MITSUBISHI ELECTRIC
AIR CONDITIONING SYSTEMS

Information Guide

Carbon reduction in the built environment

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Information Guide

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today. The guide accompanies a series of seminars, all of which are CPD accredited. The changing face of construction in the 21st Century demands that designers, specifiers and suppliers work as teams to create better buildings - for occupants and the environment. Mitsubishi Electric aims to be a part of this by encouraging employees and customers to work together to increase their knowledge of the latest technology, legislation and markets.

Contents

Performance monitoring

As the European Union seeks to reduce its carbon emissions, buildings are being targeted more closely since they use more than half of the energy produced in the EU. In the UK, there are already more stringent energy-use regulations for design of new commercial buildings, and homes.

And in 2008 more rules will be introduced for the existing building stock.

Next year, a large number of the UK's commercial buildings will require Energy Performance Certificates (EPCs). Exactly when these are required depends on the size of the buildings:

More than 10,000m² - from April 2008

2500m² up to 10,000m² - from 1st July 2008

Less than 10,000m² - from October 2008

EPCs will rate buildings based on their energy use, in particular targeting areas such as cooling, space heating and water heating. Buildings owned or operated by government or local authorities will have to display their certificates where they can be seen by visitors.

But for most private commercial buildings, the owners or occupiers will have to produce information on the energy rating of their building when it is sold or rented to new tenants.

This new legislation is already provoking a response from owners/occupiers. Many have called in energy assessors to examine how much energy their building is using, and where this is being used. As a result, there is an increasing interest in the performance of building services.

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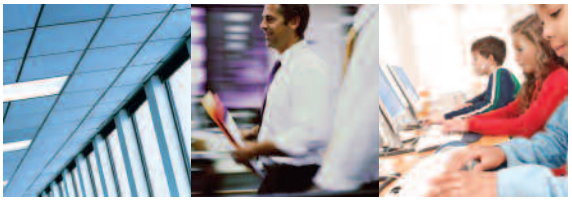
Air conditioning systems will be under added scrutiny, with the introduction of regular inspections which are scheduled to begin towards the end of 2008. Like EPCs, the inspections are part of the Energy Performance of Buildings Directive, and aim to increase energy efficiency in buildings.

Although the details of the inspections are yet to be finalised, the overall objectives are to encourage good maintenance and efficient use of controls - as well as highlighting opportunities to reduce cooling loads or periods of operation of the equipment.

Both air conditioning inspections and Energy Performance Certificates are encouraging greater interest in the performance of air conditioning systems among facilities managers and other end-users. Maintenance has been shown to extend the life and efficient performance of such equipment, and in plans for air conditioning system inspections it has been noted that proof of good maintenance practice will reduce the level of inspection required.

Poor maintenance of air conditioning systems can result in reduced performance caused by clogged filters or heat exchangers which make the system over-work and consume more energy. For example, an air conditioning system which is operated for four years without even basic servicing (such as filter cleaning) could use as much as 50% more energy than a system which has been looked after.

Another reason for good maintenance is to avoid unexpected failures which lead to call-outs for repair - leaving premises without cooling or heating facilities, with a detrimental impact on the comfort of staff and customers.

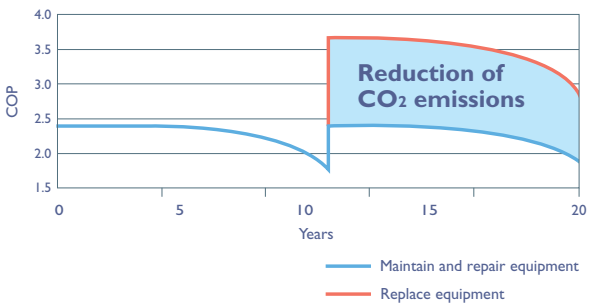


However, while repair and maintenance will keep a system running for some time, the resulting energy efficiency performance levels of an older air conditioning system can never reach those of today's.

