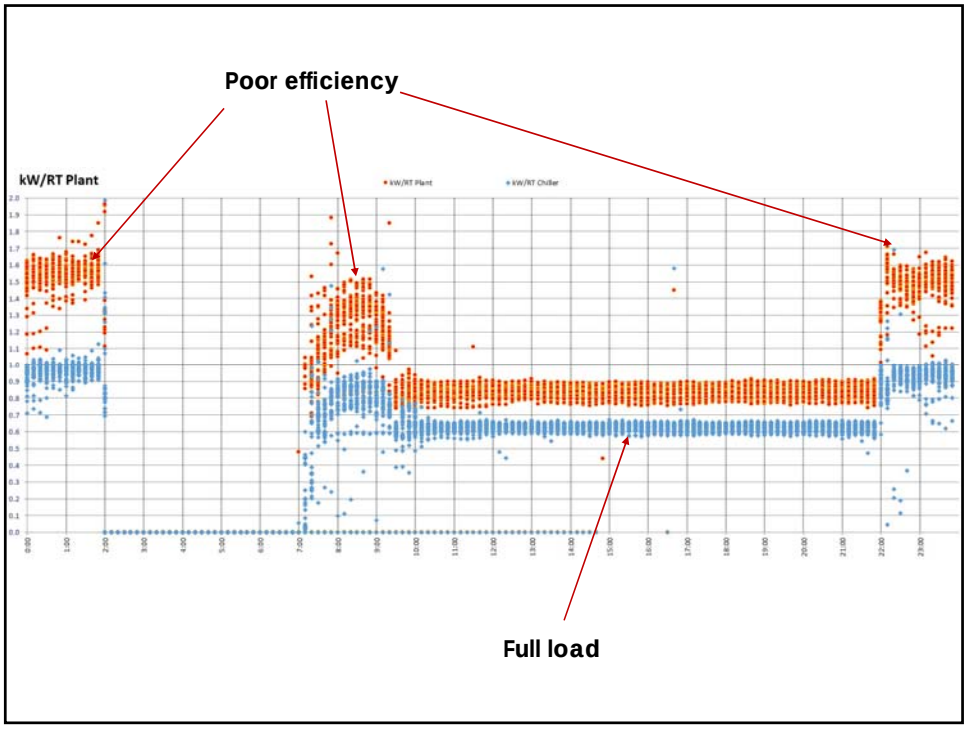
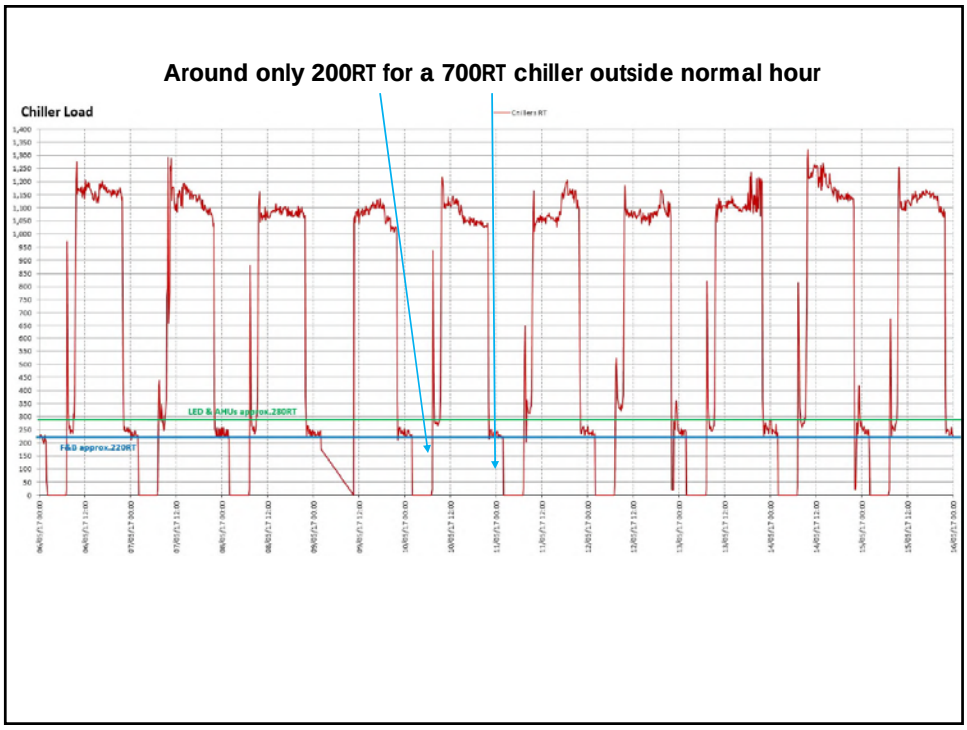
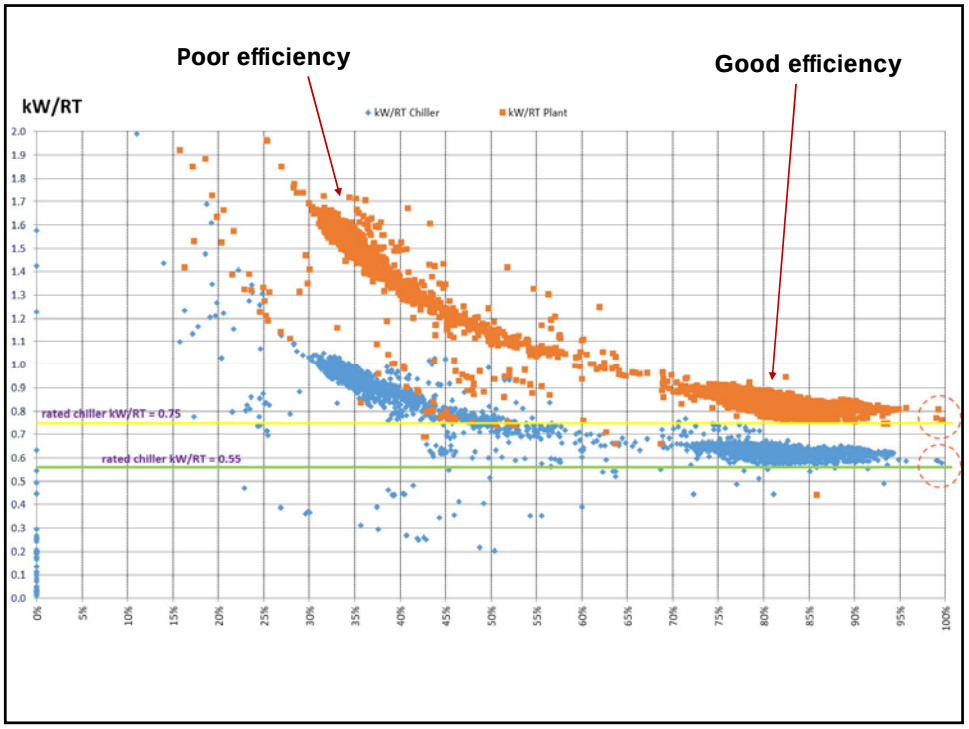

