Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations 2007

Air Conditioning Inspection Report (Level 4)

For

Sample Hospital

Date of Issue **21 December 2011**

Report prepared by **David Frank**

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Introduction

On 4 January 2003 the European Parliament and the Council of the European Union published Directive 2002/91/EC on the Energy Performance of Buildings (EPBD). This requires Member States to bring into force 'the necessary laws, regulations and administrative provisions to comply with the Directive'. Article 9 requires Member States to introduce measures to establish a regular inspection of air conditioning systems.

In England and Wales the Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations 2007 implement Articles 7-9 of the Directive. They require inspection of all air conditioning systems with rated outputs over 12kW at intervals not greater than 5 years.

To minimise the impact of the introduction of this requirement, the first such inspections will apply to systems with a capacity of over 250kW and must be completed by 4th January 2009. The remaining systems over 12kW must have the first inspections completed by 4th January 2011.

New systems brought into use after January 2008 will not require inspection until they have been in use for a maximum of 5 years.

These inspections may only be completed by an accredited Air Conditioning System Energy Assessor (ACSEA).

The EPBD Regulations define an 'air conditioning system' as: a combination of all the components required to provide a form of air treatment in which the temperature is controlled or can be lowered and includes systems which combine such air treatment with the control of ventilation, humidity and air cleanliness.

The rated cooling output of an air conditioning system could exceed 12kW where a number of individual units of less than 12kW rated cooling load output are installed to provide distributed cooling within the building under the operator’s demise, irrespective of whether or not the individual units are linked to a common control system. Low capacity packaged units such as 'through the wall' units may therefore need to be assessed where the total cooling capacity in the building exceeds 12kW.

Scope of the inspection required by the EPBD Regulations

The primary aim of the inspection is to give building owners and operators information about the performance of their buildings and plant, and to identify opportunities to save energy and cut operating costs.

The Inspection and Report were undertaken in accordance with CIBSE's methodology, Inspection of Air Conditioning Systems TM44: 2007 by an inspector accredited to the National Occupational Standard and accredited by CIBSE Certification.

The inspection is as far as possible carried out by making visual observations of representative sample of the air conditioning equipment and other visual indicators such as refrigerant sight glasses, pressure, temperature or filter gauges, although where these are not available the inspector may have taken some test readings. The inspection also included an examination of records of design, construction and maintenance where made available.

The inspector is also required to estimate whether the system is suitably sized for the cooling loads in the treated spaces, and to provide advice on ways in which improvement might be made.

Health and Safety Issues

Inspectors have a duty to comply with relevant health and safety legislation. This includes a duty to draw the building owner or manager's attention to obvious instances of inadequate maintenance or neglect, where these might have implications for the health and safety of building occupants or the public.

Executive Summary

System Description

The Hospital was constructed during the 1980's and is typical of healthcare buildings of its time. Cooling is from a large distributed chilled water system fed from chilled water plants, supplemented by split and multi split packaged units.

Inspection Observations

The building services are well maintained, and the plant was seen to be in good condition and in clean and tidy plant rooms.

Alternative Solutions

None identified.

Document Checklist

Level	Item	Seen
Essential	Itemised list of installed air conditioning and refrigeration plant including product makes, models and identification numbers, together with cooling capacities, with locations of the indoor and outdoor components of each plant	Yes
	Description of system control zones, with schematic drawings	At BMS
	Description of method of control of temperature	Yes
	Description of method of control of periods of operation.	Yes
	Floor plans and schematics of air conditioning systems	
Desirable	Reports from earlier inspections of air conditioning systems, and for the generation of an energy performance certificate	No
	Records of maintenance operations carried out on refrigeration systems.	Yes
	Records of maintenance operations carried out on air delivery systems, including filter cleaning and changing, and cleaning of heat exchangers	Yes
	Records of calibration and maintenance operations carried out on control systems and sensors.	Yes
	Records of sub-metered air conditioning plant use or energy consumption	No
	For relevant air supply and extract systems, commissioning results of measured absorbed power at normal air delivery and extract rates	No
Optional	An estimate of the design cooling load for each system (if available). Otherwise, a brief description of the occupation of the cooled spaces, and of power consuming equipment normally used in those spaces	No
	Records of any issues or complaints that have been raised concerning the indoor comfort conditions achieved in the treated spaces	Yes
	Where a BMS is used the manager should arrange for a short statement to be provided describing its capabilities, the plant it is connected to control, the set points for the control of temperature, the frequency with which it is maintained, and the date of the last inspection and maintenance	No

Recommendations

Monitor and Target Energy Consumption

Install energy meters to major plant items such as motor control centres, large condensing units and heat raising plant. Automatic monitoring of these will enable management to keep an eye on energy consumption.

