



HVAC SYSTEM MAINTENANCE

A guide to effective
equipment servicing

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Unenlightened companies view maintenance as a cost with no benefit – the maintenance workforce is simply measured on speed of response to breakdowns. Excuses for failing to implement proper maintenance abound – it's too expensive, disruptive, complex, time-consuming, troublesome, difficult, and so on. In fact, the case for effective maintenance should be a no-brainer because its cost is absurdly low compared to the cost of dealing with a catastrophic HVAC equipment failure. Indeed, maintenance is the most cost-effective way to ensure reliability, safety, and energy efficiency in HVAC plant and equipment.

There are many compelling reasons to take maintenance of HVAC systems in commercial buildings seriously. Quite apart from the need to comply with health & safety and environmental legislation, it makes sense to provide

comfort for building occupants to avoid complaints and improve productivity.

It also saves energy and therefore operating costs, retains the assets' value, enhances the business's reputation, leads to better working relationships and reduces disruption to the business. Increasing energy costs are another good reason to employ an effective maintenance strategy; best practice maintenance can deliver cost savings of 10 to 40% compared with poor maintenance.

Air conditioning components consume enormous quantities of energy; chillers, for example, are responsible for using more than half the energy used on some buildings so keeping them working at their optimum efficiency will effectively contribute to a company's bottom line. Implementing a maintenance plan will also ensure a longer a life for the AC system and reduce its total cost of ownership dramatically.

One of the best reasons for a properly implemented maintenance strategy is that it guarantees reliability. And just about every indicator – safety, environmental performance, morale, retention, customer service – gets better if reliability is established as a core value of the organisation.

Finally, the pressure on companies to reduce their emissions footprints has been an incentive for them to develop best-practice maintenance strategies.

Every HVAC system will have an average useful life – a typical lifespan after which it is running on borrowed time. That's why it makes sense to implement an effective maintenance plan. Not only will this extend the system's lifespan, but it will also boost the system's dependability and therefore contribute to peace of mind.



MAINTENANCE POLICY

Good HVAC maintenance begins with a commitment from the top of the organisation to develop a corporate policy on maintenance, repair and overhaul that is unified and clearly communicated. From here, an effective maintenance strategy can be developed with the policies (aims) and strategies (the means for achieving the aims) sometimes combined into a single document.

A maintenance policy is a written statement that defines the standards to which a building and its services will be maintained. In other words, it is a set of actions that need to be applied during the life cycle of a system or piece of plant or equipment to maintain or restore it to defined operating conditions. The maintenance policy should align with the business's sustainability objectives.

The policy will typically contain:

- A list of the maintenance goals (for example, safety, reliability and peace of mind).
- An outline of the maintenance strategy (the plan that sets the direction for annual maintenance programme and contains action plans for achieving a desired future state for the organisation).
- Key performance indicators (KPIs) to measure progress in the maintenance programme.

MAINTENANCE STRATEGY

The maintenance strategy can contain one or a mix of the following types of maintenance – corrective, preventative, predictive and reliability-centred.

Corrective maintenance involves restoring defective equipment to a working condition as quickly as possible.

Since it means fixing breakdowns it is, essentially, a 'run to failure' approach. It is reactive and unplanned because remedial work is carried out as and when equipment fails in operation. It will not deliver high performing HVAC equipment and also is expensive in the long term, leading to the depreciation of asset value.

The old adage 'prevention is better than cure' doesn't apply only to the health of people; it is equally applicable to plant and equipment. It has been estimated that total building costs could be slashed by up to 50% simply by switching from a reactive to a predictive maintenance programme.

With the benefits of some form of preventive maintenance including extended equipment life, reduced energy usage, less frequent system downtime and decreased interruptions to building operations, it makes solid business



sense to attempt to predict the future rather than simply react to the present.

Preventive maintenance is designed to ensure the best possible operation of equipment and avoid expensive unforeseen equipment failure or shutdowns. Unlike corrective maintenance, planned preventive maintenance (PPM) finds potential problems before they cause equipment to fail.

Essentially, PPM – which includes tests, measurements, adjustments, parts replacement and cleaning performed specifically to preclude faults – is a two-part procedure: Ensure the plant is operating at its highest possible efficiency and maintain this performance.

