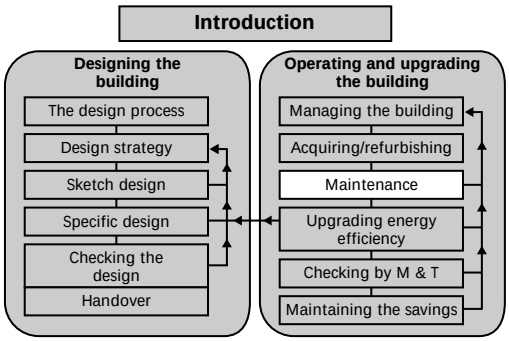
17 Maintaining for energy efficiency



This section provides a checklist of specific maintenance issues that influence energy efficiency. The appropriate checks should be included in a planned maintenance programme that promotes energy efficiency. Manufacturers' instructions should always be followed, particularly in relation to safety. This section should be read in conjunction with HVCA Standard Maintenance Specification[1]. Section 16 and CIBSE Technical Memoranda TM17[2] provide strategic guidance on maintenance policy and management.

17.1 Good housekeeping as a maintenance issue

Significant reductions in energy consumption can be achieved through good housekeeping measures, e.g. switching off lights when not needed. A 'switch it off' policy requires no capital expenditure but requires the co-operation of all staff, especially maintenance staff who are responsible for a large part of good housekeeping. Motivating staff to save energy is covered in section 14. Further good housekeeping measures can be found in DETR's *Introduction to energy efficiency* booklets[3].

The following are typical good housekeeping measures:

— Adjust controls to match heating, cooling and lighting use to occupancy periods, and to ensure service levels meet the needs of occupants, i.e. avoid over-heating, over-cooling and excessive lighting levels.

— Establish responsibility for control setting, review and adjustment.

— Arrange partitioning and layout to make best use of natural lighting and building services.

— Concentrate out-of-hours occupancy in as few areas, or buildings, as possible and run plant in these areas only.

— Switch off non-essential office equipment when not in use.

— Close windows and doors when the building is unoccupied during the heating season.

— Ensure automatic door closers function properly.

— Discourage supplementary electrical space heating appliances except for out-of-hours use when, otherwise, central systems would have to be operated.

— Switch off miscellaneous extract fans when the building is unoccupied, unless continuing operation is essential.

— Use window shading devices during summer to minimise air conditioning loads. Close window shading devices during the heating season, and when dark outside to minimise radiation losses.

— Reduce heat generation from internal sources during the cooling season, i.e. lighting, machines, cooking equipment, etc.

— Ensure catering equipment is only on when necessary, particularly kitchen ovens, hot plates and dishwashers, but also local hot water urns, vending machines etc.

— Instigate a purchasing policy that considers energy consumption when buying new equipment.

— Ensure that security staff and cleaners practice a 'switch-it-off' policy

17.2 Building fabric

Maintenance of the building fabric is essential to avoid excessive infiltration and minimise heat losses. The following are examples of maintenance measures:

— Rehang misaligned doors and windows.

— Replace weather stripping or other sealant if damaged.

— Keep curtains and blinds clean and in good working condition.

— Ensure openable windows can be properly closed and latched, with a good seal.

— Replace broken or cracked glazing.

— Replace or upgrade damaged or missing insulation.

17.3 Controls

Regular checking/maintenance of controls to ensure correct setting and operation is fundamental to energy efficiency. Checks should be made to ensure that:

— controls are correctly commissioned and are set at the desired levels; also ensure that calibration of sensors and controls has not drifted

— the building environment is regarded as comfortable and that changes in building use have not occurred to warrant alterations in the controls

— zone controls meet the needs of the occupants and there are no occurrences of overheating, over cooling or annoyance due to automatic light switching

— plant operating times are optimised and time switches/optimisers operate in accordance with the intended settings, and provide appropriate flexibility in relation to occupancy patterns

— weather compensators and optimisers have been gradually adjusted over a long period in order to find the best settings

— occupants understand the use of local controls, e.g. that room thermostats and TRVs should be left alone once set, rather than used as on/off switches

— air conditioning terminal controls are linked to the central plant to give the lowest acceptable level for heating requirements, and the highest acceptable level for cooling

— central plant is modulating/sequencing to match the load while ensuring that controls are stable, i.e. not causing excessive cycling; unnecessary or standby plant should remain off, particularly during periods of low demand

— simultaneous heating and cooling does not occur except where maximum humidity control is essential.

The building manager should keep a current record of the control settings and display them near to the controls to assist in returning them to optimum settings if they are tampered with.

17.4 Ventilation systems

Good maintenance of ventilation and air conditioning plant can have a significant effect on the overall success of the ventilation strategy, energy efficiency, comfort and indoor air quality. Cleanliness, balancing and control are particularly important. The following items should be checked:

— Correct operation of window ventilation fittings and furniture.