Poor efficiency
kW/RT Plant
Full load

11


Around only 200RT for a 700RT chiller outside normal hour
Chiller Load
LED & AHUs approx.280RT
F&B approx.220RT

12

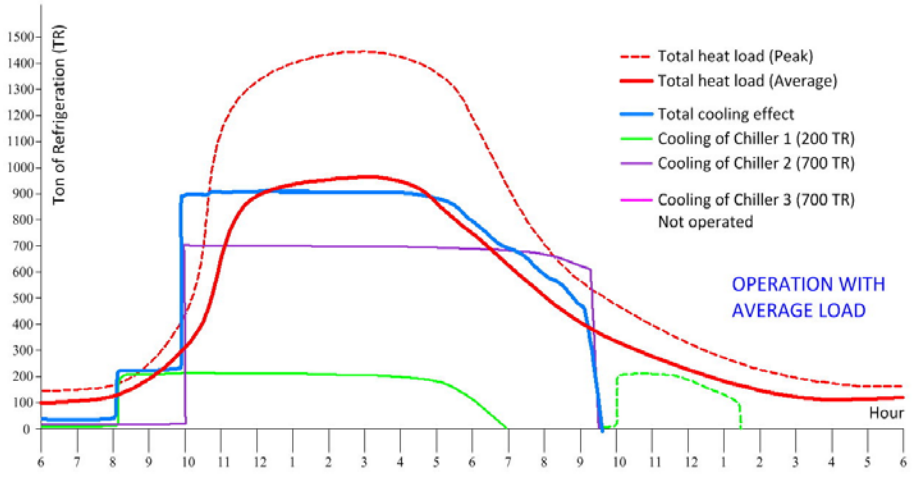


13

Another Mall with 2 nos. of 700RT & 1 no. of 200RT constant speed chiller

All building systems are designed for maximum anticipated load:

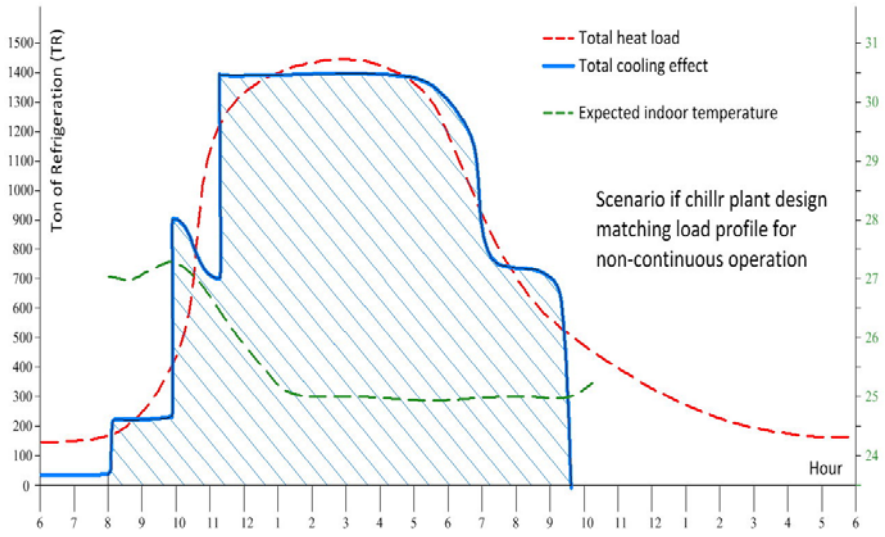
This is applicable to AC, lighting, water systems, etc…
It is this hard fact that optimization opportunity available for part loads…