The metering could be programmed to automatically generate reports of energy consumption against weather data, and raise alarms for exceptional energy use such as equipment being operated out of hours.

The existing BMS is likely to have the functionality to incorporate the above, alternatively there are stand alone systems available which send meter readings to a remote bureau and automatically generate regular reports and raise alarms for unusual patterns of energy use.

Useful guidance is contained in CIBSE TN39 "Building Energy Metering".

Building Energy Log Book

Prepare and implement a building energy log book. Log books are required under the Building Regulations whenever a building is constructed, or when major plant is replaced.

Log books provide an easily accessible summary of the building, and include the facility for recording alterations, additions and energy consumption.

It is recommended that a log book is prepared in accordance with the recommendations given in CIBSE publication TM31 "Building Log Book Toolkit".

Measure and record specific fan power

It is recommended that the air volume and running currents of the major ventilation plants is measured and recorded. This is to establish a benchmark as to which future energy performance can be measured.

Override packaged air conditioning systems to remove the risk of excessive use

It was noted that the packaged systems operate according to the percieved needs of the staff. Additionally, it is not clear whether or not the systems are switched off during hours of non occupancy.

It is recommended that the packaged systems are connected to the BMS, so that the Trust can be assured that the systems do not operate during inappropriate periods, such as nights, weekends and bank holidays.

Chiller operation

Both main chillers were enabled and running, however the ambient temperature, at 18 degrees C did not appear to justify this. It is suggested that the control strategy is reviewed, and that the standby / lag chiller is inhibited until the lead is fully loaded. This should enable the chillers to operate at their most efficient.

Building and Assessor Details

Organisation name	Hospital NHS Trust
Building Manager	
Street Address	
Postcode	
UPRN	

Accredited Inspector	David Frank, B.Eng (Hons), C.Eng, MCIBSE, MIHEEM
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Accreditation scheme	CIBSE Certification
Accreditation number	CACI 002171
Scope of inspection	Level 4
Date of Inspection	6 April 2011
Date of Report	7 May 2011
Valid until	6 May 2016

Chiller System 1

Manufacturer	York		
Description	Air cooled water chiller		
Model / Ref	TCAJ98XD7		
Serial number	16372		
Year plant installed	1998		
Rated cooling capacity	225 kW		
Refrigerant type	R407C	Weight of refrigerant	64 kg
Regular inspection required?	Yes	Date of last inspection	Dec 09
Location	Ground compound		
Areas / systems served	Theatre air handling units		
Note discrepancies between information provided and on site			

Chiller Plant Visual Inspection	**Comments**
Is chiller operational	Yes
Is area around chiller clear of obstructions and debris	Yes
Is general condition of chiller and associated plant in good order?	Yes
Assess temperature difference/ and observe refrigerant via sight glass or pressure gauge. Suitable?	Yes
Does area around plant show signs of oily stains indicative of a refrigerant leak?	No
Is insulation on primary circulation pipe work, well fitted and in good condition?	Yes
Is the chiller unit placed clear from warm air discharge louvres?	Yes
Are there any energy efficiency measures evident in the system design? e.g. free cooling (separate coil or compressor by pass), connection to ground water, heat recovery of condenser water	No

Appropriately sized cooling plant		**Comments**
Floor area	2000 m^2	
Occupant density	/ m^2	
Installed cooling capacity	225 kW	
This equates to	113 W/ m^2	
Benchmark capacity	100 W/ m^2	
Acceptable?	Yes	
Running observations		
Commentary on view through the refrigerant site glass	Clear	
Ambient temperature	18 ^{0}C	
Pre-compressor temp	6 ^{0}C	
Post-compressor temp	6 ^{0}C	
Compressor oil level	ok	
Record design CHW setpoint	5.5 / 12.5 ^{0}C	
CHW F&R Setpoints at service	5.5 / 12.5 ^{0}C	
CHW F&R Setpoints observed	5.5 / 12.5 ^{0}C	
Regularly maintained by suitably competent persons?	Yes	
Frequency of maintenance?	4 service visits per year	Last serviced August 2009
Is metering installed to enable energy consumption of chiller plant to be monitored	No	
Is a BMS installed which could warn of out of range values?	Yes	
Further comments	Ambient temperature 10 degrees, both chillers seen to be operating – there doesn't seem to be a load sufficient to justify this. Suggest that chiller control strategy is reviewed.	

