Fundamentals & Practical Approach to Building Commissioning
(Day 3)

13th to 15th February 2014

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Fundamentals & Practical Approach to Building Commissioning (Day 3)

Session 7: Examples of Design Review on Various Systems that Affect the Results of Final Commissioning (con't)

Expectation of Clients on Input from Commissioning Specialist
How To Work In Sync & Contribute to the Construction Team for Overall Success of Project Objective Achievement:
Part 2

We shall continue from Part 1 yesterday…

Several Commissioning Review meeting slides will be shown
Question & answer as we get along

Fundamentals & Practical Approach to Building Commissioning (Day 3)

Session 8: Extraction of Raw Data from Building Automation System Definition of Energy Management System

Verification Using Raw Data on System Performance Challenges and Pitfalls of Automated & Manual Computation

Input/Output (I/O) points of Building Management System (BMS)

Points List:

Point Name	Hardware Points AI	AO	BI	BO	Software Points AV	BV	ALARM	Show On Graphic
ON/OFF STATUS			x				COMMAND & STATUS MISMATCH ALARM	x
OCCUPIED/UNOCCUPIED						x		x
TRIP ALARM			x				TRIP ALARM	x
FILTER CLOGGED ALARM			x				FILTER ALARM	x
AUTO/MANUAL MODE			x					x
SUPPLY AIR TEMPERATURE	x						TOO HOT/TOO COLD ALARM	x
RETURN AIR TEMPERATURE	x							x
DUCT STATIC PRESSURE	x						TOO HIGH/TOO LOW ALARM	x
CO2 CONCENTRATION LEVEL	x						TOO HIGH ALARM	x
START STOP COMMAND				x				x
MODULATION VALVE CONTROL		x						x
VARIABLE SPEED DRIVE CONTROL		x						x
CONTROL FA DAMPER		x						x
CONTROL VALVE POSITION	x							
AIRFLOW MEASURING STATION	x							
UVGI STERILIZATION SYSTEM			x					
FIRE ALARM						x	FIRE ALARM	x

SUMMARY I/O TABLE

NO	DESCRIPTION	LOCATION	LEVEL	QTY	TOTAL DO	DI	AO	AI	HLI	I/O & HLI POINT DO: START/STOP	DI: VAV DAMPER CONTROL, STATUS (ON/OFF)	DI: TRIP FAULT	DI: AIR FILTER	DI: MANUAL/AUTO STATUS	AO: CONTROL VALVES (MODULATE)	AO: CONTROL FA DAMPER (MODULATE)	AI: VSD CONTROL	AI: SUPPLY AIR TEMP	AI: RETURN AIR TEMP	AI: DUCT STATIC PRESSURE	AI: CO2 CONCENTRATION LEVEL	AI: CONTROL VALVE POSITION	AI: AIR FLOW MEASURING STATION	AI: SPACE TEMP	HLI: UVGI STERILIZATION SYSTEM
	AIR HANDLING UNIT (AHU)																								
	CORE 1			10	10	40	30	10	10		10	10	10	10	10	10	10	10	10	10	10	10			10
	CORE 2			5	5	20	15	30	5		5	5	5	5	5	5	5	5	5	5	5	5			5
	CORE 3			12	12	48	36	72	12	12		12	12	12	12	12	12	12	12	12	12	12			12
	CORE 4			7	7	28	21	42	7	7		7	7	7	7	7	7	7	7	7	7	7			7
	CORE 5			6	6	24	18	36	6	6		6	6	6	6	6	6	6	6	6	6	6			6
	CORE 6			5	5	20	15	30	5	5		5	5	5	5	5	5	5	5	5	5	5			5
	CORE 7			7	7	28	21	42	7	7		7	7	7	7	7	7	7	7	7	7	7			7
	CORE 8			10	10	40	30	60	10	10		10	10	10	10	10	10	10	10	10	10	10			10
	CORE 9			7	7	28	21	42	7	7		7	7	7	7	7	7	7	7	7	7	7			7
	TOTAL AHU			69	69	276	207	414	69	69		69	69	69	69	69	69	69	69	69	69	69			69
	FAN COIL UNIT (FCU)																								
	TOTAL AT CORE 1			25	25	75	25	25		25		25	25		25	25									25
	TOTAL AT CORE 2			4	4	12	4	4		4		4	4		4	4									4
	TOTAL AT CORE 3			14	14	42	14	14		14		14	14		14	14									14
	TOTAL AT CORE 4			6	6	18	6	6		6		6	6		6	6									6
	TOTAL AT CORE 7			13	13	39	4	13		13		13	13		13	4									13
	TOTAL AT CORE 8			21	21	63	1	21		21		21	21		21	1									21
	TOTAL AT CORE 9			6	6	18	6	6		6		6	6		6	6									6
	TOTAL FCU			89	89	267	60	89		89		89	89		89	60									89
	VAV																								
	AH-GF7-1 (OFFICE)	CORE 7	G	15	15			30		15													15	15	
	AH-1F7-1 (OFFICE)	CORE 7	1	20	20			40		20													20	20	
	TOTAL VAV FOR PHASE 1			40	35			70		35													35	35	
				193	543	267	573	69	158	35	158	158	69	158	129	69	69	69	69	69	69	104	124	69	
					1645					193			543				267				573			69	
																	1645								