14

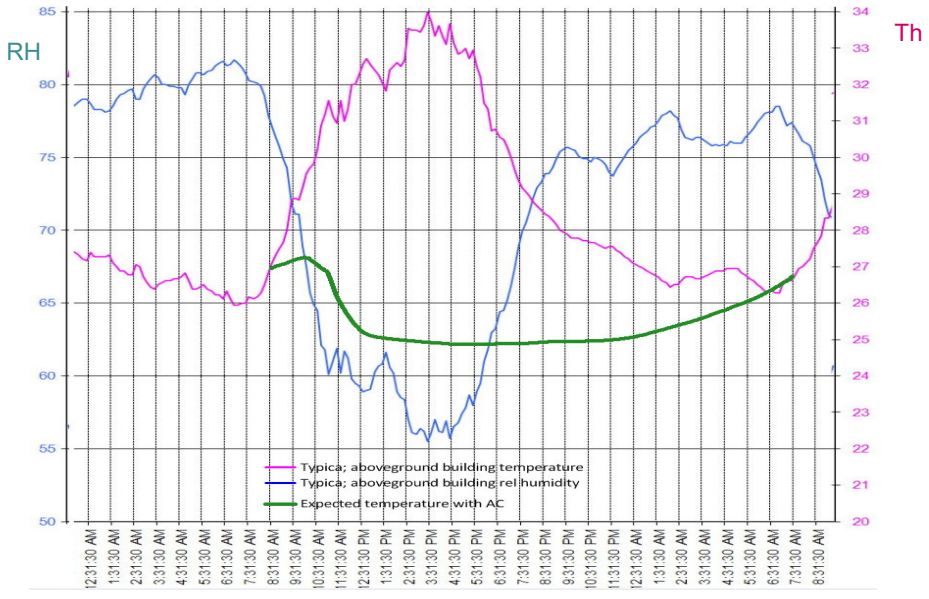
Basis Of Design (BOD):

Building heat load & operation of chillers:



15

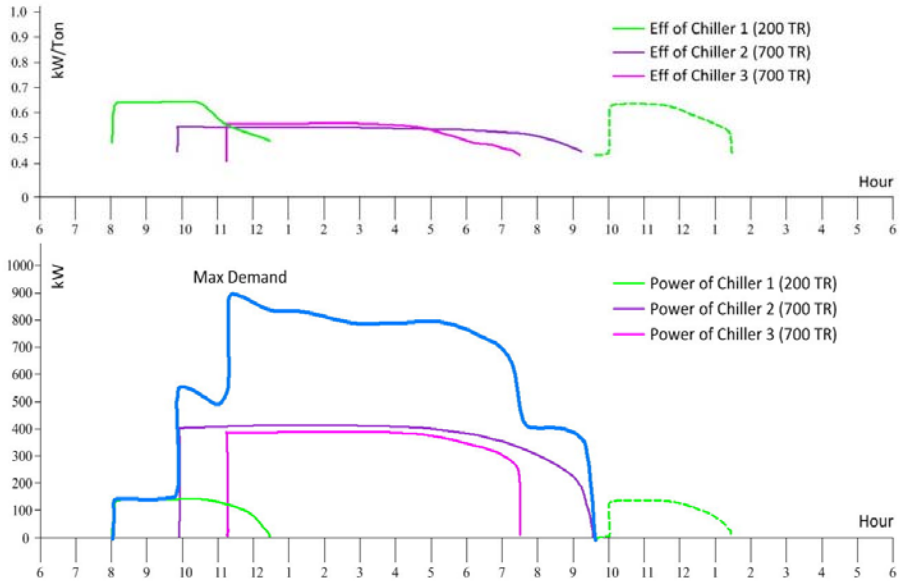
Basis Of Design (BOD): what is tolerable indoor condition?



16

Basis Of Design (BOD):

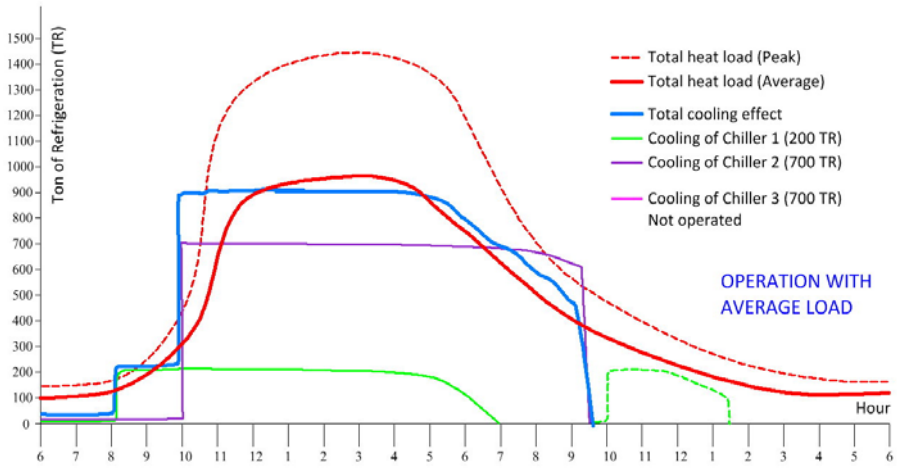
Building heat load & operation of chillers:



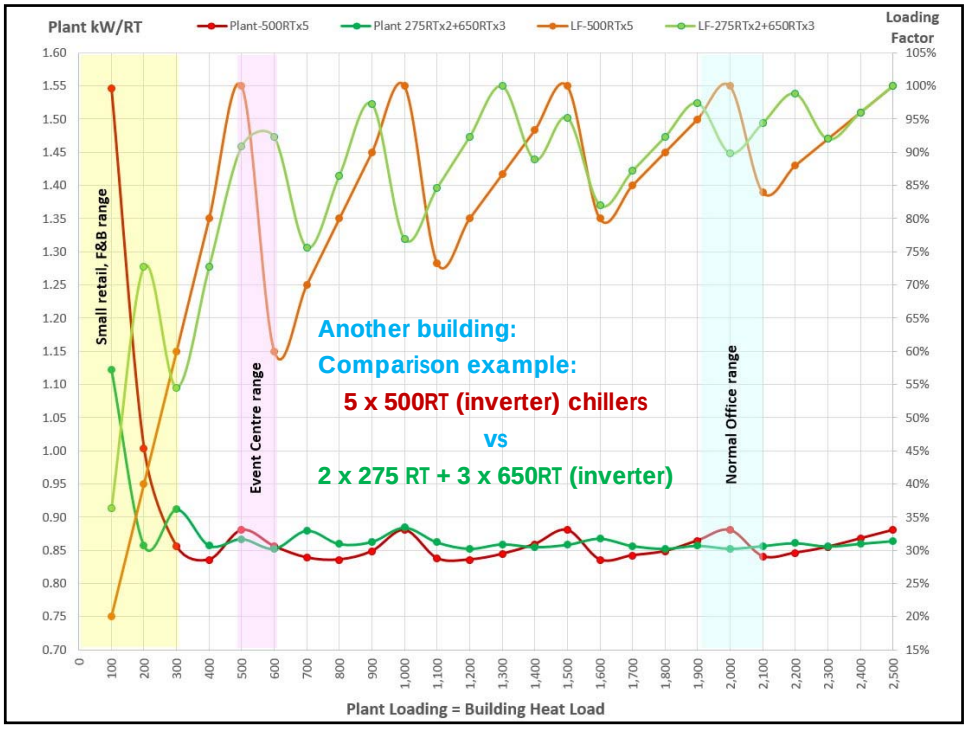
17

Can the ideal selection of chiller matches scenario of real operation?

Building heat load & operation of chillers:



18



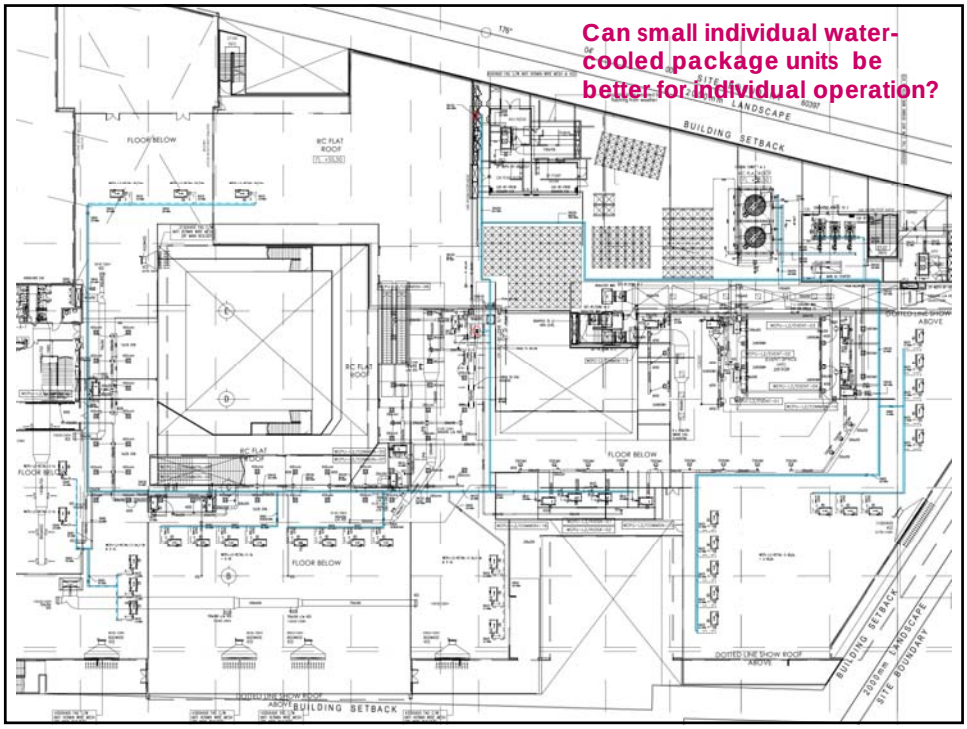
19

Staging of chillers for maximum efficiency: can we program it?