Secondary Chilled Water Pumps

Serial No.	ID plate not readable	
Systems served from pump plant	Cooling coils in AHU's	
Manufacturer	Wilo	
Year systems installed	Not known	
Location	Chiller compound	
Detailed Inspection Notes		
Guidance Notes	Inspection Notes	Comments
Visually inspect the route and condition of the cooling system pipework serving local areas Check that pipework is adequately insulated	Pipework and insulation appears to be in reasonable condition	
Check for signs of water leakage	None found	
Visually check the condition and operation of pumps and ancillary equipment	Pumps appear to be in reasonable condition	
Establish the operation of the pumps and drives Provide comment regarding operation	No comments Pumps are enabled by the BMS and run with the chillers	

Air Handling Unit 3

Systems served from air handling plant	North Plantroom AHU	
Manufacturer	Packaged Air Handling Ltd	
Year systems installed	Not indicated	
Plant Location	Roof plant room	
Areas / systems served	Hydrotherapy Pool (C2)	
Detailed Inspection Notes		
Guidance Notes	Inspection Notes	Comments
Check condition of intake air filters and check air inlets and outlets for obstruction Note the usual filter changing or cleaning frequency and the elapsed time since the last change or clean, in relation to industry guidance	Air intakes clean and the filters appear to be in good condition Panel filters are changed on a three monthly, bags six monthly basis, depending on condition	
Estimate the specific fan power (SFP) of air movement systems, provided that this can be done simply from existing records of the installed fan capacities and the flow rates and pressure drops noted in commissioning records for co parison with the industry guidance	Calculated SFP 3.6 W/(litre/s)	
Assess condition of heat exchangers. Note whether any heat exchanger surfaces are significantly damaged or blocked by debris or dust. Where reasonable practical and where suitable information is available for comparison, the air path resistance across the heat exchanger should be measured	Heat exchangers appear to be clean and in good condition	
Note whether refrigeration heat exchangers show signs of oily staining that could indicate refrigerant leakage. If present, check whether any attention to this is noted in the maintenance records	Not applicable as cooling is from the chilled water system No signs of oil leaks observed	
Fan type and method of speed control	Variable speed centrifugal Inverter drive	

Identify if the systems have any energy conservation facilities e.g. heat recovery, free cooling sequence, and check for evidence that such facilities are/have been functioning	Run around coil	
Observe the air handling plant and visible air containment including ductwork, floor or ceiling plenums and builders work shafts for signs of excessive leakage and energy loss	No significant losses identified	
Locate the inlets for outdoor air		
Note any significant obstructions or blockages to inlet grilles, screens and pre-filters	None identified	
Note where inlets may be affected by proximity to local sources of heat, or to air exhausts	None identified	
Check the settings and operation of air / recirculation dampers	Appear to be set correctly	
Is ductwork appropriately insulated?	Yes	
Comment on control strategy	Enabled and controlled off BMS	
Other comments / observations	System seen to be in cooling mode, surprising as the ambient is 18 degrees	Suggest strategy is checked

HDSU Office Packaged Cooling

Description	Split cooling to HSDU office		
Year installed	2008	Manufacturer	Daikin
Model	Pu-p1.6vgaa	Serial No	3B000239
Condensing unit location	Ground		
Areas served	Office		

Visual Inspection		
Guidance Notes	**Inspection Notes and Comments**	
Heat rejection plant operational?	Yes	
Comment on condenser location	No adverse comments	
General condition of the heat rejection plant / outdoor unit	Appears to be in reasonable condition	
Observation through sight glass	Sight glass not visible	
Condition of indoor unit(s)	Appears to be in reasonable condition	
Condition of pipework / insulation	Appears to be in reasonable condition	
Floor area	20 m2	
Installed cooling capacity	2 kW	
This equates to	100 W/ m2	
Comments on cooling capacity	Appears to be reasonable	

Guidance Notes	Inspection Notes	Comments
Refrigerant	R407C	
Weight, kg	2.5 kg	
F Gas inspection required	No	
Date of last inspection		
Comment on maintenance regime and frequency	Serviced annually – last service Feb 10	
Comment on positioning and geometry of air supply openings. Is air diffusion affected by partitioning of furniture	Wall mounted evaporator – no adverse comments	
Comment on control strategy	Unit operated by staff as necessary.	