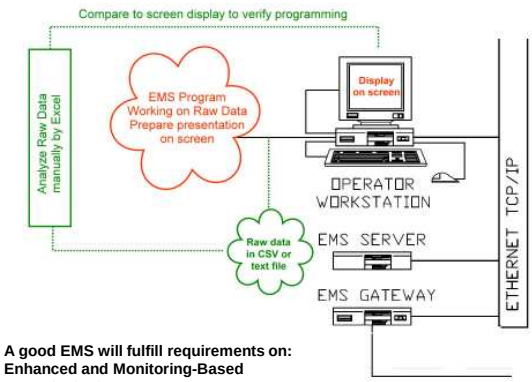
I/O with trending function will be picked for continuous Cx

NO.	DESCRIPTION	POINT TYPE				SOFTWARE FUNCTIONS									HLI
						ALARMS					TREND		OTHER		
		AI	DI	AO	DO	HIGH ANALOGUE	LOW ANALOGUE	SAFETY	OFF NORMAL	STATUS MISMATCH	PERIODIC	CHANGE OF VALUE	SET POINT	TOTALIZE RUNTIME	
1	START/STOP COMMAND				1							X			
2	ON/OFF STATUS		1						X			X			
3	TRIP ALARM		1						X			X			
4	BAS/ AUTO/ MANUAL SELECTOR		1						X			X			
5	CO2 SENSOR	1				X					X				
6	AIR DUCT STATIC PRESSURE	1				X	X				X		X		
7	SUPPLY AIR TEMP	1									X				
8	RETURN AIR TEMP	1									X				
9	CONTROL VALVE POSITION	1									X				
10	VSD/FAN SPEED			1							X				
11	AIR FLOW MEASURING STATION	1													
12	VALVE MODULATION	1									X				
13	UVGI FILTER														X

Database is in row & column naturally

NO.	DESCRIPTION	POINT TYPE				SOFTWARE FUNCTIONS								
						ALARMS					TREND		OTHER	
		AI	DI	AO	DO	HIGH ANALOGUE	LOW ANALOGUE	SAFETY	OFF NORMAL	STATUS MISMATCH	PERIODIC	CHANGE OF VALUE	SET POINT	TOTALIZE RUNTIME
1	ROOM TEMPERATURE	1				X	X				X		X	
2	AIR DUCT STATIC PRESSURE	1				X	X				X		X	
3	VAV DAMPER POSITION			1							X			

Configuration of EMS

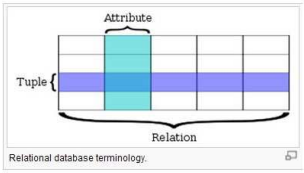


A good EMS will fulfill requirements on: Enhanced and Monitoring-Based Commissioning

Database is in row & column naturally

Relational database theory uses mathematical terminology first introduced in 1970 by E. F. Codd. The table below summarizes some of the most important relational database terms and their SQL equivalents.

SQL term	Relational database term	Description
Row	*Tuple* or *record*	A data set representing a single item
Column	***Attribute*** or ***field***	A labeled element of a tuple, e.g. "Address" or "Date of birth"
Table	*Relation* or ***Base relvar***	A set of tuples sharing the same attributes; a set of columns and rows
View or *result set*	***Derived relvar***	Any set of tuples; a data report from the RDBMS in response to a query



Relational database terminology.