Total RT of chiller RTs stated below:	275	275	550	550	550	650	925	925	925	1,300	1,300	1,300	1,300	1,575	1,575	1,950	1,950	1,950	1,950	2,225	2,225	2,225	2,500	2,500	2,500
275	1	1	2	2	2	0	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	2	2	2
650	0	0	0	0	0	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
Total building HEAT LOAD	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500
Unit	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
Plant Load factor	36.4%	72.7%	54.5%	72.7%	90.9%	92.3%	75.7%	86.5%	97.3%	76.9%	84.6%	92.3%	100.0%	88.9%	95.2%	82.1%	87.2%	92.3%	97.4%	89.9%	94.4%	98.9%	92.0%	96.0%	100.0%
For Chiller 275RT																									
Upper factor	40.0%	80.0%	60.0%	80.0%	100.0%	100.0%	80.0%	90.0%	100.0%	80.0%	90.0%	100.0%	100.0%	90.0%	100.0%	90.0%	90.0%	100.0%	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Upper kW/RT	1.0552	0.8578	0.8712	0.8578	0.8815	0.8815	0.8578	0.8658	0.8815	0.8578	0.8658	0.8815	0.8815	0.8658	0.8815	0.8658	0.8658	0.8815	0.8815	0.8658	0.8815	0.8815	0.8815	0.8815	0.8815
Lower factor	30.0%	70.0%	50.0%	70.0%	90.0%	90.0%	70.0%	80.0%	90.0%	70.0%	80.0%	90.0%	100.0%	80.0%	90.0%	80.0%	80.0%	90.0%	90.0%	80.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Lower kW/RT	1.2410	0.8569	0.9459	0.8569	0.8658	0.8658	0.8569	0.8578	0.8658	0.8569	0.8578	0.8658	0.8815	0.8578	0.8658	0.8578	0.8578	0.8658	0.8658	0.8578	0.8658	0.8658	0.8658	0.8658	0.8815
Plant kW/RT	1.1228	0.8572	0.9119	0.8572	0.8672	0.8694	0.8574	0.8630	0.8772	0.8575	0.8615	0.8694	0.8815	0.8649	0.8740	0.8594	0.8635	0.8694	0.8774	0.8657	0.8727	0.8797	0.8689	0.8752	0.8815
For Chiller 650RT																									
Upper factor	40.0%	80.0%	60.0%	80.0%	100.0%	100.0%	80.0%	90.0%	100.0%	80.0%	90.0%	100.0%	100.0%	90.0%	100.0%	90.0%	90.0%	100.0%	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Upper kW/RT	1.2001	0.8721	0.9763	0.8721	0.8592	0.8592	0.8721	0.8505	0.8592	0.8721	0.8505	0.8592	0.8592	0.8505	0.8592	0.8505	0.8505	0.8592	0.8592	0.8505	0.8592	0.8592	0.8592	0.8592	0.8592
Lower factor	30.0%	70.0%	50.0%	70.0%	90.0%	90.0%	70.0%	80.0%	90.0%	70.0%	80.0%	90.0%	100.0%	80.0%	90.0%	80.0%	80.0%	90.0%	90.0%	80.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Lower kW/RT	1.4197	0.9115	1.0697	0.9115	0.8505	0.8505	0.9115	0.8721	0.8505	0.9115	0.8721	0.8505	0.8592	0.8721	0.8505	0.8721	0.8721	0.8505	0.8505	0.8721	0.8505	0.8505	0.8505	0.8505	0.8592
Plant kW/RT	1.2800	0.9008	1.0272	0.9008	0.8513	0.8525	0.8892	0.8581	0.8569	0.8843	0.8622	0.8525	0.8592	0.8529	0.8551	0.8677	0.8566	0.8525	0.8570	0.8507	0.8543	0.8582	0.8522	0.8557	0.8592
Overall	1.1228	0.8572	0.9119	0.8572	0.8672	0.8525	0.8797	0.8595	0.8629	0.8843	0.8622	0.8525	0.8592	0.8550	0.8584	0.8677	0.8566	0.8525	0.8570	0.8526	0.8566	0.8609	0.8559	0.8600	0.8641

Total RT of chiller RTs stated below:	500	500	500	500	500	1,000	1,000	1,000	1,000	1,000	1,500	1,500	1,500	1,500	1,500	2,000	2,000	2,000	2,000	2,000	2,500	2,500	2,500	2,500	2,500
500	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5
Total building HEAT LOAD	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500
Unit	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
Plant Load factor	20.0%	40.0%	60.0%	80.0%	100.0%	60.0%	70.0%	80.0%	90.0%	100.0%	73.3%	80.0%	86.7%	93.3%	100.0%	80.0%	85.0%	90.0%	95.0%	100.0%	84.0%	88.0%	92.0%	96.0%	100.0%
Upper factor	20.0%	40.0%	60.0%	80.0%	100.0%	60.0%	70.0%	80.0%	90.0%	100.0%	80.0%	80.0%	90.0%	100.0%	100.0%	80.0%	90.0%	90.0%	100.0%	100.0%	90.0%	90.0%	100.0%	100.0%	100.0%
Upper kW/RT	1.5463	1.0041	0.8558	0.8358	0.8804	0.8558	0.8388	0.8358	0.8485	0.8804	0.8358	0.8358	0.8485	0.8804	0.8804	0.8358	0.8485	0.8485	0.8804	0.8804	0.8485	0.8485	0.8804	0.8804	0.8804
Lower factor	20.0%	40.0%	60.0%	80.0%	100.0%	60.0%	70.0%	80.0%	90.0%	100.0%	70.0%	80.0%	80.0%	90.0%	100.0%	80.0%	80.0%	90.0%	90.0%	100.0%	80.0%	80.0%	90.0%	90.0%	100.0%
Lower kW/RT	1.5463	1.0041	0.8558	0.8358	0.8804	0.8558	0.8388	0.8358	0.8485	0.8804	0.8388	0.8358	0.8358	0.8485	0.8804	0.8358	0.8358	0.8485	0.8485	0.8804	0.8358	0.8358	0.8485	0.8485	0.8804
Plant kW/RT	1.5463	1.0041	0.8558	0.8358	0.8804	0.8558	0.8388	0.8358	0.8485	0.8804	0.8378	0.8358	0.8443	0.8591	0.8804	0.8358	0.8422	0.8485	0.8644	0.8804	0.8409	0.8460	0.8549	0.8676	0.8804

20



21

Can small individual water-cooled package units be better for individual operation?