BMS and Controls

Description	Site wide BMS	
Systems Served	All	
Manufacturer	Honeywell	
Year systems installed	2003	
Location	BMS room is in the estates office	
Areas / systems served	All buildings	
Detailed Inspection Notes		
Guidance Notes	**Inspection Notes**	**Comments**
Assess zoning in relation to factors such as local levels of internal gain, orientation and exposure to solar radiation	Building is highly zoned, each terminal unit has its own control setpoint	
Note the current indicated weekday and time of day on controllers against the actual day and time	Day and time set correctly	
Note the set on and off periods (for weekday and weekend, if this facility is available with the timer)	See notes at individual systems. Where systems are controlled off the BMS, the technicians set calendars accordingly	
Note whether a dead band is or can be set between heating and cooling	Yes – 3 degrees	
Note whether any temperature gauges are inaccurately calibrated/ broken	None found	
Assess means of modulating or controlling air flow rate through air supply and exhaust ducts	Generally fixed volume. Where volumes are varied, this is done so according to the needs of the individual system	

Appendix A Photographs

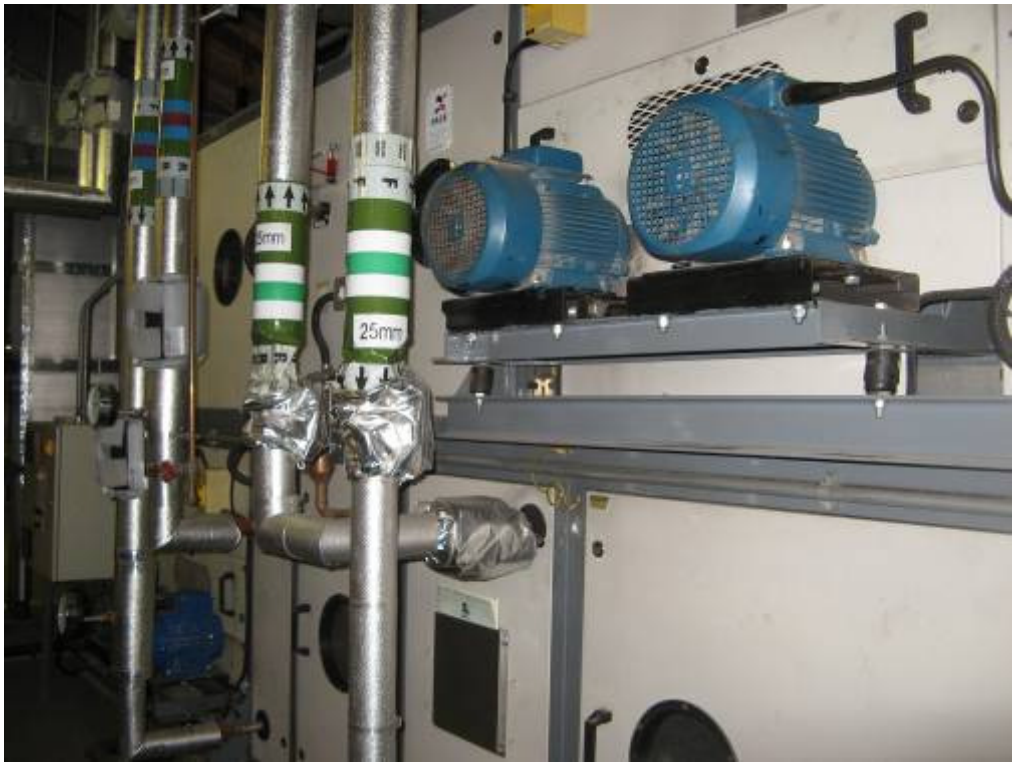

Figure 1 AHU insulation to pipework in good condition

Figure 2 Chiller pipework well insulated

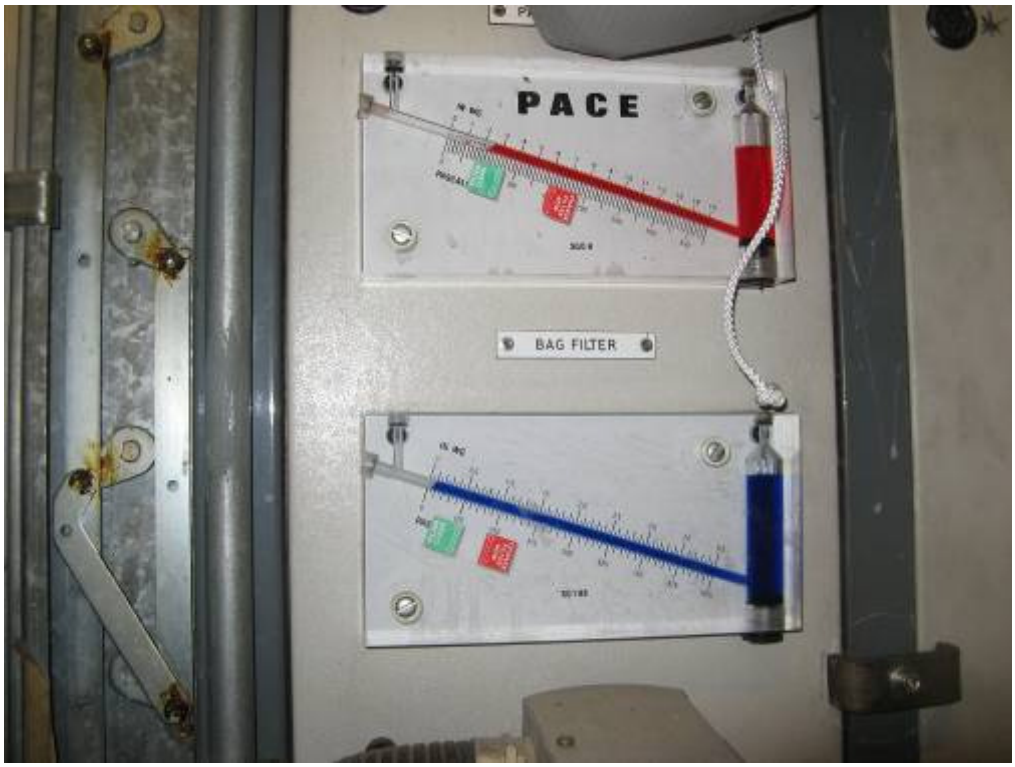

Figure 3 Most manometers on site are well calibrated

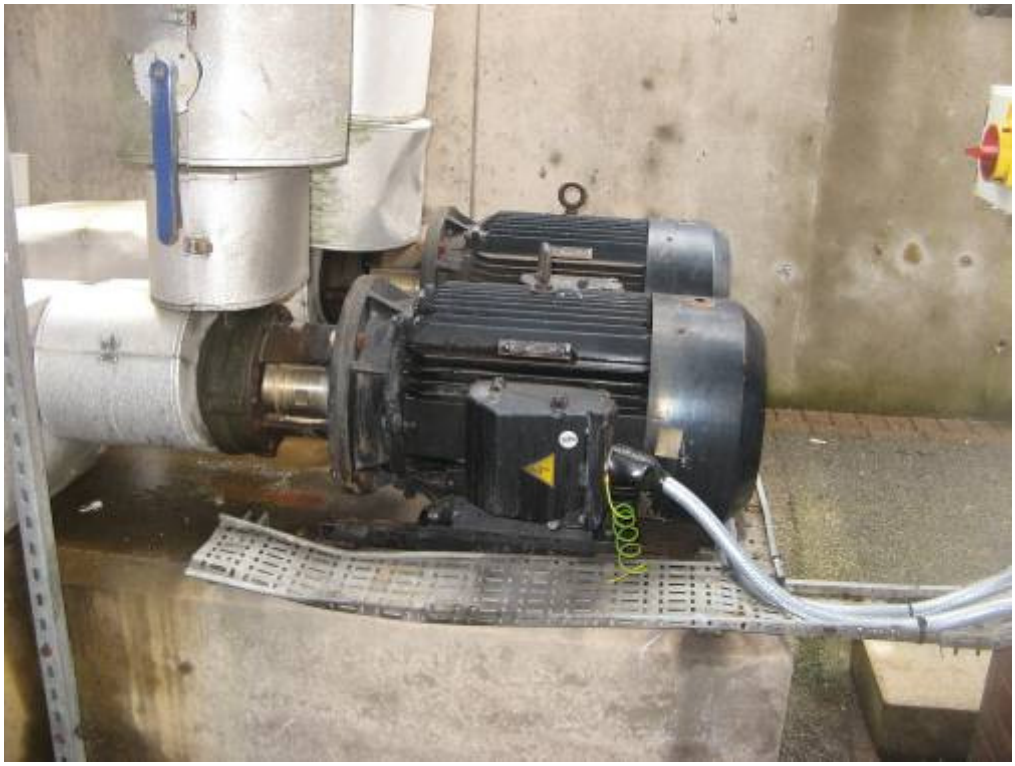

Figure 4 Secondary chilled water pumps

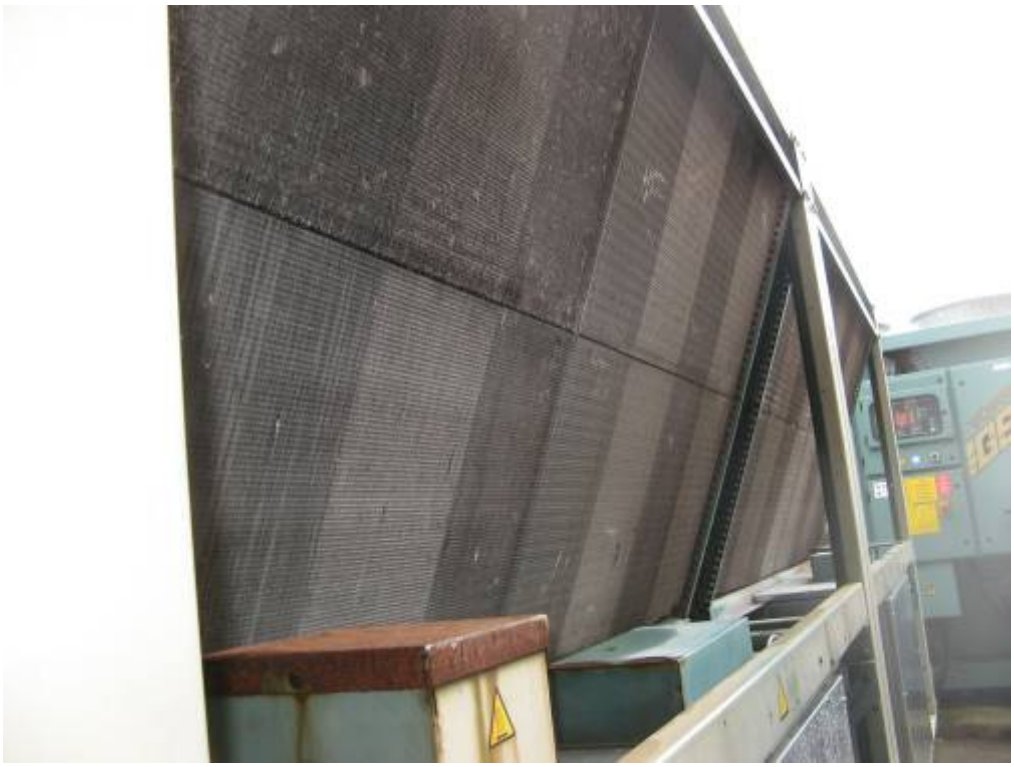

Figure 5 York chiller condensers in good condition

Appendix B Refrigerant Types

Due to concerns over Ozone depletion CFC's have been banned.

HCFCs have also been banned for use in new plants and from 31 Dec 2009 Virgin HCFC's will be banned for plant maintenance. Recycled HCFC's will be banned from 31 Dec 2014

The UK Government published and presented to Parliament on 17th November 2000 the UK's climate change programme. The programme sets out the UK strategy for tackling climate change and includes specific measures related to the use of HFCs:

- HFC's should only be used where other safe, technically feasible, cost effective and more environmentally acceptable alternatives do not exist
- HFC's are not sustainable in the long term: the Government believes that continued technological developments will mean that HFCs may eventually be able to be replaced in the applications where they are used
- HFC emission reduction strategies should not undermine commitments to phase out ozone depleting substances under the Montreal Protocol
- HFC emissions will not be allowed to rise unchecked.