Preventive maintenance involves a number of steps, including:

- Maintain a daily operating log and compare the performance you record with design and start-up data. An accurate log offers a daily snapshot of the equipment's operating characteristics, making abnormal conditions easier to spot. This means that corrective action can be taken before problems get serious and expensive. A log will also enable you to put together a history of operating conditions that can be analysed to establish trends.
- Check for leaks and moisture ingress. It has been estimated that 1psi of air in a condenser equates to a 3% loss in chiller efficiency. Moisture in a chiller can create acid that corrodes motor windings and bearings and cause rust to form inside the shell.

- Treat water with appropriate chemicals to reduce scale and corrosion and prevent biological growth.
- Finally, cleaning – HVAC equipment performance is dictated by its ability to transfer heat and that starts with clean coils and fans.

PPM offers a host of solid business benefits. For example, it:

- Boosts reliability.
- Improves energy efficiency.
- Allows you to control costs and budget more accurately.
- Helps you plan more effectively.
- Prevents unscheduled and often costly stoppages.
- Enables large repairs to be undertaken at a convenient time, limiting disruption to operations.



Reactive maintenance is up to four times more expensive than one form of predictive maintenance – so a sharp focus on CBM can result in significant savings as well as improvements in operations.

Predictive maintenance means examining the 'vital signs' of the HVAC system through testing, inspection and monitoring. This condition-based maintenance approach dictates that servicing should only be performed when certain indicators show signs of decreasing performance or upcoming failure.

To that end, it employs (typically non-invasive) predictive maintenance tools such as vibration analysis, infrared thermography, ultrasonic testing and motor current analysis to monitor systems and diagnose problems in advance.

Reactive maintenance is up to four times more expensive than one form of predictive maintenance – condition-based maintenance (CBM) – so a sharp focus on CBM can result in significant savings as well as improvements in operations.

Importantly, CBM also involves determining the condition of machinery while in operation. The key to a

successful condition monitoring programme includes knowing what to look out for, how to interpret it and when to put this knowledge to use.

Successfully using this programme enables the repair of problem components before failure. Condition monitoring not only helps plant personnel reduce the possibility of catastrophic failure, but also allows them to order parts in advance, schedule manpower, and plan other repairs during the downtime.