File exported from EMS database is normally CSV file

Comma-separated values

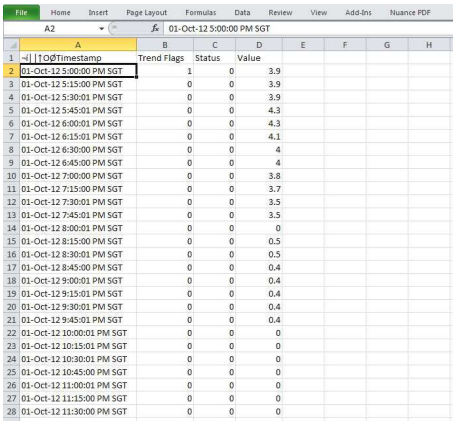
A **comma-separated values** (**CSV**) (also sometimes called *character-separated values*, because the separator character does not have to be a comma) file stores tabular data (numbers and text) in plain-text form.

Plain text means that the file is a sequence of characters, with no data that has to be interpreted instead, as binary numbers. A CSV file consists of any number of records, separated by line breaks of some kind; each record consists of fields, separated by some other character or string, most commonly a literal comma or tab. Usually, all records have an identical sequence of fields.

A general standard for the CSV file format does not exist, but it is described in RFC 4180 fundamentally. Also the used character encoding is not specified but 7-Bit-ASCII is used as the lowest common denominator.

We shall perform a few demo on what is CSV on screen…now

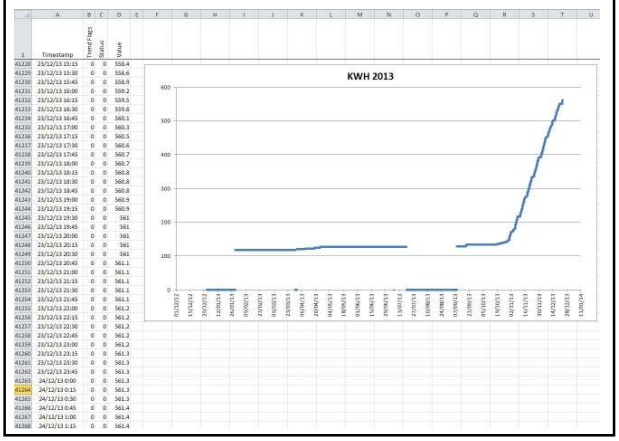
Sample of raw data



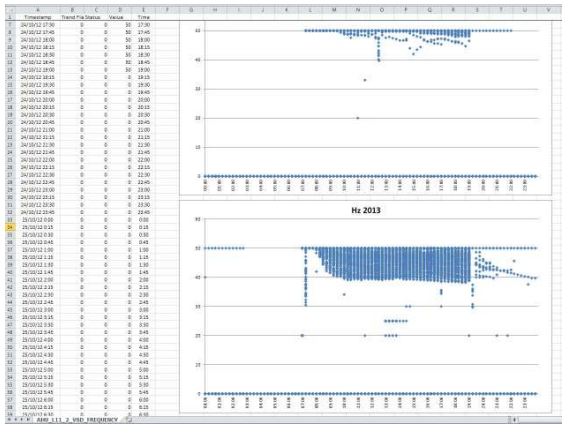
A2: 01-Oct-12 5:00:00 PM SGT

	A	B	C	D
1	TagTimestamp	Trend Flags	Status	Value
2	01-Oct-12 5:00:00 PM SGT	1	0	3.9
3	01-Oct-12 5:15:00 PM SGT	0	0	3.9
4	01-Oct-12 5:30:01 PM SGT	0	0	3.9
5	01-Oct-12 5:45:01 PM SGT	0	0	4.3
6	01-Oct-12 6:00:01 PM SGT	0	0	4.3
7	01-Oct-12 6:15:01 PM SGT	0	0	4.1
8	01-Oct-12 6:30:00 PM SGT	0	0	4
9	01-Oct-12 6:45:00 PM SGT	0	0	4
10	01-Oct-12 7:00:00 PM SGT	0	0	3.8
11	01-Oct-12 7:15:00 PM SGT	0	0	3.7
12	01-Oct-12 7:30:01 PM SGT	0	0	3.5
13	01-Oct-12 7:45:01 PM SGT	0	0	3.5
14	01-Oct-12 8:00:01 PM SGT	0	0	0
15	01-Oct-12 8:15:00 PM SGT	0	0	0.5
16	01-Oct-12 8:30:01 PM SGT	0	0	0.5
17	01-Oct-12 8:45:00 PM SGT	0	0	0.4
18	01-Oct-12 9:00:01 PM SGT	0	0	0.4
19	01-Oct-12 9:15:01 PM SGT	0	0	0.4
20	01-Oct-12 9:30:01 PM SGT	0	0	0.4
21	01-Oct-12 9:45:01 PM SGT	0	0	0.4
22	01-Oct-12 10:00:01 PM SGT	0	0	0
23	01-Oct-12 10:15:01 PM SGT	0	0	0
24	01-Oct-12 10:30:01 PM SGT	0	0	0
25	01-Oct-12 10:45:00 PM SGT	0	0	0
26	01-Oct-12 11:00:01 PM SGT	0	0	0
27	01-Oct-12 11:15:00 PM SGT	0	0	0
28	01-Oct-12 11:30:00 PM SGT	0	0	0