— Cleanliness of fan blades and interior fan casing.

— Motor drives: where necessary, replace worn bearings and ensure correct drive alignment. Correct tensioning of belts is critical.

— Operation of volume control devices, i.e. speed controls, VAV boxes, dampers, etc: ensure that damper blades and linkages for proper operation and tight shut-off for accurate control.

— Cleanliness of equipment components.

— Pressure drops: ensure that they are in accordance with manufacturers' data, e.g. heating and cooling coils, filters, casing interior, etc; clean outlet/inlet grilles regularly.

— Ductwork insulation: repair or replace where necessary.

— Cleanliness of heat transfer surfaces.

— Absence of air 'short-circuiting'; absence of leaks in ducts as this increases heating/cooling load as well as fan consumption.

— Lubrication of fan/motor bearings.

— Regularly vent air from heat exchangers, particularly fan coil units, where they become noisy or output is reduced.

— Ensure correct operation of unitary air conditioning equipment, e.g. through-the-wall units and split systems; clean heat transfer surfaces and filters; ensure airflows are not obstructed and avoid unwanted air leakage around the outside of units.

17.5 Refrigeration systems

Refrigeration systems are often used intermittently to meet short periods of excessive heat gains. This places additional stress on components, requiring particular care in maintenance. Checks should be made to ensure that:

— refrigerant is free of moisture by regularly inspecting moisture-liquid indicator; clean filters and/or recharge refrigerant when necessary

— refrigerant charge is correct as low charge reduces heat transfer

— expansion valves are correctly set

— insulation on suction and liquid lines is in good order

— chilled water temperatures are increased when humidity or load conditions permit

— condenser water temperatures and/or flow rates are kept to a minimum

— compressor operating pressure and temperatures are correct, particularly suction pressure, discharge pressure and oil pressure; investigate any changes that occur

— compressor is not cycling excessively, as this may indicate inefficient operation

— Compressor noise level is not abnormal; excessive noise or vibration may indicate drive needs attention.

— compressor joints and shaft seals are not leaking (open machines only)

— chiller performance is monitored regularly by recording water inlet and outlet temperatures and flow rate (or water-side pressure drop) to ensure cleanliness of water-side heat transfer surfaces; investigate any variations from the norm

— refrigerant pressures, air flow rates and temperatures are set correctly to keep air cooled condenser performance high

— heat rejection equipment (e.g. cooling towers) performance is monitored by recording ambient wet-bulb temperature, water inlet and outlet temperatures and flow rate

— cooling towers are kept clean to minimise air-side and water-side resistance including tower-fill or packing, nozzles (water distribution system, tower basin, water intake screens/ strainers air intake screens etc).

More information on installation and maintenance procedures for good energy efficiency are given in DETR Good Practice Guides 36 and 42[4,5].

17.6 Lighting systems

Regular maintenance of lighting installations, including planned replacement of lamps, will sustain lighting levels and ensure continued efficiency. Cleaning lamps and luminaires, windows and internal walls is particularly important. Other checks should ensure that:

— efficient lamps and ballasts are used when replacement is carried out

— internal surfaces are decorated with light colours to obtain benefit from natural and electric lighting

— surfaces are kept clean

— the operation of controls is effective and they are suitable for space occupancy and use

— lights are switched off when not needed; research shows that leaving fluorescent lighting on unnecessarily for even a few minutes is not cost-effective; building managers should make occupants aware of this.

17.6.1 Cleaning and replacement

The reduction in light output due to luminaires and rooms getting dirty can be very significant. Uplighters with glass covers are particularly prone to a fast build up of dust, making frequent cleaning necessary. In addition, the light output from most lamps decreases as they age. The illuminance from a lighting installation, therefore, decreases with time, and lack of maintenance will affect energy consumption and the productivity of occupants.

Proper cleaning materials and techniques should be used to reduce losses caused by chemical action or scratching of optics and electrostatic dust accumulation. Glass/acrylic diffusers generally have the longest useful life, whereas polystyrene tends to discolour with age and reduce the light output from a luminaire.

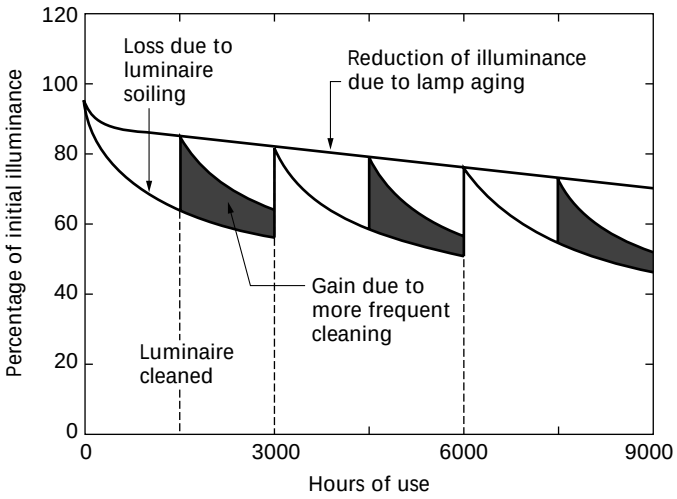


Figure 17.1 Effect of cleaning on bulk lamp changes[7] (reproduced from Thermie Maxibrochure *Energy efficient lighting in buildings*. Crown copyright (1993))