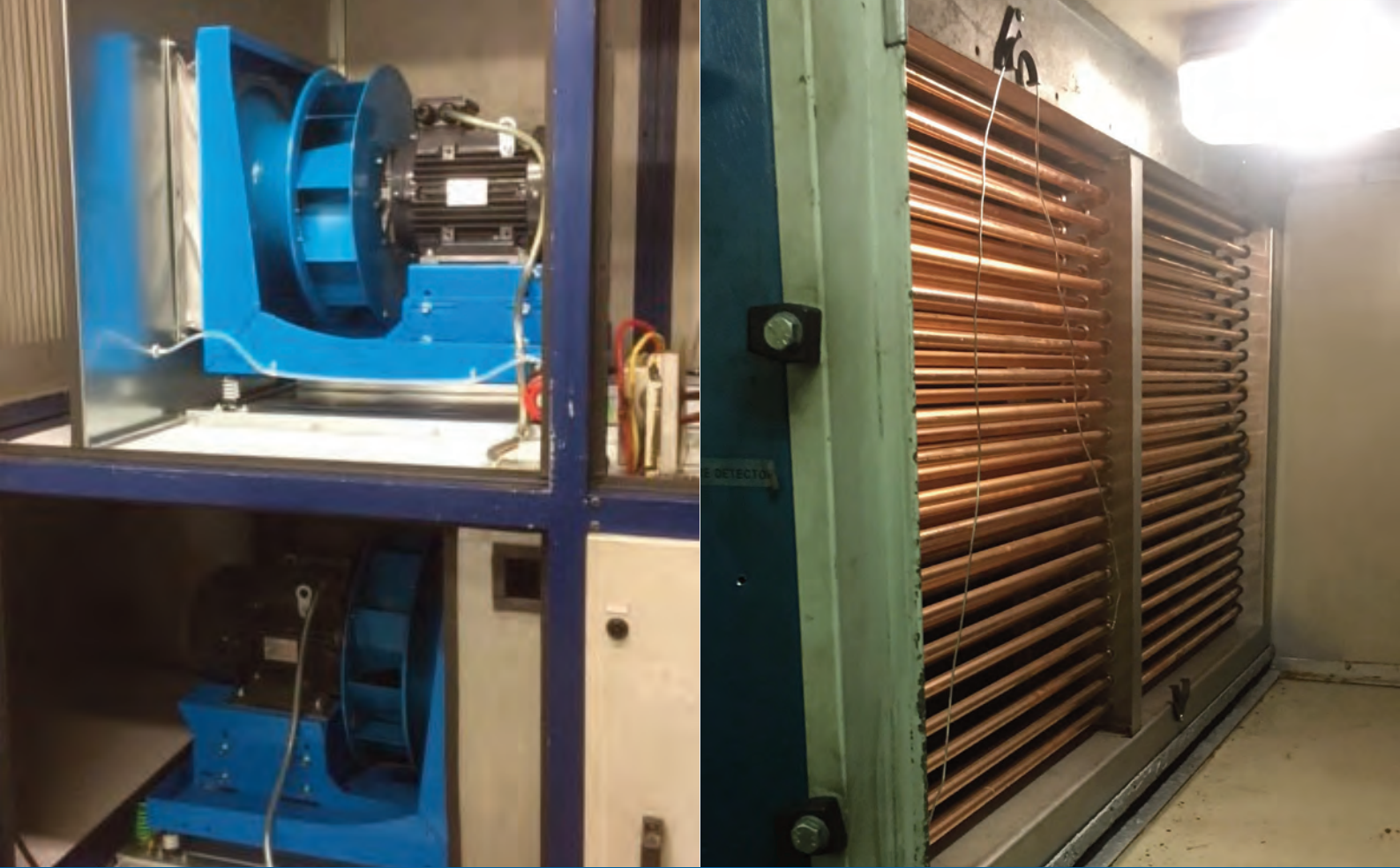
Reliability-centred maintenance (RCM) is used to systematically and scientifically determine what must be done to ensure that a HVAC system continues to do what its user wants it to do. It can be used to gather data from the results achieved and feed this back to improve future maintenance

It emphasises the use of predictive maintenance techniques in addition to

traditional preventive measures. However, it focuses on the function rather than the equipment – in other words, what the system does rather than what it is.

In his influential book on the subject ('Reliability-Centred Maintenance'), author John Moubray lists seven questions you should ask about the 'asset' to be maintained:

- What are the functions and associated performance standards of the asset in its present operating context?
- In what ways does it fail to fulfil its functions?
- What causes each functional failure?
- What happens when each failure occurs?
- In what way does each failure matter?
- What can be done to predict or prevent each failure?
- What should be done if a suitable proactive task cannot be found?



RCM differs from the previous three methods because it emphasises that the objective should be to prevent or mitigate the consequences of failures rather than the failures themselves. The consequences of failure will differ depending on where and how the HVAC equipment is installed and operated. A formal review of failure consequences will focus attention on maintenance tasks that have most effect, and divert energy away from those that have little or no effect.

RCM defines failure as 'any unsatisfactory condition'. It may be either a loss of function (perhaps the air conditioning stops working) or a loss of acceptable quality (for example, the air conditioning continues to operate, but fails to improve air quality).

RCM can be used to gather data from the results achieved and feed this back to improve future maintenance. In other words, it can improve systems and procedures and not simply keep them the same. The US-based 'Whole Building Design Guide' has defined RCM's five primary principles as:

- Function oriented – RCM seeks to preserve system or equipment function, not just operability for operability's sake.
- System focused – RCM is more concerned with maintaining system function than with individual component function.
- Reliability centred – RCM is not overly concerned with simple failure rate; it seeks to know the probability of failure at specific ages.
- Design limitations – RCM's objective is to maintain the reliability of the equipment design recognising that changes in inherent reliability are the province of design rather than of maintenance. Maintenance can, at best, only achieve and maintain the level of reliability for equipment that was provided for by design. However, RCM recognises that maintenance feedback can improve on the original design.
- Safety, security, and economics – Safety and security must be ensured at any cost; thereafter, cost-effectiveness becomes the criterion.