Sample of raw data & graphical analysis



Sample of raw data & graphical analysis



How to transform the raw data into meaningful rows & columns in Excel file and be analyzed in tabular & graphic form, we shall see a few real life practical examples…

These examples will make use of some existing data from previous project and be output to screen for illustration. Interesting focus & pitfall of continuous monitoring include:

- What happen when a field device is off-line?
- If internal accumulated value of a devices reset itself for specific duration or maximum value, how will the program detect and address it?
- Integration function of a changing value, how accurate it can be?
- Can hour run be used in-lieu totalizer for constant consumption?
- How to measure rainwater harvested?
- Etc.

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Session 9: Hands-on Demonstration of Advanced Verification Instruments by Technician and Suppliers

Including Data Loggers, IAQ Monitor, Thermography, etc. Demo of mobile digital power meter depends on site availability

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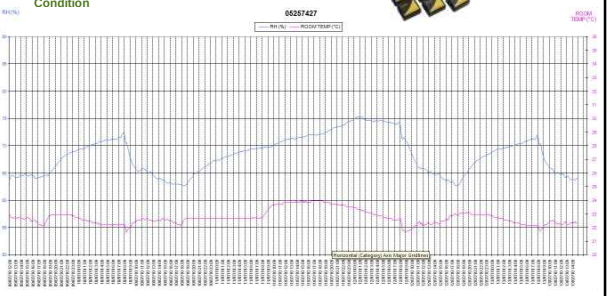
Temperature & humidity data logger is the most basic verification tool

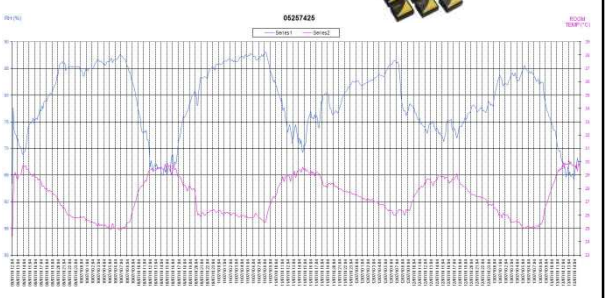
Example : Advanced but affordable instrument for assessment on actual condition & design intent – Indoor Condition



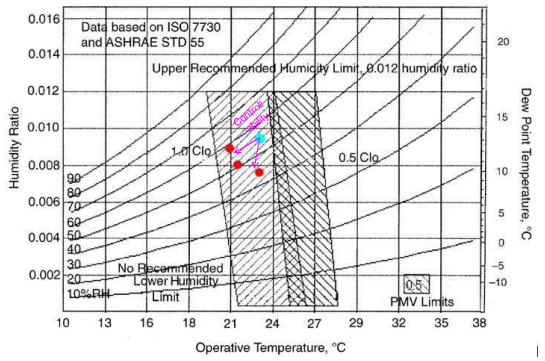
Green Building emphasize on end result:

greenbuildingindex

Example : Advanced but affordable instrument for assessment – Outdoor Condition



Verifying design to ASHRAE Std 55



Verifying air movement to ASHRAE Std 55

1341 Hot-Wire Anemometer

FEATURES

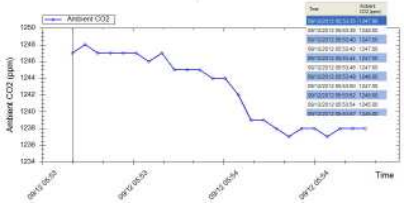
- Fast Response Probe.
- Air Flow Volume.
- Instant / Avg / 2/3 Vmax Flow Measurement.
- Velocity m/s, ft/min, knots, km/hr, mph.
- Temperature & Humidity measurement.
- Calculate Dew point temperature, Wet bulb temperature, Wind chill temperature, Humidex temperature and Heat index temperature.
- Data hold & Maximum / Minimum function
- Manual data memory and read function (10 x 99 sets).
- LCD triple display.
- Telescoping probe.
- USB interface.