Fan coil units are serving small tenants while AHUs are serving big tenants & common area.

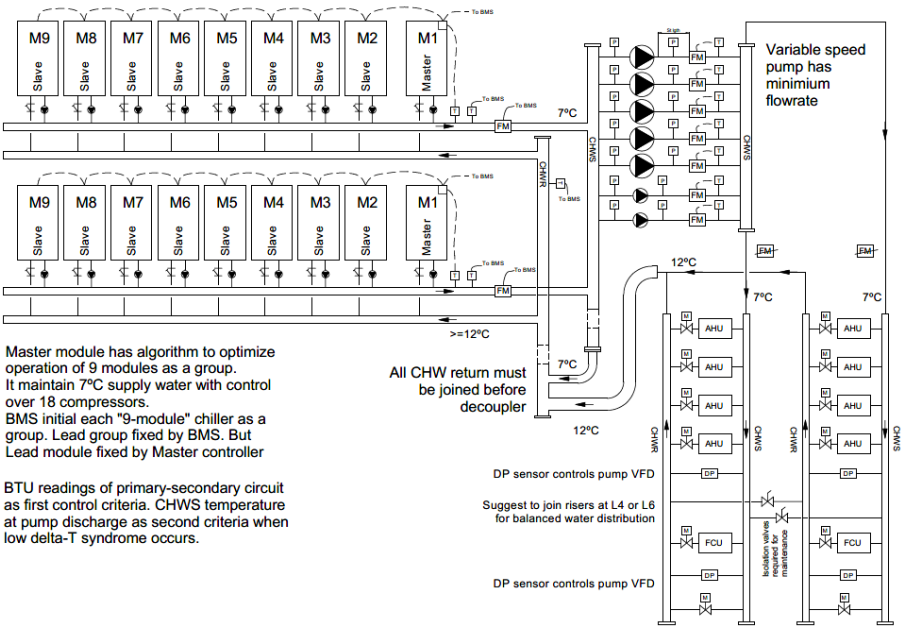
Building peak load is 750TR

22

These are "stackable mini-chiller" water cooled for maximum flexibility.
More for "global" offices.
Unless Mall has extreme Tenant diversity…. You may not need this.

23

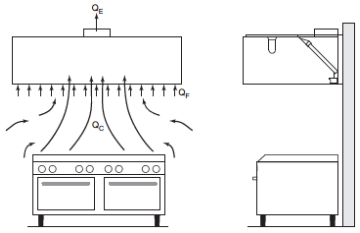
Unless Mall has extreme Tenant diversity…. More for offices

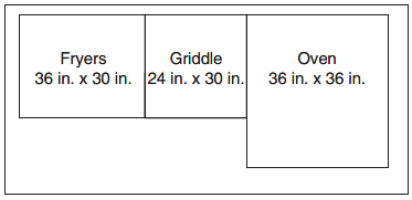


24

Kitchen Ventilation depends on type of Tenants….

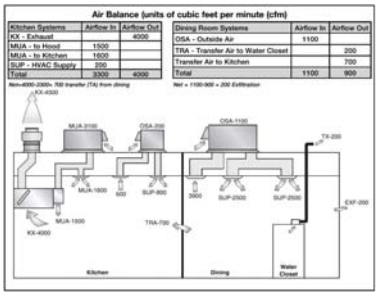
	LIGHT	MEDIUM	HEAVY	EXTRA-HEAVY
Equipment (Greenheck's Appliance Classification)	Gas & Electric Ovens Gas & Electric Steamers Gas & Electric Ranges Food Warmers Pasta Cookers Pizza Ovens Non-Cooking Appliance Smoker Rotisserie	Combi-Ovens Gas & Electric Fryers Griddles Tilting Skillets Tilting Braising Pans Grill Hibachi Grill Salamander	Upright Broiler Electric Char-Broiler	Gas Char-Broiler Mesquite Infrared Broiler Lava Rock Char-Broiler Wok Chain Broiler
International Mechanical Code 2003 Edition (cfm per linear foot)	200	300	400	550





25

Kitchen Ventilation need to be balanced for Condensation and Odor Control



Illustrated diagram beside is a typical supply air diagram for a kitchen and dining room arrangement with the accompanying air balance tables.

The hood has a dedicated exhaust fan and make-up air unit. The kitchen also has a dedicated AC supply (Roof Top Unit) unit to help take some of the conditioning load.

In the dining area another dedicated AC unit is used to supply the air and make up any losses from rest rooms or other small exhausted areas.

Notice, there is transfer air going into the kitchen from the dining area, thus the kitchen is slightly negative to the dining area containing odours although the balance of the dining area of 200 cfm exfiltration (EXF) shows that the building as a whole is at a slight positive to the outdoors as desired.