By replacing, rather than repairing, the coefficient of performance (COP) of the equipment is significantly increased. In graph 1, the blue line represents equipment that has been maintained and repaired to 10 years.

At this point the system is replaced with new equipment, giving a significant improvement in COP. The shaded area represents the amount of CO_2 emissions saved by replacing rather than repairing the equipment. The next feature will examine when it makes financial sense to stop repairing an older system and take the replacement route instead.

Graph 1: Emissions can be reduced by Replacing Old Units



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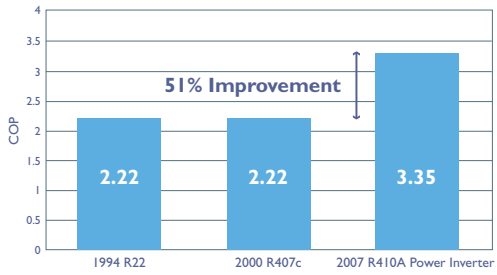
Time to replace

Good maintenance can help to ensure that an air conditioning system remains energy efficient and working well for many years. However, there is a time when replacement of the old system may be the best option.

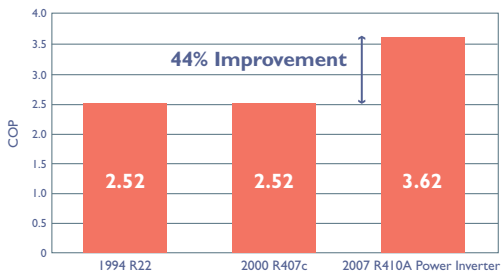
Replacement is clearly a higher capital cost option than continued maintenance, but this should be weighed against the true costs of running an older air conditioning system. Not only is this an expensive option in terms of energy costs, the building will also have a larger carbon footprint than one running more modern air conditioning equipment.

Advances in cooling technology mean that over the last decade there have been significant improvements in the performance of air conditioning systems. Graphs 2 and 3 illustrate the changes in performance of split air conditioning systems in both cooling and heating modes - a 51% improvement in operating efficiency in cooling mode.

Graph 2: 7kW Split Air Conditioning System in Cooling Mode



Graph 3: 7kW Split Air Conditioning System in Heating Mode

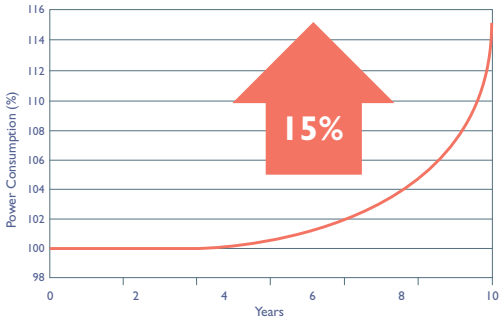


Savings in energy costs and carbon emissions can be made by moving over to more up-to-date equipment.

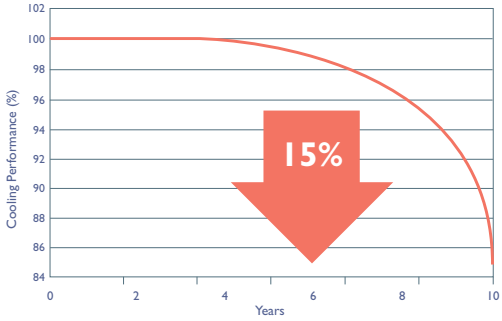
A number of factors contribute to the decline of air conditioning system performance, such as wear on compressors or bearings, or debris embedded in the heat exchangers. If an air conditioning unit is used for 10 years, studies show that performance efficiency drops due to corrosion and the deterioration of fins in the heat exchanger, as well as general wear on the compressor scroll.

As a result of these problems, caused simply by normal use, cooling performance decreases, while power consumption increases - as shown in graphs 4 and 5. What we see here is that rated capacity has reduced by 15% and energy consumption has risen by 15%. Overall therefore, the efficiency of the equipment has reduced by 74% (0.85/1.5 = 74%).