Verifying ventilation design

1% CO2, Temp & %RH Data Logger

TIM12 Desktop CO2 & RH/T Monitor/Data Logger

USB CO2 Probe Data Logger 1-30-100%



Direct sensing instrument verifying Indoor Air Quality
It is real time in comparison to Air Sampling Kits

VOCs
CO_2
CO
%RH
Temperature
+1 more Toxic Gas
IQ-610

All of the IQ-410 capability plus a ppb range PID sensor for VOC measurements.
Track VOCs over time, rapidly bloodhound VOC sources or determine optimum locations and times to take air samples for VOC speciation via lab analysis. A very powerful screening tool.

Whatever instrument, need to know limits of instrument and appreciate timing of measurement

Power data logger verifying energy consumption

Time of use data loggers

Measurement of artificial & daylight level

TES-1339 Light Meter Pro.

FEATURES

- Dual Display, 4-digit LCD reading.
- Spectral Sensitivity close to CIE photopic Curve.
- Measuring Levels Ranging 0.01 to 999900 Lux,0.01 to 99990 fc, Autoranging 5 step.
- Accurate and Instant response.
- Integral illuminance measurement.
- Luminous intensity measurement.
- Data Hold function.
- Data memory and read function.
- Reference value setting for relative or percentage deviation measurement.
- Ripple measurement for STRAY + LIGHT function.
- Time-hold function.
- Point - average function.
- Comparator function.
- Auto power off function.
- CNS 5119 Class Ⅱ .

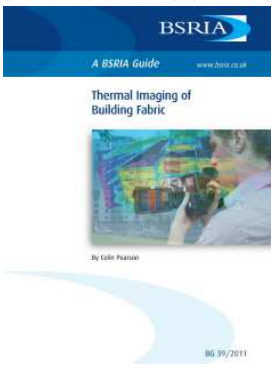
Assessment of Indoor Environment Quality level

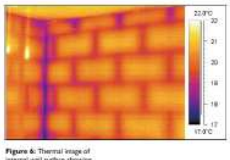
Formaldehyde meter

Sound level meter: Assessment of equivalent noise level

BSRIA The built environment experts

(owned by The Building Services Research and Information Association) has a guideline on thermal imaging of building envelop:





BSRIA The built environment experts

Predicting condensation risk

Properly adjusted thermal images from good quality cameras show surface temperatures accurately to within ± 0.1°C. When a surface is colder than the dewpoint of the surrounding air condensation will occur. There are published tables (such as CIBSE Guide C1) of dewpoint temperatures at different air temperatures and humidities. Thermal imaging can find these areas and some infrared cameras have built-in analysis features to detect areas of condensation risk as seen in Figure 7. But the temperature at the time of the survey may not be the design conditions so surface temperature could be lower at other times. The thermographer can use methods of predicting surface temperatures in other conditions.

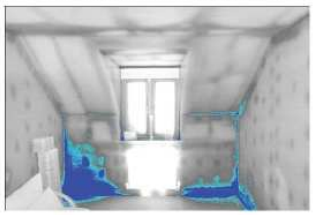


Figure 7: Thermal image with isotherms to show areas of condensation risk

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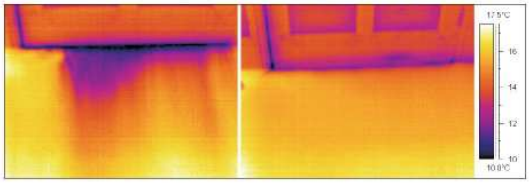
6.5 Air leakage surveys

Air infiltration contributes about 10% of the heat loss in a typical house built in the late 20th Century. Recent editions of building Regulations have aimed to reduce this by limiting the allowable infiltration and specifying airtightness testing. Unfortunately airtightness testing does not identify the location of the air leaks that are limiting the airtightness. Thermal imaging can clearly show these leaks in a depressurisation test provided that there is a temperature difference of at least 5 °C at the time of the test.

Thermal imaging is therefore a useful diagnostic tool in tests on new buildings, but it can also be used to detect air leakage that is causing heat loss from older buildings. Although a blower door is typically used to provide the pressurisation it is possible to use the effects of wind, which typically pressurises one side of a building or 'stack effect' that leads to air entry at low levels and exit at high levels in tall buildings.

Figure 10: Thermal images of air leakage under door before and after draught strip installation



MGBC

ASHRAE

MALAYSIA CHAPTER

THANK YOU

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