Alternative refrigerants such as hydrocarbons (HC's), CO2 and ammonia have lower global warming potential than HFC's but have other disadvantages such as high flammability or toxicity. The table below reproduced from F-gas Support summarises the refrigerant characteristics

Refrigerant	HFCs	HCs	Ammonia	CO_2	Low GWP FCs
GWP	✗✗	✓	✓✓	✓✓	✓
Toxicity	✓✓	✓✓	✗✗	✓	✓✓
Flammability	✓✓	✗✗	✗	✓✓	? ✗
Efficiency	✓	✓	✓	✓	✓
Materials	✓	✓	✗	✓	✓
Pressure	✓	✓	✓	✗✗[7]	✓
Cost	✓	✓✓	✓✓	✓✓	?
Availability	✓✓	✓	✓	✓	✗✗
Familiarity	✓✓	✓	✓	✗	✗

Key: Very poor ✗✗ Poor ✗ Good ✓ Very Good ✓✓

CFCs	HCFC	HFC	Other
R11	R22	R125	R744 (CO_2)
R12	R403B	R134A	R717 (Ammonia)
	R408A	R404A	R290 (Propane)
	R123	R407C	R600A (Isobutane)
		R410A	
		R413A	
		R417A	

Leakage testing frequency required under EC F gas Regulation

Frequency	Normal systems	Hermetically sealed systems
None	Less than 3 kg	Less than 6 kg
Annual	3 kg to 30 kg	6 kg to 30 kg
6-monthly*	30 kg to 300 kg	30 kg to 300 kg
Quarterly*	Greater than 300 kg	Greater than 300 kg

** Half this frequency if fitted with automatic leak detection*

Appendix C Cooling Benchmarks

The estimate in TM44 Figure 4.1 Variation of calculated total heat gains with occupation density accounts for internal heat gains but the total cooling load may also have solar gain and ventilation loads. Therefore you can use TM44 figure 4.1 with and make a necessary allowance for solar and ventilation loads or you can use the benchmark data below from CIBSE guide F

Type of Building	Total Cooling Load W/m²
General Office	125
Interior Zones	75
Perimeter Zones (up to 6m)	
- 65% glazing	180
- 60% glazing	120
Typical buildings:	
- Retail	140
- Banks	160
- Restaurants	220
- Hotels	150-300
- Computer suites	400 (approx.)

Office Type	Installed Refrigeration capacity (W/m²)	
	Good Practice	Typical
Naturally Ventilated	50	80
Air Conditioned Standard	90	125
Air Conditioned Prestige	100	135

Appendix D Specific Fan Power

SPF is the combined fan power for the supply and extract systems, divided by the greater of the supply and extract air volumes

Power factor	1	(assumed)
Supply Voltage	415	

Power = V x A x PF x √ 3

Ref		Supply					Extract					
	Vol	FLC (L1)	FLC (L2)	FLC (L3)	Power		Vol l/s	FLC (L1)	FLC (L2)	FLC (L3)	Power	SFP
	l/s	A	A	A	kW			A	A	A	kW	kW/m^3/s
AHU3	2610	6.3	6.3	6.3	4.53		2091	5	5	5	3.59	3.112

The specific fan power has been calculated based upon the methodology identified within the Department for Communities and Local Government, Non-Domestic Heating, Cooling and Ventilation Compliance Guide. Where the total fan power is divided by the design air flow rate through the system, the design air flow being whichever is the greater of either the supply or exhaust air flow in litre/second. The data used is as identified within the O&M manuals

Recommendations for specific fan power in existing buildings, taken from Table 36 in the Non Domestic Heating Cooling and Ventilation Compliance Guide 2006	
System Type	**SFP, W/l/s**
Central Mechanical ventilation with heating, cooling and heat recovery	3.0
Central Mechanical ventilation with heating and cooling	2.5
All other central systems	2.0

Appendix E Information Required

Date requested	Item	Received
10/11/2010	Unique Property Reference Number (UPRN) to enable us to lodge the completed reports. These can be found on the Display Energy Certificate for the building	
10/11/2010	Please indicate the areas served by the York chillers on a drawing for us to estimate the floor area of conditioned space	
10/11/2010	Commissioning records including supply and extract air volumes and running current for AHU's listed in reports - this will enable us to calculate the specific fan power	