26

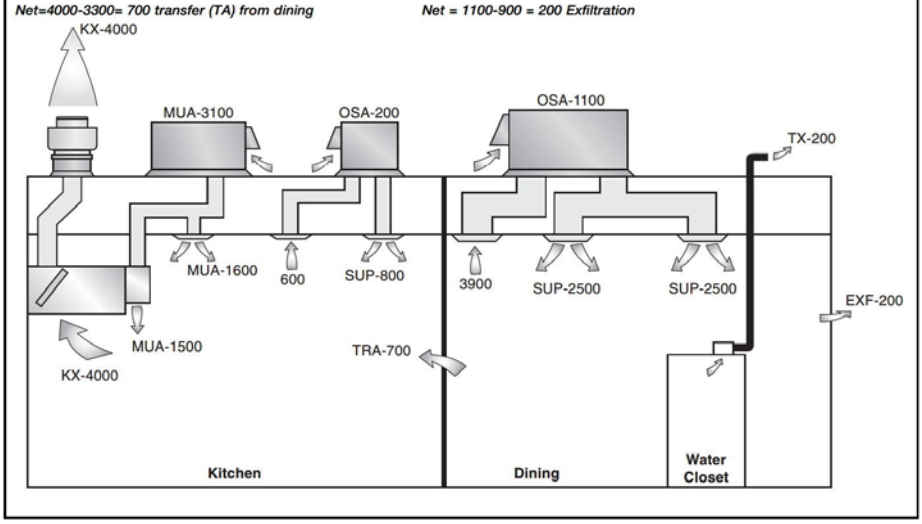
Air Balance (units of cubic feet per minute (cfm)

Kitchen Systems	Airflow In	Airflow Out
KX - Exhaust		4000
MUA - to Hood	1500	
MUA - to Kitchen	1600	
SUP - HVAC Supply	200	
Total	3300	4000

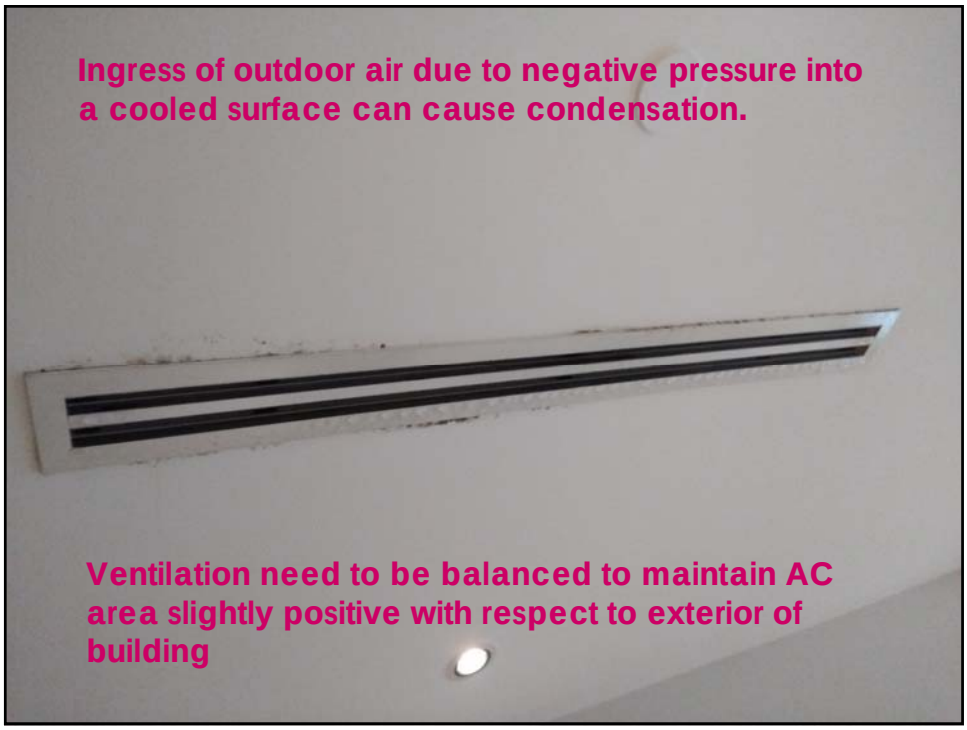
Net=4000-3300= 700 transfer (TA) from dining

Dining Room Systems	Airflow In	Airflow Out
OSA - Outside Air	1100	
TRA - Transfer Air to Water Closet		200
Transfer Air to Kitchen		700
Total	1100	900