Graph 4: Power Consumption Increases Over 10 Years



Graph 5: Cooling Performance Decreases Over 10 Years



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The ulitimate choice about replacing a system will naturally involve financial considerations, and in the tables below the costs of repair are compared with those of replacement for indoor and outdoor units. Prices are for a direct expansion split system (excluding labour) as well as the average price for replacing the unit.

In our next feature we will take a look at what is involved in the process of system replacement, and discuss how modern technology is making the replacement procedure safer, faster and more cost effective than ever.

INDOOR UNIT	Direct expansion Split-System
SPARES	AVG PRICE (£)
Fan Motor	135
Bearing	30
Air Filter	32
Drain Pan	48
Drain Pump	60
Drain Sensor	15
Linear Ex Valve	72
Heat Exchanger	300
Remote Control	65
PCB's	200
Thermistor Set	20
SPARES LIKELY TO FAIL IN 10 YEARS (not including labour)	317
AVG PRICE OF REPLACEMENT	421

OUTDOOR UNIT	Direct expansion Split-System
SPARES	AVG PRICE (£)
Compressor	725
Check Valve Assy	
4 Way Valve	75
LEV (inc coil)	75
Heat Exchanger	350
IMP	103
Contactor	65
Fan Motor	168
Solenoid Valve	80
Pressure Switch	20
PCB's	140
Thermistor Set	25
SPARES LIKELY TO FAIL IN 10 YEARS (not including labour)	1003
AVG PRICE OF REPLACEMENT	670

The spares in red are the parts likely to fail in 10 years of usage

The graphs illustrate that replacing air conditioning equipment that is approaching ten years old or more can have big benefits, and be cost effective when weighed against the costs of continued repair, maintenance or the effects of possible breakdowns. Our next feature looks at what a replacement project might entail, and the practicalities a facilities manager would have to consider when managing such a project

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Replacement in reality

There are practical and legal factors to consider when replacing an air conditioning system. Unless the latest replacement technology is used, the process can be disruptive and cause business down-time.

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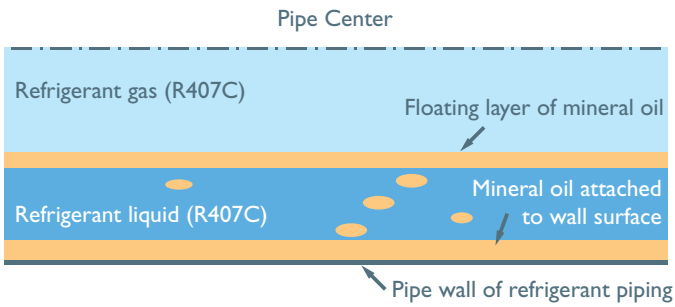
For example, if the existing system uses R22 refrigerant, this can contain mineral oil and chlorine which will contaminate a new system which uses a more energy efficient and environmentally friendly R407c or R410a - so new pipework must be fitted. This means that the existing pipework must be removed and totally new pipes fitted. In order to achieve this, the ceilings have to be removed.

Clearly, this would make replacement of an existing air conditioning system less attractive, in spite of the benefits of higher energy efficiency levels. However, there are some patented systems which can utilise existing pipework - thereby reducing replacement costs by 50% to 60% compared to projects which need new piping.

Systems currently available use varying technology to remove the mineral oil and contaminants from the existing piping. On small systems with relatively short pipe runs a charcoal filter can be used to absorb the contaminants in a dedicated cleaning mode, after which the filter is sealed from the rest of the refrigerant system.

Other larger systems with larger volumes of mineral oil and contaminants use a dedicated flushing operation, using a two phase liquid and gas mixture to remove the mineral oil and contaminants from the piping and collecting them either in the accumulator of the existing old unit which is then removed or in a dedicated oil trap kit.