If discharge lamps are only replaced when they fail, this causes efficiency and illuminance to fall. In all but the smallest installation, it is sensible to replace the lamps as a group. This planned group replacement can also reduce maintenance labour costs. Optimising replacement periods is discussed in the CIBSE *Code for interior lighting*[6].

Replacement and cleaning can be planned to correspond with a holiday period to reduce disruption to staff. However, spot replacement may still need to be done if there is an early failure. The effect of bulk lamp changing, luminaire cleaning, room surface cleaning and redecoration can be seen in Figure 17.1[7].

17.7 Heating systems

Heating and hot water systems require regular maintenance in order to ensure efficient operation[8]. The following checks should be made:

— Check boiler operating pressures, temperatures, fuel consumption, and investigate any variations from the norm.

— Check flue gas analysis, adjust burners to achieve most efficient flue gas temperatures, CO_2, O_2 and excess air settings.

— Where heavy fuel oil is used, check oil storage temperatures to avoid overheating. Check oil line steam tracing for leaks and damage, and electric tracing for continuity. Check insulation on oil tanks and for leaks in oil lines.

— Check cleanliness of water- and fire-side heat transfer surfaces. Ensure that water treatment levels are maintained and the system is free from sludge and scale.

— Ensure that boilers are not cycling excessively, indicating inefficient operation.

— Check boiler and primary pipework insulation.

— On oil fired boilers, check condition of nozzles or cups of burners, cleanliness of oil line strainers and correct operation of oil heaters.

— On gas fired boilers, check wear and cleanliness of burners, burner gas pressure, operation of gas boosters, operation of governors and controls.

— On coal fired boilers, check performance of automatic stokers and controls, excessive unburned coal (indicating inefficient combustion) and minimum effective continuous combustion for proper kindling control.

— On electric boilers, check cleanliness and freedom from corrosion of elements/electrodes, wear and alignment/spacing of elements/electrodes, absence of loose connections.

— To avoid waste on steam boilers, meter feed water, steam output, blowdown and percentage condensate return.

— Repair steam leaks, without delay.

— Ensure cleanliness of heat transfer surfaces, filters and air paths through convectors, induction units, fan coil units etc.

— Ensure proper air venting in radiators, convectors, fan coil units etc.

— Ensure that frost protection systems are not set too high causing unnecessary operation of the heating system.

— Check that pump drives are in good condition, tighten belts/pulleys, replace worn bearings, and ensure correct drive alignment. Correct tensioning of belts is critical. Ensure pump noise/vibration is not abnormal, indicating incorrect operation.

— Check correct hot water storage temperatures are maintained, but only for the periods necessary.

— Ensure that spray taps and percussion taps operate correctly.

Electric heating systems require little or no maintenance, other than checking the settings of control and washing air filters. The unitary nature of electric heating enables an individual heater to be replaced, if needed, without affecting the integrity of the heating system as a whole.

17.8 Motors and drives

Correct maintenance of motors helps to keep operational efficiencies high. Checks should include the following:

— Lubricate motor bearings in accordance with manufacturers' instructions since inadequate lubrication results in excessive friction and torque, leading to overheating and power losses.

— Check motor shaft to load alignment to reduce running losses, bearing wear, noise and vibration; where necessary, tighten belts/pulleys.

— Clean motor fan inlets and frame surfaces so that generated heat can be removed effectively. An increase in the motor stator winding temperature of 1 K can result in up to 0.5% increase in the I^2R loss, as well as shortening the life of the motor insulation. Ensure good ventilation to prevent over heating.

— Replace worn brushes, belts, sheaves, bearings and gears, as necessary.

— Check loading on large motors compared with rating and consider replacement.

— Check loads are balanced across the three phases as unbalanced supply voltage can lead to a significant increase in motor heat losses and reduced life.

— Check the power factor at varying loads is within acceptable limits; consider power factor correction where necessary.

— Check electrical connections and contacts for corrosion and arcing, and attend to loose connections or bad contacts. Thermography of drive systems offers an early warning of overheating and wasted energy, and can often help detect problems before there are signs of impending failure.

— Use motor circuit analysis (MCA) to measure the absolute and relative resistance, inductance, and capacitance of motor circuits and windings. MCA can also be used to predict circuit failure, enhancing a motor maintenance or replacement programme.

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