Net = 1100-900 = 200 Exfiltration



27

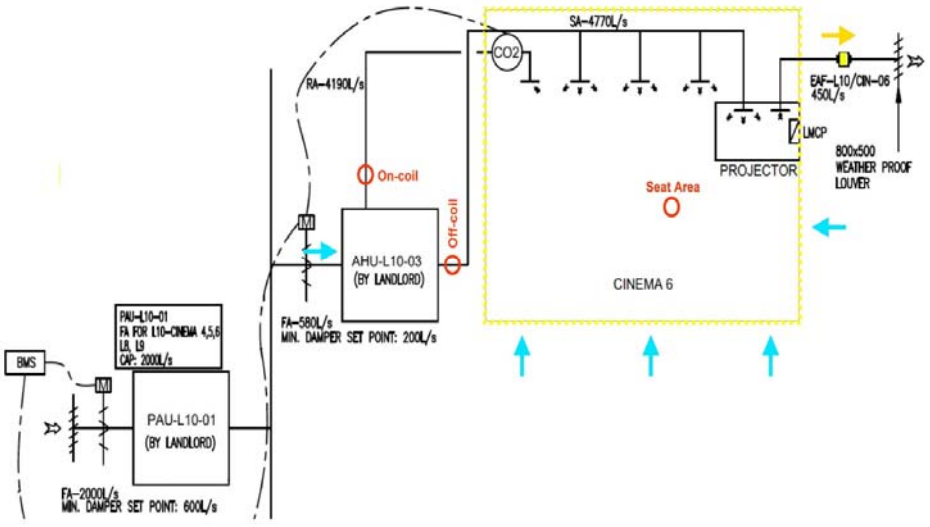


28

Air pressure & flow need to be checked by instruments

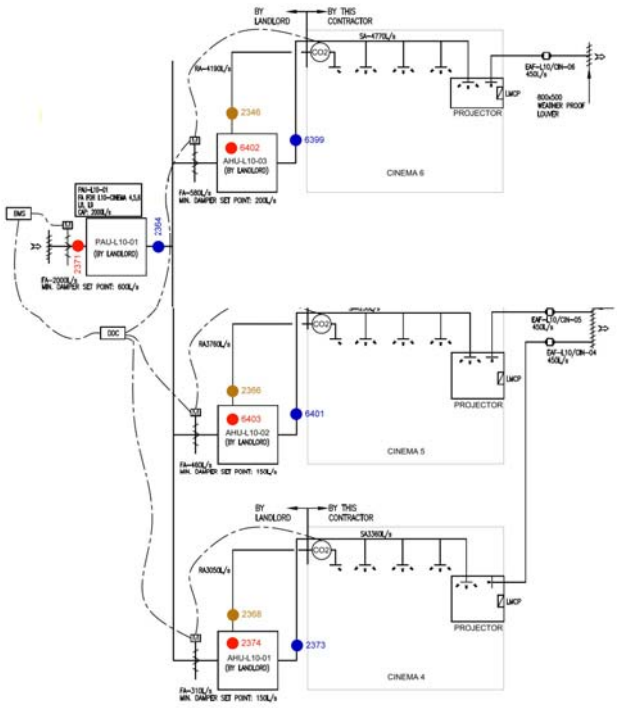
29

Example of other ventilation – Importance of positive pressure:



30

May we ask for the control strategies and pressure control & air balancing provision?

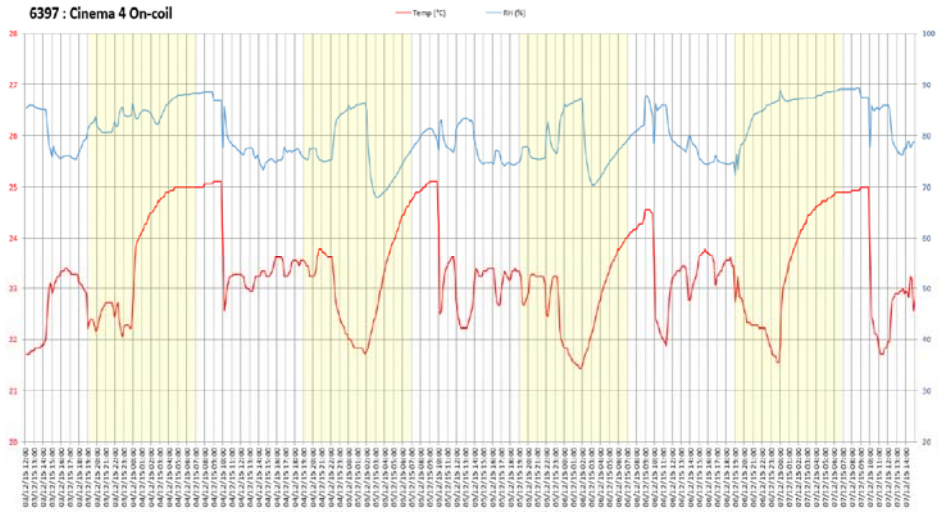


31

Data loggers deployed… to diagnose air pressure & heat load issues

32

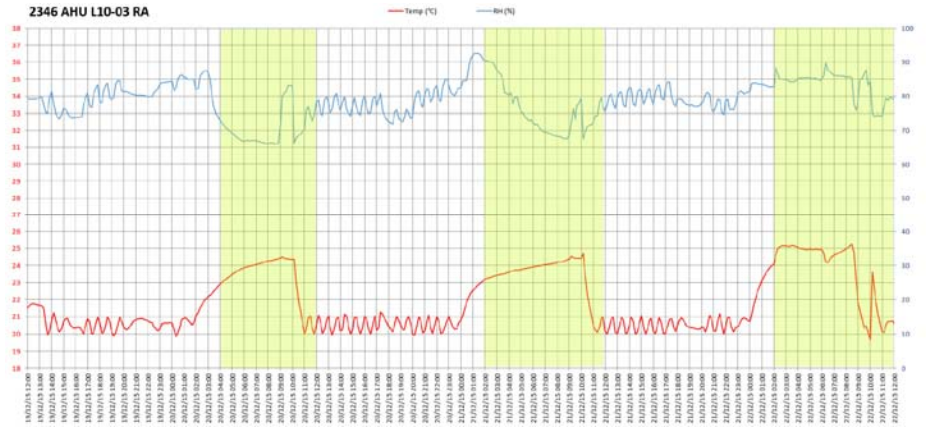
Discussion on data logging



Note: building sucks through ducting, lack dehumidification, etc.

33

Discussion on data logging



Note: RH Improved but at lower space temperatures (!!!), modulation of valves, etc.

34

THANK YOU

35