Washing with R407c incompatible with mineral oil



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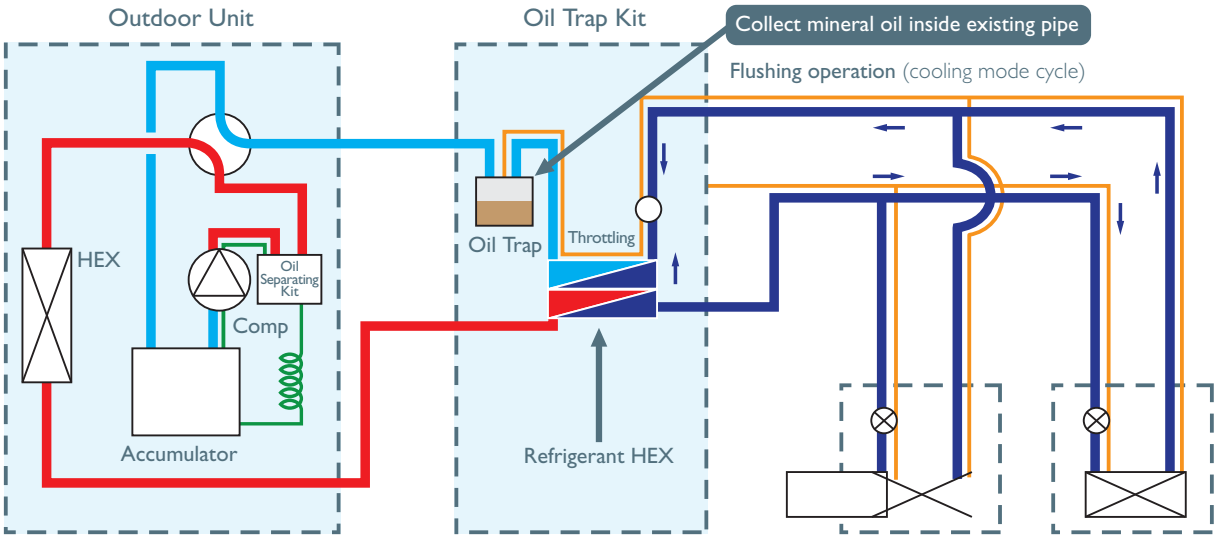
When replacing with R410A the diameter and thickness of the copper pipe should be analysed to ensure that pressure and safety regulations are adhered to as R410A operates at a higher pressure than R407c and R22.

Not only does this process save money and reduce business disruption, it uses fewer resources by creating less waste materials. A good replacement system reuses the existing pipework as well as the power source wiring, transmission line wiring and circuit breaker box. This means that only indoor and outdoor units need to be replaced. The R407c and R410a refrigerants are around 40-60% more energy efficient than the older R22 refrigerant systems.

The replacement process

The following example shows how Mitsubishi Electric's Replace Multi system can be used to replace an old air conditioning system using the replacement and flushing techniques mentioned above.



- Flow of ester oil
- Flow of mineral oil
- Flow of refrigerant (hot gas)
- Flow of refrigerant (low pressure gas)
- Flow of refrigerant (gas/liquid 2-phase refrigerant)

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Further information

For information on the Energy Performance of Buildings Directive, see the website for the Directive Implementation Advisory Group (DIAG). This contains up-to-date information on the UK's steps to implement the EPBD.

www.diag.org.uk

DEFRA's website contains information on Building Regulations, and includes background information on Energy Performance Certificates for commercial buildings and dwellings (Home Information Packs).

www.defra.gov.uk

For more information on the benefits of replacing old air conditioning equipment, ask your Mitsubishi Electric representative about the Green Gateway Initiative or visit the website.

www.greengatewayinitiative.co.uk

If you missed the CPD seminar on **Carbon reduction in the built environment**, you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

Please call one of the numbers below:

London North East & East Anglia	**01707 282480**
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