ASSESSING MAINTENANCE NEEDS

Maintenance is usually based on preserving the physical assets using failure prevention and asset care. However, such a strategy must add value to the business process. What's needed is a reliable way of assessing the maintenance needs of the services against the business risk of plant failing in service.

Research organisation BSRIA has produced a risk assessment toolkit designed to do just that. '**Business Focused Maintenance** - <https://bit.ly/2uRpo1k>' enables facilities managers to focus their maintenance activities based on a logical assessment of risk to the business, says BSRIA.

The guide provides a cost-effective way to assess, manage and maintain services, and reduces the risks of system failure. The result: maintenance that will protect your business without wasting money. The toolkit contains everything you need to prepare a complete maintenance programme based on the risk to your business."

So maintenance improvement isn't a contradiction in terms. It really is achievable. But like most things success only comes by following considered, carefully crafted and coherent plan.

Two aspects of HVAC maintenance require particular attention – air handling units (AHUs) and refrigerants.

AIR HANDLING UNITS

The AHU encourages heated or chilled air to move through ductwork so it is a critical piece of HVAC equipment. Preventing the build-up of debris in the chambers and fan blades, as well as replacing filters, drive belts and pulleys, and ensuring seals are operating efficiently will keep it working at its optimum.

Condensation is another potential problem, but this can be negated by covering drip trays and floors with an anti-corrosion coating.

F GAS REGULATION

Fluorinated (or F) gases are man-made gases used in a range of industrial applications including refrigeration and fire protection. The original F Gas Regulation (EC) 842/2006 was later revised and replaced by (EU) 517/2014. The core aims of the latest regulation include:

- Better containment of F gases in their applications.
- Recovery of F gases from products and equipment reaching their end of life.
- Training and certification of technical people and companies working with F gases.
- Reporting of production, import and export data within the EU.
- Labelling of certain products and equipment containing those gases.

But the overall aim of the F Gas Regulation is to contain and reduce emissions through responsible refrigeration practice.

The original F Gas Regulation in 2007 was designed to reduce emissions from F gases, but it really only involved factors such as leak testing, monitoring and servicing of systems. Essentially, the only ban it brought in was to say that automotive air conditioning would have to move to a refrigerant with a GWP of less than 150 for new models by 2012 and for all cars from 2017.

The second F Gas Regulation, which came into force in 2015, was different. It introduced a phase-down mechanism involving a gradually declining cap on the total placement of bulk HFCs on the market in the European Union.

F Gas Regulation 2015 set out caps and phase down schedules for the sale of F gases. So, in 2015 there was a starting point volume allocated to companies that had placed F gases on the market between 2009 and 2012. They were given a proportion of the 'quota' of gases allowed based on sales.

Finally, protecting physical assets such as the HCVAC system is all very well, but remember: your most important asset is your people and protecting them is paramount. That's why it is critical to ensure that they are can gain safe access to any equipment that is to be maintained. To that end, ECEX has published a guide to access – '**Access All Areas** - <https://bit.ly/20k0ijR>' – available for free here.



For more information, call 01635 244100 or email sales@ecex.co.uk. Visit www.ecex.co.uk for our full range of products and services.

KEEP EQUIPMENT CLEAN

Dirty equipment is disproportionately responsible for HVAC equipment failures. Ensuring it is kept clean can be helped by technology such as ECEX Air Intake Screens. These are long lasting, weather-resistant filter mesh products which fix to external intakes on air handling units, chillers and condensers. This protects coils before any airborne debris can clog the fins and reduce the efficiency of evaporator or condenser coils.

ECEX Air Intake Screens pre-filter outside air and to 'catch' detritus such as dust, pollen and leaves. By moving the airborne debris to a position in

which it can easily be removed (using a soft brush, hose or vacuum cleaner), the ECEX Air Intake Screen provides a simple, retrofit protective option for on-site equipment.

This simple cleaning regime will allow fan motors to run more efficiently, coils to remain unsoiled for longer and less frequent changes required for internal filters. Used with air handling units, ECEX Air Intake Screens can increase the life of internal filters by up to 60%, while delivering measurable results in improved energy efficiency, reduced maintenance time and costs.

As well as saving energy and reducing maintenance demands, ECEX Air Intake Screens also help extend the life of coils and ensure they continue to operate at optimal efficiency.

Furthermore, they boost energy efficiency because the fans need not work harder to overcome the effects of blockages. They also reduce maintenance requirements, largely for the same reason, and they ensure the cleanest possible air enters the building, improving the health, safety and welfare of occupants.

THE NEED FOR GOOD HOUSEKEEPING

Good housekeeping practice is part of good maintenance practice.

The Carbon Trust recommends the following general advice for air conditioning systems:

- Ideally, set timers so that there is no cooling when the building is unoccupied.
- Time-control each unit in localised cooling systems to avoid out-of-hours operation.
- Check temperature settings. Find out the temperature at which your air conditioning switches on and your heating system switches off.

The greater the temperature gap the better. Check and compare temperature settings for each unit in localised air conditioning systems. The Carbon Trust says it is common to see one unit heating and another cooling in the same space.

- Clean ductwork, fans and grilles regularly, and ensure furniture

doesn't obstruct air pathways – any blockage can increase energy consumption and maintenance costs.

- By taking these measures, you will be reducing the chance of an air conditioning system failure. But, equally importantly, you will be helping to cut carbon dioxide emissions from your buildings.

STEPS TO BETTER MAINTENANCE

Broadly maintenance improvement takes place in five steps:

- Determine where you are now with an audit.
- Decide where you want to get to.
- Plan how to get there.
- Implement the plan.
- Continuous improvement demands that you return to step one.

Maintenance improvement starts with a diagnostic – basically an audit of current maintenance activities – followed by a broad brush initial assessment to identify areas for improvement, then a detailed justification of individual projects

selecting specific methods to achieve overall business objectives.

This last point is critical – your maintenance strategy can't operate in isolation. It must be firmly rooted in your business plan.

CHILLER MAINTENANCE IN A NUTSHELL

Steps that can be taken to maximise your chillers' efficiency include:

- Turn off unnecessary chillers or sequence your chillers to save energy as well as wear and tear.
- Schedule maintenance operations on a daily, weekly, monthly or annual basis and draw up a checklist that is signed each time a maintenance operation is completed so that everybody knows the state of the maintenance plan.
- Check for condenser and evaporator tube corrosion and clean. Clues to potential problems include poor water quality and excessive fouling.
- Inspect chilled water and condenser water piping systems annually for evidence of corrosion and erosion.
- Lubricate the compressor, pumps and motors to comply with the manufacturer's specifications.
- Check refrigerant condition annually and level and top up if necessary. Have the refrigerant analysed to ensure that it has not degraded. Also, check for refrigerant leaks – excessive refrigerant loss indicates a leak, which you need to fix as a matter of urgency.
- Check wiring for overheating and tightness of connections.
- Test the compressor motor and oil pump motor windings.

COIL MAINTENANCE – CLEAN, REPAIR AND PROTECT

Coils contained in condensers and evaporators are placed under additional strain in the cold winter months and, should they fail, a business could potentially be brought to a halt. However, this can be prevented by applying effective maintenance and the right equipment to prevent clogging, corrosion or leakage. There are essentially two types of coil:

- Condenser coils which dissipate heat absorbed from the refrigerant.
- Evaporator coils which absorb heat from the surrounding environment rather than the refrigerant.

Airborne particulates such as leaves, pollen and dirt begin to layer up on the fins and tubes of condenser coils over time. As a result, the condensing

temperature increases which makes the compressor work harder for longer to achieve the necessary cooling effect.

This makes the condenser coil more expensive to run and increases the strain on the unit leading to an increased risk of breakdown.

An evaporator coil can also become easily clogged with airborne debris, but the consequences are slightly different. By restricting the airflow through the unit, the pressure drop means the cooling effect of the air is also reduced so the unit has to run for longer to achieve the requisite level of cooling.

Reduced airflow not only results in the unit remaining operational for longer than is necessary, but also means that it has to work harder in order to

achieve the airflow required. Both these factors place the unit under greater risk of breakdown and more importantly, downtime for the end client or tenant.

In a typical building services installation, both condenser and evaporator coils are left unfiltered. However, there are several steps you can take to reduce the problems associated with clogging and, indeed, reduce it altogether.

ECEX offers a range of coil services including repair, replacement, maintenance and protection. Not only can the company bring equipment up to its most efficient through effective maintenance and cleaning, but it can also repair localised damage or completely replace if required.



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